A Case Study of Reading in a Writing-Intensive Physics Course for Non-Majors

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Writing-intensive courses inevitably are to some degree "reading-intensive," even in physics. Surprisingly, though, we know little about reading in college science classes, even after decades of writing-(and reading)-across-the-curriculum course offerings. What little we do know traces in large part to studies, some decades old, about conceptual schemata, text structure, and the social construction of knowledge.[1] Particularly relevant here is Charles Bazerman's 1985 study, "Physicists Reading Physics: Schema-Laden Purposes and Purpose-Laden Schema," although his study focuses on professional physicists functioning in very different activity systems from those in which non-physics majors function when reading introductory physics texts. In this study of five college readers, I revisit Bazerman's study to look more closely at his discussion about "opening the black box," a discussion of what readers do when they are on uncertain ground. Even his expert readers tended to read more trustingly—less rhetorically—under those conditions. While Bazerman's 1985 social- and schema-based study leans toward macro-textual issues, this study leans toward micro-textual issues by comparing the ways five non-physics majors enrolled in a writing-intensive physics class read passages from two different physics texts addressing the same topic, energy conservation.

The Five Readers And Their Instructor

The five readers in this case study were enrolled in a college physics course for non-majors called "Concepts in Physics." The course satisfies a general education requirement for science, meets one of the two university-wide writing-intensive requirements,

and appeals to students who have some interest in physics but who may be intimidated by algebra- and calculus-based physics survey courses. The five students in the case study were majors in business, classics, English, statistics, and textile and apparel management, respectively. They shared some anxiety about math, but they differed considerably both in terms of their overall aptitude and their reading habits, in and out of school. Two considered themselves voracious readers, while two read little more than what they had to for class, and even that was not done carefully. Another was drawn toward non-fiction outside of class but only recently had begun taking academic reading seriously. Their tastes in reading varied considerably, as did their reading habits (such as re-reading interesting or troublesome passages).

Although the physics instructor is a seasoned professor, he does not teach the large-lecture calculus-based physics course that serves science (but non-physics) majors, partly because he is dissatisfied with the conventional methods for teaching introductory physics, methods that focus on coverage more than understanding. He is also dissatisfied with the fat physics books typically used in introductory physics courses, books that attempt the impossible by covering everything a little bit and nothing in depth. Instead, he seeks a narrow but deeper approach to teaching, one that complements the approach advocated in many writing-in-the-disciplines programs and by John Bean in *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking and Active Learning in the Classroom*. He frequently offers his courses as writing-intensive, not only when teaching the course for non-majors called "Concepts in Physics," but also when teaching courses for physics majors.

For the non-majors course, the instructor selected a text by MIT-physics-professor-turned-writing-teacher Alan Lightman, a text that explores four major concepts in physics in historical and cultural context. The book, *Great Ideas in Physics,* is structured very differently, both visually and textually, from other introductory physics books such as James Walker's commonly-used *Introduction to Physics.* In addition to using a text that honored

his narrow-but-deeper convictions, the instructor used a progression of writing assignments to develop the physics concepts treated in the course. The writing assignments are characterized in the course description as follows: "Through these assignments and their revisions, the students practice reasoning with and applying the concepts that they are learning. In order of increasing depth and complexity, the assignment types are: a report on a take-home minilab, a response to a conceptual problem, and a longer essay (2-3 pages) in which the students are free to select their own topic within guidelines."

The Study

Before describing the procedures used in this study, I will address issues related to text and to genre systems. Most of what Bazerman suggests in his 1985 study complements arguments he makes over the next two decades about reading and writing as activity and also about genre—as recurring typified events. In this study, too, I nod to a whole movement in genre studies that examines the reciprocal, dynamic ways in which students interact with texts in socio-historic context, but I resist insisting that the whole activity system must be the unit of analysis.[2] For more focused study of texts, I turn to work done in English for Specific Purposes and in educational psychology where small units of text or of arguments are considered appropriate for study, even though claims are conditional and heavily qualified. It is from these disciplines, primarily, that I find what little contemporary research there is on reading in content areas on the college level.

