PICTURE A SCIENTIST:
A VISUAL RHETORIC APPROACH TO THE PROBLEM OF GENDER
DISPARITY IN STEM FIELDS

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By
Holly M. Wells

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Dissertation written by
Holly M. Wells
B.A., Youngstown State University, 1984
M.A., Youngstown State University, 2001
Ph.D., Kent State University, 2012

Approved by

Sara Newman, Professor of English
Chair, Doctoral Dissertation Committee

Raymond A. Craig, Professor of English
Member, Doctoral Dissertation Committee

Derek Van Ittersum, Assistant Professor of English
Member, Doctoral Dissertation Committee

Laura G. Leff, Professor of Biology
Member, Doctoral Dissertation Committee

Mandy J. Munro-Stasiuk, Professor of Geography
Member, Doctoral Dissertation Committee

Accepted by

Robert W. Trogdon
Chair, Department of English

Raymond A. Craig
Dean, College of Arts and Sciences
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*Trust in the LORD with all thine heart; and lean not unto thine own understanding. In all thy ways acknowledge Him, and He shall direct thy paths. (Proverbs 3: 5–6)*
Summary

The dissertation argues that images in some middle school science textbooks represent females and males inequitably, both in number and in power relationships, and examines the extent to which this bias may contribute to middle school girls’ loss of interest in science fields as potential careers. Using an analysis method comprising elements of theories from Finnegan (2001), Kress & Van Leeuwen (1996), and Fahnestock (1999), the present study finds that images in three seventh-grade science textbooks are naturalistic or a combination of naturalistic and abstract, meaning they are easily accepted by viewers as realistic. Further, the study finds that these visuals argue enthymematically as a result of their realism, and that the arguments they make are repeated throughout entire texts. Many of the visual arguments made in these textbooks perpetuate endoxa of Western cultural gender stereotypes and thus are not positive for women and girls interested in pursuing STEM careers.

Keywords: visual rhetoric, naturalistic enthymeme, endoxa, enthymeme, science, gender, feminism, STEM
Chapter 1: Statement of Problem and Literature Review

In December 2008, the National Science Foundation (NSF) updated statistics on race, gender, disability, and marital status of people in science, technology, engineering, and mathematics (STEM) careers, from business to academia (National Science Foundation, 2011). While more women are entering the traditionally male STEM careers, the numbers are still well below those of men. The NSF considers this disparity a serious problem, offering grants to support research to help solve it (ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers [ADVANCE]). But without a firm understanding of where the problem begins, researchers are finding it difficult to make changes that will successfully bring more women into the STEM fields.

According to the NSF, women are vastly underrepresented in STEM careers in both business and academia, with fewer than 35% of jobs in both areas; when they do work in academia, they are more likely to be postdocs or adjuncts, both of which are lower-paying and lower-prestige careers; and in almost every job category, they make

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1 It is important here to clarify my use of STEM throughout this dissertation. At times, it may appear that I am using “STEM” and “science” interchangeably. However, I have several reasons for switching back and forth. In some cases, research I am citing examined only sciences, and in others, all of STEM. In the case of classroom research, engineering and technology courses are not common (especially in the middle school years), so research usually comes from science and/or mathematics courses. I have attempted to be specific about the subject(s) being discussed in each instance.
significantly less money than men. However, many young girls may not know this: I asked 24 high school girls involved in a science education program entitled Igniting Streams of Learning in Science (ISLS) whether they thought women were underrepresented in STEM fields. Nearly half of those surveyed responded either that enough women were pursuing STEM careers, or that they were not sure. While this is hardly a scientific study, the results are interesting because the subjects had been in ISLS for ten months and were perhaps more aware of issues in the field than average high school juniors and seniors. The fact that 11 of 24 girls in a science program were not aware of the gender disparity issue should concern educators and employers all over the country.

**Importance of the Problem**

**Gender Stereotyping in STEM Fields: How Do We Know a Problem Exists?**

A quick glance at the NSF statistics on gender and STEM fields is enough for most researchers to conclude a problem exists. While an exhaustive listing of all the ways in which self-identifying females fall short of males in STEM careers (e.g., in sheer numbers, salaries, levels of unemployment, etc.) would take too much time in this document, here are a few examples:

- Women represent only about 34% of scientists and engineers in business and industry.

- Women represent only 32% of STEM Ph.D. holders in academia.
Women are far more likely to be unemployed, and to cite family responsibilities as the reason for their unemployment, in STEM careers.

Women earn less than men across the board in STEM careers. The average salaries for all STEM careers/all degrees are as follows: women, $53K per year; men, $75K. According to the NSF, these averages control for level of education, position, and other variables, to ensure that the statistics are truly “comparing apples to apples.”

But how do we know the disparities are the result of gender stereotyping? Much research supports this conclusion (see, e.g., Whyte and Byrne, 1986; Kelly, 1981; Volman, et al., 1995); this research is elucidated in the literature review.

Assuming, then, that gender stereotyping may be at least partly to blame for the unattractiveness of STEM careers to girls, the questions of where to find this stereotyping, and how to overcome it, become relevant.

**Purpose and Scope of the Study**

The current study approaches the problem of why girls are not attracted to, or do not stay in, science courses (and later careers) by investigating images of females in STEM careers. Though exposure to images is but one piece of a much larger puzzle—the puzzle of why girls so infrequently pursue STEM careers—it is an important one. We know now that girls make decisions about whether to pursue science careers when they are quite young—somewhere in the middle school years, when for many who are concerned primarily with their image as a good student with good grades, science can appear
intimidating and risky (Carlone, 2004). Thus, it is important that research focus on images to which girls in this age group are routinely exposed.

A review of recent literature on gender in children’s books, including picture books and textbooks, exposes that, although some improvements have been made, inequalities still exist in both the number of women (vs. men) represented and the kinds of activities and occupations women (vs. men) engage in as illustrated in these books (see e.g., Turner-Bowker, 1996; Schau and Scott, 1984; Evans and Davies, 2000; Kelly, 1985; Sadker and Sadker, 1994; Elgar, 2004; Whiteley, 1996). Studies have also been conducted on the use of gendered language in textbooks (see e.g., Porreca, 1984; Harrison and Passero, 1975; Poulou, 1997; and Campbell and Schram, 1995). However, little research exists in the area of visual rhetorical analysis—that is, in closely examining graphics in science textbooks or electronic resources to determine what those graphics are arguing, and how. The few existing studies have not focused on gender as a variable (e.g., Dimopoulos, et al., 2003); similar studies that have focused on gender (Kelly, 1985; Bazler and Simonis, 1991) have simply counted the appearances of each gender and tracked the roles of the subjects. Thus far, research has not scrutinized the gendered relationships depicted in textbook photos and graphics.

Why is the image important to a study of gender and career choices? On the surface, it may not seem likely that young people choose their careers based on pictures they have seen; however, we know now that the media do influence people’s perceptions of science and scientists (see e.g., Steinke et al., 2007; Steinke, 2005, 1997), as well as perceptions of gender and gender roles. For instance, a study of children’s science
television shows (Steinke and Long, 1996) demonstrated that men appear twice as often as women in scientist roles, and that women are much more likely to be assistants, apprentices, students, or science reporters than science experts. Steinke and Long (1996) argue that children in particular may be influenced by images they see in the media because they are still developing the ability to interpret the world around them, and because they are exposed to abundant mass media sources before starting school. Supported by a large body of evidence (including studies of children’s books, textbooks, and other media), it is easy to speculate about a connection between the images of scientists presented to kids, and the fact that kids overwhelmingly imagine scientists as White males. The numbers, unfortunately, seem to support this conclusion (nsf.gov).

The specific purpose of this study is to add to the expanding theories of visual rhetoric by applying principles of visual analysis, based on the social semiotic theory proposed by Halliday (1978) and adapted by Kress and Van Leeuwen (Reading images: The grammar of visual design, 1996), to images from a collection of current life science textbooks for middle-school students. Additionally, the study aims to apply rhetorical analysis (based on enthymemes and repetition) to images to look for and interpret visual arguments. Because we know that the middle school years are important in girls’ changing attitudes about STEM careers, it is imperative that we begin to build a stronger body of evidence concerning why girls drop away from science at these ages, and to find ways to prevent this from happening.

I acknowledge that science textbooks are hardly the only influences on young girls’ attitudes about their career choices at this, or any, age. Indeed, peers and parents
are probably equally influential. However, failing to pay attention to the visuals with which children are daily bombarded leaves researchers with an incomplete picture of how children develop their social identities in a culture.

**Assumptions**

Before undertaking the current project, it is necessary to address a number of assumptions at the foundation of the research. They are as follows:

- Gender is not necessarily a simple binary (male/female), but may best be treated as such for this project.
- Children identify with pictures they see in textbooks, with regard to how they imagine themselves when they grow up. If children do not see images that they can identify with in working roles, then they will have trouble imagining themselves in such roles.
- Girls and boys reading U.S. science textbooks interpret images using Western *endoxa*.
- Girls decide during the middle school years to abandon plans for science careers.
- Rhetoric of science exists.
- Visual rhetoric exists.
- Photographs are assumed to be representations of reality.
- Pictures can argue; when they do, they do so enthymematically.
- Women pursue STEM careers less often than men, and this is a problem for our society.
An important assumption of any study that has gender as one of its variables is that gender is a simple, biological binary. Studies in the past twenty years or so are beginning to break down this assumption. Influenced by such feminist works as Butler’s (1990) *Gender Trouble*, some researchers in humanities and social sciences have gradually begun to treat gender as a continuum, rather than as an either/or proposition.

For the purposes of this study, it may not be necessary to settle upon an accepted set of gender categories. Although it is true that many individuals fall somewhere between “male” and “female” on the spectrum, just as the color grey can fall anywhere on the spectrum between white and black, it is probably also true that most of the people being researched and to whom this research will be the most useful identify at or fairly close to one or the other—i.e., male or female. Also important, young people going through puberty experience a process of socialization into gender roles during this development, and many of the artifacts of this process—from textbooks to television to clothing—promote a binary vision of gender. As such, it may not be particularly useful to consider gender on a continuum if in fact the majority of people affected by the results do not consider themselves to be on a gender “spectrum.” It may, however, be useful to consider that those who do fall somewhere in between “male” and “female” may, or may not, identify more often with one absolute gender than the other—and in these cases, results will be useful to those individuals as they identify in their approach to STEM careers. For those individuals who choose not to identify with a gender absolute, statistics regarding gender disparities in STEM careers may not be especially interesting
or meaningful, anyway. Furthermore, attempting to add a gender continuum as a variable may complicate the project unnecessarily, with results that say perhaps little different about the images’ effects on readers than keeping the study a simple consideration of male or female representation. As mentioned above, however, the presumption is that children are affected by what they read and view in their textbooks—by no means a presumption safe to make without evidence, which I detail in the following section.

**Textbooks and Children**

In this section, I illustrate, through a series of recent examples, how the scholarship in science education lags somewhat behind feminist language studies in its operationalization of sex and gender in language studies. Then, I review the literature dealing with gender in science texts, noting a significant gap existing in research on gender and power roles in textbook photographs. Finally, I place the current study within that gap.

An informative and thorough review by Brotman and Moore (2008), entitled “Girls and science: A review of four themes in the science education literature,” examines the entirety of peer-reviewed journal scholarship on science teaching (which comprises about eight journals). In their introductory paragraphs, the authors implicitly situate themselves as social constructionists by stating that they see gender as a continuum, not a binary, and as constructed in conjunction with other variables such as race and religious beliefs. (Biological sex, on the other hand, remains to be treated as more or less a given of birth.) The authors isolate four basic themes in gender research
and give several examples of recent scholarship exemplifying each. These themes include differences in learning styles, bias in texts, approaches to teacher education, and approaches to parenting and socialization.

One of the themes the authors identify relates to the ways in which textbooks may affect children through inherent bias. Two early studies in this area, by Peter Whiteley (1996a and 1996b), take on integrated science and physics textbooks, respectively, used in Jamaican high schools, questioning whether images in these books are in fact “gender-fair” (i.e., representing males and females in roughly equal numbers). The results are interesting: In the first case, men were more frequently depicted, particularly as adults; Whiteley (1996a) surmises that this disparity may have “an adverse effect on the numbers of girls continuing their studies in physics” (p. 169). In the second case, he found that when children were represented visually, they came out in fairly even numbers; however, when adults were represented, males were heavily favored (1996b). Thus, though children from anywhere in the gender spectrum were able to see plenty of examples of kids like themselves, images of adults working in science fields tended to represent these careers as intended for men. These results are similar to those found in the present study (see Chapters 3–5).

More recently, this issue has been taken up by many researchers in education, a handful of whom have focused on the science disciplines, according to Elgar (2004). In her examination of lower secondary science textbooks in Brunei, a country in which dress codes are common to differentiate between men and women in public life, Elgar (2004) found bias at all levels. She broke her study down into two parts: analysis of images and
analysis of text. She treated photographs and drawings separately, on the theory that viewers may process and be affected by drawings differently. In analyzing the text, she looked for gendered pronouns and gendered names that could be reliably attributed to either male or female. Finally, she tracked uses of either gender-generic (for example, androcentric “he” used to refer to anyone of any gender) or gender-neutral (for example, “he or she” or singular “they” employed to avoid bias) language. On all counts—pronoun use, proper names, and generics/neutral language—males were heavily favored in these textbooks. Most interesting to Elgar, women currently have many career opportunities outside the home, so it is confusing and perplexing to her that the representations of women in schoolbooks do not seem to be adjusting to reflect changes in society.

In general, much of the research on gender in science education is conducted by linguists, sociolinguists, and others affiliated with English or communications departments; in the selection of about 25 articles I found, this was overwhelmingly the case. Research is of course also performed in teacher education departments, with a strong focus on ways to educate teachers to be gender sensitive and gender neutral, or else to help them find ways to cope with the supposed differences in learning between girls and boys. From a feminist perspective, much of this research can likely be problematized; for instance, two studies on gender-inclusive teaching practices (one in a physics class) found that both boys and girls benefitted from a gender-inclusive teaching style (cited in Brotman and Moore, 2008). Research into extracurricular science programs for girls has been mixed: one study found success with girls in a girls-only
science program, but another, which focused on an after-school program, found that financial difficulties and cultural pressures in an urban setting produced less-than-expected success (Brotman and Moore, 2008).

At first glance, it seems that a major task for science education is simply to tease apart all the various influences on girls—language, teaching styles, parents, peer groups, and culture—with the goal of approaching girl students as individuals who will have different experiences of the science classroom. However, we cannot simply approach gender in education as though the category of “girls” were internally homogeneous.

Another factor to consider is the research questions asked thus far: all but a handful of studies have asked, “Why do girls not succeed in science, despite early interest and success?” and “Why do girls avoid science careers, or drop out of them?” Instead, perhaps research should focus more on finding out why some girls do pursue science and do succeed, whether in spite of, or as a result of, those qualities of science largely considered “masculine.”

Let me take the analysis of science stereotypes a bit further. Gilbert and Calvert (2003) studied girls who love science and the “internal conflict” this love of science produces. The authors explain that our culture has constructed science as a masculine pursuit. Men, they argue, are considered dispassionate, rational, and logical; by chance, these traits are also traits of (positivist) science. Further, since our culture has constructed sex as a binary opposition, masculinity is the opposite of femininity; thus, it follows that if masculinity is a perfect approach to science, then femininity must be a poor approach to science. The result, for the girls in the Gilbert and Calvert study, was a
deep sense of conflict over their love of science—did it make them masculine? Did it mean they were abnormal, not real girls? Yet, they succeeded at science because of their love for those very aspects of it that are considered masculine: rationality, logic.

Clearly, our cultural endoxa argue that science is a masculine pursuit, and that what we consider feminine traits are not compatible with science as our culture defines it. The tension these endoxa create for researchers is powerful: for instance, how do we avoid approaching girls (those who love science and those who do not) as though they are a homogeneous group, as though femininity were a universal for anyone with XX chromosomes? As researchers, we need to frame our questions to girls who pursue science in such a way that we do not predispose them to think of themselves as different, unfeminine, weird—in other words, we must not reinforce the idea that they have succeeded in spite of being girls.

The present study builds upon previous work done with textbooks by adding exploration of power relationships through an additional layer of visual analysis on all images and through enthymematic analysis of a selection of images. I discuss this in more detail in Chapter 2.
STEM careers and women.

Anyone who has taken a science, math, technology, or engineering class at a university lately has probably noticed the dearth of female professors. Engineering departments, and engineering jobs, are filled predominantly by men; the same goes for math, technology, and science, to a slightly lesser (but still significant) degree. One need not trust anecdotal evidence, however: the most recent statistics from the National Science Foundation’s Web site (http://www.nsf.gov/statistics/wmpd/) tell the story.

Is this gender disparity a new issue? Hardly. In fact, Alice Rossi, writing in a 1965 issue of Science, noted, “Particular stress has been put on the need for women in fields in which there is a critical shortage of manpower—teaching, teaching science, and engineering—and conferences on women in science have been held under federal auspices, at Marymount College in 1963 and at the Massachusetts Institute of Technology in 1964” (p. 1196). What is amazing about Rossi’s article is the number of issues she raises that are still being raised today—with little change in the meantime. For instance, she states that “a very large proportion of women in all grades of the Civil Service are unmarried, and a very large proportion of those who are married have no children” (p. 1197). In the 2009 NSF data, it is clear that women in STEM careers are significantly more likely than men to be unmarried and/or childless. Also in Rossi’s research: “Significant numbers of women have been trained in the [science] professions but withdraw for varying periods of time to home and child-rearing” (p. 1197). The NSF data betray a similar problem today. On pay disparities: “At each level of educational attainment the median salary of men was markedly higher than that of women” (p. 1197).
Still true today. Rossi also cites the problem of women’s staying away from physics and engineering, preferring instead the biological sciences—this trend remains today.

In the next section of Rossi’s article, she discusses ways in which American culture contributes to keeping women out of the sciences, beginning with attitudes about career: “What a man ‘does’ defines his status, but whom she marries defines a woman’s” (p. 1198). This is less the case now than in 1965, but the multitude of women’s magazine articles about how to snag the right husband suggest women still do not define themselves as readily as men by their careers. In 1965, men overwhelmingly felt that women should “not choose a career difficult to combine with child-rearing, and disapproved of women’s working when they have preschool children” (p. 1198). Rossi also discusses the effects of career interruption during the childbearing years, arguing that in the sciences, “the peak of creative work is reached in the late twenties and early thirties”—exactly the time when many career women are at home with small children (p. 1199). To solve this problem, Rossi says, “work must be less dominant than it is in the lives of men in order for it to be more dominant in the lives of women” (p. 1199).

Another issue is the misperception that women are somehow harming their children by being away at work. Not so, Rossi argues: “Now there is increasing emphasis on the role of mothers in their children’s cognitive development. […] The better educated the mother, the greater will this stimulation of the child [through language and ideas during the preschool years] tend to be” (p. 1199).

Finally, Rossi takes on the issue of whether women are ill-suited to science, and whether part of the reason is cognitive differences between boys and girls—an inferno
still blazing in modern debate about the brain. During the 1960s, it was believed that girls’ and boys’ brains did develop differently; Rossi cites studies arguing that much of the difference can be attributed to “the kind and degree of training in independence the child receives” (p. 1200). Also, the degree to which a child has been socialized to “stand alone” and “aim high” or to “be cooperative and responsive to people” (these being the traditional social expectations of boys and girls, respectively) affects whether the child will excel in sciences. “As a nation, we have become sensitive to the social handicaps of race and class but have remained quite insensitive to those imposed because of sex,” she argues (p. 1201). She views the “triple roles of member of a profession, wife and mother” as difficulties that, for women to succeed, should be “recognized as a social problem to be dealt with by social engineering rather than be left to each individual woman to solve as best she can” (p. 1201). In other words, if American society wants to encourage more girls and women to follow their interest in science, we must change the girls—not the science:

If we want more women to enter science, not only as teachers of science but as scientists, some quite basic changes must take place in the ways girls are reared. If girls are to develop the analytic and mathematical abilities science requires, parents and teachers must encourage them in independence and self-reliance instead of pleasing feminine submission; stimulate and reward girls’ efforts to satisfy their curiosity about the world as they do those of boys; encourage in girls not unthinking conformity but alert intelligence that asks why and rejects the easy answers. (p. 1201)

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2 For more on this topic, see, e.g., Benbow & Stanley; Meece, Parsons, Kaczala, & Goff; Voyer, Voyer, & Bryden; Kimura; Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher; and Guiso, Monte, Sapienza, and Zingales.
While Rossi’s Second Wave (1960s–70s) feminist critique of social expectations for professional women in America is consistent with many of the same criticisms of science that Third Wave (modern) feminists have, it is not without some traces of the positivism of masculine science that pervades even today’s critiques: It is not necessary to change the way we do science; rather, it is necessary to change the way we make girls. In fact, we must make girls more like boys if they are to succeed in sciences.

The socialization children bring to the science classroom is one of the important topics discussed by Alison Kelly (1985). After describing how teachers are part of the problem in reproducing gender differences in the classroom, she adds this caveat:

[I]t is largely the behaviour of the children themselves which is crucial. Boys bring with them to science lessons a conception of masculinity which includes toughness, aggression, activity and disdain for girls; girls bring with them a conception of femininity which includes timidity, conscientiousness, deference, person orientation and a concern for appearance. (p. 145)

Kelly is arguing for a transformative science classroom—not one in which girls are relegated to a “ghetto” in which “science for girls” is taught, but rather, one in which all children can learn science in a way that is slightly more “feminine.” In other words, unlike Rossi, Kelly is arguing for a change, not to girls, but to science itself. Part of the reason for doing so, she argues, is that “the present gulf between science and a concern for people encourages the dangerous situation in which science develops as though it had an internal dynamic with no relevance to social issues” (p. 150). Kelly’s arguments are compelling, and useful for the current project: it is all well and good to argue that girls are not pursuing science as often as boys, but what of it? As Kelly points out, science as it
Rossi and Kelly are far from the only authors shining a critical light on classroom bias. Myra and David Sadker’s (1994) *Failing at Fairness: How Our Schools Cheat Girls* recounts the many ways in which textbooks and teachers reproduce the masculine science of which Kelly (1985) speaks. In a history workshop, for example, one of the authors was surprised by a homework assignment she collected: of 150 biographies of famous Americans, only five were of females. “When I examined their textbook more closely, I saw there were few females in it. And there were even fewer books on famous American women in our school library” (p. 7). More troubling, the authors found that teachers themselves inadvertently perpetuate bias: In one instance, a female teacher had created a worksheet to teach young students which objects “go with” which gender—unfortunately, the cooking, cleaning, and sewing implements were meant to go with the woman and the power tools with the man. Even after being called out on this sexism, the teacher did not change the worksheet (indeed, the parent who called her out on it had another child receive the same worksheet a few years later).

Textbooks fare no better in the Sadkers’ study. Concerned that students were seeing too many male exemplars in their textbooks, the Sadkers asked 16 groups of 4th
through 6th graders to list, in five minutes, as many famous people as they could—but not to list athletes or entertainers. The authors recommended the students try to name at least ten people of each gender. None could think of ten females; the average was three.

Concerned, the authors examined 15 math, language arts, and history texts, counting the numbers of males and females depicted in each text. The results of this examination were sobering: one history text has four times more males than females; one had only 11 female names in the entire book (not one of whom was an American); and one 631-page text had only seven pages related to females—but nothing on Susan B. Anthony, for instance. “Given the content of their history books, it was a tribute to their creativity that they could list any female names at all,” the authors lament (p. 72).

Another troubling find in modern textbooks is that when females do appear, they appear thinner. Feminist critiques of advertising abound; feminists complain that women are sex objects, thin beyond reality, airbrushed to perfection, and impossibly beautiful—an inappropriate and disturbing role model for young girls dealing with the natural weight gain that comes with puberty. However, to think that an eight-year-old’s textbook could be sending her subliminal messages to lose weight is horrifying. “In third-grade texts published between 1900 and 1980, boys do not change in terms of shape or weight, but over that span of eighty years little girls lost weight and grew relentlessly thinner” (Sadker and Sadker, 1994, p. 103).

One would hope things had improved for girls by the time of the book’s 2009 update. Sadly, no—in Still Failing at Fairness, Sadker, Sadker, and Zittleman found teacher bias, classroom sexism, and textbook biases were all still pervasive. In one study
of high school STEM courses, boys in a computer science course “made comments about girls and their bodies, appearance, and competence. The male teacher did nothing to stop the harassment. […] Not surprisingly, female enrollment in these advanced computer science classes continued to fall” (p. 19).

Textbooks, too, appear to have made only limited transformation. As Sadker, Sadker, and Zittleman (2009) state, females are appearing more frequently in textbooks, and they are being depicted with a wider range of career options and personal traits. However, male names and experiences still dominate:

Men are seen as the movers and shakers of history, scientists of achievement, and the political leaders. Boys are routinely shown as active, creative, brave, athletic, achieving, and curious. In striking contrast, girls are often portrayed as dependent, passive, fearful, docile, and even as victims, with a limited role in or impact on the world. (pp. 88–89)

Does it matter, though? Do these images in textbooks really affect the way children see themselves? Yes, say the authors: “Gender stereotypes and the lack of female characters contribute negatively to children’s development, limit their career aspirations, frame their attitudes about their future roles as parents, and even influence personality characteristics” (p. 92). In short, seeing girls depicted in such limited roles and with such limited range contributes to girls’ feeling less worthy than boys.

The authors cite several ways in which subtle gender bias still exists in textbooks, in spite of recent reforms. An example of each follows in parentheses:

- Invisibility (little to no visible examples of females; no visual examples of males in traditional female roles)
• Stereotyping (all females depicted in family roles)

• Imbalance and selectivity (describing women as having been “given” the vote, as though they did not work for it)

• Unreality (romantic notions of the nuclear family that many students cannot relate to)

• Fragmentation (setting off women’s stories in sidebar text, for instance, as though women are somehow out of the mainstream of humanity)

• Linguistic bias (generic masculine pronouns to refer to all of humankind)

• Superficial equity (equal numbers of girls and boys in photos, but the girls are all performing “secretarial” tasks, while the boys are actively doing experiments)

Couple this constant subliminal messaging with the tumult of the middle school years, and the result can be a self-esteem collapse, according to Sadker, Sadker, and Zittleman (2009). Citing an American Association of University Women (AAUW) study on the self-esteem of boys and girls, the authors point out that while boys have some loss of self-esteem between elementary and middle school, girls experience a drop of 31 points, what the authors describe as “free fall” (p. 107). If elementary school girls are all about their scholastic performance, middle school girls are all about their attractiveness, with many even going out of their way to do worse in school to avoid being called “nerds.”

3 Interestingly, this “free fall” was evident in White and Hispanic girls, but not in African American girls, who actually experience a rise in self-esteem from elementary through middle to high school. Researchers postulate that strong racial identity in Black communities helps both boys and girls build self-esteem.
At the same time girls are struggling with their new, dual roles of scholar and sexual being, teachers and administrators are “short-circuiting” their attempts to learn. Whereas teachers tend to give boys many chances to solve a problem, they often simply do things for girls, or ask boys to help girls when they are struggling. In one seventh grade science classroom, a girl complained, “Teachers don’t expect us to be good in science. That’s why I think we have less time on instruments like the microscope than do boys. Instead we are in charge of cleaning and putting away the equipment” (Sadker et al., 2009, p. 110). The most fun the girls in that class get to have is writing experimental results on the whiteboard. Watching passively as boys play with expensive equipment, dissect frogs, or perform experiments only intensifies girls’ belief that they are less capable of doing science.

What if a young girl finds herself in seventh or eighth grade and in love with learning? What if science or math is really her “thing”? Chances are that either she hides it very well, or she pretends to be less bright to fit in better. One national prize winner for mathematics research regularly skipped lunch so she would not have to be subjected to the taunts of her schoolmates; another girl, a smart African American, told the authors, “I am a pressure cooker ready to explode. I hide my good grades so my boyfriend doesn’t get insulted” (Sadker et al., 2009, p. 121). At no point did girls in the middle school age group cite intelligence as a trait related to popularity; in fact, often it was cited as a trait to be hidden or denied.

Sadker, Sadker, and Zittleman’s (2009) work is just one example of the research citing middle school as a crucial time in girls’ lives, a time when intelligence is
considered a handicap and plans for careers in traditionally masculine fields such as science and mathematics seem ridiculous. Indeed, if the average girl spends the years between ages 12 and 15 concentrating more on her hairstyle and waistline than her math and science skills, it seems reasonable to assume she will start ninth grade deficient in areas she needs to be able to succeed in tougher high school courses.

In this section, I have shown that the dearth of females going into STEM careers can partly be traced back to childhood, with manifold origins, including family, friends, teachers and administrators, textbooks, and cultural endoxa. Solving all of these issues seems a daunting task indeed, the scope of which might be enough to put off activists with the best of intentions. With whom does the ultimate responsibility lie for this problem? It is my contention that responsibility lies with everyone who has contact with a girl during her lifetime, including the girl herself. Where parents see bias, they must call it out. Where teachers see it, they must fight to change it, or at least not perpetuate it (I think now of the teacher who kept handing out the same biased worksheet year after year). Members of the media, particularly advertisers (really, anyone who is “selling” something, be it a product or an intangible), must look honestly at their practices, refusing to perpetuate images that downplay or denigrate femaleness. Religions are more difficult to deal with from the outside; members of religious traditions that privilege maleness must be willing to voice their opposition to this practice in all its forms. Families must teach their boys to be equal partners in relationships, so that the bulk of child-rearing and housework does not fall on women; knowing this burden will be part of their future is another reason women defer their science dreams. Only by persistently
chipping away at the sources of gender bias in our society will we begin to see girls eager to bring their unique contributions to science, technology, engineering, and mathematics careers and teaching.

Thus far, I have discussed the problem of gender disparities in the various STEM careers, pointing to the possibility that a visual rhetoric of science textbooks may be negatively influencing young girls at precisely the ages when they are most likely to abandon career plans that do not seem to allow for the probability of women’s success. In the next section, I review the literature on visual analysis, including research on rhetoric of science, visual rhetoric, and art history and criticism.

**Rhetoric of Science**

Any study that hopes to shed light upon the influence of visuals on readers of science textbooks must address two assumptions in particular before that study can proceed: first, that *rhetoric of science* and *visual rhetoric* exist, and secondly, in the past century in particular, that rhetoric of science offers one perspective that overturns the assumption of science as an objective enterprise.

A relatively new endeavor as theoretical disciplines go, rhetoric of science has attracted the attention of many prominent rhetorical theorists—as well as that of many prominent scientists. Among the latter group, that a rhetoric of science exists is hardly a given; in fact, some scientists react with ire, even mocking, at the mere suggestion that rhetoric has any place whatsoever in philosophy or practice of science (Gross, 2006). “The entire approach emphasizing ‘relative’ truth seems to me a piece of humbug
masquerading as an academic discipline; it pretends that its practitioners can set themselves up as judges over *scientists whose science they fail to understand*” (Max Perutz, quoted in Gross, 2006, p. 3; emphasis added). Perutz’s 1995 remarks betray not only a dismissive attitude toward the entire idea of rhetoric in science, but also a firmly positivistic epistemology; indeed, he states, “Good research needs no rhetoric, only clarity” (quoted in Gross, 2006, p. 3). He fails to acknowledge the importance of rhetorical figures, strategies, and intertextuality in science writing, topics that are taken up by theorists throughout the 1980s and increasingly so in subsequent decades. Indeed, Perutz is so certain of the objectivity of science that he cannot even acknowledge his own use of rhetoric to argue that point.

