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# 11

## A STUDY IN RHETORICAL READING

### HOW EVOLUTIONISTS READ

#### "THE SPANDRELS OF SAN MARCO"

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In a review of a recently published collection of essays by Stephen Jay Gould, L. B. Slobodkin, a professor of ecology and evolution at the State University of New York at Stony Brook, criticized the style of Gould's writing as essentially unscientific. His basic objection has to do with the intrusion of Gould's personality and beliefs into the writing: "One of the most difficult aspects of scientific work is reporting what one sees without having it colored by one's own preconceptions. It may be ultimately impossible. Nevertheless, in most scientific prose the author strives for clarity in the dual sense of expository simplicity and in making oneself transparent so that the empirical world is visible through the text but the peculiarities of the author are invisible" (Slobodkin, 503). As readers of this volume are doubtless aware, Slobodkin's stance, as a scientist reading scientific discourse, has a distinguished pedigree; it is strongly reminiscent of the position of Francis Bacon and other scientists of the early Royal Society, who condemned ornate stylistic devices, metaphors, and other figures, schemes, and tropes for at best merely obscuring matters and at worst swaying a scientist against his reason, and presumably against the empirical evidence, to believe in some specious claim (see Halloran and Bradford). Since at least Bacon's time, scientists have taken as their ideal a form of scientific discourse that is straightforward, objective, and dispassionate, discourse that confines itself to describing independently confirmable observations and drawing dispassionately logical conclusions from them. As such, generations of scientists have conceived of their discourse as standing outside the realm of rhetoric, the classical art of persuasion.

Slobodkin, like many others, has cast the issue in terms of prose style, as a matter of whether or not the writing is clear and simple.

Underlying many injunctions for clarity and simplicity, however, is the far more basic issue of the purpose of scientific discourse and how scientists are expected to read it and act on it. An extreme empiricist-positivist position would have it that we live in a stable, uncontroversial, empirically knowable world and that science consists of theory-neutral facts and logical inferences that any competently trained—read, *invisible*—scientist could produce. Scientific discourse becomes controversial, because, as fallible humans, scientists are apt to tinge, distort, and otherwise muddle their account of the world when they attempt to describe it in writing. Scientific language is meant to be a kind of windowpane, through which, if we keep it clean enough, we can see the world plainly (for similar accounts, see Bazerman, *Shaping Written Knowledge*; Miller, "A Humanistic Rationale"). In this view, the work of scientific readers is also quite simple: they need only comprehend a text, verify its technical accuracy, and integrate its results with their prior knowledge. The purpose of scientific discourse, then, can only be exposition, providing authoritative information—not argument. No rational person should require *persuasion* to accept an accurate description of the world. Rhetoric being therefore unnecessary, its use can only provoke suspicions of foul play.

Recent work by philosophers, rhetoricians, and sociologists of science, of course, has convincingly challenged the accuracy of this view, finding compelling evidence that science is in fact a richly rhetorical enterprise that reflects the complex, ambiguous, and probabilistic natural world that scientists and the rest of us actually inhabit (Bokeno). A wealth of rhetorical strategies have been found in constant use in scientific journal articles, proposals, and other standard forms of communication (Miller and Selzer, Fahnestock and Secor, Halloran and Bradford, Gragson and Selzer). Furthermore, ethnographers and sociologists observing scientists at work have found them quite adept (though perhaps unconsciously so) at weighing the appropriateness of specific rhetorical approaches for various audiences (Law and Williams, Myers; Latour and Woolgar).

As this research suggests, the aim of scientific discourse is profoundly argumentative and not merely expository; the goal is to persuade readers, to convince them of the validity and importance of the work, and to motivate them to acknowledge the force of the contribution by explicitly accepting and building upon it. The demands placed on the reader go well beyond simple comprehension and verification of neutral facts. As an equal participant in an argument, a reader is free to resist the writer's claims—even those claims that seem logically valid—by employing dissociation or devaluation or any of the other rhetorical tech-

niques open to the writer (Perelman and Olbrechts-Tyteca). In this context, the traditional impersonal scientific stance becomes just one more tool in the writer's endeavor to stave off a reader's potential challenges to the writer's ethos: the very features that make scientific discourse seem most impersonal, dispassionate, and objective themselves amount to a deliberate rhetorical strategy to convince readers of the competence, thoroughness, and caution of the scientist. Paradoxically, the scientific discourse that is most successful as argumentation may be that which appears most disinterestedly expository.

The question that arises, of course, is what happens when scientists encounter texts that violate these rhetorical conventions of scientific dispassion? What happens, for example, when evolutionists read Gould and Lewontin's "Spandrels of San Marco"? "Spandrels" can in no way be considered a piece of dispassionate, objective, scientific prose. As readers of this book will be well aware, Gould and Lewontin's article is basically an attack on the mainstream approach to evolutionary biology, the so-called "adaptationist programme," which seeks an adaptive purpose for each feature of an organism's physiology or behavior, an explanation that optimizes the organism's chances for survival through natural selection. Gould and Lewontin argue that the adaptationist program is reductionist, incapable of falsification, subversive of Darwin's initial intent, and ultimately unscientific.

As several other chapters in this book argue, Gould and Lewontin try to shake up their readers, to loosen their paradigmatic preconceptions, by employing a wide array of unusual discourse strategies. The title of the article itself initiates one of the most significant moves, an extended literary ad hominem, branding the adaptationist program as the "Panglossian paradigm." This insulting characterization equates the adaptationists in their predilection for optimization with Dr. Pangloss, the ridiculous figure in Voltaire's *Candide* who sees every disaster as being ultimately for the best "in this the best of all possible worlds"; the phrase recurs—replete with quotes from *Candide*—throughout the first half of the article (149, 151, 153). Other atypical discourse strategies in the article include irony, invective, allusions to high Western culture, explicit references to its own rhetoric—all the elements, in short, of a vigorous intellectual debate. "Spandrels" is an atypical piece of scientific discourse, one that almost gleefully flouts the strictures for a plain style, one that is overtly and unrepentantly tendentious, while science normally represents itself as disinterested. Yet the "Spandrels" article is clearly intended as a serious contribution to evolutionary science. How can we understand Gould and Lewontin's choice of a rhetorical stance that apparently accommodates their scientific audience so little?