To focus on smaller units of analysis within a larger genre or activity system, I invoke a term coined by ecological psychologist J. J. Gibson, "affordances," a term that has been well recognized by other genre theorists and that will be explained below. By looking at textual units as "affordances," not as fixed, invariable structures, I contend that we can make provisional observations about the ways in which students (functioning in larger, complex activity systems) interact with particular textual structures.

From the perspective of activity theory and much other recent scholarship in composition, there are limits to the methods used here: an online survey, a read-aloud protocol analysis, and interviews, with some discourse analysis of the textual units in the two textbooks. Nonetheless, I believe that we need to use such research tools to make focused observations, however provisional, and that we can do so if we interpret our findings with keen awareness of socio-historic variation.

The five students in this study took a web-based survey about their reading habits before meeting with me for a taped read-aloud of passages on similar topics (conservation of energy) taken from two different physics books. The first book is James Walker's *Introduction to Physics*, a physics text commonly used in US universities and one that illustrates well textual principles for "clarity" and cohesion advocated by Joseph Williams and others. The other book is Alan Lightman's *Great Ideas in Physics*, the assigned text for the non-majors course and one that features stylistic devices used by novelists and historians, devices that might be appealing to students in the humanities.

Passages selected from each text were roughly matched for content, and study participants were asked to read them aloud, commenting on the texts as they read. Following the read-aloud protocols, students were interviewed about their specific reading experiences with these two texts as well as their general reading experiences in and out of school. To analyze the textbooks, I used as a proxy for principles of Hallidayan functional linguistics principles that Joseph Williams identifies in his book *Style: Ten Lessons in Clarity and Grace*. The surveys, read-aloud tapes, and interview responses were then coded and analyzed.

The Texts

The ten principles that Williams addresses in his book *Style: Ten Lessons in Clarity and Grace* were established by functional linguists and discourse analysts but popularized by Williams and by George Gopen and Judith Swan in their widely cited article "The Science of Scientific Writing." Arguably, the most important

principle below is number four, which is advice for creating textual cohesion between and among sentences, paragraphs, and larger units of text. It is cohesion, above all, that creates a text that strikes many readers as "clear." As functional linguists have noted, textual cohesion is created by establishing old or given information in the theme of a sentence, often the first part, while new information is reserved for the rheme, often the predicate of a sentence. In subsequent sentences, the given information at the beginning of a sentence leans back, linking to previously established "new information." Williams represents this principle in his fourth point and to some degree in points five and seven (point seven says "push new, complex units of information to the end of the sentence"). His ten principles are these:

1. Distinguish real grammatical rules from folklore.
2. Use subjects to name the characters in your story.
3. Use verbs to name their important actions.
4. Open your sentences with familiar units of information.
5. Begin sentences constituting a passage with consistent topics / subjects.
6. Get to the main verb quickly.
7. Push new, complex units of information to the end of the sentence.
8. Be concise.
9. Control sprawl.
10. Above all, write to others as you would have others write for you.

These principles are all evident throughout Walker's more traditional textbook, *Introduction to Physics.* Even though Walker consistently demonstrates these principles, he had never been introduced to Williams or his ten reader-based principles of style.[3] Instead of classroom teachers or writing books, Walker traces influences on his writing to his father and grandfather, as well as to nature writers such as Joseph Wood Krutch, Annie Dillard, and Edward Abbey, and later to other writers he admired. Walker admits to consciously thinking about things like using the active

voice and organizing information for the benefit of student readers.