A similar condemnation comes from Susan Haak’s (2003) reaction to Gross’s earlier book, *The Rhetoric of Science* (1996). In her book, she compares Gross’s perception of science as akin to “an atheist’s view of theology” (a lovely metaphor, quoted in Gross, 2006, p. 3). “[S]cience is different from theology in a crucial respect: that there is a real world which in a certain way and not other ways is a presupposition not only of scientific inquiry, but of all empirical inquiry […]” (p. 3). It is not difficult to see Haak’s positivist attitudes: what she is essentially saying here is that writing about science is a relatively simple matter of conveying *truth*, as though it were out there to be discovered through empirical inquiry and could never be disputed once “proven.” Once again, a scientist employs rhetoric to argue for the objectivity of science, while at the same time dismissing the use of rhetoric for analyzing the written products of scientific inquiry.
Of course, an examination of the history of science writing shows no such agreement on universal “truths” and no such inclination of scientists to leave “truth” alone once it has been “proven.” In fact, many well-known scientific theories, despite support from hard empirical evidence, have been rejected by the scientific community before they were accepted. One such example is the finding that *Helicobacter pylori* cause stomach ulcers. Barry Marshall and Robin Warren’s 1982 conclusion was widely dismissed by the medical community, which believed that no bacterium could survive for long in the acidic environment of the stomach. To demonstrate the validity of the pair’s claim, Marshall drank a concoction containing the bacteria. After developing stomach ulcers, Marshall administered antibiotic medication to himself and was cured. The scientists were awarded the Nobel Prize in Medicine in 2005 for this discovery. As a result of this amazing finding, says Brian Spratt, a molecular microbiologist at Imperial College in London, "Drug companies had to radically change their approach from containing ulcers with antacids to treating with antibiotics. Ulcers predispose people to gastric cancer—so antibiotics also prevent cancer" (Connor, 2005). Obviously, then, having one’s theories accepted in the broader discourse of one’s discipline is not as simple as exposing the truth by producing hard data and writing a paper.

In fact, Greg Myers (1985) presents a well-known analysis of the process of writing a scientific paper and the difficulty in negotiating the claims to fit into the spaces (both physical and theoretical) allowed in the journals to which the paper is submitted. Describing the social construction of authors’ claims in two biology articles, Myers illustrates how the scientific community itself decides whether an author’s claim is too
high- or low-level, not supported by previous literature, or just simply not the right type of claim for that journal. In arguing that the scientific writing process is a social construction right from the outset, Myers shows us that even as authors revise their own first drafts for submission, they do so with editors and reviewers, as well as the entire scientific community and literature, in mind. It is as if the scientist, in preparing to share his or her findings with the world, must have an internal conversation with unseen forces, and then later a real one, through reviews and comments (but still often with unseen forces), in which the paper is accepted, rejected, or returned for revision. It is pretty clear that publishing a scientific article is hardly a process of discovering something new and unleashing it upon the world; the author must first negotiate that discovery’s place within the larger body of literature, either in the broader field or in a subspecialty. In other words, the scientist must be aware of, and employ, rhetoric.

Rhetoric is not, however, limited to the construction of scientific claims; as Latour and Woolgar (1979) discovered in their observation of endocrinologists at the Salk Institute, scientific facts themselves are in large part a product of rhetorical invention. Using what the authors term "technological inscription devices" to produce "evidence" to support a theory and to publish the results in a scientific paper, scientists then count on the “Greek chorus” of citations and research references to increase the “facticity” of their claims. Latour and Woolgar break down the continuum of facticity into five approximate types, strongest (barely needing stating) to weakest (conjectures or speculations), suggesting that scientific facts are not the absolute truths our culture often treats them as, but socially constructed variables vulnerable to challenge.
So, Alan Gross (1996, 2006) and others show that science does indeed employ rhetoric; Myers (1985) asserts that scientific claims are socially constructed; and Latour and Woolgar (1979) contend that scientific facts themselves are socially constructed. When viewed as a complex negotiation, the process of publishing new research in the sciences loses some of its positivistic sheen and starts to look somewhat more postpositivist—which must certainly be upsetting to a few modern researchers fighting to preserve their relevance by clinging to a misguided scientism in which there is no place whatsoever for rhetoric. However, those who deny the presence of rhetoric in modern scientific writing perhaps think themselves outside such “sophistic” moves; even if the rest of human knowledge is a social construction, science cannot be, for scientific knowledge is the product of careful empirical research dependent upon strict adherence to scientific method. After participant-observations such as Latour and Woolgar’s (1979) and Myers’ (1985) exposed the degree to which data and claims are manipulated to create a publishable argument, it is difficult to imagine how the entire enterprise of modern science is anything other than a social construction.

**Visual Rhetoric**

Having shown that science is a rhetorical endeavor and that visuals in textbooks should be examined, I now explore the best way to accomplish this analysis. Scholars generally accept that images have the potential to argue; the salient issue is how to read and interpret those arguments.
According to the Wikibook for a visual rhetoric course at James Madison University (2007), “[W]hile most scholars agree on the validity of visual rhetoric and find it deserving of academic study, the attention given visuals’ rhetorical purpose is still very contested in academia; due to its novelty, it has not yet been determined how to study or explain visual rhetoric” (p.1). I interpret this statement as an indication that visual rhetoric’s contested nature is obvious even to undergraduate students and as evidence for the need of combined theories and methods of analyzing visual rhetoric separately from written or spoken rhetoric. It is precisely the latter objective which the current project aims to achieve: to develop and test a methodology for visual analysis that incorporates familiar topoi from classical rhetoric with (perhaps unfamiliar to many rhetoricians) theories of art criticism to expose the concealed arguments in photographs and images.

For anyone educated or employed in advertising, the idea that visuals argue will come as no surprise: Of course they do. That is why people buy products. Advertising capitalizes upon—indeed, sometimes creates—many of the endoxa in western culture, such as, “Women who are young and thin have higher value than those who are not.” However, some in the field of rhetoric have been slower to accept the notion that an image can argue (in the Aristotelian sense—through either dialectical logic or rhetorical syllogism) because images lack print language, which is, some argue, an essential component of argument. After extensive reading in the areas of visual rhetoric, rhetoric of science, and advertising rhetoric, I am not convinced that visuals can easily present arguments on their own, without the addition of at least some verbal context such as captions or commentary. My view is that when visuals argue, they do so, as Valerie...
Smith (2007) suggests, *enthymematically*, and that visuals must necessarily be analyzed only within the culture or social context in which they occur for those arguments to be meaningful.

Because my study focuses on photography in textbooks, it is important to present a comprehensive understanding of the theories of photography and art that allow researchers to approach photography as a representation of reality (e.g., Arnheim, 1960, 1974; Gombrich, 1978; Barthes, 1981; Tufte, 1997; Bolter and Grusin, 2000). In this section, I build that foundation beginning with modern art historians’ views of photography before progressing to the work on visual argument and enthymeme.

Rudolf Arnheim’s 1960 book *Art and Visual Perception* is an excellent place for a non-art historian to begin to understand how the art field treats the concept of visual perception. Chapters cover the experiences of light, space, form, shape, balance, color, tension, movement, and expression. For the purposes of the current project on visual argument in photography and graphics of humans, it is particularly useful to understand how humans experience light, color, motion and tension (the latter two of which are related to the vectors discussed by Kress & Van Leeuwen, 1996). It should be noted, however, that photography is not a prominent topic of this book; in fact, it warrants only 29 mentions in 400 pages.

One important distinction Arnheim makes is the difference between how the human eye records data and how the camera does so. “There has been a tendency among scientists,” he states, “to describe the experience of vision in analogy to the physical process.” The mind was envisioned as operating similarly to a camera, performing
passive recording. This is not, Arnheim argues, how vision works. “[I]n looking at an object, we reach out for it. With an invisible finger we move through the space around us, go out to the distant places where things are found, touch them, catch them, scan their surfaces, trace their borders, explore their texture” (1960, p. 28). He describes vision as a “creative activity of the human mind,” explaining that “[p]erceiving achieves, at the sensory level, what in the realm of reasoning is known as understanding. […] Eyesight is insight” (p. 31). That insight, then, comes not only from “what strikes the eye at the time of observation,” but also from “an infinite number of sensory experiences that have occurred throughout the person’s past life” (p. 32). In other words, perception has its own intertextuality (in the sense Porter, 1987, uses it): in perceiving, we as humans consult everything we know about a given percept to aid in interpreting what we see in the present. This is an important idea to remember when we think about how children interpret visual arguments in their textbooks.

On the topic of realism, Arnheim seems firmly grounded in the school of thought that photographs are captured reality. Further, it seems he would agree with the assertion that a product chained to reproducing reality might have very little artistic content.

Even after many decades of spade work by modern artists, one of the things the ‘man in the street’ finds hardest to accept is that a picture may present a perfect likeness of people or a landscape and yet be entirely incomprehensible visually and therefore devoid of artistic content. This difficulty has been created by the ‘scientific’ approach to copying a model with mechanical exactness as well as by candid photography and the movies. (1960, p. 90)
This attitude toward photography is softened somewhat in Arnheim’s (1974) later article, “On the Nature of Photography,” in which he states,

> In a photograph, the shapes are selected, partially transformed, and treated by the picture taker and his [sic] optical and chemical equipment. Thus, in order to make sense of photographs one must look at them as encounters between physical reality and the creative mind of man—not simply as a reflection of that reality in the mind but as a middle ground on which the two formative powers, man and world, meet as equal antagonists and partners, each contributing its particular resources. (p. 159)

Here, Arnheim is more ready to concede some artistic potential in the photograph, as long as the viewers “take the picture for what it is,” something “made and controlled by man and not as a mechanical deposit of light” (p. 158). However, we will invariably be let down “if we approach photographs with an expectation trained by the perusal of handmade images” (p. 158). In other words, we need to approach photos as photos, not as paintings or sculptures, for their artistic potential to be fulfilled. However, photography, he argues, can never achieve the artistic heights of “handmade” art:

> Wedded to the physical nature of landscape and human settlement, animal and man, to our exploits, sufferings, and joys, photography is privileged to help man view himself, expand and preserve his experiences, and exchange vital communications—a faithful instrument whose reach need not extend farther than that of the way of life it reflects. (1974, p. 160).

In essence, photography need never attempt to go beyond being simply a recording device for the human experience; it “seems to operate under a definite ceiling,”
“consistently limited in its range of expression as well as in the depths of its insights” (p. 160).

If one of the greatest art historians and critics of modern times dismisses photography as simply a visual “tape recorder” for human existence, then it is not difficult to imagine how the medium is still, to this day, treated as a simple reproducer of nature and reality—even after more than a hundred years of photographic art, even after museum sales perhaps in the billions\(^4\), even in the age of ubiquitous digital manipulation. To carry this a little further, it is not difficult to imagine how photographs—even the obviously staged, slightly abstract ones found in middle-school textbooks—could be taken by readers as evidentiary of reality.

Another great mind of the art history and criticism genre is E. H. Gombrich, whose book *The Story of Art* has enjoyed sixteen editions since its original publication in 1950. Gombrich’s attitude toward photography also makes clear that he views photographs as simple representations of reality. For instance, in a discussion of photography as a rival to painting, he states,

> Not that the painting of the past ever aimed entirely and exclusively at the imitation of reality. But as we have seen, the link with nature provided some kind of anchorage, a challenging problem that kept the best minds among artists busy for centuries and provided for the critics at least a superficial standard. […] [T]he argument that art must now explore

\(^4\) The Richard Avedon photograph “Dovima with elephants, Evening dress by Dior, Cirque d'Hiver, Paris, August 1955” sold in November 2010 for $1.1 million, a record auction price for Avedon. If this is the price for one photo from a well-known photographer, imagine the total worldwide sales of all fine art photography.  [http://www.christies.com/departments/photographs-72-1.aspx](http://www.christies.com/departments/photographs-72-1.aspx)
alternatives to the representation of nature is plausible to many. (1978, p. 488)

In this excerpt, taken from Gombrich’s postscript in the thirteenth edition, entitled “The Changing Scene,” he worries that the move from the early formal, posed photography (made necessary by the length of time needed to properly expose a photographic plate) to the modern preponderance of snapshots and holiday pictures has caused “photographic” to become “a dirty word among painters and teachers of art appreciation” because of the focus on photorealism as a critical standard for painting (p. 488). Yet, Gombrich (1978) attributes the “new interest in the history of art” to nine factors, one of which is photography (p. 485). Is he merely making the best of a bad artistic situation? Perhaps—“After all, a photograph is nothing but […] a natural trace, a series of tracks left…on the emulsion of the film by the variously distributed lightwaves which produced chemical changes made visible and permanent through further chemical operations” (1969, p. 60). Essentially, he says, a photograph is just light waves developed onto paper—nothing more, nothing less—a simple representation of the reality the lens sees. This assessment certainly sounds like a ringing endorsement of photographic naturalism.

In this section, I have examined the contentions of major art historians and critics who have argued that photography is merely a reproduction of the visible world. Next, I review theories on either side of the issue of whether images may be rhetorical.
Images cannot be rhetorical in the absence of text.

It seems fairly common now for theorists of rhetoric to agree that images are an important part of an argument and can enhance it. However, no consensus exists on whether images can argue all by themselves. For instance, Myers (1988), studying illustrations in a sociobiology text, holds that images are very important, perhaps even more so than the text itself; however, he does not go so far as to give images credit for being rhetorical. “[T]he iconography of a science is more likely to have an impact on the public than the words or mathematics,” he says, “which may be incomprehensible to them” (p. 235). In this statement, Myers touches upon an important aspect of scientific images, one which I hold as important to the current project: the conversation between science and the public. If one of the purposes of scientific research and progress is to improve the human condition, then certainly scientists must find ways to communicate their findings to people other than their own colleagues, and images are one very effective way to do so. “If we ask, for instance, what most people would recognize from Watson and Crick’s 1953 Nature article, it would not be the exact phrasing of the claim, it would be the picture of the double helix” (pp. 235–36). Indeed, the spiral of chromosome pairs twisting like a ladder wound about a curling iron is one of science’s most easily recognized images.

Of course, that well-known image would have meant little to nothing to the average viewer without some sort of text to explain its purpose—at minimum, a detailed caption. Yet, Myers argues that even simpler images need some help: “Some textual explication is necessary even for pictures that seem to carry a self-evident meaning” (p.
He cites the danger of misinterpretation as one reason, and the need to guide the viewer’s eye to the right details as another: “[T]o see what claim [is] being proved, one needs to be directed by the caption” what to look for, particularly in a photograph. Drawings do not have the same problem, he says, because extraneous detail is left out by the artist, helping ensure that the viewer sees only the subject. Thus, it seems Myers is willing to give photographs rhetorical power, but not without accompanying text.

At the time of the Argumentation and Advocacy (hereafter A&A) issue devoted to the topic of visual argument in 1996, the area was still relatively unexplored academically, and theorists were coming out on either side of the issue. All seemed to agree on the Aristotelian definition of an argument as a claim or claims plus evidence for the claim(s); however, a sharp division existed (and still does) on the issue of whether an image alone can constitute an argument. In the aforementioned A&A issue, the most vocal opponent of the notion of visual argumentation is David Fleming. In “Can pictures be arguments?” he wastes little time in stating unequivocally that an image alone can never constitute an argument: “[A picture] lacks the requisite internal differentiation; it is impossible to reliably distinguish in a picture what is position, and what is evidence for that position” (p. 13). In brief, his reasoning is that one vital part of an argument is that it must be refutable or able to be negated. He further states that a picture cannot be negated in any reliable way, and therefore, a picture cannot in itself be an argument. He also invokes Chaim Perelman and Lucie Olbrechts-Tyteca (1969), who state that anything outside the realm of the verbal cannot constitute an argument. Finally, he cites Jamieson (1992), who states that if verbal arguments are claims plus evidence, visuals are claims
alone. So, with regard to the 1996 discussion of visual argument, Fleming presents perhaps the most detailed case against it.

In a 2009 article, Alan Gross agrees with Fleming that visuals alone do not argue; Gross makes his case by pointing out that images cannot be propositional. His line of reasoning goes like this: To argue means to make a claim and provide evidence for the claim. Evidence does not need to be propositional (thus, a photograph can be evidence); however, the claim that the evidence supports must be propositional: it must “assert of some state of affairs that it is either true or false” (p. 148). Because a picture cannot assert a proposition, it cannot, without some verbal claim, be an argument on its own. Gross allows, however, that visuals are increasingly an integral part of argument and, consequently, that it is important to analyze their role.

Gross suggests that rhetorical theory as we have traditionally used it is not sufficient for analyzing the contributions of visuals to argument. He proposes a complex methodology drawn from Gestalt psychology, linguistics, logic, narrative theory, and Peircean semiotics to analyze how the brain perceives visuals and verbal texts. Using a version of Allan Paivio’s Dual Coding Theory (or DCT) augmented by Gestalt principles of perception, Gross analyzes the memoir of famous geologist Lavoisier, whose final book was not only a scientific discussion but also, as Gross puts it, an argument about the condition of the world and its history. And according to Gross, images are central to providing evidence for Lavoisier’s argument. However, images do not, by themselves, argue.
Gross contends that verbal texts and images argue best when used in tandem: “In texts that combine the verbal and the visual, meaning is the consequence of the interaction of these two DTC components, logogens and imagens” (p. 154), where logogens are verbal and imagens are non-verbal. He adds that the preponderance of visual content in sciences today means that we as rhetoricians ignore the visual at our peril, charging not only his contemporaries but also himself with ignoring the visual in argument (and this gentle indictment includes names like Bazerman, Moss, Fahnestock, and Myers, among others). Traditional rhetorical theory, he states, is not meant for analyzing the contributions of images because it was developed for the analysis of speech and verbal argument. However, he comes at this issue from the point of view of formal logic (dialectic), rather than rhetoric, which is intended to persuade the common folk rather than the elites. It is true that visuals do not so much fit the syllogism as in dialectic, because certain propositions are left to the viewer to fill in based on shared cultural knowledge (as in enthymeme). But this is the way in which rhetoric works: Rather than providing, ad nauseam, a detailed history of all shared knowledge and cultural convention, the rhetor assumes this information is shared and gets right to the point of drawing the inference between the original claim and the expected conclusion. So, for instance, in dialectic, a syllogism about the Iraq war might look like this:

- The terrorists who attacked the U.S. on September 11, 2001, were declaring war on us.
- Saddam Hussein was directly involved in this terrorist attack.
• Therefore, our war in Iraq with the goal of deposing and capturing Saddam Hussein is justified, because his attack on us was a declaration of war.

In rhetoric, however, it is not always practical or effective to “spell everything out” for the listener or viewer. Thus, the enthymeme might look like this:

• The terrorists who attacked the U.S. on 9/11 were declaring war on us.
• (Assumed proposition: Saddam Hussein was involved in the plot.)
• Therefore, our deposing Saddam Hussein is justified.

At the time of the Sept. 11 attacks, the implications of Saddam’s involvement were everywhere, even without irrefutable evidence, so there was no need to repeat this part of the argument each time the enthymeme was delivered. The shared cultural knowledge ensures that even if the listener does not agree with the conclusion, he or she understands the argument and fills in the missing information.

In sum, many of the dismissals of visual rhetoric come from the point of view that Aristotle never intended rhetoric to be used to analyze anything other than speeches. As Gross (2009) points out, “Aristotle categorized all ‘proofs’ other than verbal as inartistic and the tradition has universally honored this boundary-line” (p. 149). Of course, it may be argued that speeches were, in fact, the primary technology for imparting knowledge in ancient times; therefore, how could Aristotle, for instance, have foreseen a need to use rhetoric for any other purpose? At best, though, this query is nothing more than devil’s advocacy. Rather than follow it to its inevitable fiery demise, I use the next section to
demonstrate how contemporary theorists are using rhetorical analysis to reveal the ways in which something as simple as a line drawing, or as complex as a nature photograph, can communicate a powerful argument.

The authors discussed above have made convincing cases for the possibility that visuals can be rhetorical with or without accompanying text. For the purposes of the current project, however, it may not be necessary to take a firm position on whether visuals alone can be rhetorical: In the context of a science textbook, nearly all the photographs being analyzed include captions and/or references in the text itself, and where images exist without text, the context of the chapter in which they appear certainly provides sufficient verbal information to assist in analyzing the purpose of the photograph. Further, viewers must ask of any image that appears without obvious textual accompaniment, Why is this picture here? What do the editors want me to “get” from this image? Thus, it seems probable that viewers may assign some proposition to the images they view, whether or not rhetoricians agree that images may be propositional.

**Images can be rhetorical without supporting text.**

In this section, I examine theories of how visuals argue without supporting text such as captions.

Early attention came to the topic following the 1996 issue of *Argumentation and Advocacy (A&A)* devoted to visual rhetoric. Many of the articles in the 1996 A&A issue came out in favor of the concept. Some, however, were more reserved than others in their endorsements. For instance, Blair (1996) states that visual arguments can and do exist, but that they are relatively uncommon. He also believes that visual arguments lose
some clarity and precision over similar arguments constructed verbally. Thus, he gives
primacy to verbal arguments.

To better understand how a visual image can argue, I rely on Finnegan’s (2001)
concept of the *naturalistic enthymeme*, which, in short, argues that viewers see the
photograph as an actual representation of nature. Without accepting this notion of the
photograph as an accurate representation of reality, the proposed analysis of the ways in
which photographs in science textbooks affect readers could not be undertaken. If
photographs are not taken at face value, then students’ responses to representations of
gender in photographs cannot be analyzed visually, if indeed students have any responses
at all.

Finnegan (2001) explicates *how* visuals argue by describing how photographs
have, since the invention of the medium, come to represent direct icons of reality due in
large part to the perception that a photograph is produced without human intervention.
Barthes (1980), for instance, refers to a photo as a mirror of reality. (Never mind the
begged question here—that a mirror reverses the image, thus reversing reality!) He
claims that nature basically imprints itself onto the photograph by means of light and
chemicals. He is not alone; many art theorists have treated the photograph as absent of
human agency, as representative of nature and reality. As a result of this (erroneous, in
my position) treatment of photography as devoid of human influence, photos have
traditionally been treated as documentary and evidentiary of “reality” in Western culture.
It is this assumption of naturalism that ultimately allows for the possibility of visual
argument.
Finnegan’s case study focuses on the Farm Security Administration (FSA) photographers of the 1930s, who were charged with the task of documenting the Great Depression and everything that accompanied it in the United States. One of those photographers, who had little experience in photojournalism before he got the job, went to the Dakotas to document the drought that had raged for an inordinately long time and was, to the FSA’s director, worthy of documentation and attention. The director had evidently been giving the photographer, Arthur Rothstein, some negative feedback on his compositions, so one day Rothstein went out on the plains and came across a cow skull. Perhaps keeping his boss’s advice in mind, he first took many different pictures of the skull from several different angles and with several different backdrops; he then moved it about ten feet and took even more shots of it, trying to get a well-composed and well-exposed photograph (see Fig. 1).

The trouble started as soon as one particular image of the cow skull was picked up by the newspapers back East. This photo of the skull was taken out of context and portrayed as evidence of the drought in the Dakotas. When the North Dakota newspaper *The Forum* heard about this, the editors were incensed. First of all, they did not particularly want negative press for the Dakota region at that time. So when they saw that the image had been taken out of context, they investigated further and found that the photographer had taken many images of the skull, all in seemingly different contexts.

**Fig. 1.** Arthur Rothstein. *The bleached skull of a steer on the dry sun-baked earth of the South Dakota Dry Lands.* May 1936.
The photographer’s choice of composition in the photo in Fig. 1 cropped out a spread of green grass in the background, which meant that anyone viewing this photo on its own might assume the situation in the Dakotas to be far worse than it was. Rothstein’s creative license gave the Forum just the loophole they needed: They immediately ran a front-page editorial calling the photo a “fake.” Their analysis showed that the skull was meaningless in the visual context in which it had been photographed, and further, that the photo hardly made the case for the severity of the drought that the Eastern newspapers were saying it did. They were able to make an effective argument against the validity of the skull photographs, thereby essentially discrediting the FSA.

Finnegan argues that the naturalistic enthymeme is what allowed for the Forum to make its case against the FSA photos. For the newspaper editors to be able to argue that the FSA photos were faked, the possibility that the photos were real needed to exist. In other words, the editors did not take issue with the possibility that the photo could have been a realistic depiction (they left the naturalistic enthymeme intact); rather, they argued that the photographer’s choices were suspect.

To better understand Finnegan’s concept of the naturalistic enthymeme, it is helpful to revisit Aristotle’s definition of the term. Aristotle’s enthymeme has been viewed as an abbreviated syllogism; however, according to Burnyeat (1996), this definition is incomplete and misleading: “The Rhetoric’s official definition of enthymeme is its definition of sullogismos” (p. 96). “An enthymeme,” Burnyeat summarizes, “is an argument (sullogismus tis) in a rhetorical speech” (p. 98). In other words, the enthymeme is a rhetorical (as opposed to a dialectical) syllogism. In the
enthymeme, the premises are based on endoxa (commonly accepted wisdom or things that are contingent upon the circumstances); in the latter, the premises are logically valid.

The following example of the rhetorical syllogism, or enthymeme, is taken from Silva Rhetoricae (2007):

_We cannot trust this man, for he has perjured himself in the past._

The major premise of the complete syllogism is omitted from this enthymeme:

- Those who perjure themselves cannot be trusted. (Major premise - omitted)
- This man has perjured himself in the past. (Minor premise - stated)
- This man is not to be trusted. (Conclusion - stated)

If we believe, as do theorists such as Birdsell and Groarke (1996, 2007) and Blair (1996), that visuals _can_ act as arguments (not necessarily that all do or that all are effective), then it follows that visuals are not syllogistic/dialectical arguments but rather rhetorical ones. And if visuals can act as rhetorical arguments, then such visuals must argue _enthymematically_ (Blair, 2004; Birdsell & Groarke, 1996, 2007; Finnegan, 2001).

With photographs, the acceptance of the enthymematic argument depends on presumed realism (“photorealism”) of the image (Finnegan, 2001). The viewer understands the argument being made by the photograph precisely because the viewer accepts the photograph as realistic, not altered or manipulated. So long as the photograph is considered a faithful representation of reality, it argues simply by virtue of its existence (i.e., it is indexical of something): “The pictured subject or event occurred, and this photograph is evidence thereof.” Or, as Barthes (1981) puts it, “[T]he Photograph
mechanically repeats what could never be repeated existentially” (p. 4). Whether or not photos do, in fact, represent what they depict is an argument for another project, and one which is currently considered in the disciplines of art and art history, among others.

The photograph in Fig. 1 created a controversy upon its publication in 1936. The Fargo Forum, a local newspaper in Fargo, ND, objected that the photo was a “fake” because the skull had not originally been in the position in which Rothstein photographed it, and because Rothstein cropped out healthy grassland. As Finnegan points out, however, the possibility for the photo to be real had to exist before it could be called fake. And, as anyone who has ever taken a photograph knows, the camera does not see “reality” as the human eye does. Furthermore, because no single definition of “reality” exists, arguing the “reality” of a photograph is quite possibly a pointless endeavor.

However, the assumption of naturalism in photographs is only the first step in the process of analyzing visual argument. Rhetoric provides a framework by which to analyze visual arguments—and this notion of using rhetoric to analyze communication outside of writing or speech is not new. Jeanne Fahnestock (1999) deconstructed scientific arguments to illustrate the use of rhetorical figures, such as antithesis, antimetabole, ploche, and polyptoton, in scientific writing and visuals. To those who would doubt the existence of rhetoric in science, she set out “to weaken the old misconception that the domain of rhetoric does not extend to the sciences since rhetorical
invention presumably prescribes only the reassembly of conventional truths, while scientific invention involves the discovery of new truths” (p. xi). With a nod to works such as that of Lakoff and Johnson (1981) on metaphor, Fahnestock argues that “language does do much of our thinking for us, even in the sciences,” and that rather than being a bane, it has in fact been a boon, “helping individual thinkers generate concepts and theories that can be put to the test” (p. xi). Fahnestock demonstrates that visuals appear as visual rhetorical figures—for instance, a light micrograph of cytokinesis in a plant cell in telophase (see Fig. 2) is, she argues, a “physical antimetabole” (p. 138), a visual of the sort of mirror-image of clauses that constitutes the prose antimetabole (e.g., *La vie, c’est le germe et le germe, c’est le vie*—Pasteur). Fahnestock’s argument that both verbal and visual examples of rhetorical figures may be found throughout the history of scientific writings is amply illustrated with examples of both, leaving little doubt but that scientific knowledge has depended to a great extent on the power of rhetoric.

Myers (1988) also deals with the rhetorical potential of images when he addresses the assumption of photography’s self-evidence: “Photographs come with apparent self-evidence, because they are taken as mechanical reproductions of an image” (p. 239). Even though the human brain understands that a photograph is a collection of grains exposed to light and reproduced on paper, humans are able to “reconstruct a moment in time” from those grains or pixels (p. 240). Our understanding of realist paintings and of conventions of photography from our own casual camera use enables us to place ourselves in the position of the photographer, and it is this assumption of place that “gives a photo, or a realist painting, its immediacy and self-evidence” (p. 241). Where
the frame of the photograph removes details, our brains are able to imagine its
continuance: “we assume that the rest of the world goes beyond the edges of [the] photo;
this is one slice of a world that is continuous with our world” (p. 241). Like Barthes’
(1980) view, Myers contends that “by freezing time, [the photograph] suggests a
narrative of events,” a “particular moment” in a “particular place,” captured for posterity
(p. 241). The fact that photographs often contain extraneous detail is, for Myers,
important because that detail makes the photo “seem to be a document recording an
unmediated perception of a particular piece of nature” (p. 242). In other words, viewers
assume that a photograph is organized in the same way their own vision of a scene would
be—taking for granted the mediation of the photographer’s composition, the choice of
film speed, the aperture and shutter speed, the choice of color or black and white, lens
focal length, and so on. Myers has not named this phenomenon the *naturalistic
enthymeme*, but it seems close to what Finnegan (2001) proposes.

As I have pointed out, acceptance of the naturalistic enthymeme allows
photographs to be understood as rhetorical in some sense. However, the ubiquitous
nature of digital photography and easy availability of photo manipulation software may
endanger acceptance of the naturalistic enthymeme at some point. Of course, whether or
not photos do, in fact, represent what they depict is an argument for another project, and
one which is currently under consideration in the disciplines of art and art history, among
others.

A 2007 issue of *Argumentation and Advocacy* includes several other authors who
discuss how visuals argue. Among those are Michelle Gibbons; Hatfield, Hinck, and
Birkholt; Melanie McNaughton; Robert Pineda and Stacey Sowards; Kathleen Roberts; and Valerie Smith. I now summarize the research of each of these authors, paying particular attention to Smith and her focus on the importance of enthymeme to visual argument.

Gibbons (2007) points to the MRI as visual argument, discussing how the images change their arguments when they go from being published in scientific journals (with accompanying hedged language and assertions) to popular culture media (where they become arguments about the processes of thought). It seems that context is particularly important to Gibbons’ argument about images.

