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Making a Story Sticky

A sticky idea is an idea that is more likely to make a difference.
—CHIP HEATH AND DAN HEATH

There are many ways to evaluate whether a story works, but perhaps the best is to ask, "How long after you read it do you remember it?" Some stories are riveting while you read but are gone as soon as you close the book. Perfect airplane reading. Others may stay with you for your entire life and be passed on to your children. Some are so powerful that they have lasted intact from the dawn of civilization.

Although nothing in science competes with the *Iliad* or the *Odyssey*, Darwin is still up there with his contemporaries Dickens and Dumas. Really good papers may be read and cited for years and decades. One of the nicest compliments I ever heard was someone saying a colleague wrote papers with "legs"—they stood the test of time, remaining interesting and relevant.

How do we write papers with legs—papers with immediate impact but that still accrue citations for years? In their book, *Made to Stick*,[1] Chip and Dan Heath frame this question as "What makes an idea 'sticky?" Why do some ideas stay

1. C. Heath and D. Heath, *Made to Stick* (Random House, 2007).

with you while others are eminently forgettable? Heath and Heath identify six factors that make an idea sticky and organize them in a simple mnemonic: SUCCES.

S: Simple
U: Unexpected
C: Concrete
C: Credible
E: Emotional
S: Stories

I go over these factors briefly here and come back to them repeatedly through the book. They are fundamental to good storytelling and thus to good science writing.

3.1. SIMPLE

Ideas that stick tend to be *simple*. A simple idea contains the core essence of an important idea in a clear compact way. Simple ideas have power.

During the U.S. Civil War, one of Abraham Lincoln's greatest challenges was dealing with antiwar Democrats, and in 1863 he faced a crisis. A leader of this faction, Clement Vallandigham, was preaching against the draft and encouraging soldiers to desert, undermining the war effort. He was arrested for treason, tried, and sentenced to prison. The fallout was furious. Was Lincoln using executive power to shut down the political opposition? Was Vallandigham just exercising his freedom of speech? The arguments were complex and impassioned. Lincoln cut through them all with a single question: "Must I shoot a simple-minded soldier boy who deserts, while I must not touch the hair of a wily agitator who induces him to desert?"

That question collapsed the complex legal and political arguments into a simple moral dilemma that people could understand and sympathize with. It made the innocent victim not Vallandigham but the soldier who listened to him and might pay the ultimate price for doing so. By framing the controversy in a simple, clear way, Lincoln refocused it and then shut it down. Bill Clinton was elected president on an even simpler message: "It's the economy, stupid."

It is important, however, to distinguish simple messages that capture the essence of an issue from those that are just "simplistic." Simplistic messages are dumbed down, trivialize the issue, or dodge the core of the problem, rather than targeting it. Many political slogans are simplistic; for example, "you pay too much in taxes" is catchy, appealing, and might even be true, but it ignores the underlying issues of what services those taxes pay for, whether you want or need them, and whether they provide good value for your money. Rather than condensing complex arguments about the balance of costs versus services, it avoids them—hence not simple, but simplistic.

Most science is driven by simple ideas. Frequently, the simpler an idea is at its core, the larger its swath of influence. Biology, for example, is driven by Darwin's theory of evolution by natural selection. Natural selection—fit organisms survive and pass on their genes while unfit ones don't—is a very simple idea, yet it contains great power for explaining nature and vast potential for study.

Other fields are equally driven by simple ideas. Modern geology, for example, is driven by the concept of plate tectonics, which explains the shape of the global landmasses, the rise and fall of mountain ranges, and the long-term geochemistry of our planet. Organic chemistry is driven by atomic orbital theory and the idea of hybrid orbitals, which explain the structure and reactivity of organic molecules. Molecular biology is driven by the double helix of DNA and the genetic code.

These simple ideas don't explain the details and fine fabric of natural systems, but they do provide a large structure on which more complex dynamics elaborate. A colleague of mine once said, "I have to make things simplistic enough that I can understand them." In his humble way, what he meant was that he looks for the simple explanation that captures the essence of a problem, which allows the rest of us to apply those insights to our own systems. His ability to do this is why he was elected into the U.S. National Academy of Sciences.

A simple idea, therefore, is one that finds the core of the problem. It takes no special talent to see the complex in the complex. Cutting through the clutter to see the simple in the complex is what distinguishes great scientists from the merely competent.

