

Part 2

All examples from Writing Science by Joshua Schimel, 2012 Oxford University Press 1

## I. Openings

### 5.1. EXAMPLES OF GOOD OPENINGS

\* Here are openings from different areas of science. The fundamental question for each is: does it achieve the three goals? Is it clear what the paper is about? Does it frame the problem? Does it introduce the critical characters? Read the openings and answer these questions, before going on to my analysis. Do you agree with my assessment?

This first example is from a synthesis paper I wrote reevaluating our understanding of how nitrogen (N) is processed in soil.

#### Example 5.1

Since the late 1800s, N mineralization has been the perceived center point of the soil N cycle and the process that controls N availability to plants.<sup>1</sup>

The key word in this sentence is perceived, a distinctive and unusual word that draws your attention. Clearly, this paper is going to challenge that perception. Additionally, there is going to be a historical element—evaluating how the perception has changed since the late 1800s.

The second example is from a study evaluating whether giving pregnant women supplemental folic acid may cause their children to develop asthma.

#### Example 5.2

Current public health guidelines in the United States, the United Kingdom, and Australia recommend that women consume a supplemental dose of 400 µg of folic acid per day in the month preceding and during the first trimester of pregnancy to reduce the risk of neural tube defects in children.<sup>2</sup>

Can you imagine that this paper is *not* going to challenge that 400 µg recommendation? That sentence doesn't give the grounds for challenging it, but because the title of the article highlights childhood asthma, you can infer the entire story: folic acid supplements during pregnancy may increase the risk of childhood asthma.

In these first two examples, the opening sentences are dramatic and launch quickly into the story.

Problems:  
No direction  
Misdirection  
Too much standard material (developing scholar problem)  
Platitudes

## II The Focus

Questions  
Hypotheses  
Objectives

### Example. 7.6

We evaluated the possibility that hares influence the structure of shrublands by acting as keystone herbivores that maintain gaps between the shrubs and so influence the competitive interactions of plants recruiting into those gaps.

In this one, the question itself is unclear. What do hares do that influences shrubland structure and competitive interactions? What does the investigator hope to learn?

There are several implied hypotheses within this challenge: (a) hares control plant community structure, (b) they maintain gaps between shrubs, and (c) they influence competitive interactions within the gaps. Those hypotheses should be explicit and concrete. This should also describe the experiment that will test those hypotheses. Consider this as an alternative:

*"We hypothesized that hares control the structure of shrublands by foraging on shrub seedlings in the gaps between mature plants. If true, hares act as keystone herbivores by maintaining these gaps, in which grasses can outcompete shrub seedlings. We tested this hypothesis by following hare movement to determine where they eat and by analyzing their feces to determine what they eat."*

This states the hypothesis and suggests its larger implications—hares are keystone species that have a disproportionate impact on ecosystem structure and function. It also briefly identified the experimental approach used to test the hypothesis.

Problem:

Focusing on the information they are trying to acquire rather than on the knowledge they are trying to acquire.  
Weak goals chronological rather than intellectual

### III Resolutions: The Endcap

3

Weak resolutions fail to frame the conclusions. In this type of ending, authors usually synopsise their results and then tell you that they are important, but don't clarify how—they don't answer the questions they were asking and don't synthesise their information into knowledge. Here's an example.

#### Example 9.5

A proteomic evaluation of hummingbirds under simulated migratory conditions revealed evidence of several stress-associated processes: protein degradation in wing muscle tissues, depletion of metabolic cofactors, and enhancement of stress-response proteins. These results suggest that changes in the hummingbird proteome may provide new insights into the complex physiology of avian systems biology. *weak*

To fix a resolution like this, you need to identify the new insights.

*"A proteomic evaluation of hummingbirds under simulated migratory conditions revealed evidence of several stress-associated processes: protein degradation in wing muscle tissues, depletion of metabolic cofactors, and enhancement of stress-response proteins. While hummingbirds migrate long distances over water without feeding or resting, it is physiologically stressful, and the birds' ability to manage this stress may limit the distance they can migrate."*

If the authors wanted to open the hourglass wider to explicitly encompass other migratory birds, they could modify the last sentence to make hummingbirds a member of that larger group:

*"While many birds, such as hummingbirds, migrate long distances without feeding or resting, it is physiologically stressful, and birds' ability to manage such stress may limit the distance they can migrate."*



## The Resolution - 2

### 9.2.2. Distracting

Some papers conclude with material that is distracting—ideas that should be in the Introduction or is already in textbooks and that neither synthesizes nor synthesizes the results. The next example is from a paper about forest tree nutrition, asking how much organic N is taken up by mycorrhizal fungi, which acquire nutrients from the soil and transport them to the root.