Hatfield, Hinck, and Birkholt (2007) analyze a Belgian UNICEF public service announcement (PSA), stating that it works as a visual argument because it is constructed to overcome viewer fatigue with repeated depictions of starving children in other countries. The PSA accomplished this goal by depicting the Smurfs, a popular child’s cartoon, being subjected to animated violence. By taking a familiar set of characters associated with childhood and comfort and throwing them into a situation of war, Belgian UNICEF successfully obtained renewed interest in its mission.

McNaughton (2007) studied representation and argument in the penitentiary setting, arguing that prisoners, who have few to no other ways of representing their identities and cultural connections, do so visually by tattooing themselves extensively. She describes a complex system of representation including aligning oneself with certain gangs or other subcultures within the prison system, and points out how the context of the visuals, including bodily placement, color, size, and so on, influence how seriously the
argument is taken by other inmates. For instance, a large tattoo “gains points” for the bearer no matter where it is placed on the body, even if it is usually covered by a garment. However, even a small tattoo in a location that is constantly visible makes a strong visual argument for belonging to a given subculture. I further discuss composition in the section on Kress and Van Leeuwen’s (1996) *Reading Images*.

Pineda and Sowards (2007) describe how Mexican immigrants to the U.S. use flag waving as visual argument. In early demonstrations for their rights, the immigrants waved only the Mexican flag. This type of demonstration drew criticism and negative publicity, so they revised their strategy to include waving both Mexican and U.S. flags while demonstrating. In this way, the Mexican immigrants argued visually for their belonging in both cultures.

Roberts (2007) studied the artifacts left by the Blackfeet Indian tribes that were colonized by white missionaries in the 19th century. The missionaries forced Christianity and Western cultural customs on the “godless savages” of the Indian tribes; this cultural whitewashing included influencing the way the women decorated their ceremonial clothing. One especially potent symbol for the Blackfeet was the triangle, which represented the shape of the sacred lodge dwelling, and was to be found in almost every aspect of their art prior to being colonized by whites. Missionaries tried to get them to replace the triangles with floral motifs, but the Blackfeet artists subtly resisted by, for example, embroidering flowers into triangular shapes and making flowers or petals that were vaguely triangular. In these surreptitious ways, the Blackfeet preserved one of the most sacred symbols of their culture. However, in the absence of any verbal text
detailing the process of imperialization, the art alone remains as a visual argument to tell
the story of how the Blackfeet resisted this invasion, and attempted destruction, of their
culture.

Finally, Valerie Smith (2007) contributes to the theory of visual argument by
arguing that Aristotle himself gave us a basis by which to consider the image as
argument. In her article in *Argumentation & Advocacy*, she makes the case for
enthymeme as the structure for visual arguments. When the audience is familiar with the
topic and the propositions surrounding it, Smith argues, an image can argue in the same
way a speaker can—by means of enthymeme. The enthymeme is useful in analyzing
visual arguments because it allows for the assumption of certain propositions which are
generally difficult or impossible to represent visually. In rhetoric, she points out, the goal
is to persuade the masses, and images work well to this end because they have a special
connection to *pathos* and *ethos* (in addition to, or instead of, *logos*) when used to argue
for a claim. It is perhaps true that she does not carry her analysis far enough to convince
some of the potential for visual argument by enthymeme, but she opens a new door for
further investigation.

The support of visual argument extends beyond *Argumentation and Advocacy*,
and also shows up in other volumes of the journal in between the crucial 1996 and 2007
special issues. The topic also comes up in several edited volumes published in recent
years, including one by Lawrence Prelli (*Rhetorics of display*, 2006). One of the central
ideas of this book is that “rhetorics of display are nearly ubiquitous in contemporary
communication and culture and, thus, have become the dominant rhetoric of our time” (p.
2). While the various chapter authors have differing ideas and arguments, they do agree on that central claim.

In addition to the articles from A&A, Long (2003) and Lamp (2009) have each contributed support of visual argument in their respective articles. Though Finnegan’s (2001) article denotes the début of the term ”naturalistic enthymeme,” Kathryn Long (2003), writing in *Church History*, essentially makes a case for the naturalistic enthymeme without actually using that term. Her article discusses the missions to Ecuador in which Elisabeth Elliot and her husband, among others, were missionaries among the Waodani tribe of aboriginals. After the Waodani murdered her husband, Elisabeth stayed on, documenting them while living among them. Later, Cornell Capa, the famous *Life* magazine photographer, extensively documented the Waodani, showing the day-to-day lives of a people who appeared to most fundamentalist Christian Americans at that time to be godless savages. Both Capa and Elliot depicted a very human side to the Waodani, with images that argued for their godliness and gentleness. However, the church that sent Elliot and the others was not ready to accept these arguments about the Waodani; it wanted these people to be converted to Christianity, dressed to hide their obscene nudity, and made to look as much like Westerners as possible. In this case, the visual arguments made by the photojournalism undertaken in Ecuador were not accepted by the immediate audience, but found an audience later (by means of Elisabeth Elliot’s book *Through Gates of Splendor*) that treated the photos as evidence of the humanity and goodness of this tribe. Thus, Long’s case study helps support, if indirectly, Smith’s (2007) concept of the naturalistic enthymeme.
Finally, Kathleen Lamp (2009), in a recent article for *Rhetoric Society Quarterly*, gives an interesting account of the visual argument constructed by Emperor Augustus of Rome, who endeavored to build a political myth not only about his leadership, but also about the history of Rome and Romans in general. In so doing, Augustus hoped to link himself to a long line of leaders and senators and establish his own place in this divinely appointed line. The Ara Pacis Augustae, Augustus’s monument, argues, through its many visualizations of historical events and persons, that the Roman people, since the creation of Rome by Romulus, have always relied on their religion and been rewarded by the gods—at least until about 75 years prior to Augustus’ rule. Through the images in the monument, Augustus invites the viewer to link him to the return of the Romans to their religion and the resulting restoration of success and peace to the Roman Empire. In addition, the physical context of the monument adds to the argument: It is placed among important monuments to Roman heroes and senators, as well as important events in Roman history. Lamp points out that Augustus is hardly remembered as a great orator; however, he established a position for himself among the greats of Rome by constructing an impressive visual argument in the Ara Pacis.

The naturalistic enthymeme is not the only way in which scholars have considered the persuasive power of visuals. One of the ways visuals argue, Fahnestock (1999) tells us (above), is through the use of repetition. Statistician and visual design expert Edward Tufte helped set up the discussion of visual repetition using a different terminology: *parallelism*. In the stunningly illustrated *Visual Explanations* (1997), Tufte gives examples of what he calls “parallel” uses of images meant to be compared by the viewer.
For instance, a photograph and an X-ray image of a horse (reproduced on p. 79) invite comparison because of their similar size and location on the page. Tufte compares this visual parallelism to similar verbal techniques: “Are there visual analogs to syntactical and rhetorical principles? Analogs to the more subtle aspects of parallelism in language, such as ellipsis and deliberately faulty parallelism” (p. 79)? Indeed there are, he argues, and breaks down this visual parallelism into parallelism in space and parallelism in time (p. 80). Spatial parallelism, he posits, takes advantage of our notable capacity to compare and reason about multiple images that appear simultaneously within our eyespan. We are able to canvass, sort, identify, reconnoiter, select, contrast, view—ways of seeing all quickened and sharpened by the direct spatial adjacency of parallel elements. (p. 80)

In other words, the repetition of similar images, such as the horse and its X-ray image, in close proximity allows for quicker apprehension of meaning.

Similarly, parallelism in time helps the viewer compare visuals in “time-bound sequences” (p. 80). The example illustrated is one of “A cottage altered, in Langley Park,” and features two drawings of a landscape: one with a red cottage, and one with a Grecian-style dwelling in place of the cottage. The surrounding landscape remains largely the same in both images, though a few deciduous trees have changed color with the season (pp. 80–81). “For time-bound sequences,” Tufte admits, “comparisons must be made by contrasting a remembered image with a currently viewed image, a sometimes difficult task”—a task he simplifies by providing an overlaid flap featuring the first
version of the cottage; when the flap is lifted, the Grecian revision is featured beneath (p. 80). Lifting that flap to compare the two versions is an example of this time parallelism; “the flap is integrated into the surroundings by means of its contoured shape and small size; its local quality concentrates our attention on how before differs from after” (p. 80). The time parallelism “enhances the reading of differences” and helps prevent the disorientation of flipping back and forth between separate pages (p. 81).

In addition to visual parallelism, Tufte also illustrates the visual repetition he calls “multiples.” “Multiple images reveal repetition and change, pattern and surprise—the defining elements in the idea of information,” he states (p. 105, emphasis in original). “Multiples directly depict comparisons, the essence of statistical thinking” (p. 105). In addition, they “enhance dimensionality,” “help viewers analyze, compare, differentiate, and decide,” “represent and narrate sequences of motion,” and “amplify, intensify, and reinforce the meaning of images” (p. 105). Multiples, Tufte is saying, argue.

To assist in understanding whether a photograph has truth value, or modality as Kress & Van Leeuwen (1996) call it, and to offer context for my visual analyses, I now review the work of Charles Sanders Peirce, whose semiotic concepts of icon and index are useful in understanding the naturalistic enthymeme.

The role of semiotics in truth value.

It is relevant here to consult semiotics, and in particular Peirce, for another way to consider the photograph. Peirce’s semiotics defines three types of sign: icon, index, and symbol. For instance, it is commonly argued that a photograph of someone is an icon depicting them in the same way that a statuette of the Virgin Mary is an icon of her, or
the little square image on the computer desktop that links to Microsoft Word is an icon of that software program. An index is an indicator of something else in the perception of some animal; for example, smoke billowing from a window of a home is indexical of a fire, or a growl emitting from a dog is indexical of the danger of attack. Finally, a symbol is something that may be arbitrary or not in representing something else; for instance, letters in English arbitrarily represent English sounds, or a circle with a diagonal bar through it represents “don’t do something” (depending on what is depicted inside the circle—say, a cigarette). I argue later that photographs can, in certain contexts, be all three types of Peircean sign.

Roland Barthes (1980), in Camera Lucida, elevated the photograph to the status of index, stating that a photo is always both icon and index. His book is basically about his mother dying and how a photo of her as a child “pierces” him (he uses the word punctum to represent that “puncturing,” although the Latin translation of the word is a point or small spot). He discusses the relationship of photographs to memory, and argues that a photo is indexical in that it is indicative that the subject was in a particular location at a particular time, as evidenced by the photograph proving the event. Although Camera Lucida is not regarded as contributing greatly to his theoretical foundation, the book seems to be frequently quoted in discussions of art and photography.

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5 See a footnote in Gross [2009, p. 153] in which he states, “It might seem that a snapshot of Aunt Ida refers to her. No; it depicts her.” Kress and Van Leeuwen argue, however, that images can and do represent; for instance, a small child may not be able to draw a car, but if he can draw circles to represent wheels, then he has in effect represented “carness” by using the criterial aspects of a car: in this case, wheels.
When is a photograph an iconic representation of a subject? I argue that a photo is an icon, for instance, if it is a quick snapshot, devoid of any composition and lacking in essential qualities or “criterial aspects.” One might argue that an X-ray or MRI of a patient is an icon, because it would seem to be devoid of criterial aspects of that person. However, in some cases the medical image of a patient could go beyond an iconic relationship, particularly in the case of, say, a patient such as Joseph Merrick (a.k.a. the Elephant Man). An X-ray of this man, who suffered from neurofibromatosis or Proteus syndrome (the result of which was grotesque tumors covering his body), would reveal twisted and mangled bone structures beneath the malformed exterior. Such an image could certainly be thought of as representing criterial aspects of the subject.

A photo is indexical, as Barthes argues, in the sense that it indicates the event depicted. For instance, a family’s holiday snapshots are considered evidence (again, relying on the naturalistic enthymeme) that they were in Yosemite National Park on a given date. It is this indexical quality of photographs that has made them reliable as evidence in court cases, for instance. If a prosecutor can produce a photograph taken from a gas station video camera showing that a suspect was in the lot on a given date at a given time, the case may be made against the suspect. Of course, with the rise of digital technology, the indexical quality of photographs is undoubtedly in question. Anyone who watches television shows such as CSI knows that the technicians may employ digital enhancements to grainy photos to bring out hidden details. Perhaps it is only a matter of time until we hear of a major court case in which the truth value of a forensic photograph
is called into question on the basis of digital enhancement.\textsuperscript{6}

It is also possible for a photograph to become a symbol. Keilbach (2009) employs the naturalistic enthymeme (again, without using that term) in her article in *History and Theory* discussing amateur photographs from World War II. She points out that while the official photographs of the Holocaust, mostly taken by the Nazis themselves, construct a reality that serves the Third Reich, it is the amateur photographs taken by both German and Allied soldiers that show just how fluid meaning can be in images. One brief example from this article is a photograph in which a man on a bulldozer is pushing an enormous pile of dead bodies toward the photographer’s position. The man’s uniform does not identify him; he appears to be white, however, and he is wearing a surgical mask. Without contextualization, it was widely assumed this was a photo of a Nazi soldier mistreating the bodies of Jewish victims. However, it turns out the photo was taken by an English soldier, and the man on the tractor was an American soldier. Their understanding was that the bodies needed to be dealt with quickly and in this very hands-off manner to prevent the transmission of disease and bacteria. In this context, the image argues very differently. Fig. 2 shows another example: the well-known (but staged) photo of the flag raising after the battle of Iwo Jima. The story behind the photo is all but lost in its symbolism of American victory in World War II. Members of the Greatest Generation instantly recognize the photo as being from that battle, but younger viewers and those not familiar with the details of World War II likely see it as symbolic of the

\textsuperscript{6} Digital forensics is already an important part of the legal process. For a discussion of current technology, see Wen & Yang (2006).
war itself.

Keilbach focuses on the fact that some photos, used again and again over time and taken out of their original contexts, lose their referentiality and become abstractions. She notes that many photos from World War II have come to be categorized under such abstract, broad headings as “atrocities” and “Holocaust,” and in the process have lost all reference to the original events they depicted in the first place (See Fig. 2). She points out that such photos have come to be symbolic and thus are essentially useless for depicting historical truths.

Assuming the case is made for the concept of images as potentially rhetorical, then the next important step in the process of considering visual arguments is to settle upon at least one valid theory for analyzing images as they work in arguments. Gross (2009) has, as previously mentioned, already argued against the current existence of such a theory, proposing one of his own based on Dual Coding Theory. However, his article does not address the work of Kress and Van Leeuwen (1996), whose book Reading images: The grammar of visual design spells out in detail the different ways in which images work, implicitly supporting the notion of visual argument. Furthermore, it requires no expert knowledge of specialized areas of psychology; Kress and Van Leeuwen’s theory is accessible to researchers from most backgrounds, including the humanities.
Finally, Kress and Van Leeuwen spend much of the book discussing the role of composition and layout in meaning making. Aspects of design such as position on the page and placement relation of images to textual elements add to meaning in Western culture. For instance, Kress and Van Leeuwen argue that horizontal layouts usually place “given” information at left or top left of the page(s) and “new” information to the right. Consequently, the Western reader, accustomed to reading left to right and top to bottom, sees what he or she already knows first; then, the new information is given after a relationship has been established between the author and the viewer. In the example in Fig. 3, a common graphic from a duct cleaning service illustrates the old/new information layout: At top left is what you already know—that your ducts are dirty. The next thing you see is the new information—how your ducts will look when the company is done.

This is but one of many examples of how page layouts are constructed to gain the trust of a Western audience. The authors also discuss, for instance, an example of an Eastern layout, in which the given or central idea is placed, accordingly, in the center of the page, with “satellite” images placed all around it. The “satellites” may be relatively equal in importance, or they may increase in importance as the viewer goes around the
circle. This layout is not as common in Western cultures, where Judeo-Christian majority background leads us to read images differently.

**Truth value of images.**

Continuing to review how scholars have discussed visual rhetoric, I now discuss in more detail the concept of image *modality*: how viewers arrive at it, how notions of modality may have been affected by the preponderance of digital imaging, and how an understanding of the truth value of images contributes to my proposed critical reading of images in politics or sciences.

**Reality(-ies).**

Discussions of truth are never simple, even in common parlance. Bring the discussion into philosophy, and it becomes a tangled web of “-isms” and “-ologies.” I attempt here to give a “nutshell” version of millennia of philosophical thought on the nature of reality—just enough to lead the reader to my own position on the concept.

My understanding of the major philosophical positions on the nature of reality begins with Plato. As a Realist, Plato believed that everything we see on earth has an exemplar in some other place (in the ether, if you will)—a “universal” or “form.” Thus, when referring to, say, a chair, you are in fact referring to that universal form of chairness. The trouble with this conception, of course, is that no one has ever been “in the ether” or seen any of these universals, so it is difficult to prove they even exist, let alone that we have any idea whatsoever what the universal chair looks like. Nominalists (of which there are many subdivisions) reject the concept of universals and believe that,
for instance, a chair is a chair because (in short) the predicate of the sentence says “is a chair.” Rationalists use reason to determine whether something is real; empiricists use evidence (the more something can be quantified, the happier empiricists are). People like Kant—transcendental idealists—need both reason and evidence to prove to them that something is real.

I now discuss some of the various positions on the ability of images to be true or false. Barbara Savedoff (1997), writing from the art criticism perspective, seems to be a firm believer in the naturalistic enthymeme (though the term does not appear in her article). She argues in particular that the rise of digital imagery threatens the primacy of photography as documentary/evidentiary and questions how society will function, basically, when all images are suspect. In her article, she cites Fred Ritchin’s (1990) popular book *In Our Own Image*, in which he discusses the use of context to change the meaning of a photograph. The example Ritchin gives is a 1980s photo of the late Sen. Edward Kennedy (D-MA) leaving a Kennedy Center gala event. In the photo, which first appeared in the conservative Washington *Star* (now defunct) newspaper, Sen. Kennedy appears to be leaving the Center accompanied by a much-younger woman.

Viewers need to be familiar with Senator Kennedy’s history to understand the visual argument the *Star* was making. A married Catholic, Kennedy nonetheless has had a colorful history as a member of the Kennedy political clan that produced an American President. As a young man in 1969, he left a party drunk, with a young woman named Mary Jo Kopechne, and drove off the Chappaquiddick Bridge. Kopechne died; Kennedy swam to safety. The incident was a huge disaster for the Kennedy family and a stain on
the young Kennedy’s reputation. It was widely believed then (as now by many) that because of this tragedy, Kennedy would never be able to run for President, as his brothers John and Robert had.

The public conception of Kennedy as a womanizing drunk has remained in the public consciousness since that incident many years ago, even though by the 1980s Kennedy had a solid political service career to his credit. Thus, when the Star obtained the photo, the editors evidently saw the opportunity for a political dig at a powerful Democrat. They ran a cropped version of the photo, which suggested that Kennedy was accompanying a young woman other than his wife to a very public event. It was later discovered that the original photograph, which ran unedited in the New York Times, had been cropped to suggest the marital infidelity, and that in fact Kennedy had been walking beside a priest. The young woman, on the other hand, was walking some distance behind Kennedy, accompanied by a young man.

Savedoff’s use of Ritchin’s example illustrates with great clarity the power of the naturalistic enthymeme. The argument would look something like this:

- (omitted minor proposition) Ted Kennedy once made a very bad mistake.
- (omitted major proposition) Those who make mistakes in their past are not to be trusted.
- (omitted major proposition) Photographs are representations of reality.
- Therefore, because a photo showing Ted Kennedy with a younger woman is real, Ted Kennedy is not to be trusted.
It is clear from her article, however, that Savedoff understands photographs to be evidentiary, primarily because of her deep concern that the rise of digital imaging will threaten that documentary status. In short, the naturalistic enthymeme is upheld.

Another author who regards photography as a reproduction of reality is Roger Scruton (1981), who, in an article for *Critical Inquiry* concerning the discussion of whether photography should be considered art, relegates the photograph to a “mirror” of reality. While his overall goal is to argue that photographs are not art, his argument is interesting because he insists that a photograph cannot represent anything due to its nature as, essentially, an *icon* of reality. In other words, he is arguing that only a (painted) portrait can capture the essence of a subject, its *criterial aspects* (to borrow a term from Kress and Van Leeuwen), and if a portrait photographer endeavors to capture those eternal qualities of a subject, then the resulting image ceases to be a photograph. Photos, he says, cannot capture the eternal; only “real” art can do that.

One of the more complex discussions of truth value in photographs comes from John Berger (Berger & Mohr, 1982). He makes a case for considering photography as essentially the act of capturing nature and imprinting it upon film—and any manipulation of that process then falls outside of the definition of photography. "At one level,” he argues, “there are no photographs which can be denied. All photographs have the status of fact. What has to be examined is in what way photography can and cannot give meaning to facts” (p. 98).

Arguing that photography, unlike painting or drawing, has no language of its own, he goes on:
It is because photography has no language of its own, because it quotes rather than translates, that it is said that the camera cannot lie. It cannot lie because it prints directly. […] (The fact that there were and are faked photographs is, paradoxically, a proof of this. You can only make a photograph tell an explicit lie by elaborate tampering, collage, and rephotographing. You have in fact ceased to practice photography. Photography in itself has no language which can be turned.) And yet photographs can be, and are, massively used to deceive and misinform. (p. 95)

Berger is setting up his explanation of how photographs, used in certain ways, can convey meaning. He carefully distinguishes between an “expressive” photograph and a “snapshot,” making the case that photos are “quotes” of reality, and whether those “quotes” tell much or little depends on the information contained in the photo. The expressive photograph, “whose expressiveness can contain its ambiguity of meaning and ‘give reason’ to it—is a long quotation from appearances: the length here to be measured not by time but by a greater extension of meaning” (p. 128). When a series of such photographs is arranged into a collage or montage, they can then relate a narrative: “The essential relation between teller, listener (spectator) and protagonist(s) may still be possible with an arrangement of photographs. It is, I believe, only their roles, relative to one another, which are modified, not their essential relationship” (p. 287). The placement of the photographs and the discontinuities created by the absence of information between those photographs bring the spectator into the story: the images are thus “restored to a living context: not of course to the original temporal context from which they were taken—that is impossible—but to a context of experience. And there, *their ambiguity at last becomes true*” (p. 289). Later, I discuss the ways in which the images in a single
science textbook can be seen to act as a montage, creative a narrative about gender and science for each reader or “spectator” who encounters it.

The philosophers and theorists mentioned above argue that a reality exists that can be ascertained through some method and reproduced through imaging techniques. I am of the social constructionist camp. These theorists hold that reality is socially constructed by a given social group, so there is not one “reality” but rather many “realities.” Kress and Van Leeuwen (1996) fit into this group. Critical theorists (e.g., feminists, Marxists, GLBT theorists, etc.) view reality/ies through the lens of power relations. They take the idea of social construction one step further, arguing that some social groups are more powerful than others, and are thereby able to define reality for others. Powerful groups have greater access to dissemination of information (through the media, school systems, and so on) and can make less-powerful groups work harder to understand “reality” (for instance, the abstract writing of higher education acts as something of a “gatekeeper” to keep out those who cannot “speak the language”). I count myself and my research among the critical theorists.

To delve into the topic of truth value of images, one must first understand that a large part of what determines the “truth” of an image, for those who believe images can be true or false (and not everyone does), is the image’s correspondence with “reality.” As indicated previously, the naturalistic enthymeme holds that images that accurately depict what the eye sees are given the highest truth value (or modality, as Kress and Van Leeuwen call it). However, the naturalist enthymeme is based upon assumptions rooted in positivist modes of thinking, and even though positivism is largely outmoded in
modern philosophy, the “commonsense” naturalism of photography nonetheless perseveres.
The theories discussed above depend, to differing degrees, on an assumption of photographic naturalism; however, none offers a precise definition of the term. It is tempting to depend upon the commonsense definition of naturalism as “photorealism”; and, to an extent, photorealism is the basis for my understanding of naturalism. However, my operationalization of naturalism depends less on art history (i.e., naturalism vs. realism vs. Romanticism) than on literary criticism and upon an opposition between naturalism and abstraction. According to William R. Herman (1960), “[T]he non-abstract artist deals in similes, the abstract artist deals in metaphors. The former requires us to see a similarity between things: the painting of this lady looks like this lady. The latter tells us that these lines and colors stand for this lady” (p. 233). In many ways, this definition, which depends upon the literary devices of simile and metaphor, is well-suited to describing photographic naturalism (as opposed to abstraction) in the sense that I am using it: The naturalistic photograph works on the viewer’s mind as a visual simile,
whereas the photograph that contains elements of abstraction works as a visual metaphor.

Thus, I operationalize naturalism as follows:

To put this visual definition into words, a photo containing naturalism, for my purposes, is one that (1) viewers can imagine themselves as being the subject of (or doing the subject procedure), (2) contains a scene that viewers can imagine actually happened and is not a product of digital manipulation or other tinkering, and (3) contains elements that look as viewers would expect them to look to the naked eye (or a camera with a standard lens). This definition relies upon terms and concepts from literary theory, semiotics, rhetoric, and art criticism.

In this section, I have shown several examples of the possibility for truth or falsehood in images, particularly photography. I have also outlined a definition of naturalism for the current project. Having made a reasonable case for considering visual
argumentation, and having pointed out concepts of particular interest such as the naturalistic enthymeme, I now frame the research questions that guided the project.

**Research Questions.**

Previously, I reviewed and responded to a series of assumptions about gender, rhetoric of science, and visual rhetoric. The following questions emerge from the existing scholarship:

1. How are gender roles presented in the photographs in science textbooks?
2. How do science textbooks present the occupational roles and activities of gender roles in these texts?

I have developed the following hypothesis about gender representation in middle school science textbooks:

\[ H_1: \text{While girls and boys are photographically represented fairly equally in science texts published within the past ten years, girls are still being represented in less-powerful and/or less-important roles than boys.} \]

In the next chapter, I detail the methodology used to test this hypothesis. Following that, I dedicate Chapters 3, 4, and 5 to case studies of three 7th-grade life science textbooks, including visual analysis (Kress & Van Leeuwen, 1996) and enthymematic analysis (Fahnestock, 1999; Finnegan, 2001) of all images that include humans. The aim of these qualitative analyses is to begin to understand what arguments about gender are being made by images in science textbooks.
Chapter 2: Methodology

This chapter covers chosen methodology. The analysis relies upon three theoretical foundations: Kress & Van Leeuwen’s (1996) grammar of visual design; Finnegan’s (2001) concept of visuals arguing through naturalistic enthymeme; and Fahnestock’s (1999) notion of visual repetition, particularly ploche and polyptoton, in visual arguments.

Theoretical Foundation

As indicated in Chapter 1, my theoretical framework for this study depends first upon Kress & Van Leeuwen (1996), and then upon Finnegan (2001) and Fahnestock (1999). Kress & Van Leeuwen provide a method for determining whether images in these textbooks may be considered naturalistic in Western culture, a prerequisite for considering visual argument; then, Finnegan and Fahnestock provide two viewpoints from rhetorical studies that allow me to uncover some of the likely arguments the images may be making given the endoxa of American culture.

Kress & Van Leeuwen (1996) examine image composition, including actors and non-actors, vectors, and so forth, as well as image modality (or “truth value”), using the key markers of visual modality (saturation, depth, brightness, illumination, modulation,
differentiation, and representation). In brief, here are the major aspects of Kress and Van Leeuwen’s theory. First, they discuss modality markers; then, they define coding orientations; and finally, they spend a great deal of time discussing composition.

Modality markers and coding orientations contribute the majority of the indications of image modality in my methodology.

**Modality markers.**

Briefly, the eight modality markers are as follows:

- color saturation
- color differentiation
- color modulation
- contextualization
- representation
- depth
- illumination
- brightness

Each of these is given higher or lower modality, or truth value, depending on the coding orientation that is privileged in the given context. These modality markers are discussed in detail below.
Coding orientations.

The four coding orientations that exist in Western culture, according to Kress and Van Leeuwen, are as follows:

- naturalistic orientation
- abstract orientation
- sensory orientation
- technological orientation

Because Kress and Van Leeuwen are adherents of Halliday’s (1978) social semiotic theory of representation, they take the view that certain orientations are privileged over others in our culture.

- The naturalistic orientation comprises the “commonsense,” or what is commonly called the “photo-realistic.” In this orientation, the highest value is given to images that depict what is commonly accepted as “reality,” or what can be seen by the naked eye.

- The sensory orientation comprises much of advertising imagery, such as food ads, travel brochures, and interior decorating, to name a few. Highest modality is given to deeply saturated images with very highly detailed representation; the goal of sensory images is to represent visually what can usually be perceived only through touch, smell, or taste. Accordingly, sensory images rely heavily on pathos.
• The **technological coding orientation** is used by science and, especially, fields such as technical writing, engineering, and cartography, or in any situation in which accuracy is paramount. Maps and user manuals are examples of the technological coding orientation.

• In Western culture, the most privileged coding orientation is the **abstract**. This is the orientation of higher education (particularly science and philosophy) and “high art.” The reason for this orientation is held in such high esteem is that the ability to think and understand abstractions is a learned ability, not an innate one. For example, science textbooks for young children employ many simplistic images; as students move up in the grades, however, the text becomes increasingly more abstract and the images fewer and fewer.\(^7\) The ability to interpret abstractions in art (let alone the ability to produce art that can be analyzed in this way) is considered the goal of so-called high art literacy.

**Categories.**

Visuals category.

Items for analysis in this category include the following categories and modality markers:

• **Objects/Artifacts** (what objects appear in the image, and who is using them?)

• **Colors**
  
  o **Modulation** (is it low, medium, or high?)

\(^7\) This assertion is supported by Dimopoulos, et al. (2003), who studied science textbooks across all grades and found density of photos in Grade 5 Primary texts to be 19.8 images/1000 words, declining to 7.4 images/1000 words in Grade 3 of Lower Secondary texts (approximately 8\(^{th}\) grade).
Saturation (is it low, medium, or high?)

Differentiation (is it low, medium, or high?)

- Contextualization (how much background context is given in the image?)
- Representation of Detail (how much detail is represented in the image?)
- Depth (how deep or shallow is the perspective in the image?)
- Illumination (how natural is the light source in the image?)
- Brightness (how wide a variation exists in brightness in the image?)
- Coding Orientation (how does the image approach its intended viewers?)
  - Technological
  - Sensory
  - Abstract
  - Naturalistic

- Horizontal and Vertical Angles (how do the viewers approach the image?)

All but the first item come from Kress & Van Leeuwen (1996); the first, Objects/Artifacts, I have added to aid in determining the roles of subjects in each photo.

In this category, I counted the number of scientific artifacts or objects being used, listed what they were (if I knew), and noted who was using them. For example, in one photograph, a woman in a lab coat was sitting at a computer; a microscope of some sort was next to the computer, but she was not using it. I counted both the computer and the microscope, but noted that the woman was using only the computer.
Colors.

I coded the following categories of colors: modulation, saturation, and differentiation. The scale of modulation runs from fully modulated colors (for instance, many different shades of a given color) to unmodulated color (only one shade). Although Kress & Van Leeuwen do not include a modality scale for modulation, they discuss it in detail in a 2002 article:

Flat colour is generic colour, it expresses colour as an essential quality of things (‘grass is green’), while modulated colour is specific colour (‘the colour of grass depends on the time of day and the weather’), it attempts to show the colour of people, places and things as it is actually seen, under specific lighting conditions. Hence the truth of flat colour is an abstract truth, and the truth of modulated colour a naturalistic, perceptual truth. (Kress & Van Leeuwen, 2002, p. 357)

It is reasonable to gather from this description that the lower the modulation, the lower the modality, with black and white (no color modulation) having the lowest modality. Those photos coded as low modulation may feature many colors but not much contrast (meaning all appearances of red, for instance, looked about the same intensity), or feature few colors on subjects that had no areas of shadow, for example.