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In their reader-response analysis of "Spandrels," Graggson and Selzer argue that Gould and Lewontin's rhetorical strategies invite scientists to depart from their usual reading strategies, to read as more than "mere" biologists, "to apply to the text the habits of mind of cultured intellectuals who are always ready for a lively debate. If scientists in fact adopt this role, the argument goes, then they might be more receptive to Gould and Lewontin's proposals. Halloran makes a similar argument in attributing some of the stunning effect of Watson and Crick's "A Structure for Deoxyribose Nucleic Acid" to its unusual rhetorical stance, in particular to the breezily confident ethos established by its authors. These text-based analyses describe hypothetical readers implied within the text and indicate ways in which real readers might approach it. But what of the real scientists who read "The Spandrels of San Marco"? Do they rise to Gould and Lewontin's rhetorical bait? Are they willing or able to abandon their "biological prejudices," to become the unconventional readers that the discourse requires? We cannot, of course, reconstruct with absolute certainty how scientists read "Spandrels" when it first appeared—though given the continuing controversy that the piece has inspired, we know that it was neither dismissed out of hand nor entirely successful in winning over its readers.<sup>1</sup> What we can study, as I investigate here, is how evolutionary biologists today read the article and, in particular, how they react to each of Gould and Lewontin's rhetorical strategies. Expressly because it departs from the conventions, "Spandrels" provides a particularly good opportunity to study how scientific readers cope with rhetorical strategies that generations of scientists have been trained to condemn as unscientific. For rhetoricians, this study also provides a valuable opportunity for illuminating how, and how well, the rhetoric of a specific scientific text works, in this case by means of tracing the responses of individual readers.

### Method

I asked scientists from Gould and Lewontin's intended audience to read and react to the "Spandrels" article. The participants were seven evolutionists: five ecologists, one paleontologist, and one anthropologist. Readers from several disciplines were selected because "Spandrels" is not aimed exclusively at readers within one of the specialized subdisciplines of evolutionary studies, but rather addresses the theory and practice of evolutionary biology broadly conceived. The participants varied in standing within the academic scientific community: four were graduate students (two master's degree candidates and

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two Ph.D. candidates) and three were faculty members (one postdoctoral fellow, one associate professor, one full professor). My goal in selecting participants was to get a range of different levels of experience and different disciplines within evolutionary science, rather than to find a fully representative sample. While it is often desirable in reading research to limit the participants' previous familiarity with a text, all of these participants were well acquainted with at least some of Gould's work, and most had heard of "Spandrels" previously. Given Gould's reputation and the article's controversial nature, it would have been quite difficult to find completely "naïve" readers, who would come to the text without preconceptions. And in fact, such an attempt would in some ways have defeated the purpose of this investigation into rhetorical reading. After all, argument rarely takes place between neutral parties who have no previous knowledge of their interlocutor or attitudes toward the issue in question; this is especially true when the parties in the debate are figures as well known and controversial as Gould and Lewontin. From the outset of this study, therefore, it was clear that the participants would read the article through the lens of history; they brought to it a wealth of knowledge and associations—both personal and professional—about the article itself, its subject matter, and its authors.

To enable observation of the participants' immediate reactions to specific rhetorical moves in "Spandrels," I asked the participants to read it using a method known as "thinking aloud."<sup>2</sup> This methodology is widely used in cognitive psychology to study skill learning and problem solving; within English studies, the technique is used by many researchers to study both reading and writing processes.<sup>3</sup> To perform the think-aloud reading, participants were instructed to read the text aloud and to say aloud whatever thoughts went through their heads as they read. Although I was present during the think-aloud session, participants were told that they should ignore me as much as possible, that the purpose of the commenting was not to explain the text to me but to come to terms with it for themselves. They were told that many people mumble comments to themselves when they read; in a think-aloud session, they were simply to raise the volume of the mumbling to an audible level. After these brief instructions on the purpose and method of thinking aloud, participants were given an opportunity to practice it on a brief passage of a separate text. The participants were then asked to use the think-aloud method to read "The Spandrels of San Marco," treating the text as they would any other journal article that a colleague had recommended. While the participants varied greatly in the amount of their commenting, none had any apparent difficulty with the thinking-aloud method.

The participants were not required to read the entire article, both because thinking aloud becomes fatiguing and because it provides such rich data that a sampling from the article was considered sufficient. After reading for thirty minutes, therefore, participants were asked to stop at the end of whatever section they had reached. Within this time frame, most managed to read about half the article. In an open-ended interview after the think-aloud reading, I asked participants about their backgrounds and their previous experience with the issues raised in the article, as well as about some of the comments they had made while reading. Both the think-aloud reading and the interview were tape-recorded and later transcribed for analysis.

The analysis of the participants' comments was designed to uncover how scientists come to grips with the argument of a text, reading not simply to understand the information presented on the page but to decide whether or not to believe it, whether or not it matters, whether or not to act on it. A secondary goal was to compare the comments of faculty members and graduate students in order to learn more about how scientists learn to read like scientists. It may be that scientists have characteristic habits of mind that they bring to their discipline (or that help them survive within it); if so, we would expect graduate students and faculty members to comment in similar ways. Conversely, as evidence from other studies suggests (e.g., Herrington), students may require acculturation to the strategies of scientific literacy. This study begins to address these questions by comparing the kinds and quantities of comments from different participants in the act of reading "The Spandrels of San Marco."

To analyze the participants' comments, I segmented the transcripts or "protocols" of the think-aloud sessions into continuous episodes. The episodes were not defined as sentences or clauses but rather as "units of concentration in the [reader's] process," following Flower and Hayes. A new episode began whenever the reader shifted focus, changed a train of thought, or set up a new plan. The final segmentation of the protocols produced 664 commenting episodes, or an average of about ninety-five comments per participant. These episodes were then categorized according to a coding scheme (figure 11.1) that includes categories both for standard reading comprehension processes and for higher-level rhetorical processes. One set of categories (drawn from those used by Olson and his colleagues and by Bereiter and Bird) reflected the participants' efforts simply to comprehend the text (involving such processes as rereading, paraphrase, inference, and prediction). Another set of categories, developed inductively by me from the comments observed in the protocols, was established for partici-

pants' evaluations of the text (agreeing or disagreeing; commenting on importance, relevance, or interest; drawing on prior knowledge). A final set of categories, also developed inductively, was for comments about the structure of the text itself, in which participants called attention to the genre of the article ("it's a pedagogic piece") or to the nature of particular sections ("this isn't really a conclusion"). The comments were coded twice with this scheme, once by me and once by an independent rater. The interrater reliability was estimated with Cohen's Kappa and found to be acceptable:  $K = .77$ ,  $N = 664$ .

*Comprehension Processes*

- Rereading  
A verbatim repetition of text already read
  - Paraphrase  
A restatement or summary of essentially the same ideas as in the text ("so when we fail to explain something by natural selection, then we just ignore it")
  - Inference  
A conclusion or implication warranted by the text but not stated there explicitly ("in other words, we are missing the point"), or a problem-solving episode to figure out what the text means ("neotenic" means it's retained in an early stage of growth and development. . . .")
  - Prediction  
A reference to or neutral comment about earlier information in the text, a prediction about what the text will be about, or a confirmation or withdrawal of an earlier prediction ("that's what I thought he was going to conclude")
  - Metacomment  
A comment about the reader's own understanding or lack of understanding ("OK, got it," "unfamiliar term"); explicatives or ambiguous comments ("OK," "Oh, Lord"; a comment about a plan for recovering from loss of comprehension ("better look at that again"))
- Evaluations of Content, Arguments, and Claims*
- Validity judgment  
An explicit assessment of the truth value or probability of an assertion ("OK, I can live with that," "yes, I believe that," "that's not true," "maybe," "bullshit")
  - Value judgment  
An explicit evaluation of an assertion's interest ("well, that's not surprising"), importance ("so what? "that's a good point"), or relevance ("oh, this is a very orthodox view nowadays," "a rather poor example, at least not a familiar one").
  - Reference to prior knowledge  
New information introduced by the reader, including opinions, interpretations, examples, criteria, or associations with respect to the text, the authors, the subject matter, etc. ("this is a very deterministic argument," "I can probably think of some examples here," "I wish I knew a little more of Aztec cosmology," "that's overly simplistic," "yeah, but how do you test that?")