There are different ways to find and express a simple message. For some it would be an equation; for others, a verbal description. I have always felt that I don't understand something until I can draw a cartoon to explain it. A simple diagram or model—the clearer the picture, the better. For example, the most highly cited paper I have written was a synthesis that developed a new hypothesis about how the physical structure of soil regulates how microorganisms use nitrogen, and thus controls the nitrogen forms available to plants.[2] The essence of the paper is a cartoon illustrating these interactions among chemicals, organisms, and spatial patches in the soil (figure 3.1). It wasn't until I read Heath and Heath, though, that I realized that I was searching for the simple explanation, but being a visual person, I look for it in a picture.

A contrasting example, highlighting the difference between simple and simplistic, is another paper I published evaluating the effect of freeze-thaw cycles on microbial respiration in arctic tundra soils.[3] In some soils, freeze-thaw cycles increased respiration relative to a control, whereas in others they decreased it. Initially we didn't see any pattern as to which soils respired more versus less; that inconsistency was the simple story in the first submitted version of the paper. The reviewers, however, thought that was simplistic and said so in no uncertain terms.

2. J.P. Schimel and J. Bennett, "Nitrogen Mineralization: Challenges of a Changing Paradigm," *Ecology* 85 (2004): 591–602.

3. J.P. Schimel and J.S. Clein, "Microbial Response to Freeze-Thaw Cycles in Tundra and Taiga Soils," *Soil Biology and Biochemistry* 28 (1996): 1061–66.

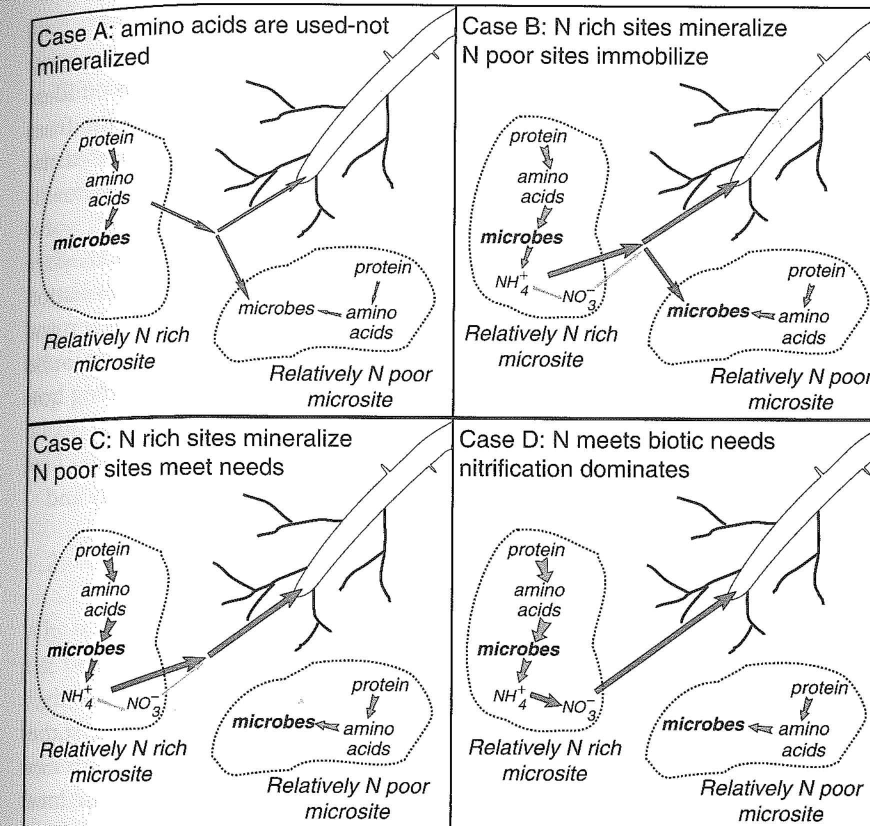

Figure 3.1. Changing patterns of N-flow in soil as N-availability increases. From Schimel and Bennett (2004).

