Popular Science Writing: A Challenge to Academic Cultures

by Lena Erickson

Lena Erickson is a Mathematics major from Oklahoma City, OK. She wrote this essay in "The Writing Life," taught by Eric Bosse.

The sky darkens. A human floats beneath the stars. Moonlight reflects off a face clenched in concentration; eyes open to see water waves crash. Suspended in a cloud, the human stretches fingers through fog to see forms. Illumination falls upon sea, sand, shore. Eyes close, and darkness consumes the scene. The face emerges under fluorescent lighting in a Caltech office.

Human quickly writes, "Is the wind a sloshing of the air analogous to the sloshing motion of the water in the sea? What common features do different movements have? What is common to different kinds of sound? How many different colors are there?" (Feynman, Leighton, and Sands 2-1). As Richard Feynman writes, his questions, his descriptions of physical phenomena, and his stories of the scientific process form what later become *The Feynman Lectures on Physics*, an ambitious three-volume textbook of essential undergraduate physics. From the beginning, Feynman and his co-editors establishes their intention to make the lectures accessible: "Even so, the laws are so hard to grasp that it is unfair to you to start exploring this tremendous subject without some kind of map or outline of the relationship of one part of the subject of science to another" (1-1). They allots the first three lectures to an introduction to scientific thinking, including the thrill of scientific enquiry and the human perspective it offers. Even when the lectures address denser topics, Feynman's excitement and commitment to clarity remain evident. Through his published lectures, books, interviews, and semi-autobiographical texts, Feynman—nicknamed "the great explainer" —popularized the field of physics. Beyond his contributions to physics expressed through academic science writing, Feynman wrote science-centered works that could be read by anyone, works that convey the beauty and value of science and a scientific perspective. Popular science writers, like writers of literature, use this successful rhetorical strategy of ascribing "beauty" to phenomena in order evoke a particular positive response in the reader. Going against an epistemological vein of science, popular science writers make the discoveries of scientists available to non-specialists by emphasizing what academic scientific papers necessarily exclude: the human stories and emotions of the scientists behind the discoveries.

Feynman's success at connecting science with beauty and human experience problematizes a

Photograph of Richard Feynman

common view within academia—namely, that science and the humanities are fundamentally irreconcilable. In Feynman's popular science works, the aesthetic meets the empirical, as scientific knowledge is transmitted through a medium of story. Accepting tenets of both literary works and academic science writing, popular science writing, through its very existence, challenges the dichotomy of scientific versus literary cultures. Popular science writers like Richard Feynman, Carl Sagan, Stephen Jay Gould, Natalie Angier, and Neil DeGrasse Tyson—scientists who have authored books of creative scientific nonfiction for a lay audience—must face conflicting epistemologies in science and the humanities, paying careful attention to the translation from scientific material to expressive forms. Popular science writers represent a precedent of literary-scientific work that challenges the two cultures' dichotomy in Western thought.

Academia's fracture into a limiting cultural dichotomy has been an ongoing contemporary meta-discourse since 1959, when physicist and novelist C.P. Snow lamented an observed division between scientific and literary cultures as a part of his famous Rede lecture, published in 1962 as *The Two Cultures*. His lecture sparked debate among academics. Are the sciences and the humanities irreconcilable? If not, should they be yoked? There were a variety of responses, but it became most popular to deny the separation of scientific and literary cultures (Locke 1). Those who claimed that the fields should remain separate—separation supporters —argued that cultural relativism, a view commonplace in the humanities, conflicted with the factual nature of science. Separation deniers retorted that conflicts such as these dissolve upon consideration of science as a cultural phenomenon. Murdo McRae writes in *The Literature of Science*, that "science *is* a relative matter, in the sense that *science must be related to the ideologies, values, habits of thought, and linguistic and rhetorical practices that shape our culture*…" (1, emphasis in original). By considering science a cultural phenomenon, separation deniers argued that science and the humanities had too much in common to be "separate cultures." However, the explanation of science as a cultural phenomenon lacks rigor; it neglects the epistemological basis of science as objective observation of physical phenomena, where the phenomena themselves are independent of societal values. These characterizations reveal a problem with Snow's terminology: the existence of scientific culture in academia does not necessarily mean that science is an essentially cultural phenomenon. While parts of Snow's lecture, particularly his political statements, are today outdated, his discussion of opposing academic cultures has persisted and remains heated. David Locke, author of *Science and Writing*, contends, "That the denial still seems necessary is because the thesis still appears to most of us so patently, so obviously, true" (1). At their foundations, the methods of science and the humanities clash. Epistemological conflicts cause the separation of cultures lamented by C.P. Snow, yet while these conflicts currently have no solution, popular science writers continue to generate informative, expressive writing that does not fit neatly into the category of either culture.