## References to Text Structure or Genre

- *Intratextual*  
A comment explicitly identifying or referring to a structure within connected prose, such as the abstract, introduction, conclusion, summary, title, examples, wording, definitions ("this is really sort of a final discussion," "and here's the quote from David's article," "and this is still going on parenthetically")
  - *Extratextual*  
A comment indicating a search for or reference to a structure outside the connected prose, such as works cited, tables or figures, the journal citation line ("what's the date on this?" "any more figures?")
  - *Holistic*  
A characterization or comment on the text as a whole, its genre, goal, aim, or approach ("this is an attack," "OK, it's a pedagogic piece")
- Global Metacomments*
- *Metacomments*  
Comments on the reader's normal or habitual behavior ("I'd normally go look that up"), on reader's immediate behavior or circumstances ("this is a bad copy," "I should Xerox that actually," "I'm drifting from it"), or on current reading process or strategy ("OK... I'm just going to run through this paper")

Figure 11.1. Coding scheme for thinking-aloud comments

The data, consisting of the coded protocols and the interview transcripts, were analyzed both quantitatively and qualitatively. The analysis was designed to answer three questions particular to the rhetorical situation of reading Gould and Lewontin's article: 1. How did the participants go about reading the article? Is there any evidence that they accepted the textual invitation described by Gragson and Selzer to abandon their normal scientific reading strategies? 2. What aspects of the article provoked reactions from the participants? In particular, did participants react to the unusual rhetorical devices? 3. How did the participants react? Did they act as dispassionate logicians or inflamed partisans? On what basis did they accept or reject Gould and Lewontin's points?

### Global Reading Strategies

Before describing the participants' reading behaviors, I would like to consider briefly how we might expect scientific readers to approach this article. Gragson and Selzer's analysis of "the reader in the text," because it is based on the sequential unfolding of the argu-

ment, seems to presuppose that readers would treat the article like an essay or piece of fiction, starting at the beginning and working through each successive point to the conclusion. The shape of the text itself certainly seems designed to encourage such an approach. The paper opens with a carefully plotted series of nonbiological examples that leads readers to question the assumptions of the adaptationist program. In the first of these examples, alluded to in the article's title, Gould and Lewontin draw an extended analogy between salient traits in biological organisms and the decoration of spandrels in Gothic cathedrals. While an adaptationist looking at the ingenious and intricate decoration of the spandrels might conclude that they were "the cause in some sense of the surrounding architecture," that the cathedral was designed to enable their creation, any reasonable reader, of course, would conclude that the artist of the spandrels simply made good use of a space that resulted conveniently and quite accidentally from the constraints of the architecture. Gould and Lewontin's point is that biological phenomena, such as the color of a land snail, may arise from similar circumstances—not from adaptations to the environment. The spandrels example is followed by another in the same vein concerning the development of human sacrifice in Aztec culture. At the end of the series, Gould and Lewontin comment openly on their strategy: "We deliberately chose non-biological examples in a sequence running from remote to more familiar: architecture to anthropology" because in these cases the relative triviality of local adaptations would not be "obscured by our biological prejudices" (147). The sequence of major sections in the article was surely planned with equal care, with the intention of gradually accumulating doubt in the reader about the logic of adaptationist reasoning (Introduction and section 2), about the scientific validity of its results (section 3), and about its Darwinist pedigree (section 4). Only after introducing a long list of such doubts about adaptationism do Gould and Lewontin turn to a systematic exploration of the logical alternatives to adaptationism (section 5), ending, full circle, with a non-adaptive approach to the very types of "architectural" phenomena presented in the introduction (section 6). The careful sequencing of these points suggests that the argument of the text works in a linear fashion and consequently may depend upon a linear reading to achieve its desired effect.

Linear readings, however, are not typical behavior for real scientists. From the little research we have on how scientists read, we know that they typically read selectively, starting from their decision about whether or not to read an article or report in the first place. For example, in a survey of more than eight hundred engineers and research scientists

(mainly specializing in aeronautics) Pinelli, Cordie, and Vondran found that most respondents considering whether to read a technical report began by looking over its most general sections: the abstract, summary, introduction, and conclusion. In many cases, they stopped there—deciding that the report wasn't sufficiently relevant to their work. On those occasions when they went on to read the body of the report itself, the scientists again tended to read selectively; more than 90 percent reported reading the results and discussion, only 79 percent the research procedure, and a mere 67 percent the tables of data. The scientists also read parts out of order, reading the results before the experimental methods and the conclusions before either of those. Similar reading strategies were reported by the physicists whom Bazerman interviewed (*Shaping Written Knowledge*, chapter 8); they read relatively few articles in their entirety and almost none in order from start to finish. They also read selectively and purposively—some focusing on methods, some on theory, others on data. These global reading strategies reflect the small amount of time scientists have (or make) available for reading; like any other professionals, they rarely can devote attention to work that is irrelevant to their immediate purpose or their general research program.

Given that nonlinear reading strategies seem to be habitual for scientists, it would be surprising to find that the participants of this study read Gould and Lewontin's article in sequence. What I observed was a mixed bag. The least experienced participants—the four graduate students—all read in sequence. In contrast, two of the three faculty members—the two most senior ones—read nonlinearly. One faculty member began by previewing the organizational structure of the article; after reading the title, he leafed through the article, read the captions on the figures, noted the absence of a summary at the end, and then read the abstract and the introduction. When he reached the rhetorical question that ends the introduction, he again broke out of sequence, as shown in the excerpt below. (In this excerpt and other excerpts from thinking-aloud protocols, the text from "Spandrels" that the participant is reading at the time is represented in ordinary typeface. The reader's comments and observations are represented in italics. My observations in brackets. Excerpts from the transcripts of the interview, which took place after the thinking aloud was complete, are presented in a distinctive font. To preserve the anonymity of the participants, arbitrary two-letter codes rather than initials are used to identify the readers, while "DC" refers to me.)