They were right. I hadn't taken Anne Lamott's advice and listened to my characters carefully enough. We went back and banged our heads for several weeks trying to find the truly simple story in the data. Was there a coherent pattern underlying the apparent inconsistency? There was—in rich soils, freeze-thaw cycles reduced respiration, whereas in poor soils they enhanced it, a pattern that suggested possible mechanisms and insights to test in future research. It was one of those "what an idiot!" moments, where something suddenly becomes clear, and you wonder how on Earth you could have missed it before. That paper has been cited over 100 times, largely because the reviewers held our feet to the fire to do a better job of finding the simple story in the complex data. That isn't the only case where I owe reviewers thanks for criticizing me for not having done a good enough job on data analysis or story development. Of course, it's better when reviewers hang tough than when they are "nice" and let you publish less-than-perfect work. The pain of an embarrassing review lasts a few days, the pain of an embarrassing paper lasts a lifetime.

3.1.1. Simple Language: Schemas

Part of being simple is expressing your thoughts in language that builds off ideas that your readers already know. Heath and Heath borrow the term *schema* from psychology to identify ideas we bring with us to a problem. Lincoln used the images of "simple-minded soldier boy" and "wily agitator"— you can immediately flash mental pictures of those characters.

Why are schemas so important to create messages that feel simple? They are how people learn; we start with existing schemas and then attach new information to develop new, more sophisticated ones. It's hard to learn new material when you can't fit it into an existing intellectual structure—in that case, you need to build the new structure from the ground up. For example, if you were describing how alligator meat tastes, you might say:

> It's a light-colored, finely textured meat, with very little fat. It cuts easily and is moist if not overcooked. The flavor is mild.

Or you could say:

> It tastes like chicken, but a little meatier.

The first explanation describes the individual traits of alligator, but that somehow misses the point—it doesn't make it evocative. The second grounds this new idea firmly in one you probably know well: the taste of chicken. Alligator meat may not taste exactly like chicken, but this explanation gets you most of the way there.

The idea of schemas and how they relate to learning is why university science curricula are structured as they are—first-year inorganic chemistry introduces the idea of electron orbitals as energy bands that electrons can jump between. Second-year organic chemistry modifies that schema to introduce the idea of hybrid orbitals and resonance structures. Third-year physical chemistry takes this further, introducing the Schrödinger equation, which treats orbitals as probabilistic distributions of electrons. Similarly, in molecular biology we start with the simple transcription/translation model of DNA →RNA→ protein, and the idea of one gene/one product. Only after establishing those schemas do we start introducing ideas such as post-translational modification of proteins and overlapping reading frames (a single stretch of DNA may actually be part of two separate genes). Each step takes a simple schema and modifies it, making it increasingly elaborate and nuanced.

This sequential approach means that we usually start with an explanation that to an expert may seem horribly simplified or just plain wrong. A physical chemist knows that the way we explain reactions in freshman chemistry is a ghastly misrepresentation of how the systems truly work. However, you don't teach someone to swim by throwing them into the deep end of the pool and describing how to do the butterfly. You have to start simple and work up to it. You establish schemas and then expand and modify them. Building off established schemas makes ideas feel simple.

To communicate effectively in science, we need to know what schemas our audience holds so we can build from them. If we assume readers hold schemas they don't, we write above their knowledge level and confuse them, whereas if we explain schemas they do hold, they may feel that we are writing below them.

Because schemas are our core ideas, we often take them for granted. We think and write based on the schemas we and our closest colleagues hold, limiting the reach of our writing to a narrow community. Succeeding widely, however, requires reaching a broader audience, so when you use ideas and terms, stop and think about whether they relate to schemas held by the target audience. If not, don't be afraid to redefine your ideas in simpler terms and more broadly held schemas.

3.2. UNEXPECTED

Why is being unexpected important in telling a good story? Well, any paper that just presents another data set showing things we already knew, that presents a slight variation on an existing method, or that merely reinforces dogma is going to be forgettable. Most papers (even solid ones), are forgettable, because they are incremental, filling in gaps and providing additional facts that solidify a platform for launching new ideas. Incremental science can be important, but really good papers go beyond incremental to *novel*—they say something new and unexpected.

Novelty and unexpectedness lie in the questions you ask and the interpretations you develop. There are no areas of science where there aren't new questions to be asked (physicists have occasionally thought so but learned better). Few data sets don't provide the opportunity to develop new insights. Conversely, few data sets are so imbued with novelty that you can't use them to tell a boring and uninsightful story. Your job is to find what is novel and highlight the unexpected elements. Frame new questions and look for new insights. Make them clear in your writing.

In science, the key to highlighting the unexpected is through the knowledge gap theory of curiosity described by Heath and Heath. There is undoubtedly an enormous mass of knowledge on your overall topic, but your work should identify the unknown within that mass. By highlighting that unknown, identifying ignorance in the midst of knowledge, you create unexpectedness and engage a reader's curiosity.

