Science Writing: Guidelines And Guidance (Https://Carlzimmer.Com/Science-Writing-Guidelines-And-Guidance/)

These are notes for a class called "Writing about Science, Medicine, and the Environment," which I have taught for several years at Yale. I update them here from time to time. They are published under Creative Commons Licence (CC BY-NC-ND) (https://creativecommons.org/licenses/by-nc-nd/4.0/)

Structure

In this class, we are writing stories. Without structure, stories are random sentences and fragments of scenes. Here are some thoughts about how to give a story an effective overall structure:

The All-Important Introduction

Within a few paragraphs, a reader will decide whether to finish reading your story or to move on to something else. In this brief preliminary time, you should give readers a clear idea of where the story is heading, an idea compelling enough to keep them with you.

Journalists call the sentence or two where you sum up the gist of your story the **nut graf**. Your nut graf should be intriguing, perhaps even surprising. If it states something most readers already know, they won't feel the need to keep reading. If it is too obscure, readers won't know why they should care enough to invest more time with your story.

You should be able to underline your nut graf. Scattering it in bits and pieces around the first half of an article is not acceptable. Don't leave it up to your reader to gather those bits and pieces together and assemble your nut graf for you.

As you write the rest of your story, make sure that it really lives up to the nut graf. Otherwise, your readers will feel like they've been the victims of a bait-and-switch.

If you find yourself struggling to come up with a nut graf, that may tell you something important. You may not actually have a story yet. You may only have a topic.

Think of it this way: *Ebola* is not a story. *How health workers and scientists together stopped an Ebola outbreak* is a story.

Think about your reader's brain, part 1: no mind-reading required.

Once you have done the research for a story, all its pieces are accessible to you all at once. If you write some of it down on the page but leave things out, your expert mind will automatically fill in the gaps. It can be hard to realize how much you're filling in — it's a journalistic equivalent of an optical illusion.

Your readers don't have access to that knowledge. They have to rely for the most part on what you put on the page. If you leave a crucial piece of information out, or omit some crucial event in a sequence, you leave your reader to struggle. Be kind!

Think about your reader's brain, part 2: no ships in bottles.

Let's say you've taken part 1 of this guidance to heart as you work on a story about solar power. Determined to leave no gap in the story, you start explaining physics, from Archimedes to Newton to Bohr. By the time you're done with the ancient Greeks, you hit your word limit.

There's a paradox at the heart of science writing. On the one hand, you have to make sure that you include essential pieces of information in a story. But you cannot try to write *everything* about your story. In fact, a substantial amount of the work in giving a story structure is figuring out all the stuff you can throw out and still get away with a successful narrative. Rather than building a perfect miniature ship in a bottle, think of what you're making as a low-dimensional representation of reality: a well-made shadow.

Time is your friend.

Introductions distill your story's point at the outset, perhaps with a compelling scene or anecdote. Once you get past the introduction, give the overall story a structure that readers can follow intuitively. Stories take place in time, so use time as a tool.

Pick a point in time to begin telling your story. Let the reader know when that time is. Then move forward through time, in clearly marked steps. If you jump forward a year between paragraphs, let us know. Otherwise, we'll have to guess if you've jumped forward an hour or a decade. Again, be kind!

For the most part, narrative time should flow in one direction. Jumping back and forth in your chronology can be effective, but only if readers can keep up with your temporal acrobatics. Just as importantly, you need to make it clear why you're abandoning a strict timeline for flashbacks or flash-forwards. Otherwise, it may simply seem like bad organization. Remember that you alone can see your timeline clearly in your head. Readers have only what you put on the page.

Transitions

Why does one paragraph follow another? Why does one sentence follow another? Readers should be able to see for themselves the way that the parts of a story link snugly together. Otherwise, it's easy to get lost among disconnected passages.

When you follow a timeline, you can use chronological order to make these links clear. But if you are shifting from one aspect of a person's life to another, you can't rely on time. You need to find other ways to make the shift logical and compelling. If you are working your way through an explanation or an idea, you will have to show the conceptual links between the parts.

Magazine articles and books sometimes use line breaks and drop caps to divide stories into major sections. But these breaks are not an excuse to start up from some other, arbitrary place. To keep students focused on the importance of transitions, I don't allow section breaks in class assignments.