Like Walker, Lightman is a physicist. But, as a writer, Lightman more actively straddles the arts and sciences, having published both fiction and non-fiction and having taught both writing and physics at MIT. He has published essays about science in a range of general-audience publications, including the *Smithsonian, The New Yorker, The Atlantic Monthly, Harper's Magazine,* and *The New York Review of Books*. One of his novels, *Einstein's Dreams,* was an international bestseller and has been widely translated. As both a reader and writer, Lightman has been influenced strongly by literary texts, which generally feature textual strategies that open rather than constrain interpretation.

Like Walker, Lightman demonstrates many of Williams' principles of style, but, arguably, to a lesser extent. Both Lightman and Walker demonstrate principles two, three, and six: Both writers tend to put characters in subjects and actions in verbs, resulting in heavy use of the active voice; both writers tend to get to the main verb quickly:

> "In this section, we consider the connection between heat and mechanical work." (Walker 510)
> "The British mathematician Brook Taylor (1685-1731) performed a number of experiments in which he *mixed* hot and cold water together and *was able to predict* the resulting temperature by assuming that heat *was* a conserved 'quantity.'" (Lightman 39).

Even in Lightman's longer sentence, the same principles apply: within each clause, the main verb comes quickly. Although both writers compose sentences that average the same number of words, Lightman struck some study participants as wordy, perhaps because he did not have short sentences in key places (introducing concepts) and he spent longer dwelling on historical asides. The two authors' average sentence length and use of active voice are similar.

What distinguishes their style, to some degree, are the principles most closely tied to clarity (cohesion) and to concision. Williams' principles four and seven, as described earlier, lead to textual cohesion, whereby sentences begin with backward-leaning familiar information and move forward with new information. The difference between Walker and William is less on the sentence level than on the levels of paragraph and larger section, where Walker's use of sub-headings reinforces textual cohesion and a hierarchical layering of information.

Another issue distinguishing their style is concision, represented by Williams' principles eight and nine. Lightman's average sentence length is no longer than Walker's, and the average sentence is about as dense with information (percent of total word count that are content words). Whether Lightman is concise depends not on number of words, however, but on both readers' and Lightman's purpose for engaging with the text. In *Great Ideas in Physics*, Lightman focuses not so much on current principles in physics as on the evolution of four main ideas, one of which is conservation of energy. He traces these four ideas through the millennia and shows in some detail the ways in which earlier thinkers like Lucretius anticipated some current findings. Lightman's approach appeals to buffs of intellectual history and to many readers who have posted positive evaluations on Amazon.com.

Nonetheless, given his focus on the history of ideas, Lightman tends to approach physics indirectly and inductively. He leads up to points on the sentence level as well: "Hot chicken soup in a pot, for example, doesn't leap out of the pot. Individual molecules move but are constantly changing directions, so that there is no net motion over time." (38) Readers are asked to think along, making inferences as they go. Indeed, in the introduction to a collection of essays, Lightman describes the importance of the reader's journey:

> When I'm reading a good essay, I feel that I'm going on a journey. The essayist is searching for something and taking me along. That something could be a particular idea, an

> unravelling of identity, a meaning in the wallow of observations and facts. The facts are important but never enough. An essay, for me, must go past the facts, an essay must travel and move. Even the facts of the essayist's own history, the personal memoir, are insufficient alone. The facts of personal history provide anchor, but the essayist then swings in a wide arc on his anchor line, testing and pulling hard ("Introduction," *Best American Essays 2000).*

However, when the goal of reading his text is learning the facts, learning physics as it is understood today, the more meandering style may create extra hurdles for the reader. It is an open question whether the textual hurdles impede a reader's clear understanding of the text or whether they challenge the reader to slow down and process the text more thoughtfully.

Differences can be found not only between Lightman's and Walker's textual styles, but also between their visual styles. Lightman's text *Great Ideas in Physics* has a few figures but not many. The text dominates nearly every page with little white space. In contrast, Walker's *Introduction to Physics* has a great deal of white space and makes use of visual design to direct the readers' attention to key issues: As already suggested, a hierarchy of subheadings reinforces a hierarchy of "important" textual information. Other important information is flagged via change in font, color, and placement on the page. For example, equations are set off with italics and prose labels with bold print. Sub-headings are printed with a separate color. Side-bars and supplementary information are put in boxes with different color background. Problem-solving steps have labels in another color.