We all work on big questions that have been around for years or decades, and we do good science by identifying new aspects of those questions—pieces that, if we accomplish them, will make progress on the bigger questions. The knowledge gaps we identify may be small, but that doesn't mean they are unimportant. Science doesn't advance by great leaps but by many small steps, each of which makes its own contribution. In any event, it is better to write about a small knowledge gap than about no knowledge gap at all.

Unfortunately, highlighting the unknown is often difficult for us. We're scientists—we know a lot, and we like to show off what we know. Particularly for junior authors, who may not be comfortable with how much they know, and how much they don't, it can feel important to show off their knowledge. But showing off knowledge doesn't create curiosity. Rather, in the words of Heath and Heath, "Our tendency is to tell people the facts. First, though, they must realize they need them." We make a good story by identifying the knowledge gap we will fill.

You frame a knowledge gap by using what is known to identify the boundaries of that knowledge. It's like framing a window—build the structure to support the area you will fill in. Identifying a knowledge gap creates curiosity. Filling that gap creates novelty.

3.3. CONCRETE

> If those who have studied the art of writing are in accord on any one point, it is this: the surest way to arouse and hold the reader's attention is by being specific, definite, and concrete.
>
> —STRUNK AND WHITE, *The Elements of Style*

As an example of the power of being concrete, I'll go back to Bill Clinton and "it's the economy, stupid." That is a concrete way of expressing a classic maxim in politics: you must stay focused. Anytime Clinton found himself being drawn into other interesting directions, the rude bluntness of "it's the economy, stupid" helped pull him back to his core message. Simple has power, but concrete adds mass to that power. A balloon is simple, but you notice more when you get hit in the head by a brick.

The importance of being concrete might seem an obvious and inherent characteristic of writing science. After all, science is about data, and data are concrete. But science is also about ideas, and ideas are abstractions—the antithesis of concrete.

Science lives with this tension between concrete data and abstract ideas. We even use the abstractions to make sense out of the concrete. The world is too complex to understand in all its detail, so we create abstractions—models and theories—to shape the complexity into structures simple enough for us to understand. In fact, being able to convert the concrete into the abstract is part of what makes someone an expert. For a novice, a specific detail is a concrete thing on its own. For an expert, it is an example of a broader set. The more we learn, the more we are able to think about a topic at a higher level of abstraction. We can get so caught up in those abstractions that it is easy to forget the concrete blocks we built them from. I struggled as a teaching assistant in introductory chemistry—I had forgotten the simple explanations my teachers had used to build concepts I took for granted, concepts like mole, valence, and stoichiometry.

Abstract and concrete, however, are not a dichotomy but a continuum, what Roy Peter Clark describes as the "Ladder of Abstraction."[4] At the top of the ladder are the widest abstractions—the simple ideas that motivate science and are broadly understandable: survival of the fittest, plate tectonics, and so on. At the bottom are the physical facts—the actual data we collect. Both of these are tractable for most readers.

The danger zone is in the middle—small-scale abstractions that are neither concrete details nor high-level schemas. This middle zone is inhabited by the concepts that are the bread and butter of scientific discourse, schemas that are typically held only by experts. Evolutionists don't spend their time discussing survival of the fittest—that is taken for granted. Rather, they write papers about sexual selection, Hardy-Weinberg equilibria, and genetic drift. Molecular biologists don't write papers about the double-helix model but about knockout mutations, ribozymes, and transcriptional silencers. When environmental engineers talk about "multimedia modeling," they don't mean audio and video but soil and water. These middle-level concepts are what outsiders consider jargon.

Scientists are drawn to the middle of the ladder of abstraction and as a result, we often write papers that are accessible to only a limited group of readers. You can't avoid the middle rungs, but you can minimize the damage—you can ground and define your specific concepts either in widely understood schemas or in the details that explain the abstractions. I discuss how to do this later in the book (particularly in chapters 11 and 14).

To illustrate the idea of grounding concepts in the concrete, consider my earlier discussion of the flow from data through information and knowledge to understanding. Would that section have made sense without the example of the discovery of the structure of DNA and the separate roles of Franklin versus Watson and Crick? By linking a concept to a concrete example, the concept itself becomes concrete—a new schema you can work with.

