

Lecture 8

Structure, Paragraph, Sentence, and Flow

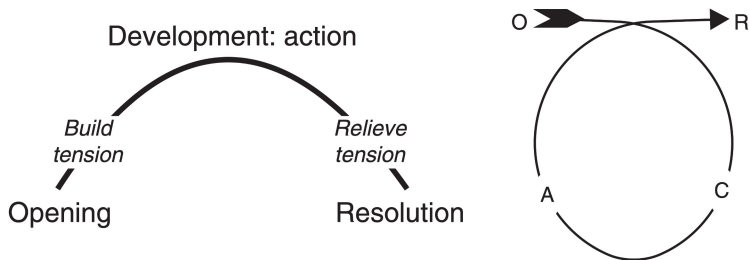
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Scientific writing as story telling

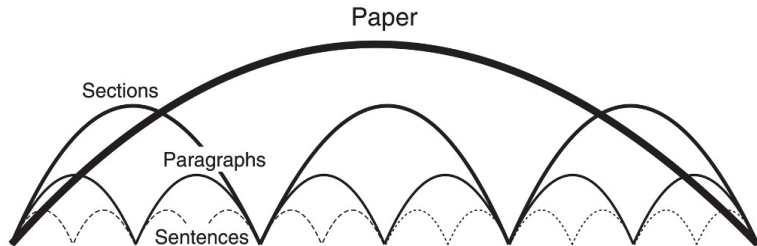
Scientific writing is story telling. Effective scientific writing thus requires a clear story arc.



(Schimel 2012, Writing Science: How to Write papers that Get Cited and Proposals that Get Funded)

Internal structure

Scientific papers are consisted of various sections. Each section tells its own story. A story does not have a single arc, but a hierarchical structure with small arcs nested within larger ones.



(Schimel 2012, *Writing Science: How to Write papers that Get Cited and Proposals that Get Funded*)

Scientific writing needs a story arc

When scientific writing lacks clear story arcs, it becomes an incoherent mass with no obvious direction, no internal structure, and no points of emphasis.

California supports rich fisheries off its coast. The high productivity of fish is supported by high rates of algal production. Algal growth in the ocean is typically limited by nitrogen supply, but this is high off California because N-rich deep water wells up to the surface along the coast. This upwelling is driven by winds that push the south-flowing surface water away from the shore, allowing deep water to rise to the surface. These off-shore winds are driven by regional climate patterns, including El Niño, that are being intensified by the greenhouse effect, which results from increased CO₂ in the atmosphere. Increased CO₂ in the atmosphere also increases the amount of CO₂ dissolved in the ocean, which reacts with water to form carbonic acid, reducing the ocean's pH. This reduced pH makes it hard for shell-forming organisms to make calcium carbonate shells, and so may reduce the productivity of important marine species such as abalone, oysters, and even sea urchins. Thus, increasing atmospheric CO₂ is going to have many important effects on marine ecosystems.

Scientific writing needs a story arc

How should we revise this paragraph? We first identify the two stories here: one about ocean circulation effects and the other about acidification. We then break them into two paragraphs, each focusing on one story.

California supports rich fisheries off its coast. The high productivity of fish is supported by high rates of algal production. Algal growth in the ocean is typically limited by nitrogen supply, and is high off the California coast because N-rich deep water wells up to the surface along the coast. This upwelling is driven by winds that push the south-flowing surface water away from the shore, allowing deep water to rise to the surface. These winds are driven by regional climate patterns, including El Niño, that are being intensified by the greenhouse effect. Thus, the productivity of California fisheries will likely change as a result of climate warming, and the changes may result via complex and unexpected mechanisms such as changes in ocean circulation patterns.

In addition, increasing CO₂ is causing the pH of the ocean to decline, and this may have separate but important effects on California fisheries. As CO₂ increases in the atmosphere, more dissolves into the ocean as carbonic acid...

Maintaining thematic coherence

Finish one story before talking about another. Do not jump between topics back and forth as it breaks the story line.

In addition to the intrinsic characteristics of DOC, the DOC degradation rate will be controlled by environmental factors, especially in the context of global climate change, the concentration of greenhouse gases in the atmosphere is increasing, and this trend will continue, will inevitably lead to an increase in inland water and soil temperatures, thereby stimulating the growth and metabolism of microorganisms and accelerating the degradation of DOC. However, how does the DOC degradation rate responds to the increase in temperature is not constant in different ecosystems, and due to the lack of relevant research, the temperature sensitivity of DOC degradation remains uncertain.