#### Example 9.7

The mycorrhizal fungal hyphae extending out from tree roots can comprise more than 1/3 of the total biomass of microbes in the soil. They greatly extend the absorptive surface area of the root system and enhance total nutrient uptake by the trees. Additional work, however, is required to assess how much mycorrhizal fungi enhance the uptake of organic N forms in forest soils.

These first two sentences are truisms that have been known for decades—textbook material, rather than results of this particular study. The only thing this paragraph says about the study itself is that additional work is required to assess how much organic N mycorrhizae take up. So did we learn anything? In the paper we actually did, but not from this resolution—it resolves nothing and merely distracts from the story.

A second way a resolution can be distracting is by introducing new information at the end. The following might appear to be a strong resolution.

#### Example 9.8:

In arid environments such as East Africa, termites are critical “ecosystem engineers.” They collect resources such as nitrogen and phosphorus from far afield and accumulate it in and near their mounds, creating nutrient hot-spots on the landscape. These hot-spots may be sites for colonization by new seedlings of both the native savanna trees and for novel invasive plant species.

The problem here is that invasive plants were never mentioned in the Introduction. The idea that termite mounds create invasion sites is interesting and important, but it *must not* be a new idea, first raised in the resolution.

## II Paragraphs

5

### point-first example

#### Example 11.2

*An Argument:* 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.<sup>3</sup>

Main point

### point-last paragraph

#### Example 11.5

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.<sup>6</sup>

Main point

The point of this paragraph is that mammoths did not migrate long distances, which is presented in the closing sentence—hence, point-last. The first sentence poses the question (did they migrate long distances?) and the approach to answering it (Sr isotope ratios). It serves as both opening and challenge, but it doesn't answer the question and so doesn't resolve. It acts as a guide to the story.

### Bad paragraph

#### Example 11.6:

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.

Not only is the point of this paragraph completely opaque, so is its structure. Is it point-first or point-last? Does it even have a point? There are several threads of argument that seem to weave aimlessly through it.

# I Sentences

Subject Verb Object  
(who) (action) (what outcome)

last words in sentence are in stress position  
carry greatest weight.

## Example 12.3

This

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

Only a minority of you likely knows what "net mineralization" is or have a schema for it. So when I start a sentence with it, the sentence (and ideas) may be challenging. Starting with more familiar concepts makes the sentence easier.

versus  
this

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

This sentence says effectively the same thing, but it starts with an idea that most people understand—plants need nitrogen. It builds off a widely held schema and educates readers about the role of microbes in controlling plant N. All it took to make the story more tractable was switching the topic. Whereas the first sentence might have seemed opaque, this should seem more transparent.

By shifting the order of the ideas in the sentence, I also buried "net mineralization" in the middle, minimizing the weight on the term itself and letting you slide over it. For people in the field, referring to the term, even in a low-emphasis position, may strengthen the message. If, however, I were writing for people outside the field, who don't hold the net mineralization schema, I could leave the term out and simplify the sentence to:

versus  
this

"The amount of nitrogen available for plants is controlled by the difference between microbial nitrogen release and uptake in soil"

This sentence says exactly the same to most people—perhaps more, as it is shorter and contains no unfamiliar information to distract.

If I wanted to define "net nitrogen mineralization" and create a schema for it that I could build on, I would move it to the sentence's overall stress position:

versus  
this

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

This emphasizes "net N mineralization" as a new term I want readers to remember. I would write it that way in a textbook. I would not, however, write it that way for a specialist journal—experts wouldn't need the term defined.



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. Tightening the structure means picking the right topic. For example, in the following sentence, what is the real topic?

#### Example 12.5

*this*

It has been predicted that the global average temperature will increase at a rate of  $0.2^{\circ}\text{C}/\text{decade}$ .

The OCAR structure here is weak because there are two sets of actors and action: (1) someone predicted, and (2) temperature will rise. Why open with the implied nameless people who did the predicting, when the story is almost certainly about global average temperature? Make that the topic:

*versus  
this*

*Global average temperature has been predicted to increase at a rate of  $0.2^{\circ}\text{C}/\text{decade}$ .*

This collapses all the action—both the prediction and the increase—into a single short action section, making the sentence clearer. It has a better internal arc structure.

#### Example 12.7

*this*

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.

What is the point in this sentence? The first clause makes the argument that nanomaterial use is increasing, whereas the second elaborates that by showing us how much it has increased. The point to emphasize, therefore, should be 1000, rather than “products on the market.” So cut those trailing words; we’ve already said “commercial products,” so we know what the numbers refer to:

*versus  
this*

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

#### Example 12.8

Plants can increase their resistance to bacterial pathogens by increasing leaf alkaloid concentrations and by synthesizing tannins to bind to bacterial enzymes within plant tissues.