Moreover, some side-bars have text that models meta-cognitive thinking. Following a word problem are steps for solving it, labeled in predictable ways (according to a four-part standard pattern):

1. "Picture the problem" (with an image and colored arrows and labels)

2. "Strategy" (a short paragraph in narrative form explaining a thought process to solve the problem)
3. "Solution" (broken down into five numbered steps)
4. "Insight" (explains the implications of the calculations; unpacks what relationship is suggested between two things such as translational and rotational energy)

So pattern and repetition are used as visual and textual cues for directing readers' attentions to particular issues.

While Lightman made little use of these visual and textual strategies, he did use narrative techniques that readers might find engaging.

Reading

Perhaps ironically, the students in this small study who expressed the most apprehension about physics preferred Walker's more controlled and cohesive style, not Lightman's humanistic style.

This may not be surprising when we think about the conditions under which a reader may want to submit to authorial direction. The five readers in this study may, for other purposes, prefer texts that give them license to fill in the gaps, to think for themselves, but, given their purpose here, may not want the responsibility of filling in too many gaps. This, too, complements Bazerman's findings *when* the physicists interviewed felt particularly unfamiliar with a topic. Under ordinary conditions (for them), the expert readers he interviewed read physics articles non-linearly and critically, focusing on elements of the article that addressed their own research interests. After noting that the physicists use different reading strategies for different purposes, though, Bazerman says, "In filling in one's ignorance, one is likely to read trustingly and un-critically" (245).

It is possible that some textual structures facilitate an uncritical reading, styles that manage—even control—information for the reader by placing it in hierarchies (where main claims come before subordinate claims and supporting explanation) and by using

principles of cohesion that make the writing seem more clear. As suggested earlier, it is possible that the very textual structures that facilitate "clear understanding" also reinforce a reductive, uncritical reading, but it is also possible that some readers are unmotivated or unprepared to benefit from the textual structures that do facilitate a slower, more thoughtful, and potentially critical reading of the text.

Following are excerpts from the read-aloud passages with embedded comments from three of the five readers. Of the five readers, student "one" (see number in parentheses below) was the least comfortable with physics and the least comfortable with reading in general. The other two readers made comments about other parts of the larger passage but did not have comments about this three hundred and fifty word excerpt.

Excerpt A: Walker's Text.

Three hundred and fifty word passage from Walker's text (small part of the reading sample) with three readers' embedded comments

In this section we consider the connection between heat and mechanical work. We also discuss the conservation of energy as it regards heat. **Again, I really like it in science books and history books and maybe in anything I don't really understand a lot of the material when they sum it up in the beginning—and with the titles of the sections and the topic sentences, I can go back and see, like, what's the connection between this and "heat and mechanical work" or between whatever and the laws of conservation. And then I can go from there. (1)**

As mentioned previously, heat is the energy transformed from one object to another. At one time it was thought—erroneously—that an object contained a certain amount of "heat fluid," or caloric, that could flow from one place to another. This idea was overturned by the observations of Benjamin Thompson (1753-1814), also known as Count Rumford, **Okay. I really like that that just in the**