AN: But we trust that the message for biologists will not go unheeded: if these had been biological systems, would we not

by force of habit, have regarded the epiphenomenal adaptation as primary and tried to build the whole structural system from it? Nope. Well, I don't know *Straw man? What else have they got?* [Leafs through paper] Part 2 is The Adaptationist Programme . . . Part 3 is Telling Stories . . . Part 4: The Master's Voice Re-examined. Right the [unclear] to Adaptationist Programme . . . 6. Another, and Unfairly Maligned Approach to Evolution. *That's the one they want to talk about. All right. Back to section 2.*

At that point, AN read through the remainder of the paper in order, except for occasionally turning to check citations in the list of references. In the interview afterward, it became clear that his previewing was a quite deliberate strategy to help him maintain his critical edge:

AN: OK, when I read a science paper, what I do . . . and what I'm always trying to get my graduate students to do . . . I read . . . I first find whether there's an abstract, a précis, or a summary and I read that first. Then I read all the legends to the tables and the figures. What I'm doing is trying to get keywords and concepts and things that will be there so that when I read the article it will not be the first time. . . .

DC: OK. So you said you didn't want to be victimized by [the text]. What did you mean by that?

AN: Well, I think if you go right into an article, and you read it word for word from the beginning, what happens is that you'll be pulled along by the author and you're not going to be critical . . . and you're going to be saying a lot of times: "Well, what is he saying? Oh yeah, I get that. And what's this word? And let me think about what's [unclear] modeling again." As opposed to, if you have an overview, then you can keep your critical faculty alive. And that's what science is about. That's, it seems to me, that's what scholarship is about . . . is the ability to say: "No, no, that's not true. Or what about this? Or why are they saying that?" I mean, like that incredible . . . I mean these tactics they use, when he quotes Voltaire and then all of a sudden there's a cut in there about the adaptationist program. I mean, you know, it's really kind of transparent.

Throughout his reading of the article, AN remained skeptical but open-minded. His comment at the end of the introduction indicates that he had not been completely convinced of the illogic of adaptationist reasoning by the series of analogical cases. As I will show later, AN quite strongly rejected the characterization of the adaptationist program as "Panglossian" as he read the article. The other senior faculty member, PA, also began by previewing the article. After reading the

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title and byline, he leafed through the article "to get an idea how long it is, because I usually have a class coming up." Then he read the abstract and looked for a conclusion. Not finding one as such ("This isn't really key, This is really sort of a final discussion"), he read the final paragraph of the final section before turning back to the introduction. PA did not explicitly associate his previewing with the ability to mount a critique—but he had no trouble maintaining a critical position.

Previewing is known to be typical of strong, active readers, as many reading researchers will attest (e.g., Mayer). Previewing facilitates a critical stance but is probably not imperative for it—I doubt, for instance, that AN would have bought the Pangloss characterization even if he had read the article in sequence. In any case, it is not difficult to see how a preemptive previewing strategy can undercut the rhetorical force of an article. Through such reconnoitering, readers have opportunities to undermine a writer's argument that audiences in many other rhetorical situations do not enjoy. Unlike the auditors of a speech, an active reader need not wait for the orator to unfold the argument. And unlike a participant in a face-to-face dialogue, an active reader gives the writer no chance to adapt and respond to his or her specific objections. The writer as represented in the text, can reconstruct the most desirable sequence for promoting arguments, but the reader need not follow it.

In addition to previewing, PA disrupted the line of the argument in an even more drastic way—by skimming. He explained his strategy in the interview:

PA: You can see that I'm not reading every little thing in detail. It's possible to tell what's going on, by skimming through some of his examples.

DC: Is that what you would normally do with this kind of article?

PA: Yeah. Yeah, I read it as I would be reading it if I were. . . . Now if I were to be giving a seminar where I was going to specifically criticize the article in detail, I would sit down and read it much more closely. But I'm treating this as a reprint or as something I've seen in one of the journals I regularly keep up with. I'm trying to get enough of what he said so that I know what's going on in the field out there. So it's not essential, for instance, that I know any of the details about mountain bluebird aggression. You know, but I'm looking at his. . . . at why he's introducing it and what he concludes out of it. . . . It's more important, for me anyway, in my own stage of development, to be able to look at the overall pattern of his argument and his thinking. And paying attention to the details, at least on this first skim through, would detract. . . . would just bog me down.

The fine points of Gould and Lewontin's argument had no chance to sway this scientist because he never read them.

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In contrast to the faculty members, the graduate students all read the main body of the article straight through. This behavior did not seem to derive from passive obedience to the instructions to read the article. Two of the four students (TO and OS) skipped the abstract, claiming always to read abstracts last. These students thus went out of their way to avoid over-viewing the argument. One of them (TO) apparently adopted this strategy expressly because of the argumentative genre of the article. He said in the interview that he would normally "flip around" more in a "data paper" but that in a "thought paper like this. . . . I would be more likely to read the whole paper, and then come back and read the abstract, and then do more thinking." So a linear reading does not preclude thoughtful critique. Several linear readers were quite capable of critiquing Gould and Lewontin's arguments—both positively and negatively. However, a linear strategy does indicate a greater willingness to follow the author's lead in this genre of scientific discourse. While the small size of the sample in this study precludes strong generalizations, the non-linear strategies of the more mature scientists may prepare them better to engage the writer's arguments.

### Provocative Aspects of the "Spandrels" Article

As they read "The Spandrels of San Marco," the participants were actively engaged in comprehending as well as reacting to the text. Table 11.1 shows the distribution of comments among the coding categories, separating out summaries for graduate students and faculty members. Not surprisingly, a major proportion of the participants' attention was devoted simply to comprehending the text. Any scholarly text requires its readers, even disciplinary experts, to exert some energy to understand it. "Spandrels" was no exception. In fact, the comprehension processes of the faculty and graduate students looked very similar. On average, a faculty member tended to make about the same number of comprehension comments as a graduate student (fifty-seven versus forty-four comments) and engaged in the same kinds of comprehension processes in about the same proportions (see the middle portion of table 11.1, a statistical comparison of the distribution of the comprehension comments showed no significant differences between faculty and graduate students). All participants encountered some unfamiliar terminology, both scientific (e.g., "orthogenetic") and non-scientific (e.g., "portcullis"), and most had to work to unravel some

Table 11.1. Distribution of protocol comments for graduate students and faculty participants

All comment types	Average number of comments per person		Proportion of total	
	Grads ( <i>n</i> = 4)	Faculty ( <i>n</i> = 3)	Grads (%)	Faculty (%)
Comprehension comments	44	57	66	42
Evaluations	19	59	29	45
Text structure/genre comments	3	12	4	9
Global metacomments	1	5	1	4
Overall	67	133	100	100
Comprehension comments				
Rereading	19	22	44	39
Paraphrase	6	10	13	17
Inference	4	8	8	14
Prediction	3	4	6	7
Metacomment	12	13	28	23
Overall	44	57	100	100
Evaluations				
Validity judgment	7	28	38	46
Value judgment	1	9	4	19
Prior knowledge	11	22	58	36
Overall	19	59	100	100

torious syntax. In general, the participants had little difficulty understanding the text—their numerous comprehension comments simply indicate good active reading habits: monitoring their understanding, anticipating what will come next, and clearing up ambiguities.