*this*

The dangling words “within plant tissues” are confusing. Does “within” refer to where tannins are synthesized or to where the enzymes are? The message to stress is not where it happens but that tannins bind to bacterial enzymes.

*versus  
this*

*“Plants can increase their resistance to bacterial pathogens by increasing leaf alkaloid concentrations and by synthesizing tannins to bind to bacterial enzymes.”*

## VI Energizing Writing

### 1. Fuzzy Verbs

#### 14.2.1. Fuzzy Hypotheses

The worst place for a fuzzy verb is in a hypothesis, yet many are wishy-washy and unfalsifiable. I've read proposals with hypotheses like the following.

Table 14.1. FUZZY VERBS VERSUS ACTION VERBS

Fuzzy Verbs (Weak)			
Occur	Facilitate	Conduct	Implement
Affect	Perform		
Action Verbs (Strong)			
Modify	Increase	React	Accelerate
Accomplish	Decrease	Inhibit	Migrate
Create	Invade	Disrupt	

#### Example 14.7

Microbial community composition is controlled by the chemical nature of plant inputs, water availability, and soil chemistry.

Here the verb is the passive and fuzzy "is controlled," and this is a truism rather than a falsifiable hypothesis. Is it conceivable that microbial community composition is not controlled by plant inputs, water, and soil chemistry? Fuzzy hypotheses almost guarantee that your proposal will end up on the "do not fund" list. To make a hypothesis compelling, you need to use concrete verbs that make a testable statement. To transform example 14.7, consider an alternative:

*"The chemical nature of plant inputs is the single strongest control on the composition of soil microbial communities and on their distribution across the landscape."*

This is in the active voice and the verb is simply "is." It is a declarative statement—the chemical nature of plant inputs either is or is not the single strongest control; we can test that. This version doesn't ignore other factors, but it puts them in perspective. This was the actual hypothesis of a proposal, a successful one.

I think people use fuzzy verbs when they are afraid that if they make strong statements, someone may challenge them or they may be wrong. If people feel challenged, you have engaged their interest, and that is good.



# Energizing Writing

## 2. Nominalizations

### 14.3. NOMINALIZATIONS

Fuzzy verbs are energy thieves. They steal energy from the action by telling, rather than showing. You can, however, go a step further and kill the action entirely. Using a strong verb, you might say something like the following.

#### Example 14.8

We investigated the effect of elevated CO<sub>2</sub> on plant growth.

Here the action is expressed in a verb, "investigated," but many would write this sentence as: "We conducted an investigation of the effect of elevated CO<sub>2</sub> on plant growth." This sentence has a verb—the fuzzy "conducted." But did you conduct an investigation, a train, or an orchestra? The action is contained in "an investigation," but that is a noun. This sentence names the action and introduces a new verb that hides it.

This process of turning a verb into a noun is known as creating a nominalization. As a result of using a noun rather than a verb to describe action, example 14.8 lost energy and gained length, but contains no more information. That is all bad, yet using nominalizations, instead of verbs, is a common failing in academic writing. Examples of nominalized verbs are shown in table 14.2.

To illustrate, example 14.9 nominalizes every important action.

#### Example 14.9

Systemic infusion of fetal stem cells appears to be the most practical mode of administration; however, limited migration of cells to the target tissue may act as a constraint on its effectiveness.

The only verbs are "appears," "to be," and "act," which is sad, as there is no shortage of actions: "infuse," "administer," "migrate," "constrain," and even "target." We can convert many of those actions to verbs, tightening this sentence:

Sometimes forcing the action into a nominalization pushes it out of a critical position in the sentence, as illustrated by example 14.10.

Table 14.2. VERBS AND THEIR NOMINALIZED EQUIVALENTS

Verb	Nominalization
Move	Movement
Differ	Difference
Suggest	Suggestion
Interact	Interaction
Analyze	Analysis
Develop	Development
In some cases, the verb and nominalization almost have the same form	
Influence	A influenced B versus A had an influence on B
Approach	A approached the problem versus A took an approach to the problem
Yield	The reaction yielded a product versus The yield of the reaction was ...

Example 14.10

*the's*

Although models exist to calculate reaction rates as a function of molecular size, a failure to reproduce the experimental data is often observed.

\* This combines a nominalization with a passive to create a sentence with the minimum possible punch. The author is making an important point—these models often fail. However, that is nominalized to “a failure.” This pushes the passive verb phrase “is often observed” to the sentence’s stress, and it buries the critical action in the bowels of the sentence: “a failure to reproduce the experimental data.” This would be better if the sentence’s two clauses were effectively linked and if there were an active verb early in the second clause:

*verses  
the's*

“Although models exist to calculate reaction rates as a function of molecular size, they often fail to reproduce the experimental data.”