first two sentences he's way more concise. I don't know exactly who the intended readers are, but for someone who's not in the sciences, sentences like these that are short, concise, and to the point really help—work much better than what Lightman was doing in that particular text. Okay, [repeats beginning of sentence . . .] (1) the American-born physicist, spy, and social reformer who at one point in his eclectic career supervised the boring of cannon barrels by large drills. **This might seem hypocritical, but THIS author has my attention a lot more. Maybe Lightman included that he [Rumford] was a spy, but he [Walker] just provides a very brief overview, which I find interesting. Let me know the beginning of this law. It's interesting.** (1) He observed that as long as mechanical work was done to turn the drill bits, they continued to produce heat in unlimited quantities. Clearly, the unlimited heat observed in boring the cannons was not present initially in the metal, but instead was produced by continually turning the drill bit. **So having already seen this, I don't find it confusing at all. It shows that we didn't need the quotes we had before. Lightman and Walker's presentation of this may be understandable to the same degree, but if you have as a goal presenting information in textbook form for people to study then this is more effective, I guess. (2) I perfectly understand what he's trying to get across. That small section with a brief summary deals well with what Thompson did—we don't need his actual words, we need this: the actions involved, the end results. He's doing exactly what I called for earlier, a paraphrase of what happened and what the results were without feeling it necessary to include an actual long, original narrative that has superfluous information in it. (3)**

With this observation, it became clear that heat was simply another form of energy that must be taken into account when applying conservation of energy. **Right there in that sentence, he summarizes what the point of it was, which I didn't get from Lightman, at least as far as I read. In one short passage and in that sentence, to me, he has explained everything that Lightman tried to do in a page and a half. (3)** For example, if you rub sandpaper **Okay. What I'm about to read is already really good because he explained in one really short sentence where the law originated from and he provided some interesting facts about that person, Count Rumford, and he explained what he discovered and then immediately in the next paragraph applied it to something that would make more sense to someone like me, rubbing sandpaper (1)** back and forth over a piece of wood you do work. The energy associated with that work is not lost; instead, it produces an increase in temperature. Taking into account the energy associated with this temperature change, we find that energy is indeed conserved. In fact, no observation has ever indicated a situation in which energy is not conserved. **That was a very concise, very comprehensible passage. That was very easy to understand, as opposed to the long passages in Lightman. This had just one simple allusion. It's good. (2) In talking about the conservation of energy, he connected the cannon barrel point with something else that makes it really clear, more readily accessible. He's taken something mundane but readily accessible and connected it with the original idea . . . he used an idea that I can relate to. (3)**

The equivalence between work and heat was first explored quantitatively by James Prescott Joule (1818-

1889), the British physicist. In one of his experiments, Joule observed the increase in temperature in a device similar to that shown in Figure 16-8. Here, a mass *m* falls through a certain distance *h,* during which gravity does the mechanical work *mgh*. As the mass falls it turns the paddles in the water, which results in a slight warming of the water. By measuring the mechanical work, *mgh,* and the increase in the water's temperature, *delta T,* Joule was able to show that energy was indeed conserved. It had been converted from gravitational potential energy to heat, and an increased temperature.

Excerpt B: Lightman's Text

Three hundred and fifty word passage from Lightman's text (small part of the reading sample) with three readers' embedded comments.

It wasn't until the nineteenth century that the nature of heat was understood. Before this time, many people thought heat was a fluid, called caloric, that could be passed from one body to another. The fluid hypothesis appeals to common sense. When a hot body touches a cold one, the hot body cools and the cold body grows hotter, as if some substance were being passed from one to the other. The British mathematician Brook Taylor (1685-1731) performed a number of experiments in which he mixed hot and cold water together and was able to predict the resulting temperature by assuming that heat was a conserved "quantity." **Okay. Whenever—especially—I don't know. I'm not a big history fan and whenever he's going into this history of whatever happened hundreds of years ago that doesn't apply to me my level of attention to what he's giving me just goes down. Even—I don't have to read, but I can see looking down seven or eight lines, he's still talking about some Scottish guy—and then I can see, I'm just doing this for amusement now, Benjamin Thompson in 1753 and then in 1798 there's a Count**

Rumford. So it seems like for the rest of the chapter he's going to do to the reader what he just did with the "Conservation Laws and Human Freedom" section—and then we'll be back in the next section to information about heat where he's concise and gives us an equation if it's necessary. (1) Summarizing his results, he wrote, "Having first observed where the thermometer stood in cold water, I found that its rising from that mark, or the expansion of the oil, was accurately proportional to the quantity of hot water in the mixture, that is to the degree of heat." The Scottish scientist Joseph Black (1728-1799), a founder of modern chemistry and pioneer in the study of heat, referred to heat as "distributing" itself in a body and wrote that different bodies with the same temperature and same mass may nevertheless have "different quantities of the matter of heat."