While the graduate students largely confined their reading activities to comprehending the text (fully two-thirds of their comments fell in the comprehension category), the faculty were deeply involved in commenting to grips with the text structurally and rhetorically. The faculty members' evaluations and genre comments were three or four times as frequent as those of the graduate students—the overall distribution of kinds and numbers of comments in the two groups was significantly different:  $\chi^2(3) = 39.2, p < .01$ . The graduate students' lack of evaluations does not seem due to their being overwhelmed by efforts to comprehend the text—as the similarity between their comprehension processes and those of the faculty attests. Rather, as will become apparent in the next section, the faculty's greater familiarity with the domain—and their greater stake in the debate—represented a stockpile of knowledge and attitudes against which they could weigh Gould and Lewontin's claims.

Not only the number but even the type of graduate students' evaluations of Gould and Lewontin's points differed from those of the faculty. As the bottom portion of table 11.1 indicates, while the graduate students primarily related what they were reading to what they already knew (prior knowledge), the faculty were significantly more often engaged than the graduates in assessing the validity and value of the text:  $\chi^2(2) = 14.9, p < .01$ . When graduate students did assess the truth value of the text, 84 percent of their comments indicated agreement with Gould and Lewontin. Faculty readers agreed 63 percent of the time. The faculty members often supported Gould and Lewontin's arguments with their evaluations (e.g., introducing more evidence or examples from their own domains of expertise), but they also frequently challenged the typicality of Gould and Lewontin's examples or their logic. In short, the activities of the two groups suggest that while both were capable of understanding the text, the faculty were much more willing or able to enter the rhetorical fray.

By sorting the evaluations according to location (i.e., the sentence being read just before an evaluation was uttered), I was able to identify a number of text segments that provoked the most numerous evaluations from the most participants. I will confine myself in this section to describing these "hot spots," leaving a more detailed description of the participants' evaluations to the next section.

In general, evaluations tended to cluster at structural junctures in the text, particularly at the beginnings and ends of paragraphs and sections. Typically, the most provocative segments were those in which Gould and Lewontin asserted some characterization of the adaptationist program. The single most provocative paragraph was the abstract, drawing a total of twenty-two evaluations, all from the three faculty participants. (For the article as a whole, the average number of evaluations per paragraph was eleven.) The evaluations of the abstract were concentrated largely around the second and third sentences, in which Gould and Lewontin give their definition of the adaptationist program ("It is based on faith in the power of natural selection as an optimizing agent. It proceeds by . . .") and the long sixth sentence, in which they present a list of charges against it ("We fault the adaptationist programme for its failure . . ."). The two next "hottest" locations were the opening paragraph of section 2 and the first full paragraph of section 3. The opening paragraph of section 2 essentially restates and elaborates on the abstract's definition of the adaptationist program. It drew a total of sixteen evaluations from six of the seven participants—from all but one graduate student. The opening paragraph of section 3 essentially characterizes the adaptationist program as incapable of empirical test



or falsification, a charge tantamount to calling it unscientific. This paragraph drew a total of twenty-nine evaluations from all three faculty and two of the graduate students. Other characterizations of the adaptationist program also drew numerous evaluations. In particular, at the end of section 2, Gould and Lewontin present a numbered list of four "common styles of argument" used by adaptationists. Five sentences—the last sentence of each of the four items plus the last sentence of the section that immediately followed—together provoked a total of twenty-four evaluations from all participants.

Two other "hot" locations deserve mention here, in both of which Gould and Lewontin draw explicit attention to their own rhetoric. In the penultimate paragraph of the Introduction, Gould and Lewontin heap scorn on the adaptationist view of Aztec cannibalism and tie this example to the spandrels example. This paragraph drew twenty evaluations from five of the participants. In the middle of section 2, Gould and Lewontin anticipate that readers may accuse them of caricaturing the adaptationist program after explicitly labeling it Panglossian. This paragraph (beginning "At this point, some evolutionists will protest . . .") drew twenty-one evaluations from five participants. The sentence immediately preceding this paragraph, which caps the characterization of the adaptationist program as a Panglossian paradigm ("Each trait plays its part and must be as it is"), itself drew six evaluations from five participants.<sup>3</sup>

While each participant reacted to different aspects of "Spandrels," the concentration of evaluations at these particular locations suggests that the participants recognized that the crux of Gould and Lewontin's argument is the validity of their characterization of the adaptationist program. As such, the article (at least the first half of it, which all participants read) amounts to an argument from the rhetorical stases of definition and value (Fahnestock and Secor). If Gould and Lewontin can demonstrate that the adaptationist program is inherently unscientific and therefore unproductive, then they create the exigence for changing to a different and presumably more purely scientific alternative.

### How Readers Engaged Gould and Lewontin's Arguments

In this section, I will describe in more detail the participants' evaluations of the article, focusing in particular on the "hot spots" identified above. The most complex commentary on the article was provided by AN (the faculty member who used the extensive previewing strategy), whose evaluations I will describe in some detail.

AN generally agreed with Gould and Lewontin's definition of the adaptationist program, as presented in the abstract. He accepted their assertion of the dominance of the adaptationist program in sentence 1 ("I guess that's true"), though in the next sentence he challenged their conflation of adaptationism with optimization ("Well, I don't know if that's true. Because optimization theory had not been at it for forty years"), and caught them a few sentences later in an important conceptual slide ("Optimization is not perfection. Anyhow . . ."). However, at the opening of section 2, when Gould and Lewontin reintroduce and elaborate the definition and explicitly apply the label "Panglossian paradigm," AN forcefully rejected it:

AN: It is rooted in a notion popularized by A. R. Wallace and A. Weismann (but not, as we shall see, by Darwin) toward the end of the nineteenth century: the near omnipotence of natural selection in forging organic design and fashioning the best among possible worlds. Oh shit. I don't know who the hell believes that. Who really believes that? If you asked them, put it to them that way? No one believes that, right? If you want to explain the appearance of the human knee or the human brain you go to natural selection, you don't go to genetic drift. We shall see.

He was equally emphatic in rejecting the Panglossian label later in section 2:

AN: The adaptationist programme is truly Panglossian. That's incredible. I mean there's a quote from Voltaire and then the next line is: "The adaptationist programme is truly Panglossian." You know he just quoted Voltaire, Voltaire is making Pangloss Panglossian. Our world may not be good in an abstract sense, but it is the very best we could have. Each trait plays its part and must be as it is. No, that's bullshit. I don't think adaptationists believe in that. Yeah all right here we go, let's . . . At this point, some evolutionists will protest that we are caricaturing their view of adaptation. Yeah, I think you're caricaturing their view.

