

TEN

The Introduction Section

The Introduction as a standalone section of a scientific paper became universal only as the IMRaD structure became the standard in the 1950s, but the function of introductory material has been well understood for millennia. Cicero, writing in 55 BC, identified the purpose of an Introduction as to “attract the hearer straight away” and to provide “either a statement of the whole of the matter that is to be put forward, or an approach to the case and a preparation of the ground” (Volume I, 441). That is, the Introduction combines three functions: advertising, summarizing, and context-setting. Of these, the advertising and summarizing functions have been reduced in importance but not entirely displaced by the addition of the Abstract to the canon. Setting context for the work is now the most important work of the Introduction.

Swales (1990) divides the typical Introduction into three components (numbered in Figure 10.1), which in order move toward the narrow waist of the paper’s hourglass:

- **Component 1: Define a research territory.** Here you begin with the hourglass at its widest: a few sentences laying out the broadest possible context for the work undertaken, to establish its importance to a large set of potential readers. For instance, our star-formation paper (chapter 7) might begin with a sentence or two about how life in the universe depends on the existence of stars and planets and thus on the physics by which diffuse gas and dust condense to form such objects.

The degree of breadth to aim for depends on the target journal. A *Nature* or *Science* paper needs very broad context to justify its appearance in a publication whose scope covers all of the sciences, whereas a paper in a highly specialized journal needs to appeal only

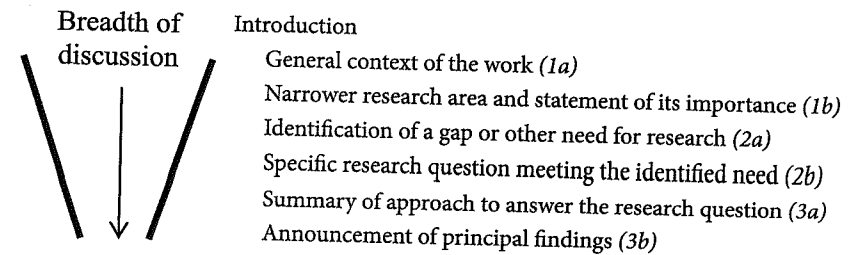


Figure 10.1 Structure and components of a typical Introduction. Italicized numbers refer to Swales’ (1990) three components: (1) defining a research territory; (2) establishing a niche within that territory; and (3) occupying the niche. The Introduction is shown in the context of the whole paper’s structure in Figure 8.1.

to the subset of scientists who read that journal. As an example, consider the first sentences of two recent particle-physics papers:

- From a *Nature* paper on the decay of the strange *B* meson (CMS Collaboration and LHCb Collaboration 2015): “The standard model of particle physics describes the fundamental particles and their interactions via the strong, electromagnetic and weak forces.”
- From a *Journal of Physics G: Nuclear and Particle Physics* paper on the detection of fragments from proton-proton collisions (Aaij et al. 2014): “Exclusive J/ψ and $\psi(2S)$ meson production in hadron collisions are diffractive processes that can be calculated in perturbative quantum chromodynamics (QCD).”

The *Nature* introduction starts with a definition of the “standard model” of particle physics, something that situates the paper well for a reader like me, but would be unnecessary (and painfully obvious) for any reader of the *Journal of Physics G*. The *Journal of Physics G* introduction, by contrast, jumps right into the predictions of quantum chromodynamics for meson production in proton-proton collisions. This is fine for the intended readers of that specialized journal, but wouldn’t capture many scientists flipping through an issue of *Nature* in the lunchroom.

While not every paper has to matter to everyone, even the *Journal of Physics G* paper sets its work in context beyond the immediate topic: it explains why technical details of particle detection matter to testing an important theoretical model in particle physics. That is, its authors

don't just describe what they did; they explain how what they did was important.

Having established context, your Introduction begins to narrow the hourglass by identifying your more specific research territory, along with its relationship and importance to the broader field. For example, having begun your astronomy paper with the importance of star formation in general, you might now indicate that your focus is the formation of massive stars. You might point out that massive stars are critical because their supernova explosions seed newer stars and planets with heavy elements. This part of the Introduction normally includes some literature review to establish the state of the art in the research territory.