Fig. 4. Saturation. From Clark & Wiebe (2000), Scientific Visualization.
The scale of saturation runs from full saturation (deepest colors with no hint of white or black added) to the absence of color (black and white). As Kress & Van Leeuwen (1996) point out, the most naturalistic photos are neither desaturated nor highly saturated; images on either extreme of this range tend to be viewed in our culture as unnatural. (See Fig. 4.)

The scale of differentiation runs from the greatest diversity of colors (say, a fully articulated rainbow) to monochrome. The highest-differentiated image contains the full spectrum, a rainbow, of colors; an image with the lowest differentiation is monochrome. In these cases, the greatest modality (truth value, or naturalism) lies closer to full color, but not at the extreme.

Before I discuss the results in the three color categories, let me offer some basic principles of human color perception. Specifically, although the purpose of the present study is not to make arguments about human ability to discern color, it is important to note that human perception is not static; research by Madrid & Crognale suggests that chromatic sensitivity continues to develop throughout childhood and adolescence (2000). In their study, the authors found that “for low spatial-frequency stimuli, there are long-term changes in the development of the chromatic pathways that are not observed in the low spatial-frequency achromatic pathways. The changes in the chromatic VEP waveforms with age may be a physiological correlate of reported behavioral changes” (p.
Along with other findings, the authors discovered that “[t]he responses to low spatial-frequency isoluminant onset stimuli designed to preferentially activate the chromatic pathway do not appear as they do in the adult until after 12–13 years of age” (p. 831). In short, studies reporting behavioral changes in responses to color as people age are supported by Madrid & Crognale, who found that responses to the chromatic pattern-onset stimuli such as are used in VEP depend upon subject age and continue to develop throughout adolescence and into early adulthood (p. 835). It may be that middle school is the general age range at which children begin to respond more to images with greater color modulation, differentiation, and saturation than they have been accustomed to seeing in children’s books and in their own art (cf. Bornstein, 1975; Boothe, et al., 1985; Madrid & Crognale, 2000; Crognale, 2002).

Contextualization.

In this category, I coded each photo on a scale from maximum contextualization (fully articulated and detailed background information) to no background at all. For instance, a photograph in which the background information has been digitally removed was coded as “no background”; a photograph with blurry but visible background information (as the naked eye might see it) was coded “naturalistic background.” Highest modality is awarded photos with a naturalistic background (for example, a child performing an experiment in a lab might be surrounded by other lab tables, pictures on the walls, etc.).

8 “The visual evoked potential, or VEP, serves as a tool for examining the development of visual processing. Previous research in adults has demonstrated the utility of the visual evoked potential (VEP) to measure the integrity of the chromatic and achromatic visual pathways” (Madrid & Crognale, 2000).
Representation of Detail.

I coded detail on a scale from maximum abstraction to maximum representation. For example, a drawing of a female showing nothing but the torso and placement of the reproductive organs was coded as “maximum abstraction”; a close-up photo of skin showing every pore and hair was coded “maximum representation of detail.” The mostly highly detailed photograph or image—for instance, a close-up of human skin shot with a macro lens—seems “hyperreal” (i.e., somewhat artificial looking; more detail than the human eye could be expected to capture); the most abstract—say, a line art representation of the brain—seems unreal (texture is omitted, and the shape is represented only by the lines that indicate its shapes and contours). Images that depict about the same amount of detail that the human eye detects have the highest modality. Photos with the most modality fell somewhere in between the two extremes, given that the human eye does not ordinarily perceive detail in the extreme.

Depth.

I coded depth on a scale from absence of depth to extremely deep perspective (such as that created by a fisheye lens). While central perspective has the highest modality, according to Kress & Van Leeuwen, angular-isometric perspective also has high modality (p. 167). The “hyper-real” perspective created by converging
verticals or fisheye lenses has low modality, as does perspective created by overlapping items. Images with no discernible perspective (a single-layer drawing, for example) have lowest modality. Figure 5 is an illustration from the text.

The human eye depends on two main sources of information: binocular disparity, a depth cue that requires both eyes; and monocular cues, which allow us to perceive depth with just one eye. The brain integrates the two-dimensional images from both eyes into a single three-dimensional image, so that we can perceive depth and distance. Monocular cues, such as interposition, atmospheric perspective, texture gradient, linear perspective, size cues, height cues, and motion parallax, are also important for depth perception (Encyclopaedia Britannica, 2012). For example, I am sitting in front of a 24” LCD computer monitor. The glass of soda sitting in front of the monitor is slightly blurry, unless I let my eyes wander from the monitor to the glass. And the desk behind the monitor is also blurry, though not as blurry as it would be if it were, say, across the house from me. In photography, a similar perspective is achieved through use of a “normal” lens, the length of which differs depending on the camera format: for 35mm, a 50mm lens is considered normal, and for the APS-C format most digital SLRs use, the normal lens is about 35mm. However, as Ron Dexter (2004) points out,

Early in photography it was decided that a focal length equal to the diagonal of the image formed on the film was “normal.” That gives us a 50-mm lens for 35-mm stills, 75-mm lens for 2-1/4 square, 150 mm for 4 x 5 etc. That was well and good if the same size print shot with a normal lens was always viewed at the same distance. But viewing a wide-angle shot close or a tele [telephoto] shot at a distance can also provide a “correct perspective.” (p. 1)
Thus, what constitutes “normal” from the camera’s perspective is dependent upon several factors, primarily the photographer’s or viewer’s distance from the subject.

To better understand the importance of depth to the realism of an image, I turn to Rudolf Arnheim (1960), who explains,

The third dimension creates an enrichment somewhat comparable to what happened in music when harmonic chords were added to the melodic line. […] [P]ictorial scenes are first subdivided into one integrated, three-dimensional whole. Here too each element belongs to two different contexts when the integration has been achieved. It has a location in the frontal plane and at the same time in the three-dimensional space represented in the picture. Correspondingly, each pictorial unit has two shapes: that of the three-dimensional object, and that of its flat projection. The picture as a whole consists of two entirely different compositions: one of them being the arrangement on the “stage” that extends into depth, and the other the arrangement within the frontal plane. The synthesis of both constitutes the meaning of the whole. (p. 86)

So, depth and volume help the viewer experience “physical reality” in an image: the frontal plane, with its flat projection of components of the image, and the phenomena going on behind that flat plane, the part of the image that reaches into the background. When an image lacks a background, viewers must use their imaginations: to what does the mind reach in a photo with nothing between the foreground subjects and infinity?

Arnheim (1960) refers to images with missing features as having reduced representation; he hypothesizes that “regular, symmetrical, geometric shape results when the tendency to simple structure is set free by a remoteness from the multiplicity of nature” (p. 102). Children, he says, tend to draw simple shapes in their images through a process of selecting “a suitable formal pattern” in the percept, something that makes
sense to the child (p. 102). In these formal patterns the child represents the essence of the item being depicted: what the child sees as the most important characteristics. Likewise, primitive artists aimed to capture “kind, function, importance, and mutual relationships” of creatures they encountered (p. 103). “Realistic detail” in such “primitive” artistic representations “would obscure rather than clarify these relevant characteristics,” Arnheim points out (p. 103).

Illumination.

I coded illumination on a scale from maximum abstraction of light and shadow to using shading and highlights to indicate protruding areas only. Highest modality goes to naturalistic representations of light falling on subjects, whether that light comes from a natural or artificial light source. I chose to code photos in which subjects were obviously lit by camera flash as “naturalistic illumination” because the play of light and shadow appeared logical to the eye. When a photo had been digitally altered to remove the background, light and shade were often abstracted, which resulted in lower modality; I coded these photos as “in between.”

According to Arnheim (1960), illumination means something different to the physicist and the psychologist or artist: For the latter two, illumination describes a phenomenon “that is directly discerned by the eyes” (p. 249). Lest this begin to sound like a “tree falling in the woods” analogy, what Arnheim means is that illumination does not necessarily refer to any actual light source but rather to the perception of one: “There may be a light source physically, but no illumination is perceived, as in an evenly lighted
object, or illumination may be seen but no corresponding light source, as in a photograph or realistic picture [of an object]” (p. 250). Arnheim’s distinction is entirely appropriate for Kress & Van Leeuwen’s discussion of illumination: after all, as the viewer, I cannot necessarily determine whether a light source was present when an image was made; however, I do have the ability to discern whether objects in the image seem to have brightness. Thus, if an object in the image has differences in brightness, this tells my eye that some illumination is present, whether it is visible in the image or not.

I should clarify that in cases in which the photo was professionally lit with studio flash, or in which the photographer used on-camera flash, I coded these images as having a natural light source, because both types of lighting are relatively easy to discern for directionality and source; on-camera flash, in particular, often creates blown-out highlights and harsh shadows that make it easy for the viewer to guess the light source. When the source of lighting in a photo is unknown or multiple, the photo may appear more abstract than natural: as Kress & Van Leeuwen explain, in these images shading may be used “to indicate receding areas and highlights to indicate protruding areas, often in ways which have no explanation in terms of the logic of illumination” (1996, p. 167).

Brightness.

Brightness is a difficult category for which to determine coding values. Kress & Van Leeuwen (1996) provide a scale running from “dark blacks and bright whites” to “minimal differences in brightness,” but to my photographer’s mind, this scale sounds more like one of contrast. As a result, I coded brightness on a scale from maximum
number of different degrees of brightness to minimal differences in brightness (e.g., two shades of grey). Depending on the medium and the subject matter, high contrast (dark blacks and bright whites) images may be given higher modality: for example, a photo of children playing outdoors in bright sunshine looks realistic if parts of the subject not in the sunlight are in deep shadow; on the other hand, a photo of a man walking along the sea in a dense fog looks realistic if contrast is extremely low. Thus, highest modality in the brightness category is largely dependent on the image itself, particularly in the case of photographs.

Coding orientation.

Kress & Van Leeuwen (1996) identify four coding orientations into which images may be categorized and which have differing modalities. These coding orientations are technological, sensory, abstract, and naturalistic. As the authors point out, naturalistic orientation is “the dominant one in our society” because “it is the one coding orientation all members of the culture share when they are being addressed as ‘members of our culture’” (1996, p. 170). Within each coding orientation, different aspects of the image are given highest modality. In Western culture, the photograph tends to hold highest modality in many situations. “Underpinning this is the belief in the objectivity of photographic vision, a belief in photography as capable of capturing reality as it is, unadulterated by human interpretation” (Kress & Van Leeuwen, 1996, p. 168). Because our culture values vision above the other senses in determining reality, our language is full of metaphors such as “I see your point” and “Do you see what I’m saying?”
Interestingly, though, we give the photograph high modality even though it is a two-dimensional representation of reality: as Kress and Van Leeuwen point out, why do we not give holograms higher modality? Because of the prevalence of photographs in our culture (as opposed to the non-prevalence of holograms at this time), we do not seem to perceive the two-dimensionality of a photograph as an indicator of lower modality (p. 168).

Of course, not every situation values photorealism as the greatest indicator of reality. In the technological coding orientation, effectiveness is given highest modality; as such, black and white images are highly valued. In sensory coding, pleasure is given highest modality; thus, highly saturated, tactile images are most valued, particularly photographs that have been enhanced with filters or digital manipulation. In abstract coding, highest modality goes to images that reduce the individual or specific to the general, with the result that line art or diagrams are given highest value, while naturalistic images such as photographs are generally given lowest modality. And in naturalistic coding, the highest modality is given to images that are most like a photograph; thus, color photography, whether digital or film, is most valued.

Horizontal and Vertical Angles.

Horizontal and vertical angles convey the level of involvement (or lack thereof) the producer wants the viewer to have with the subjects of the image. Horizontal angle is “a function of the relation between the frontal plane of the image-producer and the frontal plane of the represented participants” (Kress & Van Leeuwen, 1996, p. 141). In other
words, if viewers can imagine themselves standing directly in front of the scene in the image, then they feel involved to some extent; if, however, they are looking at it from some oblique angle, they feel more like bystanders. Thus horizontal angle conveys something about the involvement of the artist or photographer—and, by extension, the viewer of the image—with the subjects of the image.

Vertical angles in images have more to do with power relationships than involvement or detachment. As Kress & Van Leeuwen (1996) put it, “if a represented participant is seen from a high angle, then the relation between the interactive participants and the represented participants is depicted as one in which the interactive participant has power over the represented participant” – and vice versa (p. 146). As a result, photographs of powerful people are often made from a slightly lower angle, with the camera looking up at the subject. On the other hand, photographs that show the tops of people’s heads, or that show them looking up at the camera, can convey a sense of the powerlessness of the subjects. The viewer in these instances is, quite literally, “higher up” than the subjects, “looking down” on them.

I coded each photograph as follows: Horizontal angle was coded as parallel (frontal) or angled (oblique); and vertical angle was coded as high, middle, or low.

**People category.**

The items for analysis in this category include the following:

- Gender (how many males/females/undetermined gender individuals are in the image?)
• Uniform/Clothing (are subjects dressed in street clothes, or are they wearing the uniform of some science career?)
• Vectors/Interactions (are subjects looking at one another, the viewer, or the task?)
• Age (how many adults/youths are in the image?)

These categories are based in part on Kress & Van Leeuwen’s (1996) method and in part on the basic methods employed by research such as that of Whiteley (1996a, 1996b) and Elgar (2004), who counted the numbers of females and males in textbook photographs. I have added the subcategory of age because I believe it may be useful to see whether textbooks differ in their depictions of children and adults.

Gender.

In this category, I counted the number of males, females, and people of undetermined gender. I counted an individual as male if his facial features, hairstyle, and clothing choices could reasonably be assumed to be male. In nearly all cases, I was close to 100% certain of the assumption of male gender. I counted an individual as female if her facial features, hairstyle, and clothing and accessory choices could reasonably be assumed to be female. Because girls often use accessories that boys do not (such as ponytail holders or barrettes), I was close to 100% certain of the assumption of female in most cases. In instances in which I was not able to make a reasonable assumption of gender based on the given data, I coded the individual as undetermined gender. Usually, this occurred when an individual’s features were too blurry, hidden from view, or too far in the background to be easily seen. In instances in which only a small portion of the body was represented
(for instance, a hand), I coded only for the most obvious subjects and made a note about the unseen individual. One example of this was a photo in which a makeup artist was applying aging makeup to a female subject. Only the artist’s hand was visible; therefore, I coded only for the adult female, making a note later in the survey that a makeup artist of unknown gender was out of frame and represented only by the hand.

The fact that I was easily able to code for gender in practically all cases (particularly in the case of youths) is interesting; it suggests that textbook publishers may go out of their way to reinforce gender roles by selecting photos that show subjects who are easy for students to relate to, based on their own gender stereotypes. This question, of course, is for another study.

Schau and Scott (1984) distinguish between sex-biased and sex-equitable materials as follows:

Sex biased (or sexist) materials are those in which (a) females appear as main characters and in illustrations far less frequently than do males; (b) females and males usually are portrayed in sex-stereotypical roles; (c) females appear more often than do males in derogatory roles; and/or (d) male generic language is used.

In contrast, sex-equitable materials reflect the reality of the presence of females in the world, their contributions, and the changing roles of both females and males. (p. 183)

Schau and Scott break down sex-equitable into a continuum, with sex-fair materials on one end and sex-affirmative on the other. Sex-fair materials “include females and males
in numbers proportional to reality and include both traditional and nontraditional sex roles," avoiding the generic male in language (p. 183). On the other hand, sex-affirmative materials “emphasize role reversals” by focusing attention on males and females in unexpected roles, as well as detailing “the benefits and problems of these reversals” (p. 184).

Uniform/Clothing.

In this category, I coded for whether individuals were wearing uniform of a particular science field or wearing street clothes, whether or not additional science garb was present. In each instance, I counted the number of males, females, and individuals of undetermined gender. An example of a uniform would be an astronaut in a space suit, or a lab technician wearing a white coat. An example of street clothing with science garb would be a student in jeans and a T-shirt wearing safety goggles.

Vectors/Interactions.

In this category, I coded for interactions between subjects, as follows: No eye contact, or only one subject; male subject(s) looking at female subject(s); female subject(s) looking at female subject(s); male subject(s) looking at male subject(s); female subject(s) looking at male subject(s); subjects looking at one another; and subject(s) looking at object or task. These interactions represent the offer gaze, meaning that the represented subject is “the object of the viewer’s dispassionate scrutiny”—in other words, the viewer and the subject make no direct contact (Kress & Van Leeuwen, 1996, p. 124). I also coded for interactions between subjects and the viewer, as follows: Male subject(s) looking at
viewer; female subject(s) looking at viewer; and male and female subjects looking at
viewer. These interactions represent the demand gaze, meaning that the subject has met
the eyes of the viewer and is demanding his or her attention. As Kress & Van Leeuwen
put it, the contact established between this subject and the viewer first “acknowledges the
viewer explicitly, addressing them with a visual ‘you.’ In the second place it constitutes
an ‘image act.’ The producer uses the image to do something to the viewer” (1996, p.
122). Because some photos contained more than one subject with more than one type of
interaction, I coded for every type represented in the photo.

Although I did not convert these data to a quantifiable form, I used them in the
enthymeme analysis to help determine power relationships in each of the images.

Age.
I coded each photo for the number of adults (adult males, adult females, and adults of
undetermined gender) and the number of youths (youth females, youth males, and youths
of undetermined gender). I also coded for the numbers of each gender whose age I could
not determine (undetermined-age males, undetermined-age females, and undetermined
age/gender individuals).

Research design strategy.
Determining the horizontal and vertical angles of view, as well as the vectors and
interactions in the photographs, helps establish the relationship of the photograph’s
producer to the audience. As Kress & Van Leeuwen explain, “Interactive participants are
[...] real people who produce and make sense of images in the context of social institutions which, to different degrees and in different ways, regulate what may be ‘said’ with images, and how it should be said, and how images should be interpreted” (1996, p. 199). In textbook photographs, the producer is not known to the viewer, nor the viewer to the producer; therefore, the viewer is “alone with the image” and must determine for herself what the producer meant her to take from a given image (p. 120).

Angle of view and level of interaction give the viewer two strong methods for interpreting the nature of his or her relationship with the producer. Horizontal and vertical angle place the viewer in relationship with the subject (and thus, with the producer) by placing him or her either on an equal level with the subject or on some other level via use of an oblique angle. Level of interaction—demand versus offer gaze, as well as vectors that lead the viewer’s eye—help determine the degree of involvement of viewer with image. In all, the visual modality markers help determine whether viewers will consider the images naturalistic; this is the first step in analyzing for visual arguments.
The second step, once naturalism is assumed, is to analyze for visual enthymemes. Thus, I turn next to Finnegan (2001) for the second part of my theoretical foundation. Although Finnegan’s analysis demonstrates that naturalistic enthymemes exist, she does not discuss how they argue. To that end, I extend her argument, as I discuss below, using the Arthur Rothstein photograph she discusses as my example (Fig. 6).

Analyzed as a rhetorical syllogism or enthymeme, the Rothstein photograph may be seen to argue as follows in Table 1 (this is only one possible way of interpreting the photograph’s visual argument):
Table 1.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>A steer skull lies parched and abandoned on the cracked, dry soil in the Dakotas during the Dust Bowl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed premise:</td>
<td>Cattle were dying in unusual numbers during the Dust Bowl. The land across the Plains States looked much like the land in this photograph.</td>
</tr>
<tr>
<td>Inference:</td>
<td>Unless something is done to help those suffering in the Plains States, this problem will continue to grow and spread across the country.</td>
</tr>
</tbody>
</table>

Obviously, in this case, the impact of the visual argument differs based on the needs of the stakeholders: If the photo argues that conditions in the Dakotas are dire, then widespread acceptance of this interpretation could have a negative impact on the farming industry, tourism, and other economic factors in the states. Therefore, it is easy to see why the editors of the *Forum* might have objected to a photograph that depicted their area as dry, lifeless, and desperate for intervention. On the other hand, those in a position to provide such intervention—the federal government, for instance—might be swayed by the emotional component of the visual argument, whereas a dry, text-based description of general conditions in South Dakota might have done nothing to spur them to action.

As indicated previously, an understanding of the rhetorical possibilities of images (and, in particular, photographs) as “true” and “natural” is important if I am to argue that images children see in textbooks have some effect on them. Another way in which images can be seen to argue in a given text is through repetition, a frequently used
rhetorical Fig. in science. To gain better understanding, I turn now to Jeanne Fahnestock’s (1999) *Rhetorical figures in Science* for the third stone in my foundation.

Fahnestock treats as given that images argue; one of the ways in which they argue, she says, is through strategic, rhetorical repetition. I extend her argument by using repetition to locate premises of visual enthymemes. She offers Charles Darwin as a notable exemplar for verbal *ploche*, or perfect repetition: “[H]e favors *ploche*, the subtler repetitions that declare identity in reference or the interconnections among phenomena” (1999, p. 161). She then offers an example of a visual ploche: In the textbook *Viruses* by Arnold J. Levine (1992), this occurs in a diagram of a cell; a dark circle representing a virion is shown progressing from one border of the cell to another, joined by a series of arrows to indicate direction. This literal repetition of a shape she calls a visual ploche (p. 166).

Ploche, however, is not the form of repetition found most frequently in science textbooks (although certainly, diagrams do get repeated occasionally, as do actors); *polyptoton*, or repetition with a slight change (in the verbal sense, a different grammatical case), is most often seen. She illustrates her concept of a visual polyptoton on page 175, in a diagram of hummingbirds. Many common features are repeated from subspecies to subspecies, but subtle differences are visible, such as neck bands or shape of tail feathers. While this diagram represents a case of visual polyptoton within a single image, I find that the images in the textbooks I analyzed demonstrate visual polyptoton when

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9 Ploche is the repetition of the same word in different forms or with different meanings in the same sentence. The subsequent usage(s) imply more than the first, sometimes expressing a property or attribute of the first usage. An example: “Bread is bread indeed to a hungry stomach” (J.G. Smith).
considered as a whole: certain visual arguments are repeated, with subtle changes, throughout the text in several cases.

Considering these three science textbooks through a trifocal theoretical lens that includes rhetorical figures (repetition), art history, visual analysis of enthymeme offers a robust portrayal of the visual arguments contained in each, and as a result, compelling evidence for change.

**Research Method**

**Data**

Images have been collected from several comparable 7th grade life science textbooks (2005 was a year for which several comparable texts were readily available). Included are any images depicting humans. The following texts are examined:

- Prentice Hall Life Science (2005, 255 images)
- McDougal Littell Life Science (2005, 164 images)
- Glencoe Life Science (2005, 181 images)

Each textbook is treated as a “mini-case” within the broader discussion of photo data in a sample of science textbooks. Cases on each of the three publishers are chapters in this dissertation. Case study is appropriate for analyzing a textbook because it is useful to think of a textbook as not simply a collection of facts, but also as an argument in itself, constructed by the authors and publishers of the text. A good textbook is designed from the top level down to meet the needs of the various stakeholders in a school system (from superintendents down to students, but also publishers) and for a given state. The
curriculum it teaches must be domain based, rather than socially, politically, or practically based (Chambliss & Calfee, 1998). Thus, it seems constructive to consider the textbook as an entity with a set of goals to accomplish. Although the current study does not argue about each textbook’s overall effectiveness—that is outside the scope of visual rhetoric—it endeavors to characterize each textbook insofar as it visually represents the gender spectrum, and thus, influences the beliefs and self-images of those students who read it.

Photos were randomized to disguise their origin before I examined them. First, I edited in-camera to help ensure that no “give-away” details were included in each image. Then, I carefully edited the images using Google’s Picasa software to ensure that any details I may have missed during the composition of the images were removed or disguised. Finally, I sorted the files by file size, which resulted in a randomized list. The only way I could have known which book a given file was taken from would have been to memorize the file name ranges for each text, and I was careful to avoid doing so.

I began the analysis by answering a dual-category (Visual Elements, People) survey about each image (see Appendix A). When coding was complete, I reviewed the codes to look for recurring patterns, such as a tendency to feature more men than women in uniforms of science fields, or to show girls in service tasks. I listed more than 40 recurring themes from all three texts. A second coder then performed the same analysis.

Finally, another coder and I analyzed 10% of the images to see whether they seemed to present a visual argument (or visual arguments) about gender. Returning to the idea that visuals argue enthymematically, I (re)constructed some of the enthymeme(s)
implicit in each visual argument. To develop a theory of a possible reality “open to refinement” as Charmaz (2003) puts it, I revisited each text separately to see whether the visual arguments found in that text tell a story about it. These stories are the middle chapters in the dissertation.

For a sample of the research instrument, please see Appendix A.

Data Collection Procedures

To collect digital version of the textbook photographs, I set up a makeshift copy stand using a low table, digital SLR camera, tripod, and natural lighting. This method of capturing images was preferable to scanning, which would have been extremely difficult (considering the size and awkwardness of the texts) and time consuming.

After capturing the images, I saved them to a computer hard disk and made two sets of backups on external hard disks. I then used a simple photo editor called Picasa, created by Google, to do basic editing such as cropping out extraneous detail, adjusting color casts and contrast, and sharpening. I have two reasons for performing this processing: first, the images should be as clear as possible before analysis; and second, the images should appear fairly uniform from text to text, to help prevent inadvertent bias during analysis. Finally, I created two DVD-R backups from the processed files.

To randomize the photos and help prevent bias, I sorted the files by file size. I had hoped to employ a computer programmer to write a program to rename the files randomly, but I was unable to find someone in time to begin the analysis.
Data Analysis Procedures

In this step of the project, I tested Kress and Van Leeuwen’s ideas about visual modality and composition to see whether the images in these science textbooks can be considered naturalistic. To view the files for analysis, I used Picasa’s photo viewer: first, I opened the folder with the files sorted by size; then, I loaded each file individually, viewing it on a Samsung 24” widescreen LCD monitor.

Using the survey shown in Appendix A, I created an online version of the survey using Google Documents’ Forms application (which tracks results in a Microsoft Excel-like spreadsheet). I then answered the survey questions completely for each image. Fig. 7 shows a screen shot of one section of the online survey.

The advantages of using Google Documents are at least two: first, it stores a copy of the data “in the cloud,” or on an external server, meaning I have a backup in case of problems on my computer; and second, it tallies data in a simple spreadsheet, allowing me to sort it in almost any way I choose. I can also export the data into Microsoft Excel.
Once the images were analyzed using the survey categories, the results were reviewed for recurring themes (for instance, a very high number of images coded “female looking at male”). Results for each textbook are discussed in Chapters 3, 4, and 5. The results could then be applied to the individual texts from which the images came, giving me the beginnings of a “big picture” case study of each text.

In addition to the categories explained above, I included a section in the survey for Notes. Anything I found interesting about the image that was not covered by the survey questions could be included in this field. For example, if a photo seemed to have no relation whatsoever to the caption, I noted this. More often, however, Notes included items such as, “Boy is performing the active portion of the experiment, while girl watches and takes notes.” Or “Man in lab coat is speaking, as woman in street clothes sits close by, appearing to be in a supporting role.”

**Enthymeme analysis.**

After completing the survey of visual modality markers, I analyzed photos for visual enthymemes. I began with a small subset from each chapter and expanded to a total of 60 (10% of the total images) which were carefully analyzed for Observations, Assumed Premises, and Inferences (Smith V., 2007). Later, I trained an independent rater to code the same subset of 60 images for comparison. See Appendix B for a sample.

**Triangulation of Methods**

To triangulate and test the reliability of my research method, I employed an independent rater in addition to myself. To that end, I first trained my rater in the method I used to
perform the enthymematic analysis and the tests of visual modality (Kress & Van Leeuwen, 1996), and then asked the rater to evaluate 60 images (10% of the images in each text, chosen randomly).

Stake (1995) briefly defines triangulation as “working to substantiate an interpretation or to clarify its different meanings” (p. 173). To do so, Stake suggests using several different methods, perhaps even from different theoretical grounds, of getting at the issue at hand. For example, if we were attempting to determine the effects of a major employer leaving a small town, we might exploit a number of research methods and instruments: surveying the population of the town through social media; individual, lengthy interviews with several representative members; statistical analysis of such quantifiable effects as personal income, consumer purchases, registrations for unemployment benefits; corpus linguistics analysis of interview transcripts to find most common words, terms, and collates; and so on. The more data we collect on our town, the better picture we have of what has really happened to it in the wake of the company’s exit.
Similarly, I have approached analysis of the textbook photographs and gendered images using triangulation of methods (see Fig. 8). First, I have applied Kress & Van Leeuwen’s (1996) visual grammar, examining each of 600 photos for the modality indicators they discuss. Next, I have performed enthymematic analysis on a selection of photos, attempting to interpret the inferences readers may draw from them. Finally, I have asked an independent rater to perform a basic version of the same enthymematic analysis (without the rhetorical jargon) on the same selection of photos. In this way, I hope to satisfy those who might suggest my analyses could be arbitrary or, worse, motivated by bias. As Margrit Eichler (1980) states, “[W]e will only be able to improve social science
(and perhaps society) after we have engaged in a thorough criticism […]. In order to criticize, we need a vision […]. Both criticism and vision need to be grounded in data” (p. 9).

A frequent criticism of feminist critical analysis is that feminist researchers may simply be “filtering” all our data, causing us to see exactly what we’re looking for. I suggest that this is not the correct concern. Rather, I would ask of this project: can the image actually argue something outside of what the individual viewing it sees it as arguing? In other words, does an image have a “correct” argument that we can “accurately” discern through the “right” methods? I argue instead that viewers of the image are 

olutely going to run it through filters that cause them to see what they are looking for. This is how we interpret images. Based on their experience of cultural endoxa (e.g., science is for boys), school-age girls in certain social groups are bound to see sexism in an image in which boys appear to be doing all the important tasks while girls stand idly to the side.

To be clear, I do not believe any given image is inherently making any claim; rather, I believe that the image, when filtered through the cultural beliefs and experiences of young viewers, is likely to have certain inferences possible that lead to its making certain arguments for them. By adhering to the principles of art criticism (Arnheim, Gombrich, Kress & Van Leeuwen) and the careful analysis of rhetoric (Finnegan, 

Naomi Gottlieb refers to this as “the tendency to latch onto findings which make intuitive sense,” and reminds researchers that our real challenge is “to recognize the tension between truth-seeking and social reform, the place for polemic and commitment, the danger of over-empathy […] the fact that women are not homogeneous […], and that much work needs to be done to develop viable, empirically tested theories” (qtd. in Reinhurz, 1992, p. 275).
Fahnestock, Aristotle, and so on), I believe I show with this project that the inferences made from visual analysis of these textbooks are valid interpretations based on the endoxa of Western culture, particularly of the United States.

According to Kress and Van Leeuwen (1996), “[W]e think that naturalistic images can be analysed into participants and processes much in the same was as diagrams” (p. 47). They detail two methods of approach: formal art theory (for example, Arnheim) and functional semiotic theory (Halliday). Formal art theory is grounded in the psychology of perception and focuses on participants as “volumes” or “masses” (which implies weight or pull), and processes are known as “vectors,” “tensions,” or “dynamic forces.” When analyzing the participants in an image, we note that visual weight or pull comes from size, shape, color, and involvement (e.g., eye contact with the viewer). “And what is more,” the authors go on, “we recognize their shapes on the basis of visual schemas not unlike those that are realized in diagrams” (p. 47). In other words, we reduce our world to some basic forms, such as the basic shape of a dog or cat that a child might draw (Fig. 9); then, recognizing these in an image, we begin to interpret.