AN's objection here is not a sign that he rejected Gould and Lewontin's arguments out of hand. In fact, AN agreed with Gould and Lewontin throughout the introduction—he saw the point of the spandrels example ("OK, so the point of that sentence is: here's something that was an architectural side effect, and when you see the whole structure you turn cause and effect around and start thinking that is what generates everything else. Right, makes sense, says it all"). He agreed with their interpretation of Aztec cannibalism—based on his own familiarity with the researchers whom Gould and Lewontin cite: "Ed Wilson would do that sort of thing because he doesn't know the details of anthropology or the issue," and "Who's

Hins? Ortiz de Montellano. [Turns back to references] Is that the chemist? Is that him? Aztec cannibalism: an ecological . . . Yeah, that's right in Science. A real good paper. It just shows it's a lot of bullshit." AN even accepted Gould and Lewontin's use of nonbiological examples in the Introduction as a way of avoiding biological prejudices: "In other words, we can see the argument that they're making really clearly. All right, fair enough. It's a pedagogic paper."

So what is the basis of AN's disagreement with Gould and Lewontin? In certain cases, he contradicted their statement of the facts. In others, he agreed with their description of what adaptationists do, but disputed the valence or significance of these activities. Several of these responses emerge in his evaluations of the opening paragraph of section 3:

AN: First, the rejection of one adaptive story usually leads to its replacement by another—*Yeah, because that's been a success in physiology and evolution for a century*—rather than to a suspicion that a different kind of explanation might be required. *Maybe*. Since the range of adaptive stories is as wide as our minds are fertile, new stories can always be postulated. *That's right. So what? They can be falsified*. And if a story is not immediately available, one can always plead temporary ignorance and trust that it will be forthcoming. *Well, maybe. I agree that might be what you would do*.

AN admitted that adaptationists explain traits with adaptive stories, but countered that that strategy is often successful. He admitted that adaptationists are reluctant to consider alternatives to natural selection, but denied that the cause is wrong-headedness:

AN: We maintain that alternatives to selection for best overall design have generally been relegated to unimportance by this mode of argument. *No, they've been relegated to unimportance because selection is more powerful. That's why*.

Further, he saw no harm in a succession of stories, since he claimed that false stories are easily discovered. He denied outright Gould and Lewontin's claim that adaptationist stories are untestable, and in fact threw this charge back at their preferred alternatives:

AN: We do wonder, though, whether the failure of one adaptive explanation should always simply inspire a search for another of the same general form, rather than a consideration of alternatives to the proposition that each part is "for" some specific purpose. *The question is: how do you test the idea of nonfunction? And the answer is: you can't. That's why you move from one adaptive explanation to another. You can test those ideas. Oh well*.

AN's interpretation of Gould and Lewontin's claims was similar in many ways to that of PA, the other senior faculty member. Like AN, PA ended up agreeing to some extent with Gould and Lewontin's descriptions of what adaptationists do. He conceded that adaptationists try a succession of stories but countered that "you try all the different possibilities and more stories is a reasonable approach." Significantly, he flatly denied that adaptationists only consider adaptive explanations, that they always replace stories with more stories. He responded to two of the "four common styles of argument" attributed to adaptationists as follows:

PA: If one adaptive argument fails, assume that another must exist. *Well, no, we don't really do that. If an adaptive argument fails, try another—agreed, like the first choice. But then not necessarily assume another must exist. It may be that after you've tried several that . . . that you conclude that none of them work and therefore this probably isn't an adaptive feature. And that's what been recognized ever since Rudeyng put out the paradigmatic approach to functional morphology in the late sixties*.

PA: In the absence of a good adaptive argument in the first place, attribute failure to imperfect understanding of where an organism lives and what it does. *Well, but that's true. We don't know what most organisms do in terms of life-style so that's a reasonable approach. But even so we don't automatically assume that there's going to be an adaptationist explanation*.

Thus like AN, PA admitted that Gould and Lewontin's alternatives are often ignored, but on reasonable grounds—not in principle:

PA: Under the adaptationist programme, the great historic themes of developmental morphology and Bauplan were largely abandoned. *Well, they were abandoned because they didn't pan out, in terms of evidence. While that doesn't mean they're totally wrong, it does mean that the emphasis on them in Europe may be misplaced*.  
OK.

In PA's alternative characterization of adaptationists, they are not nearly as inflexible and dogmatic as Gould and Lewontin paint them. While he conceded that some adaptationists have been unwilling to consider alternatives to adaptive stories ("that's a legitimate criticism"), PA reduced the significance of the problem by restricting its scope to second-rate researchers who unfortunately practice bad science:

PA: [I]f these had been biological systems, would we not, by force of habit, have regarded the epiphenomenal adaptation as primary and tried to build the whole structural system from it?

skimmed through the discussion of aggression in mountain bluebirds saying, "Yes, consistency is not necessarily a confirmation. I think I can probably come up with some invertebrate examples that would be similar." But as we have seen, both denied that adaptationist stories in general were equally ill-founded. Interestingly, it was a doctoral student in ecology, OS, who particularly from a "soft science" like anthropology. In the interview, he said, "I never like the examples that he [Gould] uses," believing that Gould "used this example [Aztec cannibalism] that he knows that nobody likes and that nobody would argue with him . . . so people will get distracted looking at the quality of the example and he can say whatever he wants in the point that he wants to make."

The representativeness of the examples was weakened more significantly in other ways. Some participants challenged the use of the *Tyrannosaurus* example, which even Gould and Lewontin acknowledge comes from the popular arena rather than the professional literature. In the interview, TO commented that the examples were not from "classic papers" that the mountain bluebird example would be more convincing: "It was some big landmark study or something that people had built on, built a great deal on and then, these same mistakes are made in studies like that too." Several participants commented that the examples were typical of Gould, that he uses the same cases in many other articles. Their position seemed to be that if Gould and Lewontin's general characterization of adaptationism were true, then a wider range of examples in the professional literature should be easy to find and include in this and other articles.

In sum, Gould and Lewontin failed to win over most of these readers to the strong version of their position. Only one participant, LO, a master's student, agreed with them down the line. In her protocol comments, she characterized the adaptationist positions as "deterministic" and "almost creationist." On the other hand, it is not clear that "Sparndrels" was what convinced her. She reported in the interview that she was already familiar with Gould's work and tended to "favor his views that the adaptationists are rather narrow, and they don't consider other explanations at all, and they fit their experiments into their preconceived ideas, and that's bad science to begin with." The other participants, regardless of their predispositions toward Gould (which ranged from sympathy to hostility), had a wider range of both positive and negative responses to the claims in the article. They resisted the generality of Gould and Lewontin's characterization of adaptationists, but most went further than PA to give them credit for increasing evolutionists' awareness of a wider range of possible explanations.