Richard Feynman provides a description of science's epistemology in his *Lectures on Physics*, saying, "The principle of science, the definition, almost, is the following: *The test of all knowledge is experiment*. Experiment is the *sole judge* of scientific 'truth'" (1-1). While imagination is required to design experiments, and methods of experimentation change over time, physical tests form the basis of scientific knowledge. This type of epistemology, in which knowledge comes from experiment, we call empiricism. Initial experimentation gives a scientist hints about possible general rules, "[b]ut also needed is imagination to create from these hints the great generalizations… and then to experiment to check again whether we have made the right guess" (Feynman, Leighton, and Sands 1-1). These "great generalizations," which arise from a combination of scientific observation and imagination, we call theories. Theories, or models that explain physical phenomena and make predictions, change over time and often displace or are replaced by better theories. For example, scientists abandoned the "Flat Earth" theory in favor of the "Globe" theory because Globe theory makes better predictions about lunar shadows, navigation, and astronomy. Some nonscientists may imagine that Earth is flat, but the consensus of the scientific community favors Globe theory, whose predictions still hold. This way of understanding scientific knowledge, which Karl Popper established and called falsifiability, requires theories to make predictions that can be invalidated, so that when predictions hold, the theory becomes better established.

However, it is essential to realize that scientific theories are not a form of absolute truth. The epistemological problem of "proving a theory" lies within the fact that theories make predictions about the future based on observations in the past. David Hume's problem of induction states that we have no strong reason to believe the future will be like the past except the circular logic that in the past, the future has always been like the past. It follows that a theory must always continue to accurately make predictions but can never be proven correct. The longer a theory has accurately made predictions, and the more predictions it makes, the more confident we are that it represents reality. But we always have some uncertainty. The uncertainty of a theory, observation, or assertion is of great epistemological importance in science. As Feynman said, "I have approximate answers and possible beliefs and different degrees of certainty about different things, but I'm not absolutely sure of anything" ("The Pleasure of Finding Things Out").

In contrast, literature aims to evoke reactions and describe experiences through art rather than inquiry. A passage from René Wellek and Austin Warren's *Theory of Literature* explains that "literary language is far from merely referential. It has its expressive side; it conveys the tone and attitude of the speaker or writer. And it does not merely state and express what it says; it also wants to influence the attitude of the reader, persuade him, and ultimately change him" (qtd. in Locke 3). This general definition of literature sharply contrasts with academic science writing. Where literature uses rhetorical and expressive language to describe experience, academic science writing wishes to minimize the effects of language in and of itself. French semiotician Roland Barthes explains, "As far as science is concerned language is simply an instrument, which it profits to make as transparent and neutral as possible" (qtd. in Locke 5). Scientific findings in written form must be represented in unambiguous terms with mathematical foundations because expressive language can obscure the content of scientific findings. It is for this very reason that science and the humanities so commonly divide, since academic discourse traditionally occurs through the medium of written work. In conveying scientific information with greater ambiguity to a broader audience, popular science writers engage their readers not just in scientific material but also in the stories of scientists, evoking an emotional response to the beauty of a scientific perspective, persuading the reader to desire a scientific understanding of the world. But popular science writers must also employ discretion to remain accurate when writing about scientific material.