Scenes

Novels, short stories, and plays are all organized around scenes — focused moments in which people do and say things that advance the overall narrative. As reporters, we don't make up scenes. Instead, we reconstruct them from our reporting of real events.

In some cases, we can write about things we observed ourselves. While planning out your research, think about the opportunities you can have to observe parts of your story unfold. There may be an event already planned (a demonstration, a trial, a game). Or you can arrange a scene yourself, such as asking an ecologist you want to profile to take a hike together so you can observe how they make sense of the natural world.

Some scenes you'll write about took place long ago. You'll have to piece them together from whatever evidence remains — memories, videos lingering on YouTube, diaries in university archives.

Before you add a scene to a story, make sure it matters. What event or point is it illuminating? If you cut a scene out, does the story still hold together? If it doesn't, the scene is essential. If it does, then the scene is a digression. It may be funny, cool, amazing. But it has to go.

When you begin a scene, set it. Provide enough detail so that the reader knows where and when it's happening. To make it evocative, take advantage of the cinematic power of our brains. Give readers things to see, hear, touch, smell. But make sure these sensory details are relevant to the story and not random details.

Find ways to convey the humanity of people in your scenes. Use their words, appearances, and actions. A poorly developed scene will read like a procession of faceless ghosts drifting through a phantom world. Give your scenes life.

Paragraphs

Paragraphs are lovely, under-appreciated units of narrative — bigger than sentences but smaller than stories. Take full advantage of their power.

Each paragraph should be placed in the right logical place in a story. The internal structure of paragraphs matters, too. In the first sentence, we should understand why it flows from the last sentence of the previous paragraph, and each subsequent sentence should also flow logically from the previous one.

Each paragraph should have a unifying point. Don't start talking about one thing at the outset of a paragraph and then unwittingly slide into another topic midway through.

Endings

Give careful thought to where your story will stop, and how. Sometimes a quote from the main subject of your story will beautifully sum up the whole tale. Sometimes you build up to a climax, and then jump forward a few years to a brief scene that acts as a powerful postscript. An ending can be an opportunity to zoom out from the particulars of your story to the bigger picture (say, an archaeologist's work on an island and what it means for our understanding of the peopling of the world).

Resist the temptation of suddenly veering off onto a related topic at the last moment, leaving the reader hanging.

Style

Stories are about people.

It's all too easy to forget that science doesn't happen by itself. To say, "A study found that salt is bad for you," is problematic. Studies don't *do* anything. *People* run studies. And people find out things.

Interview people to understand their experiences as human beings. Scientists are not robots chunking out new bits of knowledge. Doctors are not packages of software spitting out diagnoses. Asking a simple question such as, "How did you end up spending your life studying quantum computers?" or "What was the most important experience you've had as a hospice worker?" can uncork powerful human stories.

Writing about people also helps pull in readers who might not otherwise think that your subject is interesting. People like to read about people. To get readers to care about something — say, leeches — try to make them care about the people who care about leeches. (These people do exist (https://carlzimmer.com/scientist-at-work-mark-siddall-his-subject-highly-evolved-and-exquisitely-thirsty-534/), and they can be a lot of fun to hang out with.)

Active voice, not passive

The scientific community favors writing in the passive voice. They shouldn't, nor should you. The passive voice dissolves the power of narrative. It destroys the impact of action. It sows confusion about who did what. Sometimes the passive voice cannot be avoided. (See what I did there.) But for the most part you can find an active-voice alternative. This is not a meaningless grammatical game. By making an effort to create active prose, you will end up discovering more about the actions — and the people behind those actions — that give power to your story.

Quotes

People speak, write, sign, or otherwise communicate. No story can make sense without some sort of communication. Imagine a novel where characters don't say or think a single word. Imagine a movie without a line of dialogue. A reported story without any quotes can feel just as odd.

There are exceptions, of course — business analysis stories, for example, or short crime reports. But the long-form journalism we're working on in this class needs the spoken words of its characters. So quote people, quote them well, and quote them often.