- **Component 2: Establish a niche within the research territory.** As the hourglass narrows further, your Introduction works toward your central research question by identifying a research niche: a concrete and narrow open problem within the research territory. This might mean pointing out a gap in our knowledge of some topic. It might mean noting an apparent contradiction in the literature or a published claim that's vulnerable to new information. It might mean identifying rival theoretical models that can be distinguished by new data. It might even mean suggesting an entirely novel way of thinking about a research area. This is where our astronomy paper could point out that there are multiple models for massive-star formation, making different predictions about the appearance and spatial distribution of massive protostars. Finally, your Introduction will state, clearly and specifically, your central research question (whether massive protostars always appear within local clusters of protostars, as the cluster-assist model predicts).
- **Component 3: Occupy the niche.** The third component of the Introduction indicates to a reader how your work occupies the niche you've just identified. In doing so, it further narrows the hourglass by outlining the approach you took to answer the central question, and showing how the answer to this question helps to solve the open problem you identified.

Outlining the approach doesn't mean presenting detailed methods, of course. It means indicating your basic approach (the kind of

experiments, observations, and/or theory you executed), the general form of your data (what important quantities you measured, and roughly how), and how analyses of those data can answer your central research question. For our astronomy example, you might indicate that you used radiotelescopic observations to identify massive protostars by inferring mass from the relationship between radius and rotational velocity, and that you calculated distances among protostars based on annual parallax. You would then indicate that this provides a test of the cluster-assist model, because that model is rejected if massive protostars often occur alone.

While my suggestions about the components of an Introduction should so far be uncontroversial, there is considerable disagreement over how best to end one. Some writing guides recommend ending the Introduction with the statement of your central question and approach (e.g., Davis 2005, Katz 2006). Others suggest continuing with a brief summary of your results (e.g., Montgomery 2003, Day and Gastel 2006). My own advice is to include the main result, because doing so shows your reader where you are going and helps signpost their progress through your paper. Don't worry about giving away the ending to your story: you're writing a scientific paper, not a mystery novel, and in any case your Abstract has already ruined the suspense. If you are able to state an interesting and important conclusion, readers closest to your research area will read on to find out how you support it. If other readers are satisfied with a quick answer to your central question, so much the better for all.

Chapter Summary

- The Introduction serves to define a research territory (context), to establish a niche within that territory (knowledge gap), and to occupy the niche (outlining your approach to filling the knowledge gap).
- Establishing context means a broad focus; exactly how broad depends on the target journal.
- A brief statement of your major result is a strong way to end an Introduction.

Exercises

1. Choose a recently published paper in your field, and read the Introduction. Highlight text comprising each of the three main Introduction components (establishing territory, establishing niche, occupying niche).
2. How would you change that paper's Introduction for publication in a journal of narrower scope? One of wider scope?

ELEVEN

The Methods Section

Methods sections are relatively straightforward to write. They outline the materials you used and the procedures you followed in executing your study and analyzing your data. Often, you can model substantial portions after an earlier paper in which you reported similar work or adapt text from a grant proposal. And most, if not all, of the Methods can be written while you're planning or conducting the research, when the procedures are fresh in your mind. Despite this section's relative ease, however, three issues can be troublesome: organization, level of detail, and avoiding self-plagiarism.

Organizing the Methods

It's tempting to organize a Methods section chronologically, recording what you did in the order that you did it. This might be the right way to write a travelogue or an autobiography, but it's the wrong way to write a scientific paper! Your experience in doing the research doesn't matter; what does is your reader's need to understand it.

There is no one-size-fits-all recommendation for organizing Methods to make them easily understood. One possibility is a three-part presentation of background, experiments or observations, and analysis. This organization begins with material that sets the stage for the main procedures, such as descriptions of your field sites, materials and equipment, methods for selecting subjects, or calibrations or control procedures intended to demonstrate that your procedures work as expected. The second subsection describes your experiments and the data you collected.