

# Paragraphs

Make the paragraph the unit of composition.

—STRUNK AND WHITE, *Elements of Style*

Words are to sentences what atoms are to molecules: the basic building blocks that control structure and function. If we extend that analogy, paragraphs become cells: the fundamental unit of life. A cell gains life from its structure, a structure that creates internal cohesion and external connection, allowing it to function as part of a larger organism. So, too, with paragraphs. Hence, Strunk and White's second principle of composition: "Make the paragraph the unit of composition."

But how do you make a paragraph a cell, or a unit of composition? What do those terms even mean? Paragraphs tell stories. Not surprisingly, therefore, a paragraph becomes a unit of composition when it tells a complete short story with a coherent structure, a story that fits into and contributes to the larger work. If you string sentences together until you need to come up for air, and then throw in a paragraph break, you will not have a unit of composition.

Grade school teaches that a paragraph has a topic sentence that makes a point, which the rest of the paragraph develops. This topic sentence–development (TS-D) model of paragraph structure is a simplified version of the lead/development (LD) story structure I introduced in chapter 4. It works much of the time

and is a good starting point. However, part of all advanced training is unlearning the simplifications you were taught in introductory classes. Those classes build simple schemas to get you started in the field, but to advance you must move beyond them. Electrons don't orbit around the nucleus like planets around the sun, single genes don't necessarily code for single proteins, and paragraphs don't necessarily have a TS-D structure.

You can write a paragraph using any of the story structures discussed in this book. Each paragraph needs an opening that sets the stage, and each needs to resolve by making a point, but those don't have to be either a single sentence or the first sentence. For choosing a structure, the most important decision is whether to make a point and then develop it, producing an LD structure, or to build to a conclusion, producing an OCAR or LDR structure. Joseph Williams<sup>1</sup> distinguishes these as "point-first" versus "point-last" paragraphs.

## 11.1. POINT-FIRST PARAGRAPHS

The simplest form of point-first paragraph is the classical TS-D structure. If a paper were written with only TS-D paragraphs, you could skip along, reading the first sentence of each paragraph, and still get its essence. TS-D is simple, clean, and works well for most jobs. It should dominate your writing. If you go back to chapter 8 (see examples 8.1 and 8.4), you'll note that this was how I suggested describing your methods and results. Here are several other simple TS-D paragraphs.

### Example 11.1

*A Result:* Neither calculation reproduces the experimental strength distribution. The distribution for GXPF1A is closer to the data, but it pushes the strength up too high in excitation energy. An even more dramatic increase occurs for the calculation with KB3G, although the strength integrated up to 7.5 MeV reproduces the experimental value quite well. The summed  $B(GT)$  strength up to  $E_x = 7.5$  MeV (a total of 48 states) for the KB3G interaction is  $\Sigma B(GT)_{KB3G} = 2.02$  (with a further 10% of that value located at energies up to 10.3 MeV) compared to the experimental value of  $1.95 \pm 0.14$  up to that excitation energy. The summed strength up to  $E_x = 7.5$  MeV with the GXPF1A interaction is  $\Sigma B(GT)_{GXPF1A} = 2.65$ . A further 8% of that value is located at higher excitation energies, fragmented over many weak states.<sup>2</sup>

1. Joseph Williams 1981. *Style: Toward Clarity and Grace*, University of Chicago Press.

2. G. W. Hitt, R. G. T. Zegers, S. M. Austin, D. Bazin, A. Gade, D. Galaviz, C. J. Guess, M. Horoi, M. E. Howard, W. D. M. Rae, Y. Shimbara, E. E. Smith, and C. Tur, "Gamow-Teller Transitions to Cu Measured with the Zn(*t*,He) Reaction," (2009).

## 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>

An alternative form of point-first paragraph is to use a more extended LD structure in which the lead takes several sentences. An example of this is the first paragraph in example 10.2 about nitrogen stoichiometry, in which the lead takes three sentences. The first makes the general argument that organisms have characteristic element ratios, an argument that is sharpened and narrowed to the final clause of the third sentence, which states that these ratios may “predict element mineralization or immobilization during decomposition.” That ends the lead with a point the rest of the paragraph expands on.

Another example of an LD paragraph is example 11.3, which comes from a paper about synthesizing complexes between metals and aromatic carbon-60 (C60) structures. This came at the end of the paper’s opening, which argued that such complexes are important in nature and that new techniques were becoming available to synthesize them. It makes a critical step in the funnel, narrowing down to the specific problem of synthesizing metal–corannulene ion–molecule complexes.