## Adjective Nominalizations

✂ Another problem with verb nominalizations is that they are necessarily connected to fuzzy verbs. Because the action is named in the nominalization, and a sentence still needs a verb, it will be weak. Scan your work for nominalizations—there are probably more than you imagined. As a rule, turn them into verbs.

Table 14.3. ADJECTIVE NOMINALIZATIONS

Adjective	Nominalization
Different	Difference
Difficult	Difficulty
Able	Ability
Capable	Capability
Similar	Similarity

### 14.3.1. Adjective Nominalizations

There is another form of nominalization: converting an adjective into a noun. Examples of adjective nominalizations are illustrated in table 14.3.

Nominalizing adjectives also steals color and energy from writing. They leave it heavy and flat. For example, compare the following pair of sentences. Which is stronger?

#### Example 14.11

- A. The characteristics of this condition are the oxidation of membrane lipids, the denaturation of proteins, and a reduction in growth rates.
- B. This condition is characterized by oxidized membrane lipids, denatured proteins, and reduced growth rates.

Version A nominalized every adjective: "characteristics," "oxidation," "denaturation," and "reduction." In contrast, version B makes them all adjectives; the sentence is shorter and sharper.



#### 16.4. MODIFIERS: ADVERBS AND ADJECTIVES

Write with nouns and verbs. . . . The adjective hasn't been built that can pull a weak or inaccurate noun out of a tight place.

—STRUNK AND WHITE, *The Elements of Style*

The Adverb is not your friend.

—STEPHEN KING, "On Writing"

\* Adjectives modify nouns, and adverbs modify everything else (including adjectives). But good words don't need modifying. Strong, clear nouns and verbs give writing power, a power you can't match by decorating weak words. Eliminating unnecessary adjectives and adverbs will make your writing stronger and tighter.

Example 16.8

The entire reaction sequence takes less than one hour to complete.

Do you need both "entire" and "complete"? You could easily and condense this to:

*"The reaction sequence takes less than one hour to complete."*

### Metadiscourse

#### 16.5. METADISOURSE: TALKING ABOUT WHAT YOU'RE DOING

We often include some description of our actions and thoughts, rather than limiting our words strictly to the material at hand. For example:

ugh!

We found that . . .

We argue that . . .

Our initial hypothesis was that . . .

These data may indicate . . .

To conclude . . .

This is known as metadiscourse—discussing the discussion. Some metadiscourse is necessary to develop the flow of an argument, but it can be obvious or redundant. Consider the following examples.

Example 16.13

We found that aniline did not react with . . .

These are new data, first reported in your paper—could someone else have found it? So write: "Aniline did not react with . . ."

16.6. VERBOSITY

Verbosity

I include verbosity as a separate category, but it is really the sum of multiple types of filler, creating sentences that ramble on endlessly. Verbose authors are often insecure, afraid to make a definitive statement, or can't separate their own mental processes from the story they are trying to tell. Example 16.15 is a particularly egregious case.

Example 16.15

The data show that some enhancement in the applicability of these measurements can be accomplished with freeze-fracture prior to analysis by laser-ablation mass spectrometry.

It's hard to characterize the junk that has been piled on this sentence, but if you cut it all out, the original 25-word sentence condenses to 11: "Freeze-fracture pretreatment improved analyses by laser-ablation mass spectrometry."

That is an example where the writing was awful and loaded with obese words. But verbose writing doesn't have to be terrible. Here is an example where the authors were trying to limit how much they packed into any single sentence.

~~A central dogma of ecology~~ *Ecological dogma* has long been that soil microorganisms must decompose organic matter, releasing inorganic N, before that N becomes available for plants ~~to take up~~.

Dogma is always "central," and implies long duration, so we can tighten the opening. Plants don't do anything else but take N up, do they? Obvious.

In the arctic tundra, however, several lines of evidence *challenge this*. ~~have forced us to question the importance of microbial decomposition and inorganic-N uptake by plants.~~

~~1) In these soils, Microbes appear to take up enough inorganic N during the growing season that they leave inadequate supplies of N to support the N uptake needed to sustain measured plant growth. 2) The total annual net release of inorganic N by microbes is often half the value that is required to meet the demands of plant uptake, as estimated from plant harvests over the course of the growing season.~~

1) Microbes release only half the inorganic N required to support measured plant growth.

I took the idea of "plant growth" from the first sentence, because it is a stronger concept than "demands of plant uptake," but I took the core message from the second—it was stronger.

~~3) 2) Several tundra plant species have been shown in lab studies to be able to can take up and grow on amino acids from hydroponic solution, and can use the N to support growth.~~

This was unnecessary detail that would be in a reference. I eliminated the metadiscourse "have been shown" and collapsed the detailed explanation into the simple "can."

While these studies suggest that plants ~~should take up amino acids and possibly other forms of~~ use organic N in the field, they ~~do not provide are not~~ conclusive evidence of this.