It's important to start putting quotes into a story as early as possible. An opening scene, for example, is a natural opportunity to introduce voices to the narrative. As you introduce a main character into a story, you can find a good quote from them that sums up an important aspect of the story to come.

If you wait till halfway or more through a story to start quoting people, it will be a disconcerting surprise. By then, readers will have come to assume that you're telling a story without quotes. Why, after so many silent paragraphs, are you quoting people now?

Lots of quotes help a story, but they have to be good quotes. A good quote is pungent. It brings the speaker to life in the reader's mind. It doesn't meander. If you drop in a long paragraph of words from someone into your story, it's usually a good idea to see if you can cut most of it away, leaving behind the best part.

If you're narrating an event, set quotes off in their own paragraphs. It is confusing to read a paragraph in which a quote is wedged in the middle of exposition. It's even more confusing to have two or more quotes from a person sprinkled in a paragraph. And quoting two or more people within one paragraph is unreadable. Take a look at how fiction authors use dialogue in short stories and novels if you need a model.

With few exceptions, quotes should only be full sentences, not fragments dropped in the middle of a sentence. Readers need to shift clearly into the voice of a character for a time, and then back to the voice of the narrator. Fragments of quotes leave readers flipping back and forth in unnecessary confusion.

Here are some more rules for quotes:

— No brackets or ellipses. (Remember, these are not term papers.)

— You can trim out um's and ah's and other stammerings, but you can't leave out words or replace them with words you wish your subject had actually said.

— If a quote sounds like drab exposition, just use your own words to move that part of the narrative forward.

— Quotes should, whenever possible, have this format:

> "Quod erat demonstrandum," said Irving Euclid, a geometer at the University of Athens.

They should not be set up backwards:

> Irving Euclid, a geometer at the University of Athens, said "Quod erat demonstrandum."

or

> Quod "erat demonstrandum," said Irving Euclid, a geometer at the University of Athens.

— Also, avoid needless alternatives to *said* or *asked*, such as *enthused, opined, ululated.* These words typically end up just sounding arch and arbitrary. It's the quote that matters, not the verb next to the quote.

— Avoid an "unquote." — i.e., *Euclid explained that quod erat demonstrandum*. It feels odd to have a narrator tell us what people said, rather than quoting them directly. It's as if the character is talking in another room. All we hear is muffled speech, with the narrator running in from time to time to let us know second-hand what they said.

— Introduce speakers clearly by name the first time you quote them. If you quote them again later, use their name if they haven't appeared in the story for a while. (Last name only for adults, first name for children and pets.)

Can you write in first person? If you're Joan Didion, definitely.

Students often want to write in the first person, especially when writing about scenes they witness during in-person reporting. I generally discourage this. Using the first person turns the writer into a character. Is the writer important enough to the story to warrant that special role? If not, the writer becomes an awkward guest.

There are, of course, exceptions to this rule. Sometimes first person is the right choice. A story focused on a writer's own experiences with a disease, for example, obviously requires the first person. For the most part, though, "I" am best left out of stories, even if that means making the extra effort to write around oneself.

Rhetorical questions

Try to avoid them. They are the empty calories of science writing. Replace rhetorical questions with declarative sentences that advance the story.

Jargon

Scientists invent words, which they use to talk to each other efficiently. But most people outside a scientist's subspecialty have no idea what many of these words mean — including other scientists. *Tritrophic, metamorphic, anisotropic* — these are not the words to tell stories with.

Everyday language has a wonderful power to express the gist of scientific research without forcing readers to hack through a thicket of jargon. But there's no algorithm you can use to determine what's jargon and what isn't. You need to develop your mind-reading abilities. Ask

yourself if readers will know what you're talking about. If you need help, find a friend who is not an expert on your story's subject and conduct a little vocabulary quiz.

(I keep a running list of words I've encountered in assignments that are examples of unacceptable jargon. You can find it here (https://irregardless.ly/profile/137?name=recent&collection_id=13&only_liked=false&creator_id=137).)

There may be times when you absolutely have to use jargon. These times are far rarer than you may think. If you choose to introduce a term, do not simply throw out it out in a sentence and then explain it later. Do the reverse. Until readers grasp the concept behind jargon, it acts as dead weight that pulls your story down into the murk of confusion.