Functional semiotic theory, previously used only for the analysis of language, uses such terms as “actor,” “goal,” and “recipient.” Kress and Van Leeuwen argue that these two approaches to visual analysis are compatible, even though one approach was intended for language:
Our use of these terms does not imply that images work in the same way as language, only that they can ‘say’ (some of) the same things as language—*in very different ways*: what in language is realized by means of syntactic configurations of certain classes of nouns and certain classes of verbs is in pictures realized, made perceivable and communicable, by the vectorial relations between volumes. (p. 48)

In essence, then, whether we call the prominent Fig. in a photograph a volume or an Actor; whether we say a boy pointing at a task creates a “vector” or a “transaction”; we have ways and methods of reading images that we can talk about and agree upon for the purposes of rhetorical research. My aim in this Methodology section is to make those ways and methods as transparent as possible.

**Inter-rater Reliability Tests.**

The importance of reliability in qualitative studies is hotly debated, and inter-rater reliability often appears in qualitative research, whether explicitly or implicitly (Armstrong, Gosling, Weinman, & Marteau, 1997, p. 598). Positions on the issue run the gamut. From Morse (1994): “No-one takes a second reader to the library to check that indeed he or she is interpreting the original sources correctly, so why does anyone need a reliability checker for his or her data” (p. 231)? Conversely, Mays and Pope (1995): “[T]he analysis of qualitative data can be enhanced by organising an independent assessment of transcripts by additional skilled qualitative researchers and comparing agreement between the raters” (qtd. in Armstrong, et al., 1997, p. 598). Although the present study relies on elements of social science and rhetorical analysis, its subject
matter is science itself; thus, I decided it was appropriate to include a measure of reliability.

Due to the complex and lengthy process involved in coding these qualitative data, I chose to test for reliability using a portion of the photos, rather than all 600. I randomly selected 10% of photos from each textbook, for a total of 60. Next, I briefly trained an independent rater to code this sample, both for the categories of image modality as described in Kress & Van Leeuwen (1996) and for visual arguments. Where discrepancies occurred, we discussed them and determined that the other rater’s lack of familiarity with the field of visual rhetoric and with photography in general was the likely cause. Armstrong et al. (1997), in a study of qualitative researchers, found that “there is indeed a degree of consensus in the identification of themes between the different analyses but that the ‘packaging’ of these themes showed a number of different configurations” (p. 604). In other words, whereas a group of similarly experienced researchers may be expected to produce similar results when coding a set of qualitative data, any differences that occur are likely attributable to their different disciplines, as well as their geography or their personal views and experiences (p. 605).

Alas, one hallmark of many qualitative studies is the relatively small size. In the present study, a sample of 60 images coded by two raters may yield rich description, but little in the way of quantifiable, traditionally reliable results. As Gwet (2012) puts it, “A small number of subjects […] reduces the precision of the inter-rater reliability coefficient, in addition to exposing that precision to further degradation due possibly to a small number of raters, or a small number of response categories” (p. 126).
To determine the inter-rater reliability, I began by calculating the average agreement and standard deviation of the 10% sample. Then, I determined the matches by looking at one standard deviation below the group average (55% of the categories matched per picture). This resulted in 51 of the 60 sample photos being designated as matches, for an observed percentage of agreement of 85%. Using the standard deviation to adjust the lower boundary of the group average accounts for the independent rater’s lack of formal education in the field. I then calculated Cohen’s κ (kappa) correlation for all categories at 0.412. The Cohen’s κ ranges from 0 to 1 and is considered acceptable at 0.50 (Multon, 2010, p. 627); on Landis & Koch’s (1977) scale, 0.412 is in the range of “moderate agreement.”

Determining reliability for the visual enthymeme data was more complex and required a combination of qualitative and quantitative methods. First, I created a table to compare the independent rater’s responses to my own for the same images. Then, I spent several hours reading through the responses to pick out recurring themes, which I listed on one side of the sheet. I then created a table in which I listed the file names beside the common themes: For example, the rater and I both found themes of “women are nurses” and “women assist men” in photo 1527. I decided to mark as “agreement” any photo for which my rater and I had at least two themes in common. To determine reliability, I first calculated the observed percentage of agreement at 96.67%. I then calculated Cohen’s κ
correlation for the visual enthymeme results. The result was 0.483, in the range of “moderate” 0.41–0.60 (Landis & Koch, 1977, p. 165).

Limitations of Methodology

The present study focuses on qualitative data in the interest of forming a narrative about the position of women in science textbooks intended for middle school students; therefore, it is limited in that it does not seek to examine all science textbooks, nor does it purport to produce generalizable findings about gender and science textbooks. As with most case studies, the present study hopes to shine a critical light on a select set of data with the goal of drawing the attention of other researchers to the issue of gender bias in images and the effects that bias may have on our young women in the middle-school grades.

Another potential limitation is the issue of gender and identity. Feminist researchers (e.g., Butler, 1990; Harding, 1986) have argued that gender is only one small part of individual identity that cannot be reliably teased out from identity as a whole; rather, gender is associated with religious practice, cultural affiliations, social groups, age groups, racial associations, and so forth. Thus, it is practical to consider that any research results attempting to single out gender as a causative variable may in fact be complicated by other variables which the research was not constructed to detect.

Ethical Issues

Any ethical issues arising from the results of this study would likely be caused by an attempt to generalize the results to a broader subject base, rather than viewing them as
part of a conversation about gender representation in school textbooks. For instance, a finding of bias in one publisher’s textbook in the subcategory of girls’/boys’ roles in lab experiments should not be generalized as “Middle school science textbooks favor boys over girls.” The danger of such generalization in the academic literature is lower; however, because gender bias is a highly politicized topic, a danger exists that studies of this nature could be watered down for the wider media and broader statements about textbook bias made where no such findings exist.

On the other hand, failure to expose bias that may be affecting girls’ interest in science courses and careers is also an ethical issue. If our culture is still, in spite of decades of attention to the matter, producing teaching materials that favor boys over girls, then we ignore the issue at society’s peril.

**Conclusion**

In this chapter, I have discussed in detail the research methodology for the present study, explaining the rationale behind each of the criteria I examined in middle school science textbook images. Kress & Van Leeuwen (1996) provide the means to locate where arguments occur, and my extended understanding of Finnegan (2001) and Fahnestock (1999) allows me to discover the arguments made to the audience. In so doing, I address the following research questions, posed earlier:

1. How are gender roles presented in the photographs in science textbooks?
2. How do science textbooks present the occupational roles and activities of gender roles in these texts?
In the next three chapters, I let each textbook publisher “tell its own story” through quantitative graphs and qualitative case study, including careful analysis of the results of my surveys. Chapter 3 covers the Glencoe Life Science 2005; Chapter 4 is a case study of the McDougal-Littell Life Science 2005; and Chapter 5 covers the Prentice Hall Life Science 2005.
Chapter 3: Glencoe Life Science 2005

“I always remember pictures.”

Overview

McGraw Hill Education (MHE) is a New York-based publisher of textbooks and consumer titles including the imprints Macmillan/McGraw-Hill, SRA, Wright Group, Glencoe, Contemporary, and Jamestown. Its product line is extensive, comprising Pre-K–12, higher education, assessment, and professional divisions. The Glencoe text I analyzed for this project, Life Science (2005) for seventh grade, is part of the extensive line of Pre-K–12 textbooks offered by MHE.

Gender.

Because this project is about gender, it seems relevant to mention the gender representation among the authors, consultants, and reviewers. Fig. 10 below illustrates the distribution.
It may be interesting to note that two of the five authors, all of the science consultants, and five of the series consultants are doctoral degree holders (see Fig. 11); on the other hand, none of the reviewers is, most likely because the reviewers are middle and high school teachers from around the country. Of the women with doctoral degrees, five of those degrees are in sciences, mathematics, or science.
education; the other two have degrees in education and in literature, communication, and culture, respectively. (All five of the males’ doctoral degrees are in STEM.) So, while more females appear in the review staff than in the authoring or consulting side of things, the females seem just as likely as the males to have studied STEM in the highest levels of their education.
Results

Visuals.

In this section, I first present the results of my analysis of the nine variables in Kress & Van Leeuwen’s (1996) framework to analyzing visuals: color saturation, color modulation, color differentiation, contextualization, representation of detail, depth, illumination, brightness, coding orientation, and horizontal and vertical angles in the 180 images I analyzed from this Glencoe text. Following that, as described in the previous chapter, I analyze the visual enthymemes.

Color saturation.

![Saturation chart](image)

Fig. 12.

As discussed in Chapter 2, color saturation refers to the richness of a given color—the purity of it, with an absence of white or grey. For instance, what we think of as “hot
“Pink” is usually highly saturated, whereas “baby pink” contains more white and is lower in saturation. Fig. 12 shows that the vast majority of images in this textbook fell into the range of medium saturation. While I did not code for degrees in between low and high saturation, I observed that most of the photos fell somewhere above the median between the two, right at the point at which Kress & Van Leeuwen argue they have their highest modality (p. 165).

Table 2 shows the results as percentages of the total.\textsuperscript{11}

Table 2.

<table>
<thead>
<tr>
<th>Color Saturation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>2.2%</td>
</tr>
<tr>
<td>Medium</td>
<td>93.4%</td>
</tr>
<tr>
<td>Low</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

\textsuperscript{11} In some cases, percentages may not add up to 100. This is due to rounding.
Color modulation.

Fig. 13.

As described in Chapter 2, color modulation, in Kress & Van Leeuwen’s (1996) theory, focuses on the number of different shades of a given color: for example, many different shades of green as opposed to one, plain shade of the color. The images in this textbook fell into the range of low-to-medium modulation, with more than twice as many coding medium as coding low (see Fig. 13). No images coded as high modulation.

Table 3 shows the results as percentages of the total.
Table 3.

<table>
<thead>
<tr>
<th>Color Modulation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>27.6%</td>
</tr>
<tr>
<td>Medium</td>
<td>72.4%</td>
</tr>
<tr>
<td>High</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

*Color differentiation.*

![Bar chart showing differentiation levels](image)

**Fig. 14.**

Differentiation, as discussed previously, refers to the number of colors in an image. In this sample, the highest number of photos and graphics (98) coded as medium
differentiation (see Fig. 14). However, quite a high number, 82, coded as low
differentiation. Only one image coded as high
differentiation.

Fig. 15 illustrates the low color
differentiation I found in many of the images in
this textbook. The background is the page
itself; the only other colors are a few shades of
brown, one saturated yellow, and one saturated
blue (with minor variations due to shadows in clothing wrinkles). The boys’ skin tones
are virtually indistinguishable from one another, and they seem to be wearing the same
trousers. The unadorned, primary-color T-shirts add to the simplistic color scheme of the
staged photograph.

Table 4 lists the percentages of each possibility.

Table 4.

<table>
<thead>
<tr>
<th>Color Differentiation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5%</td>
</tr>
<tr>
<td>Medium</td>
<td>54.1%</td>
</tr>
<tr>
<td>Low</td>
<td>45.3%</td>
</tr>
</tbody>
</table>
As discussed previously, contextualization in images deals with the amount of background that is visible, giving the subject context. In many of the photos in this text, that contextualization is lacking, which lowers the modality of the photo by Kress & Van Leeuwen’s (1996) standards. The highest number of images (93) coded as natural background, but a high number (73) also coded as no background (see Fig. 16).

Table 5 below illustrates these results as percentages of the total.
Table 5.

<table>
<thead>
<tr>
<th>Contextualization</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly detailed background</td>
<td>0.5%</td>
</tr>
<tr>
<td>Natural background</td>
<td>51.7%</td>
</tr>
<tr>
<td>No background</td>
<td>40.6%</td>
</tr>
<tr>
<td>Combination of natural &amp; no background</td>
<td>2.2%</td>
</tr>
<tr>
<td>Other</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Representation of Detail.

Fig. 17.
As with most of these criteria, highest modality in an image usually falls somewhere between the two extremes of possibility. Representation of detail is no exception. In this text, the majority of images coded as naturalistic (see Fig. 17); however, about two-thirds as many coded somewhere between naturalistic and maximum abstraction, and about a fifth coded as maximum abstraction. As the scale moves toward maximum representation, almost no instances occur (six overall, and only one at the extreme).

Table 6 illustrates these results as percentages of the total.

**Table 6.**

<table>
<thead>
<tr>
<th>Representation of Detail</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum abstraction</td>
<td>10.6%</td>
</tr>
<tr>
<td>Between maximum abstraction and naturalistic</td>
<td>33.3%</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>52.8%</td>
</tr>
<tr>
<td>Between naturalistic and maximum representation</td>
<td>2.7%</td>
</tr>
<tr>
<td>Maximum representation</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
As mentioned in Chapter 2, depth, for Kress & Van Leeuwen (1996), refers to visual perspective on the image. While the most images (94) in the Glencoe text coded as natural (central) perspective, a large number (60) coded as shallow (absence of depth). In between, just 14 coded as somewhat shallow. Very few images fell on the other end of the range, toward deep perspective (see Fig. 18). Part of the reason for so many images coding as shallow involves the lack of backgrounds in many images. Those that coded as somewhat shallow often included such objects as...
a work table, which created a limited amount of perspective. The few photos with deep perspective often gained it from the photographer’s use of a wide-angle lens (see example in Fig. 19), which distorts natural perspective (Tamron USA, Inc., 2012).

Table 7 illustrates the results as percentages of the total.

Table 7.

<table>
<thead>
<tr>
<th>Depth (Perspective)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow perspective</td>
<td>33.1%</td>
</tr>
<tr>
<td>Somewhat shallow</td>
<td>7.7%</td>
</tr>
<tr>
<td>Natural perspective</td>
<td>51.9%</td>
</tr>
<tr>
<td>Somewhat deep</td>
<td>1.1%</td>
</tr>
<tr>
<td>Deep perspective</td>
<td>3.9%</td>
</tr>
<tr>
<td>Other</td>
<td>2.2%</td>
</tr>
</tbody>
</table>
As discussed in Chapter 2, illumination, for Kress & Van Leeuwen, involves the play of light in an image, ranging from a full representation of that play of light and shade to the absence of it.

The images in the Glencoe text show a range of codings in the category of illumination (see Fig. 20). Forty coded as abstract; 83 as natural; and 57 as somewhere in between. In most cases of an image coding in between/unsure, some light was evidenced in the image, but shadows were not present, meaning that the light source was difficult to discern.

Table 8 illustrates these results as percentages of the total.
Table 8.

<table>
<thead>
<tr>
<th>Illumination</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstraction of light/shade</td>
<td>22.2%</td>
</tr>
<tr>
<td>In between/ unsure</td>
<td>31.7%</td>
</tr>
<tr>
<td>Natural light source</td>
<td>46.1%</td>
</tr>
</tbody>
</table>
The vast majority of images in this textbook had what I characterize as naturalistic contrast or brightness (see Fig. 21). Blacks were deep and rich, with no hint of grey, and whites were pure and bright. This coding applied whether the image was a photo of two children outdoors or a graphic of a body part, so long as a wide range of brightness occurred. The few photos that did code minimal differences in brightness were low-contrast photos, in some cases (such as a photo outdoors in hazy cloud cover), or graphics with colors that fell into the same intensity range or were greyscale.

Table 9 illustrates the results as percentages of the total.
Table 9.

<table>
<thead>
<tr>
<th>Brightness</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark blacks/bright whites</td>
<td>88.9%</td>
</tr>
<tr>
<td>In between</td>
<td>3.9%</td>
</tr>
<tr>
<td>Minimal differences in brightness</td>
<td>7.2%</td>
</tr>
</tbody>
</table>

_Coding Orientation._

Fig. 22.

As Chapter 2 discussed, the four coding orientations described by Kress & Van Leeuwen are technological (e.g., blueprints), sensory (e.g., interior decorating, cooking), abstract
(e.g., higher education, high art), and naturalistic. Analysis of the coding orientations of the images in the Glencoe text reveals that while the majority code as naturalistic, more than two-thirds code somewhere in between naturalistic and abstract, with elements of both (see Fig. 22). Very few photos coded on either extreme of the spectrum: just three coded abstract, and none coded sensory or technological.

Table 10 illustrates these results as percentages of the total.

Table 10.

<table>
<thead>
<tr>
<th>Coding Orientation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>13.3%</td>
</tr>
<tr>
<td>Elements of both abstract and naturalistic</td>
<td>33.3%</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>52.8%</td>
</tr>
<tr>
<td>Elements of both naturalistic and sensory</td>
<td>0.5%</td>
</tr>
<tr>
<td>Others</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Horizontal Angles.

Fig. 23.

In this text, 101 images were composed from a frontal angle, but 75 were composed from an oblique angle (see Fig. 23).

Table 11 illustrates the results as percentages of the total.

Table 11.

<table>
<thead>
<tr>
<th>Horizontal Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angled (oblique)</td>
<td>41.7%</td>
</tr>
<tr>
<td>Parallel (frontal)</td>
<td>56.1%</td>
</tr>
<tr>
<td>Other</td>
<td>2.2%</td>
</tr>
</tbody>
</table>
According to Kress & Van Leeuwen (1996), vertical angle is an indicator of the perceived power relationship between image-producer and subject(s) (see Chapter 2). In this text, the vast majority—143—of the images containing people are taken from the middle vertical angle, implying involvement, equal standing, and action (Kress & Van Leeuwen, 1996). Only 33 coded high or slightly high; just 7 coded low (see Fig. 24).
Table 12 shows the results as percentages of the total.

Table 12.

<table>
<thead>
<tr>
<th>Vertical Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>14.2%</td>
</tr>
<tr>
<td>Between high and middle</td>
<td>3.8%</td>
</tr>
<tr>
<td>Middle</td>
<td>78.1%</td>
</tr>
<tr>
<td>Low</td>
<td>3.8%</td>
</tr>
</tbody>
</table>

Discussion

**Visuals.**

Looking at each Visuals category separately is an important step in applying Kress & Van Leeuwen’s method of analysis and discovering more about that category and its role in the image—rather like examining a flower through a macro lens. Continuing in the photography metaphor, it is now appropriate to zoom out on the scene, to consider all the Visuals categories in the Glencoe Life Science 2005 together in an effort to determine what they argue about the Glencoe text.

**Color.**

The first modality markers Kress & Van Leeuwen discuss are those related to color: saturation, modulation, and differentiation. According to the authors, the abstraction of color “relative to the standards of contemporary naturalistic representation” in Western culture reduces the modality. In the case of naturalism, the scale runs generally from
photorealistic color, with different shades or values of a given color employed in the construction of light and shadow, to plain, unmodulated color, such as is employed by children when drawing with crayons or markers.

**Color saturation.**

Saturation is measured on a scale from full saturation to none (black and white) (see Fig. 4 in Chapter 2). A fully saturated color is one in which the maximum amount of pigment makes for a deep, rich shade of the color—the richest one on the color wheel.\(^\text{12}\) For instance, jewel tones are generally quite saturated; on the other hand, pastels contain more white or grey and thus are less saturated. Remove all pigment and what is left is *desaturated*, or greyscale (depending on brightness). Fully saturated images have an appearance of extreme realism, which is generally afforded less modality in naturalism than slightly less saturated, or more photorealistic, color.

The images in the Glencoe text coded primarily in between the two extremes, which indicates that the editors of this textbook chose images with photorealistic colors over extremely saturated or desaturated images (whether they did so intentionally or not). Doing so renders the subjects of the images as natural, thus supporting, in turn, a naturalistic representation—one, in other words, based on the notion of the naturalistic enthymeme.

\(^{12}\) According to A. C. Clarke & E. N. Wiebe (2000), “Saturation refers to the dominance of hue in the color.”
Color modulation.

Color modulation is tricky to code. Textbook pages, which do not capture subtle variations in color as well as photo paper to begin with, often fade or yellow in a short time, through usage or aging; thus, colors may not appear as fully modulated as they did when the book was originally printed. Also, the method I used for capturing the photos—actually photographing them with a digital camera on a stand—may have introduced an added level of modulation reduction (although I attempted to correct for this using the simple tools in Picasa, a free photo editing program by Google), in much the same way that photocopying a photocopy causes some small loss of data. Often, I found myself “using my imagination” when coding a photograph; if it seemed likely that the red tomato next to a student wearing a red shirt, for example, was probably a slightly different shade of red, then I considered the photo to be medium modulated. Only in the case of a simple graphic using very basic, flat colors did I code an image as low modulated. Black and white photos or graphics were coded as having no modulation (I entered this in “Other”); it appears only one image met that criterion in this text. In general, the high numbers of images coding as medium modulation indicated naturalism.

Color differentiation.

The results in the color differentiation category are a bit more unexpected than some of the other results. In this sample, most of the photos and graphics (54%) coded as medium, or natural, differentiation. However, so many coded as low differentiation (45%) that I wonder whether this reflects a change, conscious or otherwise, to make
images that look more like the advertising we, and our children, see so much of on a daily basis.

Many photos in this textbook are staged to reduce the number of colors to as few as possible. For instance, I observed numerous photos in which the children featured wore complementary clothing (khaki trousers were very common, as were polo shirts in primary and secondary colors), the background was pure white, and the objects in the photo complemented the colors the children were wearing, as though the scene were arranged by a professional stylist. Again, such color may seem natural, and thus persuasive, as the norm to the students viewing the images.

I have previously observed this trend in advertising images (Wells, 2009); for instance, in analyzing the Swiffer Web site, I found that each individual product page tended to stick to fewer than three colors (with shades of those colors)—usually only two—with unwanted or undesirable items in a contrasting color (an old broom, an undesirable product, appears in bright blue, in contrast to the soothing lavender/purple of the Swiffer WetJet—the broom sticks out like a “sore thumb”). The “homes” featured on the Swiffer Web site were carefully designed to have objects in a uniform color scheme; for example, a living room with a sofa, chair, cocktail table, lamp, and bookshelf was designed in shades of white and yellow so that even the smallest accessory—a dish on a table or the spines of books on a shelf—blended into the scheme. Anything that wasn’t yellow or white would have jumped out at the viewer.

Likewise, I argue here that many of the lab images in this text are staged to limit the number of colors. The white backgrounds, while uncluttered and clean, also remove
context; the matching clothing and objects add to the impression of an unreal setting, of an “experiment in a bubble.” Rare indeed, I am sure, is the middle school science lab that gives off such a sheen of neatness and uniformity. Perhaps publishers are anticipating that young readers are so accustomed to advertising that they consider it “naturalistic” in a sense—it is as familiar to them as the naturalism of a cell-phone snapshot of a classmate. Because advertising is so prevalent, it represents some *endoxa* (“reputable or received” or “accredited” opinions) on which children may base their understanding of the world. The result in this category suggests that when publishers use images like those in advertising, they are attempting to make the images seem naturalistic and in so doing, to persuade the audience. In other words, children are accustomed to the color differentiation inherent in advertising images, so it appears “truthful” to them; although the color differentiation is low, it seems natural.

**Depth.**

Depth of field/perspective in an image ranges from shallow to deep and is created by having items in the foreground, midground, and background of the image. I was not surprised to see many photos with a natural background in this text. I was, however, surprised at how many photos had no visible background at all—either they had been staged against a blown-out white backdrop, or the background had been digitally removed. As mentioned previously, the lack of visible background (printed on a white page, the background is perceived to be white or to disappear entirely) reduces the color differentiation, sometimes significantly; it also, however, reduces depth significantly, because the eye has nothing against which to measure the distance of the subject. This is
why good nature and architectural photographers often include a familiar object, such as a human form, in photos of massive subjects such as buildings or mountains. It is difficult to judge the size of an object without something familiar for comparison. Similarly, it is difficult to judge the depth of a scene in an image when no background exists; the scale of the people and objects in the image becomes difficult to gauge, lending a sense of incongruity to the image.

If those who create images for reasons other than artistic endeavors tend to leave out elements of realistic detail that could distract from the important characteristics of the item depicted, then it follows that some viewers may better comprehend images with reduced representation of depth and other detail. This suggests that the photo editors of this science textbook chose images (consciously or not) with reduced representation in hopes of focusing viewer attention on the most important characteristics of the scene depicted. This being the case, editors should be aware that removing too much context may influence the viewer’s ability to judge relative size and distance of the objects viewed. As Arnheim (1960) explains, the depth dimension “makes the size of objects variable and thereby adaptable to the needs of the observer” (p. 26). “How much of the context is pertinent to the understanding of the matter under scrutiny” (p. 27)? If some or all of the context of the object or situation is absent—or conversely, if so much context is included that it distracts from the main subject of the image—then understanding is diminished: “Since reasoning about an object starts with the way the object is perceived, an inadequate percept may upset the whole ensuing train of thought” (p. 27), Arnheim argues.
However, it seems unlikely that the image missing a background is entirely unrecognizable by the viewer: Gestalt psychology, Arnheim tells us, allows for the recognition of an object by its “generic structural features” (p. 29). Also, depth created by an arrangement of overlapping items in the image adds to the viewer’s perception of image meaning (Arnheim, Art and visual perception: A psychology of the creative eye, 1960). For example, an object such as a table in the foreground of a photo leads the eye into the photo, to the subjects sitting on the other side of it—across from the viewer’s position. Any objects on the table between the viewer and the subjects “lead the eye like steppingstones from the front to the back” (Arnheim, Art and visual perception: A psychology of the creative eye, 1960, p. 201). Thus, the brain is able to perceive depth, even without the full, naturalistic depth that the viewer might expect from a photograph of, for instance, a lab setting. Understood from my perspective, the assumptions readers make in comprehending the “gestalt” of the images belong to a visual enthymeme, which allows the image to argue.
In Fig. 25, the photo on the left of runners in an outdoor race contains naturalistic context, including trees, a balloon, and grey sky. All these elements give naturalistic depth to the photo through overlapping (as well as through diminished color and sharpness, other hallmarks of distance). The photo on the right has no background or other elements; depth is demonstrated through the position of the viewer as across the table from the boy. The test tube stand, which creates a shadow on the table surface, helps give the impression of depth to the photo, leading the eye from the front of the table to the back of the scene—the boy himself. Depth in this photo is somewhat artificial, but the viewer is still able to discern that the boy is not a cardboard stand-up, but rather a real boy posing with an experiment. Thus discerned, and as I discuss below, the overlap provides a visual statement about the contents represented therein.

The combination of images with naturalistic depth and artificial depth suggests that the editors expect children of this age group to be able to interpret images with some abstraction. Few studies have been conducted to find out whether gender differences exist in development of depth perception; one such study (Jahoda & McGurk, 1974)
found no differences between boys and girls in pictorial depth discrimination. The answer to this question is, however, beyond the scope of the present study.

**Coding orientation.**

Kress & Van Leeuwen (1996) cite four different coding orientations to describe the “culturally and historically determined standards of what is real and what is not” in many different situations that rely on visual communication (p. 168). These include technological, sensory, abstract, and naturalistic. I discussed coding orientation in Chapter 2. In this text, naturalistic and abstract coding orientations appeared the most frequently, with many images having elements of both.

Perhaps the most surprising result of the analysis is how many photos code with abstract orientation, often due to lack of background detail. According to Kress & Van Leeuwen, “The ability to produce and/or read texts grounded in this coding orientation is a mark of social distinction, of being an ‘educated person’ or a ‘serious artist’” (p. 170). Evidently, the editors of this textbook decided to include images that would challenge their middle school readers to envision science and life on a higher level, without so much “background information” (i.e., naturalism) to fill in all the contextual blanks for them; in other words, maybe photos that are slightly more abstract require students to think more abstractly.

This suggestion makes sense in light of Kress & Van Leeuwen’s theory: the abstract orientation, when it is the basis of a text’s imaging scheme, virtually ensures that every image makes general anything specific. This notion of abstraction, of big-picture science, may be more difficult for middle school learners to grasp; perhaps, then, using
naturalistic and blended naturalistic/abstract images for this age group is the right balance of specificity they can identify with, and abstraction they can learn to grasp. After all, their understanding of the acceptance of the objective nature of science in our culture is essential if they are to succeed in our school systems. I further discuss this issue later in the chapter.

**Horizontal angle.**

According to Kress & Van Leeuwen (1996), horizontal angle is “a function of the relation between the frontal plane of the image-producer and the frontal plane of the represented participants” (p. 141). In the case of a photograph of people, the relationship of the photographer to the subjects is portrayed by horizontal angle: if the photographer, and consequently the viewer, seem to be standing across from the people in the shot, this portrays a sense of involvement, a sense that these people are part of the viewer’s “world.” On the other hand, the oblique view, in which the photographer and viewer seem to be peering in on a situation they are not part of—observers, rather than participants—gives the impression of isolation and detachment. In effect, this angle says to viewers, “These people are not part of your world. They are different, other.” If Kress and Van Leeuwen’s theory is correct, then 43% of the images of people in this text are composed in such a way that the children viewing them may feel disconnected from the very images from which they may inadvertently be learning sex roles and attitudes (see e.g., Evans & Davies, 2000; Schau & Scott, 1984; Britton & Lumpkin, 1977).

**Vertical angle.**
In film (motion pictures), vertical angle is an extremely important and popular method for conveying a sense of power, either of the director (and by extension, the viewer) or of the subject. A similar situation exists in still images. However, in a science textbook such as the Glencoe Life Science, it is not always apparent why the photographer or artist chose the angle he or she did to compose the image. As Kress & Van Leeuwen put it, “The angle may be high and frontal, and so convey power over and involvement with the represented participants, but the precise nature of the relation of power and involvement is not given” (1996, p. 148). In other words, the image may be conveying meanings that were perhaps not intended by the image-producer.

On the whole, though, vertical angle speaks to the power relationship between viewer and subject. The highest vertical angle—looking down upon the subject—conveys the most power to the viewer; at the other extreme, a very low angle—looking up at a subject—conveys the most power to the subject, who can be seen as looking down upon the viewer from a lofty position. In between is the frontal/middle angle, at which the viewer and the subject are on equal footing; it also implies action—as Kress & Van Leeuwen put it, this is the angle of “‘this is how it works,’ ‘this is how you use it,’ ‘this is how you do it’” (p. 149). The great majority of images in this text coded as middle angle, suggesting that the editors may have chosen photographs taken from the child’s point of view to help convey a sense of involvement in the task—as if the participants were saying to the viewers, “This is how you do it. Now, you try.”

In sum, although the results in the vertical angle category support empowering the reader, the categories as a whole support the stereotype that science is objective and that more males than females do science.

Overall, the images are both natural and abstract (Fig. 26): abstract because they disregard certain visual principles involving color, angle, and depth; yet natural because these values in fact conform to cultural assumptions in a visual world of advertising and the like.

In the next section, I present my findings in the People category; subsequently, I analyze and discuss these results to aid in completing the story of the visual arguments in the Glencoe Life Science 2005 text.
Results

People.

Fig. 27.

Fig. 27 illustrates the numbers of males, females, and undetermined-gender individuals, both in total and in five separate subsets: those wearing some kind of uniform, those wearing street clothes, adults, youths (including infants, small children, and anyone who appeared to be a student), and those of undetermined age. In all but one subset, females outnumber men; interestingly, that one subset is Adults, although the ratio of men to women is fairly close—59:54.
Table 13 lists the percentages of each gender in each of the subsets.