Although a number of scientists had hypothesized that heat was motion rather than substance, much of the credit for firmly establishing this view goes to Benjamin Thompson (1753-1814). At first a schoolteacher in Rumford (now Concord), New Hampshire, Thompson served in the American army at the beginning of the Revolutionary War but fled to England after the fall of Boston. Highly successful in European government and military circles, he became head of the Bavarian army and was named Count Rumford by the Bavarian duke. The multitalented Rumford recounted the following in an essay read before the Royal Society of London in 1798: **This seems completely tangential now. I don't see how this could be used to teach any kind of concept. It would be very difficult. There's all this information but all you really need to know for purposes of this course is a basic principle. (2) The same thing with the Lucretius passage: Why have this original text? To me, this is superfluous. But if you wanted to**

include this portion of history, he could have done it in a much shorter paraphrased passage that would get the idea across without padding the text that he's included here with another page for his publisher. That's all I see this being. (3)

It frequently happens that in the ordinary affairs and occupations of life, opportunities present themselves of contemplating some of the most curious operations of Nature; and very interesting philosophical experiments might often be made, almost without trouble or expense, by means of machinery contrived for the [. . . followed by a 750 word passage from Rumford].

By degree, then, the five readers (three documented above) affirmed most of Williams' claims for clarity: They did tend to find more "clear" those passages that demonstrated Williams' principles, particularly the "old/new" principle for cohesion (on paragraph as well as sentence levels). Clarity mattered considerably when reading for information, especially information they found challenging.

The five readers also affirmed Williams' claims for concision. All commented that Lightman was, relative to Walker, wordy, and several students found that annoying.

The readers who most appreciated the clarity of the Walker text also depended heavily upon both textual and non-textual design features that accentuated hierarchy or layering of information, features that directed attention to the most important concept or point in a passage. These readers tended to go back to subheadings and topic sentences for cues if they found themselves lost in a passage, and they did make active use of the "look here" message coded by changes in color, font, numbered principles, and shaded text boxes with supporting information.

Interestingly, those readers who read the text selectively for their own purposes (who read strategically and rhetorically) were not necessarily the best students of physics. Their motive for skipping around was quite different from those of the physicists in

Bazerman's study who had a well-established schema for physics-as-understood-today and who were reading selectively for new or interesting information or for information that was particularly relevant to their own research agendas. The weakest physics student's motive for reading selectively, in contrast, was to make use of the cueing system just described. Other readers who were insecure with physics but who seemed to have well-established study habits, like Bazerman's physicists, read linearly and trustingly, although they would re-read and talk themselves through passages they did not understand at first. Ironically, then, those who read the most strategically were at both ends of the novice-to-expert spectrum: The least informed read strategically simply to find some textual life buoys, while the most informed (in Bazerman's study) read strategically for critical purposes. Greater agency for strategic reading may be a function not of *few* knowledge-based constraints but of extensive (knowledge-based) constraints, suggesting that closed and open reading may be coupled, not opposed to each other.

Again, while Walker was seen as clear, he was not uniformly valued. The very textual features that made Walker's text so clear and concise made it (for two readers) dry, and those readers appreciated Lightman's digressions (even if the digressions did not help them understand physics). That is, they found Walker effective for their primary purpose (understanding physics), but they did not like reading him more. These two readers were the most widely read in general and were most apt to re-read passages they found interesting, provocative, or unclear. Moreover, all of the students acknowledged that they do not tend to read textbooks like Walker's unless they are required to do so. All the clarity in the world may be for naught if a text is not read.