In closing, it is worth considering how the article's unusual prose style influenced these readers. All the participants were quite conscious—and sometimes wary—of Gould's facility with language. PA believed that Gould intentionally used style as a smoke-screen: "by couching, by cloaking all his arguments in elaborate words, most people would be intimidated and go along with him." But even those who were often sympathetic to Gould's position found his persuasive powers difficult to challenge:

KR: Gould is one of these people who writes extremely well. And it makes him very slippery. I have found myself disagreeing with Gould on points in popular articles and having the darndest time figuring out why. Because everything he said was so reasonable.

[Laughs]

While Gragson and Selzer suggested that the literary and cultural allusions in the introduction encouraged scientists to read as intellectual humanists rather than as "mere" biologists,<sup>10</sup> there is little evidence that these readers accepted the invitation. Several participants commented that the sequence of examples in the introduction seemed far removed from the subject of evolutionary biology. KR commented at one point, "I'm, should be getting to some biology here," and later, "I'm getting tired of this analogical reasoning." PA objected to the spandrels example even before completing the first sentence of the introduction:

PA: The great central dome of St. Mark's Cathedral in Venice . . . What the hell has that got to do with evolution and biology? Except to promote Steve's erudition [laughs].

But he also saw its point for evolution:

PA: Such architectural constraints abound. In a sense, the design represents an 'adaptation', but the architectural constraint is clearly primary. Well, OK, the obvious conclusion that he's going to come to, I think, is that the animal's anatomy represents an adaptation but what it's inherited from its ancestors is a constraint that's very important to understand. So, OK.

None of the participants knew what spandrels were to begin with, and all had to turn to the illustrations to follow the discussion. Only one respondent, LO, verbalized an association with other cultural contexts. After reading the definition of spandrels, she said, "I remember this from art history." Voltaire was slightly more familiar to these readers. As described previously, AN understood and emphatically rejected the Panglossian designation. At the beginning of section 2, KR noted, "They're, uh, smuggling in the phrasing from Voltaire here," and, after reading the quote on venereal disease from *Candide*, chuckled and said "oh dear." PA's response to the same quote was "Steve and Dick are being a bit

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*Perhaps an unsophisticated adaptationist would. But nobody who had some experience with real animals would have, if they had thought about it.*

PA: Second, the criteria for acceptance of a story are so loose that many pass without proper confirmation. Well, that's true. But on the other hand, that's hardly a telling point against adaptation. It's a telling point against being sloppy and simplistic in your thinking. Which is in part what he's doing here.

Finally, even after the concession of narrow-mindedness in this smaller group, PA denied the originality and importance of Gould and Lewontin's efforts to expose the problem by claiming that it had long since been recognized. To Gould and Lewontin's announcement in the abstract of their goal of reestablishing a focus on constraints that had long been popular in continental Europe, PA responded:

PA: *The sophisticated adaptationist in America has always thought this. This isn't something that has been ignored in America. But he's like a knight in shining armor trying to reintroduce, and against everybody else, with something that . . . to some extent he's not aware that everybody else has developed. [A bit later] In fact these things were already being talked about as long ago as early sixties. Nice that he's reemphasizing them, but he's not the only one who's thought about these things . . . in this way.*

It should be clear from these examples that these readers contested Gould and Lewontin's definition of the adaptationist program. The main points of outright disagreement concerned whether adaptive stories are in fact testable and whether adaptationists are willing in principle to consider nonadaptive explanations. Their own evidence, their experience that stories can be proven false, their acquaintance with adaptationists who are more broad-minded, is laid against Gould and Lewontin's rather absolute claims to the contrary. Even when these scientists conceded that Gould and Lewontin were accurate in their descriptions of some adaptationist practices, they ascribed quite different values to the practices—that's true, but it works; that's true, but only unsophisticated scientists do it; that's true, but it's not news; that's true, but it's no worse than your alternative. In essence, then, these scientists accepted as legitimate many of Gould and Lewontin's criticisms, but rejected the extreme form in which they were cast.<sup>4</sup>

Gould and Lewontin fail then to make a deductive case that adaptationists in principle are forced into unscientific methods. But this is not the only tack they take. They also try an inductive approach. In this context, Gould and Lewontin's use of nonbiological analogies in the

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Introduction and their choice of examples of inappropriate adaptationist stories become quite important. It is patently absurd to take the spandrels as the starting principle of Gothic architecture. Their argument in essence is that adaptationist stories are just as absurd. For the adaptationist program as a whole to be classed this way, as truly Panglossian, the examples of adaptive stories must be clearly ridiculous and must hold up as representative of the literature as a whole. Gould and Lewontin win the first half of this inductive argument—no one challenged the specifics of the examples themselves. But most participants resisted the inductive leap to generalize from the examples to the adaptationist program as a whole. At the end of section 2, for example, Gould and Lewontin ridicule the adaptive explanation of the attenuated front legs of *Tyrannosaurus* and explicitly link this example to those presented in the Introduction. At the end of this paragraph, a graduate student commented:

TO: One must not confuse the fact that a structure is used in some way (consider again the spandrels, ceiling spaces and Aztec bodies) with the primary evolutionary reason for its existence and conformation. I think that, while all of these examples are to the point they are, uh . . . not the way a lot of people do science. It would be very easy to find examples to the contrary.

Another participant, the postdoctoral fellow, while sympathizing with Gould and Lewontin's general position, found the examples less compelling:

KE: The examples are good, I mean they're very graphic. But they are caricatures, you know, in this case. Basically, the point of that is . . . "OK, here's a parallel that I want you to focus on here, its essentials, can you recognize that in biological cases?" Right, fine. The problem I always have with something as broad as this is that I don't think there is a single sin in the practice of science that hasn't been committed at least once. So just the fact that they can find an instance of it doesn't mean that the whole literature is like that.

He did not reject outright Gould and Lewontin's examples, but deferred judgment until he could look at the literature himself. The examples spanned so many disciplines that no one was familiar with the issues in all of them. Lyne and Howe found that Gould ran into trouble in other contexts when he stepped outside paleontology to make claims about other specialties. That did not seem to be the case here. The participants accepted this reasoning behind the rejection of each specific adaptationist explanation. In fact, the two senior faculty members each could verify the examples within their own domains or supplement them with others. AN knew the research on Aztec cannibalism, and PA

too philosophical here, rather than scientific. And I think they're blunting the sharpness of their attack by doing so." And, of course, the allusions went right by a number of readers. After one session, in which a master's student voiced no reactions at all to the introduction or to the allusions, I asked him if he knew who Dr. Pangloss was:

MA: Well, I had an idea . . . in the context of the reading. First I was going to go in more detail and ask myself, "Well, what is he exactly talking about?" But then, you know, that would probably be missing the whole idea. So, I mean . . . it goes more to, you know, their points of view rather than . . . Like at the very beginning when he was talking about the architecture of these buildings . . . I was kind of surprised he was talking about something like that. But, you know, then you can get kind of trapped there and try to explain to yourself something that is not as important as the rest of the article. So I just considered that as part of the illustration.