## Example 11.3

Metal-PAH [polycyclic aromatic hydrocarbon] complexes are important as models for surface science and catalysis; PAHs may be used to model finite sections of a carbon surface. There is also evidence that metal-PAH complexes may be constituents of interstellar gas clouds; they have been implicated in the depletion of atomic metal and silicon in the ISM and as contributors to the DIBs [diffuse interstellar bands] and UIB [unidentified infrared bands]. *Increasing interest in metal-PAH systems has thus motivated many groups to produce these species in laboratory experiments.* Dunbar and co-workers were the first to observe metal-PAH ion complexes in gasphase experiments using FT-ICR mass spectrometry. From these experiments, they determined the binding kinetics of a variety of metal and nonmetal cations with PAHs. Our group has produced a variety of metal and multimetal-PAH sandwich complexes using laser vaporization of film-coated metal samples in a molecular beam cluster source. Competitive binding and photodissociation experiments were successful in determining structural information and

3. G. P. Yang Hong, P. Minnis, Y. X. Hu, and G. North, “Do Contrails Significantly Reduce Daily Temperature Range?” *Geophysical Research Letters* 35 (2008): L23815.

relative bonding strengths of metals with benzene, C60, and coronene. In other experiments, we used a laser desorption time-of-flight mass spectrometer to produce a variety of metal oxide and halide PAH complexes as well as mixed-ligand complexes. Experimental work has stimulated new theoretical studies investigating metal binding sites and bond energies on PAHs. Dunbar, Klippenstein and co-workers and Jena and co-workers have been active in this area.<sup>4</sup>

I’ve italicized the sentence that makes the point of this paragraph; it closes the lead and opens the discussion of research groups that have made metal-PAH complexes. The first sentences discussed why they are important, and thus why researchers would want to synthesize them. The following sentences lay out the history of synthesis efforts. Because this is a long paragraph, the authors used several sentences to build to the point, rather than a single topic sentence.

## 11.2. POINT-LAST PARAGRAPHS

In a point-first paragraph, you make an argument and then flesh it out. Sometimes, however, you need to assemble an argument, pulling threads together to weave them into a conclusion, producing a point-last structure. These may be either LDR or OCAR.

An LDR paragraph opens with an argument and then develops it, similar to an LD paragraph, but then it wraps up with a synthesis: it’s strong at both opening and resolution. A good example is the second paragraph of example 10.2 about nitrogen stoichiometry. That paragraph starts with the strong statement that animals and microbes live in a C-rich, N-poor world; it ends with a conclusion as to what that means—N recycling lags behind decomposition—hence LDR.

An additional example of an LDR paragraph is the following (example 11.4), which is about the treatment of post-traumatic stress disorder (PTSD) following battlefield injuries. The authors suggest that using morphine to ease immediate pain might also help reduce later PTSD, because its anti-anxiety effects can prevent the bad memories from consolidating.

## Example 11.4

Although much of the research in the field of pharmacotherapy for the secondary prevention of PTSD after trauma is speculative, there is theoretical evidence that early use of anti-anxiety agents can be effective. Pitman and Delahanty argued that pharmacotherapeutic interventions for the prevention of PTSD will be most effective if medication regimens are implemented after exposure to traumatic events. Morgan and colleagues and other

4. T. M. Ayers, B. C. Westlake, D. V. Preda, L. T. Scott, and M. A. Duncan, “Laser Plasma Production of Metal-Corannulene Ion-Molecule Complexes,” *Organometallics* 24 (2005): 4573–78.

investigators have hypothesized that opiates may interfere with or prevent memory consolidation through a beta-adrenergic mechanism. This theory also lends support to the idea that morphine and other opiates may prove effective in the secondary prevention of PTSD after trauma.<sup>5</sup>

In this paragraph the lead is the general argument that anti-anxiety agents should block PTSD; this point is made in the first sentence. The development is the discussion of the papers by Pitman and Delahanty and by Morgan and colleagues. The resolution is the last sentence, which argues that because morphine is an anti-anxiety agent as well as a potent painkiller, it should limit PTSD.

The other way to craft a point-last paragraph is to use an OCAR structure, in which the opening sentence introduces the issue without framing an argument—it just sets the stage. The last sentence synthesizes the material to make the conclusion. Consider example 11.5.

#### 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>

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 but as a classic OCAR opening, rather than as an LDR lead.

Another excellent example of a point-last OCAR paragraph is example 10.1 about population density and watershed N-export. That paragraph opens by arguing that these might be related. The second sentence poses the challenge, asking whether differences in population density could explain the differences in N-export between north and south. Several more sentences develop the action, leading to the resolution: population density cannot explain the patterns of N-export.

5. T. L. Holbrook, M. R. Galarneau, J. L. Dye, K. Quinn, and A. L. Dougherty, "Morphine Use after Combat Injury in Iraq and Post-Traumatic Stress Disorder," *New England Journal of Medicine* 362 (2010): 110–17.

6. K. A. Hoppe, "Late Pleistocene Mammoth Herd Structure, Migration Patterns, and Clovis Hunting Strategies Inferred from Isotopic Analyses of Multiple Death Assemblages," *Paleobiology* 30 (2004): 129–45.

Point-last paragraphs are not terribly common; they might account for 25–30 percent of a paper. Writing is dominated by point-first paragraphs, particularly by TS-D, which is the bread-and-butter paragraph. The complex structures, however, often appear at critical story points—openings, resolutions, and transitions—so you must learn when and how to use them. Additionally, although short paragraphs are usually TS-D, long paragraphs benefit from a resolution to tie them together and remind the reader of the point; they lean toward LDR or OCAR.