3.4. CREDIBLE

Science writing that isn't credible is science fiction. Credibility goes hand in hand with being concrete. We establish the credibility of our ideas by grounding them in previous work and citing those sources. We establish the credibility of our data by describing our methods, presenting the data clearly, and using appropriate statistics. We establish the credibility of our conclusions by showing that they grow from those credible data. We build a chain that extends from past work into future directions. A break anywhere in that chain makes the whole endeavour lose credibility.

I recently reviewed a proposal, and after reading the introduction, I was prepared to hate the whole thing. The ideas had potential, but instead of fleshing them out, the authors loaded them up with boldface, buzzwords, and hype. I was

4. R. P. Clark, *Writing Tools* (Little, Brown, 2006).

sure that with that much lipstick, the proposal had to be a pig. It wasn't concrete, and as a result it wasn't credible—the writing style undermined the content. I was surprised, however, when I got to the meat of the proposal: it was stellar. There, the authors demonstrated that their program was well thought out and would, in fact, address all the program goals. The proposal only became credible when it became concrete. That's what convinced me it was worthwhile and converted me from a skeptic to a supporter.

3.5. EMOTIONAL

This is an awkward one for scientists. To do good science you must be dispassionate and objective about your work. There is, however, one emotion that is not only acceptable in science but fundamental to it: curiosity. We became scientists because we are curious—we are driven to solve the puzzles that nature presents. To engage us in your work, you need to engage our curiosity. You do that by asking a novel question.

If you don't ask an engaging question, and instead just offer new information, you appeal to another, weaker emotion. You appeal to our inner nerd and our love for accumulating trivia. That won't get your paper published or your proposal funded.

The E element of the SUCCES formula is thus closely aligned with U. Unexpected things create curiosity, so use that link to your benefit. You engage emotion by shifting your focus from "what *information* do I have to offer?" to "what *knowledge* to I have to offer?" Phrased differently, shift from "what's my answer?" to "what's my question?"

Working on E this way is important to enhancing the impact of a paper but it can mean life or death for a proposal. Proposals are evaluated by a panel of your peers, and your proposal is in direct competition with other good proposals. In my experience, at least twice as many proposals are considered fundable as there is money to fund. To make it from the *fundable* to the *funded* list, you need to get at least one panelist excited enough to be your advocate, arguing why your project should be funded at the expense of other good proposals. Without such an advocate, you are likely to get one of those frustrating "if we only had enough money, we would have funded you" letters. You must excite the reviewers. Excitement is the therefore the second acceptable emotion in science, and it grows from curiosity. We get excited about work that engages and then satisfies our curiosity.

3.6. STORIES

This whole book is about telling stories—about seeing your work as a story and presenting it that way. But stories are modular; a single large story is crafted from a collection of smaller story units, threaded together. To write a good paper, you need to think about internal structure and how to integrate story modules.

For example, in chapter 2, I told a story about the role of storytelling in science. I built it from three modules, each its own story with its own characters. The first focused on Elizabeth Kolbert and her perception that scientists don't tell stories. The central characters were Kolbert, scientists, and, importantly, the idea of "story" as a character itself. In the second module, to discuss the idea that science goes from data to understanding, I used the story of the discovery of the structure of DNA. Finally, to describe how "listening to your characters" can enhance science, I used the stories of Bill Dietrich's doctoral work and that of my own. I hope that each of these short stories was sticky in its own right, and that together they created a sticky overall story.

You can use the same strategy in your writing. As you discuss your data and ideas, find units that you can package into coherent modules. Readers will be able to assimilate each piece, and it will be easier for them to see how they add up to create the whole.

These six SUCCES elements are integral to effective storytelling and science writing. Before you start writing, take the time to figure out how you are going to weave them into your work. Particularly, take the time to figure out the simple story. Build it around the key questions that will engage U and E. These will guide you in selecting the material you need to present to make the story concrete and credible.

EXERCISES

3.1. Analyze published papers

Go back to the papers you are analyzing:

Identify how the authors used each SUCCES element. Did the authors do a good job? Could they have done a better job? If so, how? Try rewriting key passages to enhance their SUCCES power.

What schemas did the authors use in building the story? Are these only held by a narrow subdiscipline or by a wider community?

3.2. Write a short article

Analyze the short articles(s) you (and your writing group colleagues) wrote for the exercise in Chapter 2.

Identify how well you and your peers used SUCCES elements. Did you do a good job? Could you have done a better job? If so, how? Rewrite key passages to enhance their SUCCES power.