Maintaining thematic coherence

Keep the focus of writing on one topic helps fix the issue here.

DOC degradation rate is controlled by environmental conditions on top of its intrinsic characteristics. The effects of environmental conditions on DOC degradation is crucial to consider in the context of global climate change. For example, increases in temperature caused by greenhouse gas emission may stimulate microbial activities and subsequently DOC degradation rates. However, how DOC degradation rate responds quantitatively to the increase in temperature and how this response varies across different ecosystems remain uncertain.

Checklist for effective story arc

Check the following aspects to see if your writing has a effective story arc:

- Does each unit make a single, clear point?
- When several paragraphs together form a section, are the linkages among them clear?
- Has every extraneous thought that breaks the serial arc structure been removed?
- When you introduce a topic, do you resolve that discussion before introducing a new topic?
- Is every major unit of the work defined by either a subhead or clear opening text?

Paragraph

Paragraph is the unit of composition. It tells a complete short story with a coherent structure, a story that fits into and contributes to the larger work.

A well-constructed and well-written paragraph should

- have a clear structure that allows the topic to be seen easily;
- be thematically coherent such that it tells a story.

Point-first paragraph

Point-first paragraph puts the topic of the paragraph at the beginning. You may read the first sentence, skip the rest, and still get the essence of the paragraph.

The **LD structure** is an example of point-first paragraph. It is particularly effective for writing methods and results. It can also be used for discussions or conclusions.

We conclude that the increase of the diurnal temperature range (DTR) over the United States during the three-day grounding period of 11–14 September 2001 cannot be attributed to the absence of contrails. While missing contrails may have affected the DTR, their impact is probably too small to detect with a statistical significance. The variations in high cloud cover, including contrails and contrail-induced cirrus clouds, contribute weakly to the changes in the diurnal temperature range, which is governed primarily by lower altitude clouds, winds, and humidity.

(Hong et al 2008, Geophysical Research Letters)

Point-last paragraph

While point-first paragraph is common, sometimes, you need to assemble an argument, pulling threads together to weave them into a conclusion. A point-last paragraph is useful here, particularly for long paragraphs.

You can use LDR (Lead, Development, Resolution) or OCAR structure for a point last paragraph.

If the Great Plains mammoths routinely undertook long-distance migrations, then mammoths at all of the Clovis sites in this study should display similar $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. However, the Dent mammoths display $^{87}\text{Sr}/^{86}\text{Sr}$ ratios that are distinct from those of mammoths at Blackwater Draw and Miami, demonstrating that the Dent mammoths belonged to a distinct population. Thus, we conclude that Great Plains mammoths did not routinely migrate between northern Colorado and the southern High Plains, which are separated by about 600 km

(Hoppe et al 2004, Paleobiology)

Paragraph needs a point

A paragraph needs to make a point regardless of whether that point is at the beginning or the end. Avoid directionless, “stream of consciousness” writing.

Adding compost to soil promotes microbial growth, which then increases microbial production of phosphatase enzymes that release plant-available P from organic matter. *Bromus carinatus* is a native grass that can be used in reestablishing California grasslands. Its success in P-poor systems can be stimulated by inoculation with mycorrhizal fungi. However, the effects of mycorrhizal inoculation of *B. carinatus* on P uptake have not been assessed.

Sentences

A sentence tells a story, just the shortest possible.

Reader usually interpret what you put at the beginning of a sentence as the **topic**. It tells the reader who or what the sentence is about;

Endings are usually power positions. Last words carry the greatest weight. Thus, the ending of a sentence is often viewed as the **stress**.

The role of topic and stress in a sentence

Shifting information between the topic and stress changes how readers interpret the sentence. Compare the following three sentences:

A: Viruses were not studied in the sea until 1989 yet are its most abundant biological entities

B: The most abundant biological entities in the sea are viruses, yet they were not studied until 1989.

C: The most abundant biological entities in the sea were not studied until 1989: viruses.

They contain the same facts but tell different stories. **A** emphasizes that viruses are the most abundant. **B** emphasizes when they were first studied. **C** emphasizes viruses itself.