Seeing Textual Cues As Affordances

Other studies of text suggest that readers process information more easily when it is structured with old, familiar ideas preceding new less familiar idea. In their 1980s studies of expository text structure, Dixon et al and Dee-Lucas and Larkin

found that goal-oriented, hierarchical structures organize information in ways that direct readers' attention and help them mentally organize and remember propositions. More recent studies in English for Specific Purposes suggest that non-native readers of English benefit from science texts with similar hierarchical structures (Huang 2006). And, recent studies in cognitive psychology suggest that readers remember information better when claims precede reasons (Britt and Larson 2003). If, though, both reading and writing are understood as heavily mediated literate activity taking place within activity systems, then it becomes difficult to make generalizations about textual units.

It is here, then, that I turn to Gibson's concept of "affordance," a feature of his ecological theory of perception. Frustrated with dualistic theories of perception, theories that separate too cleanly the perceiver from the object of perception, Gibson developed an ecological theory that describes animals functioning within niches and what they perceive as "affordances," something mediated by both their own subjectivity and the external world.

Gibson defines "affordances" this way:

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment (127)

For Gibson, neither cognition nor perception entail direct, unmediated observation of "the world." What is perceived is mediated by a number of factors both in the knower and in the knower's environment, and this can be applied to textual units, where the textual unit is not directly perceived. Textual cueing strategies, understood as affordances and not as fixed structures, will be perceived differently by different readers, even if we can

identify the potential of a particular textual strategy to impress many readers in a given way.

Different textual niches are not fixed places but sets of affordances used in various ways by various readers. As Gibson continues, "an affordance is neither an objective property nor a subjective property; or it is both if you like" (127); it is something distinct from the physical or invariant qualities of an object.

> But I now suggest that what we perceive when we look at objects are their affordances, not their qualities. We can discriminate the dimensions of difference if required to do so in an experiment, but what the object affords us is what we normally pay attention to. The special combination of qualities into which an object can be analyzed is ordinarily not noticed. (134)

Like contemporary genre and activity theorists, Gibson echoes Ludwig Wittgenstein, who understood that language can be used in various ways without being fully understood: "You do not have to classify and label things in order to perceive what they afford" (134). A researcher might identify a set of qualities related to some textual units, but those qualities do not directly correspond to the "affordances" that are perceived by various readers.

Conclusion

Viewing textual features as "affordances" is to see them rhetorically: While some textual features do layer information, create cohesion, and control the readers' attention more than other textual features, these textual features will be mediated by other factors and will not have a uniform effect. That is, while Williams' ten principles of style describe textual features that many readers do find "clear" and "cohesive," much depends on the writers' purpose for reading, reading habits, and background knowledge. The five readers in this small study reinforce the idea that Williams' principles are most applicable for expository texts read primarily for information, not for aesthetic purposes. Even

when reading for information, some readers preferred other, more open-ended textual features.

Notes

[1] For early schema-based research, see studies citing Rumelhart (1975), Stein & Glenn (1979), and Spiro (1980); for pragmatic studies of text, see studies citing functional linguists including M.A. K. Halliday (1978); and for early studies of the social construction of knowledge, see studies citing Ludwik Fleck (1935), Thomas Kuhn (1962), Bruno Latour (1979), and Charles Bazerman (1988), among others.

[2] See genre studies by John Swales (1990), Carol Berkenkotter and Thomas Huckin (1995), Ann Johns (2001), Brian Paltridge (2001), among many others. Other socio-historic and activity theorists influencing this study are David Russell (1995, 2001), Paul Prior (1991, 1994, 1998, 2004), and Charles Bazerman's more recent work (2002, 2003, 2005).

[3] As commented in correspondence with the author.

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