In fact, translation of scientific concepts to popular scientific form can be a major cause for concern among popular science writers. Sociologist Richard Whitey asserts that "the transformation of knowledge produced by one community into the language and concepts of another is very difficult, if not impossible, without seriously changing the nature of that knowledge" (qtd. in McRae 39). While Feynman and others succeed in accurately conveying scientific material, less successful popular science writers turn scientific material into a more expressive form but remove crucial information about a statement's uncertainty. This argument forms the thesis of Jeanne

Fahnestock's "Accommodating Science: The Rhetorical Life of Scientific Facts," which argues that loss of uncertainty accompanies the translation of scientific material to popular scientific form (21). This translation she calls "genre shift." Including in her selections both media representations and more traditional popular science examples, Fahnestock illustrates the potential problems of popular science writing, showing how small alterations can change the meaning of a scientific text by removing markers of uncertainty. In one example, Fahnestock provides an excerpt from an original piece of academic science writing (7a) and follows with a media representative form (7d):

> 7a. We favor the hypothesis that sex differences in achievement and attitude toward mathematics result from superior male mathematical ability, which may in turn be related to greater male mathematical ability in spatial tasks. This male superiority is probably an expression of a combination of both endogenous and exogenous variables. We recognize, however, that our data are consistent with numerous alternative hypotheses. Nonetheless, the hypothesis of differential course-taking was not supported… (Benbow and Stanley 1980, 1264)
>
> 7d. Two psychologists said yesterday that boys are better than girls in mathematical reasoning, and they urged educators to accept the possibility that something more than social factors could be responsible. ("Are Boys Better at Math?" 1980, 107) (Fahnestock 28, citations in original)

Observe the loss of certainty from the scientific article to the popular form: 7d, claiming to represent 7a, asserts that "boys are better than girls in mathematical reasoning," a declaration of almost absolute certainty. But in 7a, psychologists use the expression "we favor," which suggests a more personal, localized opinion. Also note in the original the words "may" and "probably." The original source explicitly describes their data as a fit with other hypotheses; hence, their results do not necessarily lead to their conclusion. It is evident that the original authors' language contains indicators to represent uncertainty, indicators that get lost in translation in an effort to appeal to a non-specialist audience. Genre shift removed the markers of uncertainty, misrepresenting the original scientific material. Rhetorical alterations like these mislead the reader into assuming importance, uniqueness, and certainty where they were not originally intended. These costs of translation represent just some of the difficulties in reconciling the conflicts between scientific and literary writing. Conflicts in writing—the medium of academic knowledge—support the idea that literary and scientific cultures are distinctly separate and should remain separate. Yet, in spite of these conflicts, popular science writers do achieve a successful combination of scientific and literary writing; at their best, they present scientific material beautifully and metaphorically to spark an emotional response, but accurately enough to evoke in their reader the inclination for further research and an appreciation of scientific literacy.

Scientists who do recognize the importance of accuracy when writing popular science books craft close-fitting analogies and weigh the most indispensable parts of their chosen concept in order to know what to teach. In doing so, they provide relatively accurate representations of ma-

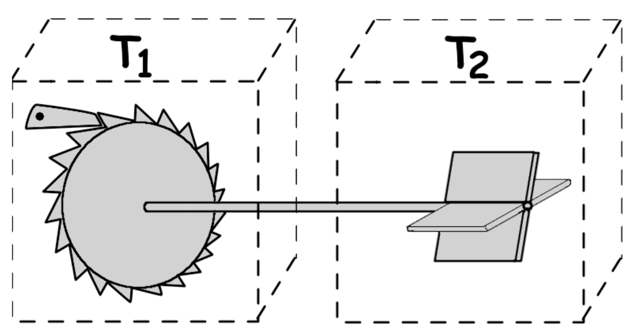

Diagram of a Brownian Rachet (also known as a Feynman-Smoluchowski ratchet), a device popularized by Richard Feynman, who used it to demonstrate the laws of thermodynamics in his famous Cal Tech physics lectures.