The role of topic and stress in a sentence

Recognizing how readers respond to information in different parts of the sentence offers a tool for tailoring the writing for your intended audience and purpose.

Net mineralization represents the nitrogen available to plants because it reflects the difference between microbial nitrogen release and uptake in soil

The amount of nitrogen available for plants is controlled by net mineralization—the difference between microbial nitrogen release and uptake in soil.

The amount of nitrogen available for plants is controlled by the balance between microbial nitrogen release and uptake in soil; we define this balance as net N mineralization.

Subject-verb connection

Sentences are highly condensed stories; there is no time for a long, gentle opening. **The verb should immediately follow the sentence's subject** in most cases.

Consider the following example, connecting the subject and the verb makes the sentence more clear and easier to read.

The pooled effect size, both with and without adjustment for environmental risk factors, were larger for DNA-based than RNA-based viruses.

The pooled effect sizes were larger for DNA-based than RNA-based viruses, regardless of whether environmental risk factors were adjusted for.

Pick the right topic

When we add words or clauses to the beginning of a sentence, we bury the topic and risk that it will be missed or misconstrued.

In most cases, we should move the real topic of the sentence closer to the beginning. Compare the following two sentences:

In this study, taking advantage of a well-annotated genome map and effective targeted-mutagenesis techniques, we analyzed the role of Bac17 in pathogenesis by *Candida albicans*.

We analyzed the role of Bac17 in pathogenesis by *Candida albicans* by taking advantage of a well-annotated genome map and effective targeted-mutagenesis techniques.

Unbury the stress

Words dangling at the end of the sentences bury the real stress. We need to either delete those extra words or move them into the middle of the sentence, thereby shifting the important words to the stress position.

The number of commercial products containing nanomaterials has risen rapidly; in 2006 there were only 212 while in 2009 there were over 1000 products on the market.

The number of commercial products containing nanomaterials has risen rapidly; in 2006 there were only 212 while in 2009 there were over 1000.

Mange long sentences

Most books on writing argue that short sentences are easier to read and understand. However, good, clear sentence can be short or long. The best writers use the mixture of both.

We often use a **LD like structure** to write long sentences: make the key point in a short initial main clause and then add others that add depth and nuance. Contrasting the following two sentences:

At the beginning of the second millennium AD, lake level at Lake Tanganyika fell and remained relatively low during the period from 1050–1250 AD, which corresponds to the timing of the Medieval Warm Period in many locales, albeit with a later onset than in some areas

During the early part of the second millennium AD, from 1050–1250 AD, a period corresponding to the timing of the Medieval Warm Period in many locales, albeit with a later onset than in some, lake level at Lake Tanganyika fell and remained relatively low.

Strategies for effective sentences

Summarizing the examples in the previous slides, we have the following strategies for effective sentences:

- The topic should be short, clear, and close to the beginning;
- The main verb should follow the topic immediately;
- The key message should come at the stress, usually towards the end of the sentence.

Flow

In addition to thematic coherence, the writing should help readers follow through your arguments and avoid derailing at transitions: the writing should **flow**.

Sentences need to link seamlessly to each other;

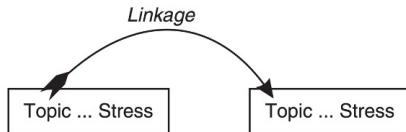
The critical element in building this chain is managing the topic of each sentence so that they connect.

Flow

The example below is thematically coherent. All sentences are about the same subject, but they do not connect.

Molecules are comprised of covalently bonded atoms. Molecules' reactions are controlled by the strength of the bonds. Molecules, however, sometimes react slower than bond strength would predict

This occurs because the passage forms a topic-to-topic link. That creates a list of statements that does not flow well.

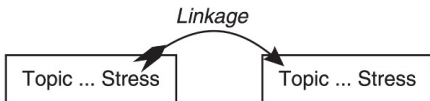


Flow

We can improve the writing of this passage by connecting the sentences. Start each sentence with something familiar from the previous one.

Molecules are comprised of covalently bonded atoms. Bond strength controls molecule's reactions. Sometimes, however, those reactions are slower than bond strength would predict.

This way of writing creates a stress-to-topic link that makes the writing flow.