Table 13.

<table>
<thead>
<tr>
<th>Glencoe 2005</th>
<th>Males</th>
<th>Females</th>
<th>Undetermined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>38.9</td>
<td>43.6</td>
<td>17.5</td>
</tr>
<tr>
<td>Raw Totals</td>
<td>38.6</td>
<td>49.1</td>
<td>12.3</td>
</tr>
<tr>
<td>Wearing Uniforms</td>
<td>41.0</td>
<td>44.4</td>
<td>14.7</td>
</tr>
<tr>
<td>Adults</td>
<td>41.3</td>
<td>37.8</td>
<td>21.0</td>
</tr>
<tr>
<td>Youths</td>
<td>38.2</td>
<td>45.9</td>
<td>15.9</td>
</tr>
<tr>
<td>Undetermined Age</td>
<td>30.4</td>
<td>44.3</td>
<td>25.3</td>
</tr>
</tbody>
</table>

Discussion

People.

Clearly, the textbook is not suffering from a lack of images of females as compared to males; however, what kinds of tasks are the females and males engaged in? In the case of this text, the images seem to fall somewhere in the vicinity of sex-fair by Schau and Scott’s (1984) definition (see Chapter 2), with females in particular appearing in some nontraditional roles; however, I saw few examples of males in typically female roles.14

14 I also suggest here that including both sexes in “numbers proportional to reality” in a science text might result in far fewer women being pictured in the text, due to the dearth of women actually working in many science fields.
Males: Same roles as always.

Some examples of what I am talking about should be helpful in illustrating my point that equal numbers of men and women do not necessarily make for equitable representation.

Fig. 28 illustrates a typical scene: A white male, standing at a podium, gives a presentation, while a few people sit and listen. The poster hanging behind him, along with the white coat he is wearing, add to the likelihood that he may be presenting scientific findings. Nothing about this photo challenges the stereotype of scientist as white male in a position of authority.

Several other photos and images in the text represent missed opportunities to challenge stereotypes of typically male behaviors. For instance:

- An adult male lifting weights is pictured, with text boxes pointing to various enormous muscles and talking about different groups of cells.
- A photo of a scientist performing an experiment in a lab setting features a white male in a lab coat, with the caption “laboratory investigations.”
• A scientist working in the field is pictured as a white man with binoculars.

• Another lab shot features a white male holding a Petri dish up to the camera.

• Three adults in white lab coats sit at a table discussing something; two are white males, and the other is an Asian female. This one hits on two stereotypes: White males as scientists, and Asians as smarter than the general populus.

• An illustration of early humans in the quaternary period features a large male carrying a walking stick and a much smaller female carrying an infant (Fig. 29).

• A man and a boy work with garden tools on a large composting bin.

• Two white male scientists study a rock of salt in which the bacteria *bacillus permians* lives (Fig. 30).

• A composite graphic identifying human muscles features a photograph of an athletic-looking adult male’s head, hands, and feet, with the body composed of drawings of his muscles (Fig. 31).

• A graphic illustrating “body movement” features a male bricklayer in a hard hat.

• An eye doctor examining a white boy is a white male (Fig. 32).
• A photograph of runners in a section on “water loss features a white male frontrunner, followed by three white males and one white female.

• A boy and girl learn to use a blood pressure cuff: the boy is doing the operation, while the girl stands passively and smiles.

• A shot of a group of teens operating a car wash features the male holding the hose while the females do the washing.

• Two photos of prominent physicians in the history of medicine: Dr. Samuel Lee Kountz, who pioneered kidney transplants, and Dr. Daniel Hale Williams, who is among the pioneers of open heart surgery.

• Several abstract diagrams of human systems feature generic male shapes, including one of the central and peripheral nervous system.

• Two males—one older, one younger—practice boxing as part of an illustration on the nervous system.

• On the title page of the chapter on “Regulation and Reproduction” is a photo of three white men sitting at computer terminals, and one white male standing.

• In a section on the capabilities of older adults, two photos of astronaut John Glenn are featured: one in his younger days in the 1960s, and one in 1998 when he traveled on the space shuttle.

• A white male shovels compost out of a container and into a wheelbarrow.
Perhaps the photos with the most egregious stereotyping, though, are the two that follow.

Fig. 33. A boy gives a presentation to his fellow students.

In Fig. 33, an African American youth gives a presentation to his classmates using an overhead projector. The five students in his audience comprise three males and two females. All the males have their hands raised, as though about to ask questions or make comments; both girls, however, sit quietly. The caption reads “A student communicates to his peers about his investigation.”

In Fig. 34, two boys are sitting at library computers, while a girl stands beside one of the boys, looking over his shoulder. The caption text discusses using the Internet to do research. Both boys are actively engaged in activities; the only girl in the photo is passively watching and, perhaps, waiting for a turn.

This evidence suggests the Glencoe text has done little to work against stereotypes of males in Western culture. A few exceptions, however, do mitigate the impact, though probably not significantly:
• A tall, dark-skinned male (possibly a teen) appears to be kneading or shaping some dough on a cutting board in a kitchen setting.

• An African American man holds a baby (which appears to be his son) and is evidently attempting to entertain the infant with a rattle. The caption reads “Infants and toddlers are completely dependent upon caregivers for all their needs” (Fig. 35).

• An African American man pushes two boys in a tire swing.

• A white boy performs an experiment using a reflective box as a solar cooker. He appears to have baked some cakes.

It may be noted that while I did not necessarily include race of the men in the previous list, I have included it in this shorter one; this is because I noted that not a single white adult male was depicted in what could be considered an against-type role. The males listed above are exceptions because they are engaged in tasks related to cooking and child care, so often considered “women’s work” in our culture.

Why focus on how men and boys are depicted, when...
the overall concern is the representation of women and girls? It is worth noting that several studies have found females in children’s books straddling the line between masculine and feminine traits (such as those described in Bem’s Sex-Role Inventory, published in 1981), but that males almost never stray from masculine stereotypes, offering support to the notion that it is easier for women to exhibit “masculine” traits than it is for men to exhibit “feminine” ones. “It seems that girls who possess or exhibit male traits are not ostracized by society but complimented, and many women reflect positively on the label of tomboy. [However, girls] usually do not incorporate the aggressiveness displayed in males” (Evans & Davies, 2000, p. 268). In their study of the representation of masculinity in young children’s reading textbooks, these authors found that females were more likely to be depicted with “positive” male characteristics such as assertiveness and self-reliance, but less likely to be seen as aggressive or competitive (p. 268). In other words, these books are reinforcing the stereotype of male-as-norm, female-as-other, by showing females willing and able to “cross over” toward male attributes, but depicting it as less desirable for males to take on female ones. In the next section, I list and illustrate some of the instances in which females take on nontraditional roles in this textbook.

Females: Safe to cross over.

In some instances, females depicted in this textbook were seen in roles traditionally considered to be masculine. For instance, one section features Dr. Jewel Cobb, an African American cancer researcher and “role model” according to the text (Fig. 36).

Following are some additional examples:
A blonde woman on her knees beside a pool, communicating with a dolphin, turns out to be a scientist. Had the caption not identified her as such, it would have been easy to mistake her for an animal trainer or other worker.

A female scientist works at a computer, comparing a photograph from a scanning electron microscope to a picture on her monitor (Fig. 37).

A woman works at an electron microscope, taking notes.

Geneticist Flossie Wong-Staal works in her lab at the University of California at San Diego. She is pictured behind the blue tops of a row of test tubes.

A female diver observes a sponge growing underwater.

In a deviation from the norm for this text, a girl is shown taking part in a competitive team sport—in this case, basketball—to illustrate different types of joints in use for this activity. More often than not, photos of children engaging in sports feature boys.

A female scientist, Dr. Bahor, noticed that Barbie doll leg joints might work as well as human finger joints, so she
started transplanting them into humans to restore some movement to those with failed finger joints.

- A girl pitches a softball directly toward the camera’s position. The caption discusses lung cancer and smoking, but adds that smoking can contribute to the development of cancers in other parts of the body. Arrows point to the mouth, larynx, esophagus, pancreas, kidney, and bladder.

- A woman gives the Heimlich maneuver to a choking man in a staged photo (Fig. 38).

- What may be a woman (going by braided hair and rounded hips) wears a hard hat and works at the scene of a semi-truck accident.

Unfortunately, the images in this text were just as likely, if not more so, to feature women in more traditional, passive roles, such as caregivers, elementary teachers, nurses, and the like. Others simply feature women or girls looking stereotypically female or doing things considered stereotypically female. Because I list so many, I have broken them down into general categories; however, some of these photos easily fit into more than one category.

Teachers, housewives, caregivers:

- A grandmother and granddaughter play with hula hoops on a front porch. This photo appears twice in the text.

- A woman uses a can opener to open a can of cat food, while a cat stands at her feet.

---

Fig. 39. Kindergarten teacher.
A kindergarten teacher poses with her students (Fig. 39). She is touching all the girls in some way, either by directly holding them or by having some part of her body in contact with them (such as a leg); she has no contact whatsoever with any of the boys.

A woman reads to her son in a series of four shots, showing him growing older.

A woman in a drawing of ancient humanoids carries an infant.

A woman, probably a mother, seems to be observing as seven teens enjoy a party at a child’s home (Fig. 40). In the same shot—and for the second time in this text—a girl is featured eating pizza and talking on the telephone.

African women in head scarves watch as a solar reflector is demonstrated for cooking purposes.

A woman holds a pan of food over a panel cooker, which collects solar heat to fry food.

A girl fries some food in a pan over a type of solar dish.

Passive bystanders:

A girl stands smiling as a boy takes her blood pressure.

In a larger graphic about the excretory system, a boy is shown running, while a girl is shown drinking a glass of water.
• In a photo of a boy giving a presentation to his class, the girls all sit still while the boys all have their hands raised (see Fig. 33 above).

• A girl watches as boys use lab computers to research on the Internet (see Fig. 34 above).

Support staff in the lab or medical profession:

• A female technician records on a clipboard data about a cat.

• A female in a lab coat gives a tetanus/diphtheria (Td) vaccination to a boy. (I am assuming this is meant to be a nurse or nursing assistant, because doctors so rarely administer vaccinations themselves.) The oddest part of the photo is the eerie blue light emanating from behind a window blind, giving the photo a weird, 1980s-fashion-shoot appearance.

• A female medical professional, likely a nurse (judging by the heart-covered scrubs), washes her hands at a sink.

Just looking and acting “like girls”:

• A drawing of a woman’s lower body, meant to help illustrate the muscles involved in walking, features the woman wearing a knee-length skirt and sensible, low-heeled shoes.

• A girl holds and talks on the telephone, holding a piece of pizza in her other hand. Since the caption discusses the human digestive system, one can only wonder why the telephone prop was necessary in this staged shot.

• Teen girls wash cars while a teen boy holds the water hose. (Is he waiting for a chance to spray them?)
• An illustration on the front cover of Toni Morrison’s novel *Sula* features a highly fashionable woman wearing a floral dress and ornate hat.

Girls’ school (the only photo in which females are shown presenting to others in this text):

• Two blonde girls give a presentation to a group of girls. One girl is speaking; the other stands silent. All the girls in the audience sit quietly, looking straight at the two girls.

Thus far, the evidence suggests that the editors of the *Glencoe* text are comfortable showing females in both traditional and nontraditional roles; however, the editors are much less comfortable showing men in anything but traditionally masculine roles, with few exceptions. I next examine the appearance of “generic” humans, in which one or the other sex serves as representative of the entire human race for the purpose of illustrating a particular body part or system.

*Generic “humans”: Male except where uteruses are concerned*

Many of the studies that have investigated gender bias in textbooks have concentrated on the tendency to use the generic masculine in verbal references to humankind, except where reference to a female was explicitly needed. In the present
study, I was able to pick out instances in which the visual equivalent of “generic male bias” frequently appears. For the purposes of this study, I considered “generic” any instance in which the system being diagrammed or analyzed was roughly equivalent in both sexes, and thus, either a male or female could have been chosen for the visual representation.

Significantly, generic statements offer visual arguments. As Newman (2005) shows, the generic is a kind of metonymic (or even synecdochal) image and functions conceptually to represent the whole. Richard Lanham (1991) describes synecdoche as “substitution of part for whole, genus for species, or vice versa” (p. 148). Interestingly, I found that when photographs depicted the human form for purposes of diagramming organs or systems, the editors were about as likely (5:4) to choose a female as a male, except in the case of diagrams of muscles: They seemed to prefer to show muscle-bound men (Fig. 41a), rather than (muscle-bound?) women, in this instance. However, in the case of illustrations, the diagram was nearly always a generic white male (figures 41b and 41c), unless the system being investigated was explicitly female—such as parts of the endocrine or reproductive system. In this text, the repetition of male-as-substitute-for-human-race in diagrams may reflect the cultural endoxa predominant in medical research, wherein the male frequently serves as representative of the species. Some examples of this perpetuation of the male-as-norm (or white-as-norm) stereotype follow.
- A diagram of the process of administering gene therapy features an adult male (Fig. 42).

- A diagram of how tapeworms go through their life cycle features a vaguely male human Fig. with large shoulders and short hair.

- A diagram of “working muscles” features the lower torso and legs of a female body wearing a skirt. Flexors and extensors are featured.

- A diagram of a girl shows her eating from a bowl, and then running. Her skin tone is a sort of nondescript “skin tone” shade that could be any number of races.

- A concept map on “body movement” features a graphic of a male dressed as a bricklayer.

- A National Geographic diagram of “Visualizing Nerve Impulse Pathways” features a baseball crashing through a window, startling a naked, bald, transparent white male, who drops his water glass in mid-air (see Fig. 41c).

- A diagram of the central and peripheral nervous systems features a rear view of a white male looking off to his left.

- A National Geographic diagram of “Visualizing the Endocrine System” features both male and female figures, both white, with organs diagrammed. The endocrine system includes sex-specific organs.

- A diagram of the sex hormones features abstract drawings of a white male and white female showing the brain and pituitary gland in each. Arrows from each Fig.’s gland point to the unique sex organs: on the female, “ Produces female sex hormones” and
“Stimulates egg production in ovaries;” and on the male, “ Produces male sex hormones” and “Stimulates sperm production in testes.”

- A diagram of the female body in childbirth abstracts the Fig. to just a white torso, showing the passage of the fetus from the uterus through the cervix and into the vaginal canal.

The inclination of these editors seems, with few exceptions, to be to depict “human” as “white male” unless a sex-specific system is being illustrated. In other words, the images argue that scientific issues and practices are masculine matters. These arguments speak to and reinforce endoxal cultural norms about science—and these cultural norms are what both male and female middle school students are learning from their science courses.

In sum, the results in the People category support the male-as-norm and the science-as-objective (and male) stereotypes through a series of synecdochal visual arguments depicting the archetypal human as a white male.

This section has been devoted to data from the People category of my analysis of the Glencoe text. In the future, I may study other 2005 Glencoe editions, such as fifth grade science and ninth grade biology texts, for example, to see whether the images seem to evolve from predominantly photo-realistic to more abstract as the readers increase in age and experience, and also to see whether texts argue from and to the same cultural norms. However, this research is outside the scope of the present study.

Thus far, I have presented the results of visual analysis of 180 photos in the Glencoe Life Science textbook, 2005 edition. In the next section, and based upon
previous statements and findings, I illustrate how photos argue enthymematically, using several examples from this textbook.
Visual enthymemes.

Results.

In all, I analyzed 180 enthymemes in this textbook. (See Chapter 1 for a discussion and example.) In general, these photos supported understanding science as involving men in STEM and physical careers, and women as passive observers (except in the case of the Heimlich maneuver photos). Below, I analyze four representative examples. I begin with a photograph previously used in this chapter.

Table 14. Visual enthymeme for Fig. 43.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>Two young boys use computers, while a young girl seems to be looking at what one boy is working on. The setting appears to be a library.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed premise:</td>
<td>Boys use computers; girls do not. This photo represents what happens in reality in general.</td>
</tr>
<tr>
<td>Inference 1:</td>
<td>If you are a girl, you probably do not like computers.</td>
</tr>
<tr>
<td>Inference 2:</td>
<td>If you are a girl, you probably will not get to use a computer, because the boys will be using them.</td>
</tr>
<tr>
<td>Inference 3:</td>
<td>If you are a girl, you are no good at using computers, and a boy has to do the work for you or show you how to use the technology.</td>
</tr>
<tr>
<td>Inference 4:</td>
<td>If you are a girl, you may teach boys how to use computers. (However, nothing in this image indicates that she is actually showing the boy what to do; her hands are at her sides, and her stance is passive—she may not even be close enough to view the monitor directly.)</td>
</tr>
</tbody>
</table>

15 As mentioned previously, this analysis does not purport to uncover all the possible enthymemes in a given image; rather, it endeavors to show some of the enthymemes that correspond to Western cultural endoxa.
As the enthymematic breakdown in Table 14 indicates, this image may argue that girls do not like to use computers, or perhaps that they do not like them, or even that they are not good at using technology (see Table 14). More specifically, it may represent a girl watching while boys perform on the computers. Because the assumed premise, or endoxon, is that girls do not use computers, the visual may validate and extend that stereotypical argument. The inferences can also be read from the boy’s point of view, for instance: *If you are a boy, you like to use computers.*

Here is another example.

<table>
<thead>
<tr>
<th><strong>Table 15. Visual enthymeme for Fig. 44.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observation:</strong> The drawing pictures a man in a hard hat holding a brick. The accompanying text discusses body movement.</td>
</tr>
<tr>
<td><strong>Assumed premise:</strong> The man is probably a mason or bricklayer. Bricklayers and masons are men.</td>
</tr>
<tr>
<td><strong>Inference 1:</strong> It is appropriate to discuss body movement using illustrations of men, because they do hard physical work.</td>
</tr>
<tr>
<td><strong>Inference 2:</strong> It is appropriate to picture a mason as a man, because women do not do this type of work.</td>
</tr>
<tr>
<td><strong>Inference 3:</strong> It is appropriate to picture a white male doing this type of work, because males of other races may not do this work.</td>
</tr>
</tbody>
</table>

As Fahnestock (1999) explains, as an enthymeme this graphic requires participation on the part of the viewers— not only do they have to interpret the drawing of the human, but
they also have to read the clues in the concept map and think through what answers belong in the blank ovals. The fact that the body is divided into, on one side, a depiction of the skeleton and, on the other, a depiction of the muscular system is intended to guide the readers to infer that body movement is made possible by the muscles and the skeleton. This is the overt argument of the image. One covert argument, of course, is that men (white men, in particular—the one hand with visible skin is white) do this kind of physical work. Moreover, the organization of the visual elements contributes to this argument. Following Kress & Van Leeuwen (1996) on page composition, the reader knows that the top single bubble is the highest and most important to which the other two lines lead. Thus, the heading “Body Movement” may be associated with the male depicted in the image, leading the reader to associate body movement with males. This notion of males as active and females as passive is a stereotype that repeats throughout all three of the textbooks analyzed.

Here is a third example:
Fig. 45. Teens having a party.

The photo of teens having a house party (which may, out of context, seem somewhat out of place in a science textbook) comes from the chapter on human development. I include this picture in a larger size because so much is happening in it that I want the viewer to see all the relationships—and, accordingly, the many possible inferences.
Table 16. Visual enthymeme for Fig. 45.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>Assumed premises:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young teens are hanging out at a house. They have different appearances and</td>
<td>Boys and girls in their early teens hang out together in houses. They may all be participating in</td>
</tr>
<tr>
<td>racial backgrounds. Four girls and three boys are at the party, as well as</td>
<td>separate activities. They like pizza and soda. They like to play instruments such as acoustic</td>
</tr>
<tr>
<td>one adult female. A boy and girl play a video game. The boy has a guitar.</td>
<td>guitar, and to play games such as Scrabble, soccer, and video games. Boys behave in certain ways</td>
</tr>
<tr>
<td>Another girl talks on the phone and eats pizza. A girl and boy play Scrabble.</td>
<td>and girls in others. Moms usually host these kinds of parties.</td>
</tr>
<tr>
<td>The boy has a soccer ball. A boy and the woman share a laugh. The woman</td>
<td></td>
</tr>
<tr>
<td>wears a skirt and holds a bowl. She has her hand on the boy’s shoulder. The</td>
<td></td>
</tr>
<tr>
<td>boy holds … something. One girl appears to be drinking soda. Two kids sit on</td>
<td></td>
</tr>
<tr>
<td>the floor.</td>
<td></td>
</tr>
</tbody>
</table>

| Inference 1:                                                                 |                                                                                                             |
| If you are a mother, you enjoy hosting parties of young teenagers. You may    | If you are a mother, you enjoy hosting parties of young teenagers. You may also enjoy serving                  |
| also enjoy serving them.                                                     | them.                                                                                                       |

| Inference 2:                                                                 |                                                                                                             |
| If you are a boy, you may enjoy playing soccer or acoustic guitar.           |                                                                                                             |

| Inference 3:                                                                 |                                                                                                             |
| If you are a girl, you may like to talk on the phone while eating.           |                                                                                                             |

| Inference 4:                                                                 |                                                                                                             |
| If you are a boy or girl, you may expect to hang out in groups of same- and  | If you are a boy or girl, you may expect to hang out in groups of same- and opposite-gender                  |
| opposite-gender children of different races.                                | children of different races.                                                                                |

A few observations of note:

- The girl in green appears to be waiting while the boy makes his move in the Scrabble game.

- The girl in red holds her video game controller in one hand, whereas the boy beside her holds his in two. I have brought up two boys, and I have never seen anyone successfully play a video game while holding the controller in only one hand. As a result, the observant viewer may interpret this to mean the boy is actively playing, whereas the girl is simply feigning interest or playing halfheartedly.
• The girl in pink is eating pizza and talking on the phone at the same time. This is the second photo of a girl on the phone and eating pizza that I have observed during this project.

• At least two of the girls show their legs; the adult woman is wearing a skirt, as well. On the other hand, the boys all wear jeans or trousers.

Taken together, this enthymeme argues by repetition on two levels: First, the images of boys support the understanding that they perform particular activities (video games, soccer, guitar); and second, girls, by repetition, do other things (eat pizza, talk on the phone, show more skin than boys). Finally, as pictured, these gender-specific activities argue for and support stereotyped cultural norms.

Here is one final example, comprising two similar photos that appear in the same chapter.
In Figures 46 and 47, the Heimlich maneuver is demonstrated. Fig. 46 is a small photo at the end of a chapter, with accompanying text asking readers if they think they could perform the maneuver if it were needed. Fig. 47 is a full-page diagram of the procedure involved in administering the Heimlich maneuver. In the following enthymematic analysis, I demonstrate the repetition of certain arguments from one photo to the next, again demonstrating how visuals in textbooks argue enthymematically through repetition.
Table 17. Visual enthymeme for Figures 46–47.

| Observation: | In Fig. 46, a white woman performs the Heimlich maneuver on a white man. The setting appears to be a kitchen, possibly in a home or office. In Fig. 47, a white woman performs the Heimlich maneuver on a medium-skinned woman, possibly Asian or Pacific Islander. The setting is abstracted by removal of all background visuals. In each case, the woman performing the maneuver appears to be at least somewhat smaller than the choking victim. The woman in 46 holds her hands lower on the victim’s abdomen; the woman in 47 holds her hands higher, closer to the victim’s breastbone. Neither the victim nor the helper appears emotionally distraught. Both women performing the maneuver are wearing red shirts. Both victims are wearing grey. |
| Assumed premises: | Women can perform the Heimlich maneuver on others. Small people can perform the Heimlich maneuver on others. The Heimlich maneuver is about technique as well as strength. |
| Inference 1: | If you are a woman or a smaller person, you can still perform the Heimlich maneuver on a choking person. |
| Inference 2: | If you are writing step-by-step instructions, it is appropriate to use abstract photos of people acting rationally, with no distracting contextual items. |
| Inference 3: | If you wish readers to be able to identify with the people in an image and the associated text, it is a good idea to include context. |
| Inference 4: | If you are administering this maneuver on a male, you should place your hands low on the abdomen; if on a woman, place the hands higher. |

Because these two images appear in the same chapter, it is easy to imagine that young readers, upon seeing the second photo, may flip backward to see the other one and compare the two. It is also easy to imagine the reaction of middle-school-aged children to Fig. 46 or Fig. 47 if the victim had been female and the helper male. The photo editors did well to choose images featuring female helpers, to help avoid any unwanted giggles in science class. In addition, the repetition of the visual argument “Women and smaller people can perform this maneuver” is positive, because it suggests that saving people in danger is not solely the enterprise of males (or knights in shining armor).
What of the color symbolism? Both helpers wear red—possibly a coincidence, but in Western culture, red has a particular symbolic value. According to Ken Rohrer of The Incredible Art Department (Rohrer, 2012), the color red signifies the following: “excitement, energy, passion, love, desire, speed, strength, power, heat, aggression, danger, fire, blood, war, violence, all things intense and passionate” (p.1). It is easy to imagine that if one is choking on something, one might appreciate a helper who has energy, passion, speed, and strength, for example, in addition to knowledge of the Heimlich procedure. Thus the choice and repetition of red support a visual argument about an emergency procedure. Also, red highlights the position of the helper’s hands and arms so they are easy to distinguish from the body of the victim. Although they suggest that women can perform this emergency procedure, the images also implicitly reinforce the notion that women are small—which is true but not typically in middle school classes, during which boys have often not yet begun puberty. The visual reminder of women’s smaller stature is also unnecessary considering the technique involved in the Heimlich maneuver: Size need not matter.

Perhaps troubling is the visual argument made by the two photos together: that placement of the hands differs depending on the gender of the choking victim. In fact, according to the Heimlich Institute (Deaconess Foundation, 2012), the instructions are as follows:

1. From behind, wrap your arms around the victim's waist.
2. Make a fist and place the thumb side of your fist against the victim's upper abdomen, below the ribcage and above the navel.

3. Grasp your fist with your other hand and press into their upper abdomen with a quick upward thrust. Do not squeeze the ribcage; confine the force of the thrust to your hands.

4. Repeat until object is expelled. (p.1, emphasis added)

The directions are the same whether the person is male or female; they differ slightly for large victims, infants, and unconscious victims. Thus, the argument made by these two images is what Fahnestock (1999) calls a visual polyptoton (p. 175): the object being repeated is the maneuver, and the slight changes from one to the next are the genders of the subjects and the placement of the hands.

Thus, it is also possible to imagine that boys viewing these two images could conclude that boys should not perform the maneuver on girls. In particular, the argument indicates that boys and girls should not touch each other the same way. A book for prepubescent children could include images that feature a male performing the maneuver on a victim. However, it seems likely that such an image in a book for older children or teens would merely be a distraction.

This section has illustrated typical visual arguments presented by images in the Glencoe 2005 Life Science textbook. In all cases, stereotypes are upheld—they are the basis for the endoxa or assumptions on which the arguments themselves are based. At times, this is not necessarily unwise. Still, no breech of norms is offered. Finally,
repetition is key to these arguments. I have shown that several images present arguments that are biased in favor of males, and that images can argue across a text by simply repeating the same types of arguments. I now summarize the findings of the Glencoe case study.

Summary
To review, most of the modality markers identified by Kress & Van Leeuwen (1996), when applied to images in the Glencoe 2005 text, are in the vicinity of naturalistic, with the exception of two: representation of detail and depth. In both these categories, the average photos seemed to fall somewhere between naturalistic and abstract, possibly suggesting a move toward the more abstract images and text associated with science textbooks on the high school and college levels. Color differentiation and contextualization also occurred in a broad range, with the majority of images coding naturalistic, but many also coding toward the abstract end of the range.

It is possible that textbook publishers such as Glencoe are as influenced by the endoxa of advertising as any other consumers in our culture. What are these endoxa? A wonderful example comes from Jean Kilbourne’s book Can’t Buy My Love: she recalls seeing a 1968 advertisement in The Lancet for birth control pills. The ad pictured a woman’s brain divided into seven boxes: one for each day of the week. In each box was a photo depicting a domestic chore, such as laundry or ironing. The point of the ad was, essentially, to show women how easy it would be to remember to take their daily birth control pill (Kilbourne, 1999).
“It was 1968,” she says later in the chapter. “When I saw the ad featuring the woman’s head with seven boxes in it, I can’t say that I understood immediately that there was a connection between that image and the fact that I was a Wellesley graduate working in a mindless job. […] But I did know there was something terribly wrong with the ad” (p. 23). What Kilbourne is describing here is the insidious belief that women are not as intelligent as men—a belief we have not entirely put to rest 40 years later, judging by some of the things that come out of academic mouths. For instance, the infamous remarks made by Harvard president Lawrence Summers in 2005, arguing that “men outperform women in maths and sciences because of biological difference, and discrimination is no longer a career barrier for female academics” (Goldenberg, 2005), show how out of touch many so-called experts in Western culture are with women’s experiences. If the endoxa from which we are reasoning our beliefs about our world are based upon the “weight of tacit knowledge and […] the authority wielded by certain illustrious members of the community—including, of course, scientific communities” (Renon, 1998, p. 97, emphasis added)—then those scientific communities may be rhetorically leading us astray. And if advertisements such as the one Kilbourne cites can appear in a peer-reviewed journal, then they are also endemic in the general media—as, it seems, in textbooks.

Having demonstrated the presumed naturalism of images in this text and several visual enthymemes, I then showed that the visual arguments in the Glencoe text reveal and support several gender stereotypes (such as “girls like to talk on the phone and eat pizza at the same time”). In Chapter 4, I discuss the McDougal-Littell Life Science 2005
analysis and findings in similar detail to that of this chapter on Glencoe Life Science 2005. Once again, I approach the case study first from the data, giving charts and tables of the results, and then move on to the analysis and integration that will help tell the “story” of gendered representation in the McDougal-Littell Life Science textbook.
Chapter 4: McDougal Littell 2005

“Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less.”

–Marie Curie

Overview

Holt, Rinehart and Winston and McDougal Littell recently merged to form Holt McDougal, a division of the Houghton Mifflin Harcourt (HMH) Publishing Company. Headquartered in Boston, HMH publishes textbooks, instructional technology materials, assessments, reference works, and fiction and non-fiction for both young readers and adults (Wikipedia.org). The McDougal Littell text I analyzed for this project, Life Science (2005) for seventh grade, is one of an extensive line of textbooks offered by HMH.

Fig. 48. Gender distribution among editorial staff.
Gender.

As in the previous chapter, it is appropriate to provide the gender representation among the editorial staff of the textbook. The chart in Fig. 48 illustrates the distribution.

Generally speaking, males outnumber females in the categories in which staff generally hold terminal degrees, and women dominate in the categories in which terminal degrees are not required. Fig. 49 illustrates the distribution of doctoral degrees among the editorial staff. Twelve males hold terminal degrees, whereas just six females do.

![Fig. 49. Doctoral degree holders among editorial staff.](image)
Results

**Visuals.**

In this section, I present the results of my analysis of *color saturation, color modulation, color differentiation, contextualization, representation of detail, depth, illumination, brightness, coding orientation, and horizontal and vertical angles* in the 164 images I analyzed from this text.