terial within their fields. Their rhetorically influenced writing optimizes preservation of the original scientific meaning compared to general media representative forms. Scientific papers in peer-reviewed academic journals will remain the most accurate form of current research, but popular science writers acknowledge that a general audience may not have the resources, understanding, or inclination to consult such forms. They also acknowledge that "everything we know is only some kind of approximation, because *we know that we do not know all the laws* as yet. Therefore, things must be learned only to be relearned again or, more likely, to be corrected" (Feynman, Leighton, and Sands 1-1). Close-fitting analogies paired with discussions of skepticism and uncertainty help the lay reader understand that conceptualizations are never exact, but can be more exact than other conceptualizations. This principle is, in fact, one of the cornerstones of scientific enquiry. When popular science writers engage readers in thought about uncertainty while maintaining rhetorical integrity and attempting to maintain accuracy, they challenge the two-culture dichotomy. Operating neither as academic science writers nor as writers of purely rhetorical or persuasion-driven work, popular science writers reject a position in either culture and instead create works of both social and informative value.

One literary method popular science writers adopt is to describe the scientific perspective as beautiful. Appreciation of beauty sways the lay audience to take pleasure in learning science and thus gain the understanding and inclination necessary to pursue science on their own. Often, this method succeeds, especially with young readers. Feynman first captured my interest in this way. Fourteen years old, I wandered through a library in my Oklahoma town and stumbled upon a book called *Feynman's Rainbow*. The passage on the back cover begins:

> "Feynman was gazing at a rainbow…"
>
> Author and fellow physicist Leonard Mlodinow approached Feynman and asked "Do you know who first explained the true origin of the rainbow?"
>
> "It was Descartes," Feynman replied. He gazed at the sky. "And what do you think was the salient feature of the rainbow that inspired Descartes' mathematical analysis?"
>
> Mlodinow didn't know. Feynman answered, "I would say his inspiration was that he thought rainbows were beautiful..." (Mlodinow, back cover).

Popular science writers elect to write about these perspectives, exposing broad audiences to biographical information. Inclusion of biographical or autobiographical information in popular science writing carries with it a literary mark: the story transcends any individual person's perspective, illuminating an insight about human experience—in this case, the pleasure attained in understanding a complex world.

One of Feynman's friends, an artist, once said that a scientist could not appreciate the beauty of a flower in the same way as an artist does. In "What Do You Care What Other People Think?", Feynman responded:

> First of all, the beauty that he sees is available to other people—and to me, too, I believe… But at the same time, I see much more in the flower than he sees. I can imagine the cells inside, which also have a beauty. There's beauty not just at the dimension of one centimeter; there's also beauty at a smaller dimension… There are all kinds of interesting questions that come from a knowledge of science, which only adds to the excitement and mystery and awe of a flower. It only adds. I don't understand how it subtracts. ("The Making of a Scientist" 13)

Through these remarks, Feynman conveys an appreciation of beauty that accompanies scientific discovery. People not yet exposed to the exciting aspects of science mistakenly perceive it as tedious and uninteresting, so Feynman wrote that a scientific understanding of the world exposes new levels at which beauty in nature can be appreciated. These literary touches in popular scientific writing create an air of literary culture in a genre of writing meant to convey scientific information and to exist within the scientific culture's realm. By integrating analogies, information, discussion of uncertainty, representations of beauty, and a generally inviting tone into a single class of writing, popular science writers blur the dichotomy of scientific and literary cultures despite evident epistemological conflicts. Their work has the potential to give insight into the foundational problems of academic tradition and to provide a precedent for future work in interdisciplinary and cross-cultural academic writing. In working towards a seemingly simple goal—to write about science to a broad audience—popular scientific writers, whether consciously or unconsciously, break free of a long-standing conflict in the culture of academia as a whole. Their words inform, but they also illuminate in the imagination a possibility of what awaits in future study, a possibility that excites the human desire to live and learn and thrive and be amazed. Feynman imagines a flower, but he sees more than a shape. He imagines a beach, but he sees more than grains of sand. He floats in the air under the moon and asks about the sloshing of the air, wondering, with a pen in hand: why?

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