While the literary allusions seem not to have lured these readers out of a scientific approach to the text, neither did they cause the readers to dismiss the text as a whole as nonscientific.

### Conclusion

Could and Lewontin, in order to persuade evolutionary biologists to change their theoretical assumptions, explicitly employ unusual examples to draw them out of their "biological prejudices." Arguably, the tightly organized structure of the article itself reflects an attempt to disrupt normal patterns of reading and thinking, patterns that presumably would tend to support the current adaptationist line. However, the scientists whom I observed seemed not to be drawn out of their normal reading strategies. Most of them were good, active, skeptical, scientific readers who took a quite serious approach to the arguments in the text—though there is evidence that these skills develop with experience in the discipline. The most senior participants read nonlinearly, as scientists typically do. The participants as a group seemed to refuse the rhetorical gambit of the extrascientific allusions. They continually brought to bear their knowledge of science, of scientific texts, and of the specific scientific debate at hand. On the other hand, they seemed remarkably tolerant of the unusual rhetorical moves in the piece: only one called them "unscientific," many attributed them to Gould's well-known stylistic proclivities or to the genre of "think pieces," and a few simply ignored them.

The major clash between writers and readers concerned the way in

which Could and Lewontin attempted to characterize adaptationists. Did Could and Lewontin convince these readers that adaptationists in general are narrow-minded dogmatists who refuse to consider nonadaptive alternatives to their successions of far-fetched and unfalsifiable stories? Well, no. In their definition of the adaptationist program, Could and Lewontin attempt to demonstrate that *in principle* it forces scientists into the absurd stance of a Pangloss. But the scientists rejected some key premises—that adaptationists cannot ever consider nonadaptive explanations and that adaptive stories are unfalsifiable. The argument devolved to an inductive one that rested on the strength of the examples of inappropriate adaptive stories. At this point, Could and Lewontin came up against the classic difficulty of clinching inductive arguments. Yes, everyone admitted the validity of the examples; they acknowledged the analogical parallels and even supplied additional examples of the same kind from their own experience. But no one was willing to make the inductive leap to the generalization. They saw the examples as the product of second-rate scientists, as isolated "sins" of the kind that can be committed in any science, or as exceptions to the general success of the adaptationist program.

Does this study of readers' responses suggest that "The Spandrels of San Marco" was rhetorically ineffective? Certainly these readers found several ways to undermine Gould and Lewontin's rhetorical strategies. We don't often think much about the clash between rhetorically active readers and the rhetorical strategies of writers. Clearly, as a reader, the recipient of an argument enjoys distinct advantages that are unavailable to a listener in an audience or a participant in a dialogue. Readers have better opportunities to control the flow of the writer's argument, to scope out the writer's rhetorical strategies. Those who undermine the writer's rhetorical strategies may be uncooperative, but we cannot call them bad readers. (On the contrary, one is more apt to be critical of overly passive readers.) Nor does it mean that the text is rhetorically deficient. If we think of rhetoric in Aristotelian terms as the marshaling of the available means of persuasion, then it is obvious that *some* of the means of persuasion set out in this article did not work—at least for some readers. Could and Lewontin's use of extreme terms and claims did not convince these readers of the general claim, but they did evoke emphatic response. According to this response and to the historical record (documented by Winsor in chapter 7 of this book), "Spandrels" succeeded according to the standards of scientific discourse. It was not ignored. So although the article is perhaps not optimally adapted to its audience, it has indeed survived.

It is difficult to draw general conclusions about scientific discourse

from this study. "Spandrels" is an unusual piece, coauthored by scientific "stars" with well-known political and literary idiosyncrasies. The age and controversial nature of the article itself increase its atypicality. We cannot recreate the processes by which it was read in 1979, when it first appeared, in part because the article itself, Gould's subsequent work, and the work of his supporters and detractors have all influenced the nature of evolutionary science and thus any current readings by evolutionists. On the other hand, "Spandrels" is not at all atypical in its most essential qualities. Gould and Lewontin generalize about biological theory from empirical evidence in the standard scientific literature. This study suggests that scientists read such discourse rhetorically: they read as is convenient for their own purposes (they read parts selectively and out of order); they weigh the plausibility of claims and evidence; they struggle to understand unfamiliar technical terms; they cheer and get mad. In other words, they read their literature the way scholars in the humanities might read *PMLA*. This behavior seems so natural and so unremarkable that it is important to remember the special objective quality that some scientists have claimed for their discourse. If scientific discourse were really based on logical deduction alone, then readers should need to do no more than comprehend the text and integrate it with their prior knowledge, as the graduate students in this study tended to do. In fact, the more professionally advanced readers were more prone to treat the text rhetorically, as probabilistic argument about facts and values. They thought about who wrote the piece, where it was published, what kind of piece it is, the quality of the evidence, their own knowledge of the subject, and so on. This essay has explored the use of thinking-aloud protocols as a method of rhetorical analysis for scientific discourse. This method of analysis indeed illuminates the complex set of factors—prior knowledge, attitudes, motivation—that influence whether an argument carries for particular readers. The results of this exploration remind us that even the most well-conceived rhetorical moves in a text are gambits that have no guarantee of success. The normal reading strategies that scientists adopt, strategies that actively work to engage as well as to defuse the force of other strategies deployed by the writer, are themselves inescapably rhetorical.

## NOTES

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1. Reconstructing the response to any work of its "original readers" is the job of reception aesthetics, as pioneered by Jauss. An excellent example of reception theory, one that includes helpful references and background, is Mailloux's analysis of the reception of *Huckleberry Finn* (Rhetorical Power, chapters 3 and 4).

2. For a thorough discussion of the theory underlying the thinking-aloud method, its limitations, and the evidence for its reliability and validity, see Ericsson and Simon. For an introduction to its use in writing research, see Hayes and Flower. For other work in English studies on the responses of real readers to literary discourse—and other methods of turning up evidence of "readers' responses"—see Holland, Fish, and Bleich. For a good introductory overview of reader-response theory, see Mailloux's "The Turns of Reader-Response Criticism."

3. It is also interesting to consider these "hot spots" from the perspective of Latour and Woolgar's five categories for statement types in scientific discourse. Of the twenty claims by Gould and Lewontin that drew the most numerous reactions, half might be classified as type 4 statements (blanket assertions qualified by explicit "modalities" or hedges). Without categorizing the claims of the entire paper, it is impossible to say whether the seemingly high proportion of type 4 statements here is due to the nature of the article itself (i.e., Gould and Lewontin make a large number of blanket assertions) or whether the participants picked out and reacted to the strongest assertions. For a fuller treatment of this issue, see Dorothy Winsor's essay in chapter 7 of this book; it analyzes the entirety of "Spandrels" in terms of Latour and Woolgar's statement types.

4. Interestingly enough, Lyne and Howe found a similar tendency toward extreme dichotomizing in Gould's controversial publications promoting his theory of "punctuated equilibrium," and a similar moderating in published responses.

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