*Color saturation.*

![Saturation](image)

Fig. 50.
As discussed in Chapter 2, color saturation refers to the richness of a given color—the purity of it, with an absence of white or grey. For instance, what we think of as “electric blue” is usually highly saturated, whereas “baby blue” contains more white and is lower in saturation. Fig. 50 shows that the vast majority of photos in this textbook, 142 (more than 86%), fell roughly at the midpoint between low and high saturation, suggesting high modality.

Table 18 below shows the results as percentages of the total.\textsuperscript{16}

Table 18.

<table>
<thead>
<tr>
<th>Color Saturation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>6.10</td>
</tr>
<tr>
<td>Medium</td>
<td>86.59</td>
</tr>
<tr>
<td>Low</td>
<td>6.10</td>
</tr>
<tr>
<td>Between medium and high</td>
<td>1.22</td>
</tr>
</tbody>
</table>

\textsuperscript{16} In some cases, percentages may not add up to 100. This is due to rounding.
As indicated in Chapter 2, color modulation, in Kress & Van Leeuwen’s (1996) theory, focuses on the number of different shades of a given color: for example, many different shades of green as opposed to one, plain shade of the color. Nearly 79% of the images in this textbook coded as medium modulation, whereas just 21% coded as low modulation, and none coded high (Fig. 51). The lower the modulation, the lower the modality, with black and white (no color modulation) having the lowest modality. Those photos coded as low modulation may have featured many colors but not much contrast (meaning all appearances of red, for instance, looked about the same intensity), or featured few colors on subjects that had no areas of shadow, for example.
Table 19 shows the results as percentages of the total.

**Table 19.**

<table>
<thead>
<tr>
<th>Color Modulation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>21.34</td>
</tr>
<tr>
<td>Medium</td>
<td>78.66</td>
</tr>
<tr>
<td>High</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Color differentiation.*

**Fig. 52.**
Differentiation refers to the number of colors in an image. The highest-differentiated image contains the full spectrum, a rainbow, of colors; an image with the lowest differentiation is monochrome. In this sample, the majority of images coded as medium differentiation, consistent with Kress & Van Leeuwen’s (1996) contention that the most naturalistic photos have neither extremely high nor extremely low color differentiation in most situations. However, more than 33% coded as low differentiation (Fig. 52). Sometimes, photos with lower color differentiation were of scenes without much color, such as a photo of a snowy scene in the woods; a few were monochrome. However, most of the photos I coded as low differentiation were staged scenes, or scenes with partially removed backgrounds, which presumably diminished the number of colors in the image.

Table 20 below lists the percentages of each possibility.

**Table 20.**

<table>
<thead>
<tr>
<th>Color Differentiation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3.05</td>
</tr>
<tr>
<td>Medium</td>
<td>63.41</td>
</tr>
<tr>
<td>Low</td>
<td>33.54</td>
</tr>
</tbody>
</table>
Contextualization in images deals with the amount of background that is visible, giving the subject context. As in Chapter 3, the highest modality is awarded photos with a naturalistic background (for example, a child performing an experiment in a lab might be surrounded by other lab tables, pictures on the walls, etc.). In this text, all but a very few images contained either a natural or no background (Fig. 53). Sixty percent of the photos contained a natural background, such as a photograph of fishermen measuring lobster tails; in contrast, more than 36% either were composed with no background (often shot against a burned-out white background that disappeared against the page or was digitally removed) or had had the existing natural background digitally removed. An example of
an image with the natural background removed appears in Fig. 54, which features a climber set against an apparently nonexistent sky, or one that inexplicably matches the exact color of the page upon which the photo is printed.

Table 21 illustrates these results as percentages of the total.

Table 21.

<table>
<thead>
<tr>
<th>Contextualization</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly detailed background</td>
<td>0</td>
</tr>
<tr>
<td>Natural background</td>
<td>60.37</td>
</tr>
<tr>
<td>No background</td>
<td>36.59</td>
</tr>
<tr>
<td>Combination of natural &amp; no background</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>3.05</td>
</tr>
</tbody>
</table>

Fig. 54. Lack of context in this scene of a climber leads one to wonder whether the setting is real.
As with most of the Visuals criteria, highest modality in an image usually falls somewhere between the two extremes of possibility, according to Kress & Van Leeuwen (1996). Representation of detail is no exception. Images that depict about the same amount of detail that the human eye detects have the highest modality.

As illustrated in Fig. 55, nearly 66% of the images coded as naturalistic, and nearly 26% coded between naturalistic and abstract. A further 8% coded as abstract. This finding supports the research by Kress & Van Leeuwen (1996) that abstraction is the hallmark of science: The vast majority of images in this textbook seem to have achieved a balance between being easily accepted as natural by readers, and bringing in elements
of abstraction without being so abstract that young readers might not fully comprehend them.

Table 22 illustrates these results as percentages of the total.

Table 22.

<table>
<thead>
<tr>
<th>Representation of Detail</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum abstraction</td>
<td>7.93</td>
</tr>
<tr>
<td>Between maximum abstraction and naturalistic</td>
<td>25.61</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>65.85</td>
</tr>
<tr>
<td>Between naturalistic and maximum representation</td>
<td>0.61</td>
</tr>
<tr>
<td>Maximum representation</td>
<td>0.00</td>
</tr>
</tbody>
</table>
As Chapter 2 described, depth, for Kress & Van Leeuwen (1996), refers to visual perspective on the image. Central perspective has highest modality, but the “hyperreal” perspective created by a fish-eye lens, for instance, has lower modality. In this textbook, more than 58% of images coded as natural (central) perspective, but about 37% coded in the shallow-to-somewhat-shallow range (see Fig. 56). A considerable number of diagrams and line art drawings helped account for the high number of images coding as shallow.

The few photos with deep perspective often gained it from the photographer’s use of a wide-angle lens, which distorts natural perspective (Tamron USA, Inc., 2012). For
example, in one wide-angle photo of a woman working at a station in a large lab (Fig. 57), the woman is about halfway back in the composition—about mid-ground—whereas the foreground is dominated by a computer station. The photographer’s choice to emphasize the computer over the worker leaves the viewer wondering if the picture was about the woman or the task being performed.

In the example of the bloodhound on a leash (shown in Fig. 58), the extreme depth of field serves two purposes: (1) It makes the dog seem unnaturally large and close to the viewer; and (2) it utterly removes emphasis from the person walking the dog, who is now so far in the background and so blurry that age and gender and not readily discernible.

Table 23 illustrates the results as percentages of the total.
### Table 23.

<table>
<thead>
<tr>
<th>Depth (Perspective)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow perspective</td>
<td>33.54</td>
</tr>
<tr>
<td>Somewhat shallow</td>
<td>3.66</td>
</tr>
<tr>
<td>Natural perspective</td>
<td>58.54</td>
</tr>
<tr>
<td>Somewhat deep</td>
<td>1.83</td>
</tr>
<tr>
<td>Deep perspective</td>
<td>2.44</td>
</tr>
<tr>
<td>Other</td>
<td>0.00</td>
</tr>
</tbody>
</table>
As discussed in Chapters 2 and 3, illumination, for Kress & Van Leeuwen, refers to the play of light in an image, ranging from a full representation of the play of light and shade to their absence. The images in the McDougal Littell text primarily coded as natural lighting (60%), although about 13% coded as abstractly lit (see Fig. 59). The grey area lies between: More than 26% coded as “in between” or “unsure,” meaning that either I could not comfortably call the lighting “natural,” or else I could not determine what the source of any lighting was.

As mentioned previously, photographs professionally lit with studio flash, or in which the photographer used on-camera flash, were coded as having a natural light
source, because both types of lighting are relatively easy to
discern for directionality and source; on-camera flash, in
particular, often creates blown-out highlights and harsh
shadows that make it easy for the viewer to guess the light
source. When the source of lighting in a photo is unknown or
multiple, the photo may appear more abstract than natural: as
Kress & Van Leeuwen explain, in these images shading may
be used “to indicate receding areas and highlights to indicate
protruding areas, often in ways which have no explanation in
terms of the logic of illumination” (1996, p. 167). Fig. 60
illustrates this issue: the lighting is so even that no real
shadows exist to betray directionality. The lack of background
information, along with the cartoon thought bubble containing the dog, merely add to the
abstractness of the image.

Fig. 60. Abstraction of light and shade results from the removed background and lack of any obvious light source.
Table 24 below illustrates these results as percentages of the total.

**Table 24.**

<table>
<thead>
<tr>
<th>Illumination</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstraction of light/shade</td>
<td>13.41</td>
</tr>
<tr>
<td>In between/ unsure</td>
<td>26.22</td>
</tr>
<tr>
<td>Natural light source</td>
<td>60.37</td>
</tr>
</tbody>
</table>
Fig. 61. This photo has low contrast due to the hazy light and resulting lack of color modulation and differentiation.

Brightness.

![Brightness Chart]

**Brightness**

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark blacks/bright whites</td>
<td>140</td>
</tr>
<tr>
<td>In between</td>
<td>20</td>
</tr>
<tr>
<td>Minimal differences in brightness</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 62.

As discussed in previous chapters, brightness is a difficult category for which to determine coding values. I coded images as dark blacks and bright whites if they had naturalistic contrast, and as minimal differences in brightness if they were low contrast (as in the foggy scene in Fig. 61).

The images in this textbook coded primarily (more than 86%) with what I considered naturalistic contrast, that
is, with dark blacks and bright whites (see Fig. 62). The few that coded as “in between” may have had dark blacks but no bright whites, or vice-versa.

Table 25 illustrates the results as percentages of the total.

Table 25.

<table>
<thead>
<tr>
<th>Brightness</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark blacks/bright whites</td>
<td>86.59</td>
</tr>
<tr>
<td>In between</td>
<td>8.54</td>
</tr>
<tr>
<td>Minimal differences in</td>
<td>4.27</td>
</tr>
<tr>
<td>brightness</td>
<td></td>
</tr>
</tbody>
</table>
As described in Chapters 2 and 3, the four coding orientations described by Kress & Van Leeuwen are technological (e.g., blueprints), sensory (e.g., interior decorating, cooking), abstract (e.g., academia, high art), and naturalistic. As the authors point out, naturalistic orientation is “the dominant one in
our society” because “it is the one coding orientation all members of the culture share when they are being addressed as ‘members of our culture’” (1996, p. 170). In this text, images coded primarily (about 63%) as naturalistic, although about 35% coded as either abstract or somewhere between abstract and naturalistic (usually having elements of both orientations). The only other coding orientation that appeared in this text was sensory, with one photo (see Fig. 63).

Fig. 64 shows a photographer at work within a constructed blind. The colors, lighting, subjects, depth, and angles all contribute to a naturalistic scene that is readily acceptable as representative of something the naked eye could perceive.

Table 26 illustrates these results as percentages of the total.

Table 26.

<table>
<thead>
<tr>
<th>Coding Orientation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>9.76</td>
</tr>
<tr>
<td>Elements of both abstract and naturalistic</td>
<td>25.61</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>63.41</td>
</tr>
<tr>
<td>Sensory</td>
<td>0.61</td>
</tr>
<tr>
<td>All others</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Horizontal Angles.

Fig. 65.

Horizontal angle is a modality marker that conveys something about the involvement of the artist or photographer—and, by extension, the viewer of the image—with the subjects of the image. If the image-producer is at a frontal angle to the image, this means he or she was positioned in front of the subject(s)—as if facing them. On the other hand, an oblique angle puts the image producer “on the sidelines.”

Fig. 66. This photo is composed from an oblique horizontal angle. The viewer is not involved in the interaction between the two women.
In this text, the prominence of naturalistic representation was not as pronounced: almost 54% coded as parallel or frontal in angle, but almost 46% coded as angled/oblique (see Fig. 65). Thus, slightly more of the images involved the viewer directly, whereas the others set the viewer off to one side or another. Fig. 66 perfectly illustrates the effect an oblique angle has on the viewer, who is completely removed from the interaction between the technician and the patient.

Table 27 illustrates the results as percentages of the total.

Table 27.

<table>
<thead>
<tr>
<th>Horizontal Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angled (oblique)</td>
<td>45.73</td>
</tr>
<tr>
<td>Parallel (frontal)</td>
<td>53.66</td>
</tr>
<tr>
<td>Other</td>
<td>0.61</td>
</tr>
</tbody>
</table>
According to Kress & Van Leeuwen, vertical angle is an indicator of the perceived power relationship between image-producer and subject(s) (see Chapter 2). In this text, the results indicate that the high vertical angle here puts the viewer in a position of looking down upon the children, implying a sense of power over them.
majority (more than 63%) coded middle, but 9% coded low, and almost 21% coded high; in addition, 5.5% coded between middle and high (see Fig. 67). The high angle puts the viewer in a position of looking down upon the subject, implying power (see Fig. 68 for an example); a lower angle puts the viewer in the position of looking up at or to the subject, thus implying a lack of power.

Table 28 below shows the results as percentages of the total.

**Table 28.**

<table>
<thead>
<tr>
<th>Vertical Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>20.73</td>
</tr>
<tr>
<td>Between high and middle</td>
<td>5.49</td>
</tr>
<tr>
<td>Middle</td>
<td>63.41</td>
</tr>
<tr>
<td>Between middle and low</td>
<td>0.61</td>
</tr>
<tr>
<td>Low</td>
<td>9.15</td>
</tr>
</tbody>
</table>
Discussion

Visuals.

As in the previous chapter, I consider each Visuals category separately to test the analysis method. Rather than repeating the discussion from Chapter 3, I now review noteworthy results of the McDougal Littell analysis.

Color.

In the categories of color saturation, modulation, and differentiation, the McDougal Littell images are comparable to the Glencoe’s in naturalism. Both texts contain images with a high level of naturalism in saturation, a slightly lower level in modulation, and slightly lower still in differentiation.

Depth.

Images in the McDougal Littell text fall into the naturalistic range at roughly the same ratio as in the Glencoe text—in the range of 52–59%. As discussed in Chapter 3, depth and volume help the viewer experience “physical reality” in an image; when an image lacks background context, viewers must use their imaginations to fill in the details.

The number of images in the natural-to-abstract and abstract ranges in this text is, as in the Glencoe, quite substantial. As discussed in the previous chapter, this suggests that the photo editors of middle school science textbooks are choosing images (consciously or not) with reduced representation in hopes of focusing viewer attention on
the most important characteristics of the scene depicted. I believe this tendency is the result of the strong influence of advertising images on Western culture.

**Coding orientation.**

The images in the McDougal Littell text were slightly more likely (63.41% v. 52.80%) to be naturalistic than those in the Glencoe. However, 35% fell into the abstract range; this finding parallels the finding from the Glencoe text. As was the case in that text, the interpretation of an image as abstract often reflected a lack of context or background information. As previously discussed, it is apparent from the images that the editors of this textbook chose (consciously or not) images that would challenge middle school readers to think more abstractly about science and scientific subject matter.

**Horizontal and vertical angle.**

Images in the McDougal Littell were less likely than those in the Glencoe to fall into the naturalistic range in these two categories. In the vertical angles category, in fact, the difference was 14.69%.

As previously discussed, Kress & Van Leeuwen (1996) state that a frontal horizontal position involves the image-producer in the situation being captured; an oblique position removes the image-producer from the situation. Thus, as was the case in the Glencoe, a fairly high number (in this case, 46%) of images were composed from an oblique angle, implying a detached relationship between the viewer and the subjects.
This emotional detachment is a hallmark of the abstract category to which science belongs: the goal of scientific communication is to generalize concepts, not create emotional attachment.

Regarding vertical angle, the choice of angle speaks to the power relationship between viewer and subject, as discussed in Chapter 3. Images composed from the highest vertical angle—looking down upon a subject—give power to the viewer, whereas images composed from a low angle—looking up at a subject—give power to the subject. Images composed from a frontal or central angle place viewer and subject in a more equal relationship and also suggest action.

In this text, about 63% of images were composed from the central angle, but 37% were not (compared with just 22% in the Glencoe). In advertising, a low camera angle gives the represented participant power. In an example given by Sells & Gonzalez (2003), low camera angle on a person wearing clothing and shoes by the DC company is “affirmed by the luxury car in the background, reinforcing the high status (and power) of the depicted. However, because the vertical angle is slight, the photo suggests that the power difference between the depicted [subject] and the viewer is minimal—small enough to overcome, perhaps by purchasing some DC merchandise” (p.1). In other words, a slightly low angle suggests to the viewer that, although the subject may be more powerful than the viewer, the viewer might easily overcome that gap by following the
advice given in the advertisement—to buy whatever product or service the company is advertising. Similarly, images that place the science textbook reader at a slightly lower viewing angle may convey a sense of attainability: “You, too, can do this one day.” A low vertical angle may also convey the point of view of a child or pet (Sells & Gonzalez, 2003).

On the other hand, high camera angle, which conveys power to the viewer rather than the subject (and was quite common in this textbook), “look[s] down on subjects, making them weaker and less important” (Sells & Gonzalez, 2003). In advertising, this vertical angle could be used to convey empathy with a smaller, less-powerful subject, such as a hungry child in a poverty-stricken area (as in Fig. 69) or a helpless puppy who
needs an expensive dog-food brand to help it grow up healthy. In the McDougal Littell text, however, the high angle appeared to be employed somewhat haphazardly (see Fig. 70), with no obvious reason for the choice. Other uses of this angle included photos of microscopic subjects, for which high angle is really the only practical one.

**Summary.**

<table>
<thead>
<tr>
<th>Category</th>
<th>0%</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modulation</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Differentiation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contextualization</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illumination</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Brightness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coding Orientation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Angles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical Angles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 71. Percentages of images falling into the naturalistic range in each of the Visuals categories**

Fig. 71 illustrates selected results from all Visuals categories: namely, the percentages of images in each category that fall into the range of naturalistic (the blue
area of each bar), as opposed to those that fall into the range of abstract (the red area).

More than 50% in every category possess elements of high modality, and in many of the categories, the percentages were well above that halfway point, supporting the perspective that photographs are constructed in ways that render them presumably natural and realistic. Nevertheless, in some categories, such as horizontal angles, the percentages in the range between maximum abstraction and naturalistic are higher than in the Glencoe text. Generally, then, they support the analysis in Chapter 3. The photographs are designed to be perceived as naturalistic and thus persuasive. As in the previous chapter, the presumed naturalism conforms to the audience’s expectations. When the photographs deviated from the natural—in the categories of angle and color—it is to conform in these situations with our Western endoxa, which are linked to advertising as well as to power relationships and stereotypes.

Fig. 72 presents the McDougal Littell results alongside the Glencoe results, illustrating the categories in which each text fell into the naturalistic range.
Fig. 72. Comparing McDougal Littell visuals results to Glencoe.

On the whole, the percentages of photos in the naturalistic range are lower in the Glencoe text than in the McDougal Littell. Three categories jump out as considerably higher than the others: saturation, brightness, and vertical angles. Saturation and vertical angles, in particular, are considerably higher than the corresponding results in the McDougal Littell.

What these results say about the Glencoe is that the editors were more likely to select images with naturalistic saturation and middle vertical angle than were the editors of the McDougal text; but the Glencoe’s lower percentages in many of the other Visuals.
categories do not support the general conclusion that the Glencoe editors were more likely to choose naturalistic images overall. In fact, as the graph illustrates, they were somewhat more likely to choose images that were more visually abstract, whereas the McDougal editors were, overall, somewhat more likely to choose naturalistic images.

Returning to the discussion of endoxa of advertising (Chapter 3), I wonder if the editors of the McDougal Littell were perhaps less influenced by attitudes popular in advertising, such as, “Girls should be pictures as smiling and wearing feminine colors,” than were the Glencoe staff. Certainly, they were somewhat less inclined to show science occurring in abstract settings than was the case for the Glencoe text (I return to this discussion in Chapter 6). Next, I discuss my findings in the People category.
Results

People.

Fig. 73. Raw numbers represented as a chart.

Fig. 73 illustrates the numbers of males, females, and undetermined-gender individuals, both in total and in five separate subsets: those wearing some kind of uniform, those wearing street clothes, adults, youths (including infants, small children, and anyone who appeared to be a student), and those of undetermined age.

Table 29 lists the percentages of each gender in each of the subsets.
Table 29.

<table>
<thead>
<tr>
<th>McDougal Littell 2005</th>
<th>Males</th>
<th>Females</th>
<th>Undetermined Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Totals</td>
<td>163</td>
<td>158</td>
<td>88</td>
</tr>
<tr>
<td>Wearing Uniforms</td>
<td>14.11%</td>
<td>11.39%</td>
<td>19.32%</td>
</tr>
<tr>
<td>Wearing Street Clothes</td>
<td>84.05%</td>
<td>81.01%</td>
<td>71.59%</td>
</tr>
<tr>
<td>Adults</td>
<td>61.35%</td>
<td>46.84%</td>
<td>35.23%</td>
</tr>
<tr>
<td>Youths</td>
<td>32.52%</td>
<td>46.20%</td>
<td>34.09%</td>
</tr>
<tr>
<td>Undetermined Age</td>
<td>6.13%</td>
<td>6.96%</td>
<td>50.00%</td>
</tr>
</tbody>
</table>

*What are all these people doing?*

In this text, relatively few persons are depicted wearing professional uniforms; the great majority wears street clothing. However, it is the genders of the adults and youths, and their activities, that are particularly interesting. Among the adults pictured, the ratio of men to women is 1.31:1, whereas the ratio of male youths to female is 1:1.42. This finding is similar to that of Whiteley (1996b), who found boys and girls represented fairly equally in Jamaican textbooks, but male adults heavily favored. It is disappointing to note that Whiteley’s study predates the McDougal text by nine years—and so little change seems to have occurred in the interim.
Males:

Fig. 74. One of several examples of a generic male figure used to illustrate a bodily system.

Fig. 75. A young male is shown in a nontraditional role for a child musician: as a flautist.

Fig. 76. Boy and girl sit on invisible surface; boy appears to levitate.

In this text, the generic human was slightly more likely to be male than female (5:4—see Fig. 74). Males appear in both traditional (stereotypical) and nontraditional (non-stereotypical) roles (such as the boy playing flute in Fig. 75); they also possess magical powers (see the levitating boy in Fig. 76). Overall, males in this text tended to appear in active roles more often than girls (also illustrated in Fig. 76), with girls tending to be note takers.
In the next section, I list and describe some of the roles females assume in this textbook.

_Females:

Women and girls in this book appear in a variety of roles, including STEM careers; however, their roles seem to be more active when they appear with other females, whereas they tend to appear in more passive, stereotyped roles when pictured with males. In figures 77 and 78, for instance, women and girls are shown in active roles when interacting with other females. The doctor (Fig. 77), for example, is...
giving a vaccination to a girl. The two girls on the playground (Fig. 78) are doing pull-ups on the bars. A third child beside them appears to be wearing a purple hair “scrunchy” around her wrist; it is likely this is also a girl.

In contrast, women and girls interacting with males often appear in more passive roles. In the photo of children recycling (Fig. 79), the girl stands holding the bag, merely a bystander, while the boy places each recyclable item into the bin. She is watching him perform this task; he is also watching the task. In the photo of children demonstrating an experiment (Fig. 80), the boy is pictured with his arm high in the air, whereas the girl stands, hand on hip, appearing somewhat posed for the camera. Her pose seems unrelated to the tasks in the experiment.

Fig. 80. Boy and girl demonstrate experiment.

Fig. 81. Marie Curie.
Some stereotypes appear, as well; for instance, two separate photos depict three people performing yoga. All three are female, perpetuating the stereotype that only women do yoga. In a scene of an Asian-American family picnicking, the woman is serving the seated family. (A man is pictured grilling food outdoors for his family—also a stereotype.) And in one caption for a photo of Nobel laureate Marie Curie (Fig. 81), her pioneering work is diminished by a prominent reminder that she built her discoveries upon the work of a male. Descriptions of male scientists did not contain similar dismissive remarks. In fact, a caption of Charles Darwin’s photo (Fig. 82) touts the fact that he “was only 20 in 1831 when he joined H.M.S. Beagle.” Conversely, the caption for head of the National Oceanic and Atmospheric Administration (NOAA) Sylvia Earle, pictured working with a student in the ocean, begins, “Sylvia Earle is the first woman to serve as chief scientist” at the NOAA (Fig. 83).

---

17 It is worth noting, too, that Marie Curie is usually the only woman scientist included in the “history of scientific discovery” sections of the life science textbooks I examined.
Fig. 82. Charles Darwin, whose chief accomplishment was, apparently, his youth.

Fig. 83. It took until 1990 for a woman to serve as chief scientist at the NOAA.
Generic “humans”:

As mentioned in the previous chapter, many of the studies that have investigated gender bias in textbooks have concentrated on the tendency to use the generic masculine in textual references to humankind, except where reference to a female is explicitly needed. In the McDougal Littell textbook, I did not find much evidence of the visual equivalent of “generic male bias.” For the purposes of this study, I considered “generic” any instance in which the system being diagrammed or analyzed was roughly equivalent in both sexes, and thus, either a male or female could have been chosen for the visual representation.

In the McDougal Littell text, I counted roughly equal uses of males or females for generic human bodily systems (5 male diagrams to 4 female); gendered systems such as endocrine and reproductive were of course represented appropriately, with 2 male and 3 female (one being a close-up of the uterus and related organs). Fig. 844 shows an example of generic human depicted as female.

This section has been devoted to data from the People category of my analysis of the McDougal Littell text. In the next section, I analyze these results.
Discussion

In this section, I interpret the results of the findings above to better tell the “story” of gender and representation in the McDougal Littell Life Science 2005 textbook. I also ponder the implications of those interpretations.

Overall, the McDougal Littell text continues to perpetuate gender stereotypes: Men appear more often in active roles and as chief protagonists. The text features some males in nontraditional (non-stereotyped) roles; however, the majority appears in stereotypically male roles. Some females do appear in nontraditional roles; however, so much attention is drawn to their status as unique in their fields that the message being sent may be more negative than positive. To continue to explore these issues, I turn now to the specific arguments these images offer. Following are several representative examples.

Visual enthymemes.

Following the pattern of the previous chapter on the Glencoe text, I now turn to the topic of images using visual enthymeme to argue. Fig. 85 depicts a girl gardening; another girl walks
behind her, holding a plant. Table 30 examines the kinds of arguments possible in the visual enthymemes in this image.

**Table 30.**

| Observation: | A girl kneels in a flower bed, planting a flower plant. Another girl walks behind her, carrying a plant. The setting appears to be a park, apartment building, or school. |
| Assumed premise: | Girls are interested in planting gardens. |
| Inference 1: | If you are a girl, you probably like to work in gardens. |
| Inference 2: | If you are a girl, you probably like to help out with projects such as planting a garden in a park or at school. |
| Inference 3: | If you are a boy, you probably are not interested in or involved with gardening. |

Because the photograph is a visual enthymeme, its context is assumed by the viewer. That context is also filled in by audience expectations. For example, what if the actual scene also featured two or three boys also planting flowers, but the photographer chose to crop them out, focusing instead on one girl, and the other girl just happened to wander into the shot? I argue that the photographer’s composition is a rhetorical choice, whether he or she made that choice consciously or not. And the photo editor’s decision to include the image is also a rhetorical choice—again, whether that choice is conscious or not.
Accordingly, the photograph argues that girls are gardeners, which implicitly conforms to the stereotype of females-as-nurturers.

The photo of Sylvia Earle (Fig. 86) is worth a closer examination because it includes text that contributes to the visual argument. Table 31 below illustrates the arguments in detail.

Fig. 86. Sylvia Earle.
As the table indicates, the image and caption can be read together as hindering girls’
interest in becoming scientists, especially in such active roles. Implicitly, the argument
speaks to stereotypes suggesting that girls who work against type have a hard task to
accomplish. As I discuss later, the problem is not just that this particular photo suggests
this argument, but rather that the abundance of such visual arguments supports the
stereotype within the text as a whole. Is emphasizing the scarcity of women in high-level STEM careers sending the right message to seventh-grade readers? In this particular case (as with the photo of Marie Curie in Fig. 81), it is the accompanying text, and not merely the image itself, that argues in a sexist manner about the world. Without the caption, Inference 1 in Table 31 might be the predominant argument to be inferred from this photo. Thus, it is just as important for photo editors to choose non-sexist images as it is for content editors to ensure non-sexist copy—even in text as seemingly unimportant as a photo caption.

One more example helps demonstrate the importance of attention to the arguments in images.

In Fig. 87, three youths are pictured performing an experiment. Table 32 shows some of the possible inferences to be read from the image. Clearly, some of them can be read as positive, whereas others may not, depending on the reader’s gender and other factors.
### Table 32.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>Three children sit at a round table. They appear to be painting on sheets of paper. The boy and one girl are smiling. The girl in the wheelchair has a neutral expression. The boy is gesticulating and appears to be speaking as the other two children listen. Both girls look at the boy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed premise:</td>
<td>Some experiments in 7th grade science require children to work in groups. These groups can include anyone in the classroom. They may require the use of a table and certain implements.</td>
</tr>
<tr>
<td>Inference 1:</td>
<td>If you are a boy, you may expect to be able to explain things to the others in the group, particularly if they are girls.</td>
</tr>
<tr>
<td>Inference 2:</td>
<td>If you are a girl, you may expect a boy to be able to explain things to you in science. You will be happy to have him do so.</td>
</tr>
<tr>
<td>Inference 3:</td>
<td>If you are in a wheelchair, you can still do science experiments.</td>
</tr>
<tr>
<td>Inference 4:</td>
<td>If you are a boy, you may expect to be the center of attention whenever you are in a group with just girls.</td>
</tr>
</tbody>
</table>

The further I take the analysis, the more insidious some of the inferences can become; for example, the fact that the other two children are smiling but the girl with the disability is not. Also, upon closer examination, the girl has her fists clenched; is this part of her disability, or is she ready to punch the boy? Regardless, the visual suggestion is clear. The pose is perhaps an odd one for the photographer to have captured; had this image...
been captured on a digital camera, the photographer might have caught the odd hand position right away and asked the children to pose for another shot. The visual argues for inclusion, at the same time that difference is noted. Thus, the attempt to include whole stereotyping occurs is consistent with the visual arguments as a whole.

Here is another example:

In Fig. 88, two children place plastic items into a recycling bin. The background and ground have been removed; thus, it appears the boy is floating in midair (along with the bin)—and we can only guess what is holding the girl down, since we cannot see her feet. Table 33 outlines some of the potential inferences.
Table 33.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>Boy places plastic items in recycling bin. Girl holds bag for him and watches his actions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed premise:</td>
<td>Boys are active; girls are passive. Boys handle dirty things; girls do not. Recycling is a worthwhile activity.</td>
</tr>
<tr>
<td>Inference 1:</td>
<td>If you are a boy, you will be taking out the recycling (trash, etc.). Maybe you are more interested in recycling than girls.</td>
</tr>
<tr>
<td>Inference 2:</td>
<td>If you are a girl, you will hold the recycling for the boy. You will not touch it. Maybe you are not interested in recycling.</td>
</tr>
</tbody>
</table>

This photo exemplifies the naturalistic-to-abstract compositions that are common in the textbook. While viewers may assume the recycling bin is outdoors, no contextual elements exist to give that impression; in fact, if we are to believe this photo, recycling occurs in a very clean, pure-white environment. Also, the children’s clothes are in basic, unmodulated colors, keeping visual interest at a minimum. Finally, the girl watches what the boy is doing, as though watching someone put a milk jug into a recycling bin is very interesting to her. Whereas it is impossible to know whether the average young reader sees any or all of this interpretation in the image, it is not difficult to imagine the boy touching the “icky” items while the girl, preferring not to get her hands dirty, simply holds the bag, touching only the handles. This interpretation certainly does nothing to
challenge the stereotype of boys playing outdoors in the mud while girls play indoors with nice, clean dolls. On the other hand, presenting recycling as a normal daily activity that even children can engage in is commendable.