I've presented these structures as distinct, but they are not; rather, they form a spectrum from paragraphs with all the power in the first sentence to those with it all in the last—pure TS-D to pure OCAR. Some paragraphs may be hard to classify definitively as TS-D, LD, LDR, or OCAR. Slight shifts in the weighting of a sentence, or of a reader's interpretation, might change how they would define the structure. It's better when the structure is apparent, because if it is unclear, then the point may be, too. It's okay to write point-first paragraphs, and it's okay to write point-last paragraphs, but don't write point-nowhere paragraphs.

### 11.3. BAD PARAGRAPHS

Because paragraphs tell stories, they can fail for the same reasons that whole stories do. Paragraphs that lack a coherent structure can seem confusing and pointless, as did example 10.3, which illustrated directionless, "stream of consciousness" writing. We fixed that paragraph by breaking it into smaller ones, each of which had a single point; the first paragraph became OCAR and the second TS-D. Anytime you come across a paragraph that seems too long, too rambling, or too incoherent, you need to look for the story arcs and elements, and restructure or break up the paragraph up to highlight them.

As an example, here is a paragraph that is about as bad as it is possible to write (example 11.6). It is about restoring damaged grasslands where phosphorus availability limits plant growth. The researchers did two things: (1) they added compost as fertilizer, and (2) they inoculated a native grass with symbiotic fungi (known as mycorrhizae) to determine whether these treatments would overcome the P-limitation and allow plants to grow well.

#### 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. First, P availability is critical

to growing plants and restoring degraded California ecosystems. Second, there are two approaches that may enhance P-uptake by plants: adding compost and inoculating plants with mycorrhizae. Third, *B. carinatus* can be used to reestablish grasslands. Finally, the effects of mycorrhizal inoculation of *B. carinatus* are unknown. Which of these is the point of the paragraph?

The paper intended to connect the first two ideas; the story was about integrating multiple approaches to solve a problem, in this case focusing on increasing P-supply to plants to get them to grow. *B. carinatus* is incidental to that story; it just happens to be a useful species to use. Unfortunately, the authors introduced that point in a way that derailed the paragraph. To the authors, how this all fit together was probably obvious, but it wasn't to a reader. This kind of incoherence frequently results from the curse of knowledge. When authors know too much but write too little, ideas get overcondensed and jumbled.

How do you fix a paragraph like this? The first step is to identify the real story: there are two approaches to restoring degraded grasslands. The second step is to decide whether this needs a point-first or a point-last structure. I argue for a point-first, LD structure. The third step is to pull apart the different threads of this story to clarify their relationships.

#### Example 11.7

Restoring degraded California grasslands requires adequate supplies of P to support plant growth. Two management approaches have been proposed to achieve this: adding compost and inoculating grasses with mycorrhizal fungi. However, which approach is more effective in enhancing P-uptake and restoration is unclear, and they may work synergistically. Compost not only adds organic P to the soil; it also stimulates microbes that produce phosphatase enzymes and so increases P-release. P uptake by plants, on the other hand, may be stimulated by inoculating them with mycorrhizal fungi.

*Bromus carinatus* is a native grass that may be useful in restoring degraded California grasslands as it grows extensively throughout the state and tolerates harsh conditions. If it can be supplied with adequate P, it establishes well and starts the restoration process. A question, however, is which approach to enhancing P supply will work best with it, or whether both are necessary.

Instead of one dense, cryptic paragraph, I've broken this into two, added explanation, and ensured that each has a clear point and a clear structure: LD and LDR, respectively. Each forms a coherent story within itself, and together they define a direction for the paper. I argue that as a rule, short is better than long (see chapter 16), but you should take the space necessary to frame critical ideas. If you confuse readers, you lose them. If you need to condense, condense elsewhere.

The key to writing good paragraphs, and fixing bad ones, is the same as for other writing problems. Identify (1) who the story is about, (2) your point, and (3) where you should make it. Put the critical pieces of information in the right places, and use the rest of the text to tie them together smoothly.

## EXERCISES

### 11.1. Analyze published papers

Go to the papers you have been analyzing. Choose a selection of paragraphs in the papers; pick the critical points of opening, challenge, resolution, and transitions, as well as a random sampling of body paragraphs. Define their structures: point-first versus point-last. If point-first, are they simple TS-D or more developed LD? If point-last, are they LDR or OCAR? Evaluate where they use each structure—is there a pattern of where the authors use each type of paragraph? Can you determine why they use a particular structure in each case?

### 11.2. Write a short article

Go back to your short article and analyze the structure of every paragraph: TS-D, LD, LDR, or OCAR? Do they seem appropriate for the particular location and function they serve? If not (or worse, they have no definable structure), rewrite to give them an appropriate and structure.

### 11.3. Edit

- A. Rewrite Example 11.2 about jet contrails and diurnal temperature variation as a point-last, OCAR, paragraph. Does it work as well?
- B. Rewrite Example 11.5 about mammoths as a TS-D paragraph. Does it work as well?