Creating flow

In this example, the writing mostly flows. But there is a break between the 2nd and 3rd sentences.

Salvage logging is an increasingly common way of harvesting forests that have been attacked by insect pests. In salvage logging, trees that have been attacked are selectively harvested. Cavities in standing dead trees serve as nesting sites for birds. The population biology of cavity-nesting birds is therefore likely affected by salvage logging

A simple solution is to creating a stress-to-topic link.

Salvage logging is an increasingly common way of harvesting forests that have been attacked by insect pests. In salvage logging, trees that have been attacked are selectively harvested. The dead trees that are harvested, however, can provide cavities that are nesting sites for birds. The population biology of cavity-nesting birds is therefore likely affected by salvage logging.

Creating flow

This example passage is choppy because 1) the sentences are disconnected and 2) lack variety.

Mount St. Helens erupted on May 18, 1980. A cloud of hot rock and gas surged northward from its collapsing slope. The cloud devastated more than 500 square kilometers of forests and lakes. The effects of Mount St. Helens eruption were well documented with geophysical instruments. The origin of the eruption is not well understood.

Begin each sentence with a subject that connects with the one before. Connecting the ideas also helps improve sentence variety.

Mount St. Helens erupted on May 18, 1980. Its slopes collapsing, the mountain emitted a cloud of hot rocks and gas. Within minutes, the cloud devastated more than 500 square kilometers of forests and lakes. Although the effects of Mount St. Helens eruption were well documented with geophysical instruments, the origin is not well understood.

Creating flow

Sometimes, a bad flow results from sentences that do not fit into the story arc of the paragraph. Removing the disrupting sentence is an easy solution. If that sentence is truly useful, put it where it fits.

Groundwater level is an important control of the fate of contaminants within the groundwater: are they taken up by plants and microorganisms in the surface soil? **Industrial landscapes are frequently disturbed, and the effects of this disturbance on the system's ability to process contaminants has not often been studied.** Low water tables could reduce an ecosystem's ability to process groundwater contaminants by moving these contaminants out of the reach of plant roots and microorganisms in the surface soil.

Creating flow

Another strategy is to use **linking words and phrases** to create flow. These words could help you 1) continue the idea, 2) pause to examine the idea in more detail, or 3) contrast the idea.

Continuing	Pausing	Contrasting
Also	In other words	However
In addition	Put another way	On the other hand
Moreover	In essence	In contrast
Furthermore	In effect	Conversely
Therefore	For example	Still
As a result	For instance	Nonetheless
For that reason	Likewise	Otherwise
Consequently	Similarly	Alternatively

Connecting paragraphs

A paragraph break indicates that you are shifting ideas and moving into a new story arc. But readers expect the new paragraph to build on the previous one, developing a larger story.

To make them connect, we can use the same stress-to-topic link strategy we discussed for connecting sentences.

Connecting paragraphs

In this example, the link between the two paragraphs is not clear, hindering a smooth flow between paragraphs.

Any trait that increases a bacterium's ability to survive an environmental stress, such as heavy metals or antibiotics, can be considered a stress-adaptation mechanism. Traditionally, however, studies have focused on internal mechanisms of adaptation: either a bacterium's ability to either repair cell damage (e.g., DNA repair) following stress or on mechanisms that make the cell more able to resist the damage in the first place (e.g., producing chaperones and transporters). However bacteria also have mechanisms that work outside the cell to reduce the intensity of stresses in the first place.

E. coli provides an excellent model system for studying how the relative physiological costs of different stress-adaptation mechanisms vary between heavy metal and antibiotic stressors. We understand...

Connecting paragraphs

We may revise the topic sentence of the 2nd paragraph so that it starts with a subject just discussed in the last paragraph.

...However bacteria also have mechanisms that work outside the cell to reduce the intensity of stresses in the first place.

An excellent model system for studying the relative costs of different stress-adaptation responses to heavy metals and antibiotics is *E. coli*...

Alternatively, we can revise the last sentence of the 1st paragraph so that it introduces the subject of the next paragraph.

...However bacteria, such as *E. coli*, also have mechanisms that work outside the cell to reduce the intensity of stresses in the first place.

E. coli provides an excellent model system for studying how the relative physiological costs of different stress-adaptation mechanisms vary between heavy metal and antibiotic stressors. We understand...