Formality, jargon's dangerous cousin

Even if you don't use a single word of jargon, you can still use language in a way that's confusing and unwelcoming. Scientists, for example, will sometimes say that a drug works "in mouse." *In* is a familiar word. So is *mouse*. But "in mouse" only makes sense to certain scientists. The rest of your readers will have to struggle to figure out that you mean that the drug had promising results in experiments on lab mice. You want your readers flying forward, relishing your metaphors and dramatic turns. You don't want them puzzling over obscure phrases and trying to guess their meaning.

Formality is also dangerous because it drains the passion from prose. It is entirely possible to let readers experience wonder, sadness, fear, outrage, and joy when reading about science — without sacrificing accuracy.

Don't presume readers think just like you.

A lot of journalism has behind it a moral mission. Reporters want to tell stories that are important. Reading a story may improve people's lives. It may lead to changes in law, shifts in political priorities, or improvements in how people treat each other or the environment. Essays, op-eds, and other opinion-based pieces can also change how people think, using rhetoric, storytelling, and argument.

In order to change minds and move readers, you must recognize that many of your readers may not think the way you do. They may not rank their values in the same order as you. Things that you take for granted as being important may not seem that way to many of your readers. This doesn't make your readers monsters. In fact, if you dig down deep enough, you'll find a lot of common ground between you and many of your readers. But if you presume to think for them, you may alienate them.

Overlooking these facts can lead writers to mistakenly assume their readers share all their own values and have reached the same conclusions about the issues they're writing about. They end up preaching to the converted. If you're writing about someone trying to make a city more "sustainable," explain what you actually mean by that buzzword, and explain why it's important. Do not expect such words to light up a whole network of meaning and values in your reader's mind. They may not be familiar with the word, or they may not value it as you do.

Reporting tips

On reporting trips, bring a small, reliable digital recorder. Olympus makes good devices, but other companies do too. Bring fresh batteries as backup.

Bring a notebook, too. Make note of things that won't get picked up by your recording — facial expressions, color of the sky, etc. Note good quotes to remember to use later. Jot down the time if you can.

Do not rely on phones as recorders. They are not as reliable as digital recorders. But use them to take photographs, which can serve as visual aids as you write your piece.

For phone calls, Skype and other software can work well on your computer — use them with recording plug-ins. In my experience, recording apps on phones are unreliable, but there may be something out there that works well.

Under Connecticut law, it is illegal for a person to record a telephone conversation without the knowledge of all parties to the conversation. Ask for permission. (Check your own state's laws if you're reporting elsewhere.)

A subject can request for a conversation to be off the record at the beginning. They cannot retroactively declare something off the record.

Checking stories

It's dangerously easy to make factual mistakes in science writing, because we deal in so many facts — from the number of insects on the Earth (about 10 quintillion) to the year in which Henrietta Leavitt discovered a pattern in the brightness of stars that made it possible to measure the universe (1912).

Some publications will employ fact-checkers to check your work. Otherwise, check it yourself. If you check facts against published sources, go as far upstream as you can — to journal papers, government web sites, and other authoritative information. Don't rely on another reporter.

Do not simply send your drafts to sources to check. In doing so, you are giving away the responsibility for your work to someone else. It's fine to call a source and paraphrase information or quotes.

For more on checking, consult *The Chicago Guide to Fact-Checking* (https://press.uchicago.edu/ucp/books/book/chicago/C/bo21182584.html), by Brook Borel.

Formatting checklist

Before submitting a story (to a teacher or an editor), go through a final checklist. Even the most gorgeous piece of prose can be ruined by careless handling. Here are some crucial items to cross your list:

Is your file properly formatted? (File format, name, word count, etc.)

Is your in-person reporting on display?

Do you have a nut graf?

Are you close to the assigned word count?

Are your quotes properly formatted?

Is your fact-checking annotation in good shape?

Double-check your spelling and grammar. Kill that last dangling participle.

(Thanks to guests who have visited my class over the years and helped shape my thoughts on these matters, including Joshua Foer, Maryn McKenna, Annie Murphy Paul, Michael Specter, Florence Williams, and Ed Yong.)