It is worth noting that the elements of abstraction in horizontal and vertical angle and in depth in this image also contribute to the abstraction that makes the image a visual argument for the primacy of science in Western culture. As previously discussed, abstraction is a main characteristic of scientific communication, which aims to generalize the specific and make conclusions applicable to broader questions. In this case, the viewer is completely disconnected from the two human subjects and the act of recycling—first, by oblique horizontal angle and high vertical angle; and second, by removal of naturalistic context. Clearly, the viewer is meant to apply the arguments in this image generally—stereotypes and all.

**Summary**

As a whole, the McDougal Littell images have used naturalistic elements to present what appears as argument which the reader simply accepts. Where images are less naturalistic, or abstract, that characteristic suggests the endoxa which the audience implicitly accepts. In the photos chosen for enthymematic analysis, I have found some positive gender messages and some negative ones. Several of the photos make strong visual arguments that women are onlookers while men are the doers; however, in one photo (Fig. 81 of
Marie Curie), the accompanying text creates a gender-bias problem that the image itself does not have on its own. Thus, the evidence in this chapter supports the argument that, while visuals may argue on their own, they also work with captions to argue—and perpetuate stereotypes about men and women. That visuals argue both ways comes out when the images are analyzed systematically: specifically, uncovering the assumptions on which the arguments are built has helped me discover the implicit bias. If editors and photographers used these methods of analysis when selecting or creating images, they could help to combat stereotypes rather than perpetuate them.

As detailed in Chapter 3, images in the Glencoe text owe more to advertising or fashion endoxa than those of positivistic science, judging by the preponderance of glossy, somewhat abstract images of clean, crisp children in spotless white settings. By comparison, the McDougal Littell features a greater number of naturalistic images, but stereotypes still appear—and some of them are troubling (I think particularly of the insinuation in caption form that Marie Curie perhaps owes her Nobel to a male scientist who basically did everything except actually name radioactivity for her—as if scientific discovery is always, or ever, based upon completely original work—Watson and Crick, for example). Again, the images could better achieve this task through editors’ and photographers’ use of visual analysis during the design process.
This chapter presents a case study of the McDougal Littell Life Science book, 2005 edition. The results of the two analyses suggest further research is needed to begin to represent gender more positively in this cross-section of 2005 science textbooks. In Chapter 5, I discuss the Prentice Hall 2005 text analysis, again including analysis of visual enthymemes.
Chapter 5: Prentice Hall Life Science 2005

“If a child is to keep alive his inborn sense of wonder without any such gift from the fairies, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in.”
–Rachel Carson

Overview

The previous two chapters presented results from a single text: Chapter 3 discussed the depiction of gender in a Glencoe textbook, and Chapter 4 did the same for a McDougal Littell text, both from 2005. In this chapter, I present results from a third 2005 text, published by Prentice Hall.

Prentice Hall, Inc., is part of Pearson Education, based in New Jersey. Pearson’s Pre-K–12 curriculum includes textbooks, e-books, and online content such as tutorials and lessons. An update to the text I analyzed was published in 2009. This chapter details the findings of my analysis of visuals and people in the images included in the 2005 text.
Gender.

The following chart (Fig. 89) illustrates the gender representation among the authors, consultants, and reviewers:

![Gender Representation Chart](image)

**Fig. 89.**

The results of this comparison are interesting in several categories. Of the main book authors, all with terminal degrees, three are female, and only one is male. However, males outnumber females 5:1 in the categories of content reviewers and Tufts University content reviewers; and 7:4 in the category of contributing writers. Conversely, females outnumber males in the category of activity field testers nearly 4:1 and in the category of teacher reviewers, 1.4:1. It is noteworthy that the content reviewers overwhelmingly
comprise university faculty, whereas the activity field testers comprise K–12 schoolteachers.

Fig. 90 illustrates the distribution of terminal degrees among the contributors to this text, by category of contribution.

![Bar Chart: Distribution of terminal degrees](image)

**Fig. 90. Distribution of terminal degrees.**
What is clear from this comparison is that the people mainly responsible for writing the content of the textbook comprise both genders and varied education levels; however, the greatest number of contributors fall into the area of reviewers, and of these, the majority appear to be males with terminal degrees and females without them (See Fig. 91). As I discussed previously, these individuals seem to lack knowledge of or training in visual argument.

**Results**

**Visuals.**

Following the pattern of the previous two chapters, this section presents the results of my analysis of color saturation, color modulation, color differentiation, contextualization, representation of detail, depth, illumination, brightness, coding orientation, and horizontal and vertical angles in the 254 images I analyzed from the 2005 Prentice Hall text.
Color saturation.

Fig. 92. Saturation.

Again, color saturation refers to the richness of a given color—the purity of it, with an absence of white or grey. For instance, what we think of as “neon yellow” is usually highly saturated, whereas “pale yellow” contains more white and is lower in saturation. Fig. 92 shows a sizable majority of images in the 2005 edition coded as medium saturation, right at the point at which Kress & Van Leeuwen argue they have their highest modality (p. 165).

Table 34 shows the results as percentages of the total. ¹⁸

¹⁸ In some cases, percentages may not add up to 100. This is due to rounding.
Table 34.

<table>
<thead>
<tr>
<th>Color Saturation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.00</td>
</tr>
<tr>
<td>Medium</td>
<td>92.94</td>
</tr>
<tr>
<td>Low</td>
<td>7.06</td>
</tr>
</tbody>
</table>

*Color modulation.*

![Modulation graph](image)

**Fig. 93. Modulation.**

As indicated previously, color modulation is the number of different shades of a given color: for example, many different shades of green as opposed to one, plain shade of the color. The images in the Prentice Hall textbook coded overwhelmingly in the midrange,
suggesting they have high modality and supporting the perspective that photographs are presumably natural and realistic (Fig. 93).

Table 35 shows the results as percentages of the total.

**Table 35.**

<table>
<thead>
<tr>
<th>Color Modulation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>25.49</td>
</tr>
<tr>
<td>Medium</td>
<td>74.51</td>
</tr>
<tr>
<td>High</td>
<td>0.00</td>
</tr>
</tbody>
</table>

About 75% of the photos of people in this edition coded as medium modulation, strongly supporting the perspective that photographs are presumably natural and realistic.
Color differentiation.

**Fig. 94. Differentiation.**

Differentiation refers to the number of colors in an image, and highest modality is awarded to images with midrange modality. In the Prentice Hall text, the percentages are nearly even (see Fig. 94): 51% of photos coded as medium (high modality) and nearly 49% as low differentiation (lower modality). Although the low differentiation amounts contribute more abstraction, that abstraction conforms to endoxa and thus contributes to the visual argument.

Table 36 lists the percentages of each possibility.
Table 36.

<table>
<thead>
<tr>
<th>Color</th>
<th>Percentage of Differentiation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>51.37</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>48.63</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

*Contextualization.*

Fig. 95. *Contextualization.*
As previously explained, contextualization in images deals with the amount of background that is visible, giving the subject context. Highest modality is awarded photos with a naturalistic background (for example, a child performing an experiment in a lab might be surrounded by other lab tables, pictures on the walls, etc.). An examination of the 2005 edition of Prentice Hall Life Science illustrates a preference for staged or digitally manipulated photos (see Fig. 95).

In this text, the editors have chosen a greater number of photos and images containing less-than-naturalistic contextualization. Backgrounds disappear or partially disappear, clothing colors are reduced, and props such as tables and instruments seem to be standardized (see Fig. 96 for an example) throughout the text.

Table 37 illustrates these results as percentages of the total.
Table 37.

<table>
<thead>
<tr>
<th>Contextualization</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly detailed background</td>
<td>0.00</td>
</tr>
<tr>
<td>Natural background</td>
<td>45.28</td>
</tr>
<tr>
<td>No background</td>
<td>50.20</td>
</tr>
<tr>
<td>Other</td>
<td>3.92</td>
</tr>
</tbody>
</table>

*Representation of Detail.*

Fig. 97. Representation of detail.
As discussed previously, highest modality in an image usually falls somewhere between the two extremes of possibility. Representation of detail is no exception. Images that depict about the same amount of detail that the human eye detects have the highest modality.

In the 2005 Prentice Hall, just under 47% coded as naturalistic, whereas more than 48% coded somewhere between naturalistic and abstract (see Fig. 97). Again, as discussed previously, the presence of abstraction in this text plays to commonly held assumptions of Western culture. Table 38 illustrates these results as percentages of the total.

Table 38.

<table>
<thead>
<tr>
<th>Representation of Detail</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum abstraction</td>
<td>3.15</td>
</tr>
<tr>
<td>Between maximum abstraction and naturalistic</td>
<td>48.43</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>46.85</td>
</tr>
<tr>
<td>Between naturalistic and maximum representation</td>
<td>0.00</td>
</tr>
<tr>
<td>Maximum representation</td>
<td>1.18</td>
</tr>
</tbody>
</table>
In Fig. 98, the student counts pens that seemingly hover in midair. She is smiling, but it is not clear what makes her smile. The source of the light is unknown; because no backdrop or contextual elements appear behind her, she casts no shadow, and her face is practically shadowless as well. The only discernible brightness appears at her crown and could come from an overhead light fixture or even a studio hairlight.\(^{19}\) Even more abstract, she appears to originate inside a red outline (inside which there is also no background), with just her forearms and hands (and those magical, floating pens) appearing to emerge from the red rectangle. The abstraction of the table surface and part of the girl’s background (all of it, really—she goes from having an ivory background to having just the page itself) must have left at least a few readers wondering what happened to her work surface. The effect focuses attention on the girl’s actions.

\(^{19}\) A hairlight is a studio lamp, usually either small or lower power, that is suspended (usually on a boom) above the subject’s head to bring reflections into the hair and to help separate the subject’s hair from the background.
As explained in previous chapters, depth, for Kress & Van Leeuwen (1996), refers to the viewer’s visual perspective on the image. Central perspective has highest modality; the “hyperreal” perspective created by a fish-eye lens, for instance, has lower modality, as does the shallow perspective of, for instance, a line-art drawing.
It is easy to see from the chart above (Fig. 99) that the 2005 Prentice Hall text employs a mixture of central, somewhat shallow, and shallow images. In Fig. 100, perspective is hard to ascertain; whereas the subjects may indeed have been captured with a “normal” lens, it is difficult to judge their relative size and position due to the lack of context. With no background, midground, or foreground elements, only the partially reproduced table at which they are working, the subjects in this scene appear a bit two dimensional. Again, the abstraction focuses attention on the students’ actions.

Table 39 illustrates the results as percentages of the total.
Table 39.

<table>
<thead>
<tr>
<th>Depth (Perspective)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow perspective</td>
<td>32.68</td>
</tr>
<tr>
<td>Somewhat shallow</td>
<td>12.20</td>
</tr>
<tr>
<td>Natural perspective</td>
<td>48.43</td>
</tr>
<tr>
<td>Somewhat deep</td>
<td>0.00</td>
</tr>
<tr>
<td>Deep perspective</td>
<td>6.69</td>
</tr>
<tr>
<td>Other</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Illumination.

Fig. 101. Illumination.
As discussed previously, illumination, for Kress & Van Leeuwen, refers to the play of light in an image. In this category, the images in the Prentice Hall Life Science textbook tended toward naturalism, but with a large number tending toward abstraction (see Fig. 101). The number of images that coded as in between/unsure is also high. This trend suggests lack of support for the presence of the naturalistic enthymeme perspective in this category.

A plurality of the images in the 2005 text coded as naturalistic illumination, but many more images coded as having abstract light and shade or as somewhere in between the two extremes. In Fig. 102, removing the background and floor surfaces eliminates any evidence of shadow, and thus, light directionality. The lack of contextualization creates the sense that the girl could be floating in midair, although our brains may fill in the missing details and help us conclude that she is standing on an unseen surface.

As explained in earlier chapters, photographs professionally lit with studio flash, or in which the photographer used on-camera flash, were coded as having a natural light source. When the source of lighting in a photo is unknown or multiple, the photo may appear more abstract than natural: as Kress & Van Leeuwen explain, in these images shading may be used “to indicate receding areas and highlights to indicate protruding
areas, often in ways which have no explanation in terms of the logic of illumination”

Table 40 illustrates the results as percentages of the total numbers.

**Table 40.**

<table>
<thead>
<tr>
<th>Illumination</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstraction of light/shade</td>
<td>32.55</td>
</tr>
<tr>
<td>In between/unsure</td>
<td>28.24</td>
</tr>
<tr>
<td>Natural light source</td>
<td>39.21</td>
</tr>
</tbody>
</table>

The images in the 2005 Prentice Hall are lit in a variety of ways, suggesting that, once again, elements of abstraction are used to focus attention on the action in the image rather than on the context or subjects.
Brightness is a difficult category for which to determine coding values. Kress & Van Leeuwen (1996) provide a scale running from “dark blacks and bright whites” to “minimal differences in brightness.” I coded images as dark blacks and bright whites if they had naturalistic contrast, and minimal differences in brightness if they were low contrast.

Almost 93% of the images coded as having dark blacks and bright whites, or what I considered naturalistic brightness/contrast (see Fig. 103). I found no images of people that coded on the high extreme of contrast; however, I did find a small number that coded as minimal differences in brightness, and several more that fell somewhere in between.
naturalistic and minimal. Thus, in the brightness category, these images are understood as naturalistic.

Table 41 illustrates the results as percentages of the totals.

Table 41.

<table>
<thead>
<tr>
<th>Brightness</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark blacks/bright whites</td>
<td>92.91</td>
</tr>
<tr>
<td>In between</td>
<td>5.12</td>
</tr>
<tr>
<td>Minimal differences in brightness</td>
<td>1.97</td>
</tr>
</tbody>
</table>

*Coding Orientation.*

![Coding Orientation](image)

*Fig. 104. Coding orientation.*
In previous chapters I have explained Kress & Van Leeuwen’s argument that the naturalistic orientation is “the dominant one in our society” because “it is the one coding orientation all members of the culture share when they are being addressed as ‘members of our culture’” (1996, p. 170). As illustrated in Fig. 104, the 2005 Prentice Hall contains a large proportion of images coding between abstract and naturalistic—more than 53%—versus about 46% naturalistic. Again, “naturalism” involves abstraction in this context.

Table 42 illustrates these results as percentages of the totals.

Table 42.

<table>
<thead>
<tr>
<th>Coding Orientation</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>5.51</td>
</tr>
<tr>
<td>Elements of both abstract and naturalistic</td>
<td>48.03</td>
</tr>
<tr>
<td>Naturalistic</td>
<td>46.46</td>
</tr>
<tr>
<td>Others</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The image in Fig. 105 shows two smiling girls watching and waiting (perhaps they are already done?) as a boy performs what must be one part of an experiment they are all working on. He, too, is smiling. The perspective is somewhat shallow due to the absence of background and midground objects; the only depth is created by the small sliver of
table that is visible. Color modulation and differentiation are on the lower end of the scale. The source of illumination is ambiguous; a slight shadow is visible under the boy’s hand, but otherwise, the lighting is so even and shadowless that it appears to come from everywhere. This image was coded as having elements of both abstract and naturalistic orientation; clearly, it focuses on the individuals rather than the context.

*Horizontal Angles.*

![Horizontal Angles Chart]

**Fig. 106.** Horizontal angles.
Horizontal angle is a modality marker that conveys information about the involvement of the artist or photographer—and, by extension, the viewer of the image—with the subjects of the image. If the image-producer is at a frontal (parallel) angle to the image, this means he or she was positioned in front of the subject(s)—facing them, as it were. On the other hand, an oblique angle puts the image producer “on the sidelines.”

Fig. 1066 shows raw results from coding of horizontal angles in images of people in the Prentice Hall textbook. Almost 64% of images coded as parallel angle, and 34.5% coded as oblique. Whereas the presence of the naturalistic enthymeme perspective does appear to be supported in this category, it is worth noting that oblique angle creates distance between the viewer and the subjects. Fig. 107 illustrates the use of frontal horizontal angle to involve the viewer. Fig. 108, in contrast, illustrates the use of oblique angle, which faces the subject away from the viewer, thus creating a lack of involvement.

Table 43 illustrates the results as percentages of the totals.
Table 43.

<table>
<thead>
<tr>
<th>Horizontal Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angled (oblique)</td>
<td>34.54</td>
</tr>
<tr>
<td>Parallel (frontal)</td>
<td>63.78</td>
</tr>
<tr>
<td>Other</td>
<td>1.57</td>
</tr>
</tbody>
</table>

Vertical Angles.

Fig. 109. Vertical angles.

According to Kress & Van Leeuwen, vertical angle is an indicator of the perceived power relationship between image-producer and subject(s) (see Chapter 2). The great majority

---

In some instances, a single image comprised several component images, some of which coded differently from the others. These “other” results included images in which, say, two of three component images coded parallel and one coded angled.
of images coded as middle angle, indicating that viewers likely encountered image subjects as equals (see Fig. 109). A small number of images coded on either extreme; many of these images were composed from a high angle using a wide-angle lens. Figures 110–112 illustrate high, middle, and low vertical angles, respectively.

Fig. 110. High vertical angle and wide-angle lens.

Fig. 111. Middle vertical angle.

Fig. 112. Low vertical angle.

Table 44 below shows the results as percentages of the total.
Table 44.

<table>
<thead>
<tr>
<th>Vertical Angle</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>15.75</td>
</tr>
<tr>
<td>Middle</td>
<td>78.35</td>
</tr>
<tr>
<td>Low</td>
<td>3.94</td>
</tr>
<tr>
<td>Other</td>
<td>1.96</td>
</tr>
</tbody>
</table>
Discussion

**Visuals.**

As in previous chapters, I now visually compare all the Visuals categories in an effort to determine what they argue about the Prentice Hall text—and what the text itself tends to offer as visual argument.

![Bar chart showing percentages of photos falling into the naturalistic range in each of the Visuals categories.]

**Fig. 113. Percentages of photos falling into the naturalistic range in each of the Visuals categories.**

Fig. 113 illustrates the percentages of images in each category that fall into the range of naturalistic (the blue area of each bar), as opposed to those that fall into the
range of abstract (the red area). More than 50% in several categories possess features of high modality. In contrast, some categories—such as contextualization and color differentiation—comprise high percentages of images in the abstract range. Fig. 114 presents naturalistic range results for the Prentice Hall text alongside those from both the McDougal Littell and the Glencoe, illustrating the areas of similarity and of difference.

![Bar chart comparing naturalistic range results in all three texts.](image)
From this chart, it is clear that the McDougal Littell text has the most categories that tend toward naturalistic presentation; it is also clear that in all three texts, certain categories are more likely than others to support naturalism: brightness and color saturation appear to be the most naturalistic categories, followed by vertical angles and color modulation. In contrast, the categories of coding orientation, illumination, depth, detail, contextualization, and differentiation feature lower numbers of naturalistic images in general, and thus are less likely to support the presence of the naturalistic enthymeme perspective (see Chapter 6).

This is the basis on which visual arguments are made by means of enthymemes. Before offering that analysis, I discuss my findings in the People category for the Prentice Hall Life Science textbook.
Results

People.

Fig. 115. People in the 2005 edition of the Prentice Hall text.

Fig. 115 illustrates the numbers of males, females, and undetermined-gender individuals, both in total and in five separate subsets: those wearing some kind of uniform, those wearing street clothes, adults, youths (including infants, small children, and anyone who appeared to be a student), and those of undetermined age.

Table 45 lists the percentages of each gender in each of the subsets.
Table 45.

<table>
<thead>
<tr>
<th>Prentice Hall Gender</th>
<th>Males</th>
<th>Females</th>
<th>Undetermined Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Totals</td>
<td>219</td>
<td>178</td>
<td>47</td>
</tr>
<tr>
<td>Wearing Uniforms</td>
<td>31.96%</td>
<td>24.16%</td>
<td>36.17%</td>
</tr>
<tr>
<td>Wearing Street Clothes</td>
<td>63.93%</td>
<td>71.35%</td>
<td>44.68%</td>
</tr>
<tr>
<td>Adults</td>
<td>46.58%</td>
<td>37.64%</td>
<td>57.45%</td>
</tr>
<tr>
<td>Youths</td>
<td>47.57%</td>
<td>47.57%</td>
<td>4.85%</td>
</tr>
<tr>
<td>Undetermined Age</td>
<td>8.68%</td>
<td>7.30%</td>
<td>14.89%</td>
</tr>
</tbody>
</table>

What are all these people doing?

Looking only at the raw totals, some patterns emerge. Males outnumber females in all categories except youths: in this category—the intended audience of the textbook—males and females occur in exactly the same numbers (98 of each). Of particular note is the disparity between adult males and females: almost 47% of males pictured were adults, as opposed to just under 38% of females. This gender disparity among photos of adults is particularly problematic because adults are more likely to serve as role models to young readers than are other children (unless those children are in the entertainment industry) (Anderson & Cavallaro, 2002; Lockwood & Kunda, 2000). A more thorough discussion
of this phenomenon, along with an examination of the importance of same-gender role models and mentors, is found in Chapter 6.

*Males:*

The representation of males in the Prentice Hall Life Science text is worth discussing. Of 32 instances of generic people, 19 are represented as female, 13 as male. However, the ratio of adult males to females is 1.25:1, and the ratio of uniformed men to women is 1.32:1. This disparity is worrying, because if children are more likely to see men working in science fields than women, then they may be more likely to accept the stereotype of STEM careers being primarily intended for men. Figure 116, of Dr. Jonas Salk and a female nurse, surely does nothing to mitigate the impact of the stereotype.

Next, I illustrate and discuss the roles of females in the Prentice Hall textbooks.

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21 Also worth noting is that the generic humans in this text are not obviously members of any particular race.
Females:

The representation of females in the two editions of the Prentice Hall Life Science texts is a mixed bag.

As mentioned, the depictions of females are rather a mixed bag in the Prentice Hall text. In Fig. 117, Marjory Stoneman Douglas—a journalist—is featured between two other females, both biologists (not pictured here). Viewed in context, the photos of the three women appear on the right-hand page of a two-page spread entitled “Science and

Fig. 117. In a section on different historical figures in science, journalist Marjory Stoneman Douglas is featured for her work in the Florida Everglades.

Fig. 118. Aiko Iso, a trainer with the Pittsburgh Steelers, is featured prominently in a several-page spread.

Fig. 119. A young woman is pictured in the kitchen, chopping vegetables that are angiosperms.
History” that features a timeline. The left page features photos of prominent male scientists. Kress and Van Leeuwen (1996) stress that such a left/right composition often signifies given/new information (p. 186); thus, we may interpret this spread as follows: Men in science are a given; whereas women in science are new. Indeed, the timeline tells us that the first woman in science appears in 1962—more than halfway through the 20th century.

Figure 118Fig. 118 shows Ariko Iso, who obtained specialized training and education to become an athletic trainer, a very non-stereotypical job for a female. In Fig. 119, a young woman smiles as she chops angiosperms—what most of us would call salad ingredients. The inclusion of a young woman in a nontraditional career (athletic trainer) is commendable, as is the lack of fuss about the fact that she is a woman in a traditionally male career (see Fig. 120 for another example).

However, the reader may wonder why angiosperms needed to be depicted as part of a salad being prepared by a female, rather than simply photographed in the salad, or even on their own.

Fig. 120. A female biologist depicted in a nontraditional job.
Generic “humans”:

Many of the studies that have investigated gender bias in textbooks have concentrated on the tendency to use the generic masculine in references to humankind, except where reference to a female was explicitly needed. In the present study, I was able to distinguish instances in which the visual equivalent of “generic male bias” frequently appears. For the purposes of this study, I considered “generic” any instance in which the system being diagrammed or analyzed was roughly equivalent in both sexes, and thus, either a male or female could have been chosen for the visual representation.

The 2005 edition of this textbook contained 32 instances of generic humans, 19 of which were female and 13 male. Figures 121 and 122 are examples of the treatment of generic human beings. Figure 121 depicts generic humans as, for example, two whites, one of whom is female; the rest are of other races and are both male and female. In addition, one of the girls is depicted as performing a martial arts-type movement (going against gender type to an extent) to illustrate the muscular system.
Unlike the generic humans depicted in some other life science textbooks (including the two analyzed in this project) as cartoons or line drawings, many of the generic humans featured in the Prentice Hall are photographs of actual children, with drawings of the organ system (or other body element being studied) superimposed over the photograph (see Fig. 122). The subjects are clearly children of about the same ages as the intended audience and represent many different races, as well as both genders. Although children can, and do, identify with cartoons as role models, they are more likely to identify with people who resemble themselves (Anderson & Cavallaro, 2002).
Discussion

Based on the preceding data, this section considers and interprets the results of the findings above to better tell the “story” of gender and representation in the Prentice Hall Life Science 2005 textbook.

Visual enthymemes.

As I did previously with both the Glencoe and McDougal Littell Life Science texts, I now examine how images argue through visual enthymeme. In general, my analysis of visual enthymemes in this textbook finds that women can do highly technical jobs such as medical dictors, but that they tend to work with other women, whereas men work alone. Also, men still tend to be pictured as doing the highly physical jobs. Finally, I found that girls tend to wait on boys to perform active tasks. Following are several representative examples.
Fig. 123. Forestry vs. health care professions.

In Fig. 123, I include two photographs, because the arguments they make are most interesting when their proximity and context are considered along with the visual data in each photograph. Tables 46 and 47 illustrate the possible enthymemes in each photo; Table 48 attempts to reconstruct the enthymeme created by the composition of the photos in relationship to one another on the textbook page.
Table 46. Visual enthymeme from forestry professions.

<table>
<thead>
<tr>
<th>Observation:</th>
<th>White male works outdoors as forestry technician. He wears a hard hat and orange safety vest. He works alone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed premise:</td>
<td>Men are interested in work as forestry experts.</td>
</tr>
<tr>
<td>Inference 1:</td>
<td>If you are male, you may enjoy this type of work.</td>
</tr>
<tr>
<td>Inference 2:</td>
<td>Forestry work is dangerous (hard hat and safety vest) and takes place outdoors.</td>
</tr>
<tr>
<td>Inference 3:</td>
<td>If you are female, you may not be interested in this type of work (perhaps because it is dangerous and takes place outdoors).</td>
</tr>
<tr>
<td>Inference 4:</td>
<td>If you are a male forestry technician, you can work alone; you do not need assistance to do your job.</td>
</tr>
</tbody>
</table>
Table 47. Visual enthymeme from health care professions.

| Observation: | A female doctor is pointing something out to a female nurse. The doctor is dressed in a lab coat and wears a stethoscope and badge. The nurse seems to be dressed more casually. The doctor is white, whereas the nurse is African American. The doctor stands in front of the nurse and has the nurse look over her shoulder. |
| Assumed premise: | Women can work as doctors or nurses. |
| Inference 1: | If you are female, you may enjoy working in the health professions, either as a doctor or nurse. |
| Inference 2: | If you are male, you may not enjoy working in the health professions (though we know from experience that the majority of doctors are male, so this inference is somewhat unlikely). |
| Inference 3: | If you are African American and female, you probably will be a nurse and not a doctor. |
| Inference 4: | Doctors are more important than nurses: they have to wear badges, lab coats, and pocket protectors, and they give instructions to nurses. |
Table 48. Visual enthymeme of the page layout.

| Observation: | A picture of a white male outdoor worker is situated above and to the left of a picture of two female health care workers. The way their bodies are placed, the male is facing down and to the left (toward the spine of the book), and the women are facing down and just slightly to the right (toward the page margin)—this creates a visual separation between them, so that even though they are in the same area of the page, they appear utterly separate. |
| Assumed premise: | Elements pictured on the left are presented as Given, whereas elements on the right are presented as New (Kress & Van Leeuwen, 1996, p. 187). |
| Inference 1: | It is a given that men do outdoor jobs such as forestry. |
| Inference 2: | It is new that women do jobs in health care (especially as doctors). |
| Inference 3: | Men work alone; women have to work in pairs or groups. |
| Inference 4: | Compared to men, women do indoor jobs that are less dangerous and physically strenuous. |

The arguments in these two photos are compelling considered separately: One image allows that women can be doctors but in conjunction with nursing and reading; the other associates men with outdoors and activity. When the images are considered together, however, the arguments are even more powerful. A gender-conscious viewer might be tempted to commend the photo editor for choosing an image of a female doctor (going
against type); however, situating her and the female nurse directly opposite a male in a very traditional (outdoor, dangerous) occupation draws attention to the fact that the health care workers are female, indoors, not wearing hard hats, and dependent upon one another to accomplish their tasks. They also read and converse, traditionally female gender roles according to Western endoxa. Even the caption text draws attention to their interdependence: “The doctor and nurse are discussing their notes.” The forestry technician photo caption makes no reference to such dependence on others; the tasks listed as part of his job seem to be tasks that can be accomplished by one person.

Here is another example.

Fig. 124. Girls watch boy taking notes.
In Fig. 124, three children take part in an experiment with aquariums at three different temperatures. The two girls appear to have already finished their data collection and are watching as the boy does his. Table 49 elucidates the possible enthymeme.

**Table 49. Visual enthymeme from Fig. 124.**

| Observation: | Three children are doing an experiment. The girls are both passively watching the boy. The boy is actively writing down data. The girls and the boy are all smiling. They are wearing plain T-shirts in basic colors. A girl and a boy are dark skinned; the other girl is white. |
| Assumed premise: | Boys and girls do lab experiments in science class. These experiments may involve aquariums and note taking. |
| Inference 1: | Girls are passive participants. Boys are active participants. |
| Inference 2: | Girls get their work done faster than boys. |
| Inference 3: | Girls wait for boys to start experiments; then, they follow. (Maybe they need to see how he is doing it.) |
| Inference 4: | This experiment is so fun that the participants are all smiling. |

The inferences I suggest from this visual enthymeme are noteworthy, particularly because they are not necessarily compatible with one another (see previous chapter). One stereotype about girl students is that they work faster and perform better than boys, who are more likely to fool around or work slowly. On the other hand, middle school is the
time when many girls drift away from science, giving as excuses “it’s too hard” or “I
don’t like experiments” or “the boys are bossy/loud/disruptive/sexist in class.” (These are
generalized statements from many different sources, including Sadker & Sadker [1994],
for example.) The enthymeme presented by this picture (or any image) probably depends
on the viewer’s experience: a girl who is a good student and loves science may infer #2
or #4, whereas a girl who struggles with science or is intimidated by the boys (or the
teacher) may infer #1 or #3. As described in Chapter 4, the explicit message may be
progressive, but the elements supporting it may, ironically, undermine that argument.
Fig. 125. Boy and girl perform statistical experiment.

Figure 125, a boy and girl performing an experiment that deals with statistics in genetics, has even more to say about the relationships of girls and boys in the lab than the previous photo. Table 50 spells out the enthymeme.
Table 50. Visual enthymeme from Fig. 125.

| Observation: | A white boy, standing, pulls an item from a paper bag. A white girl, seated, looks at the item, smiling, and writes something down on a notepad. Both wear plain, unmodulated-color shirts. |
| Assumed premise: | Boys perform experiments, while girls assist by taking notes. |
| Inference 1: | If you are a girl, then you will probably take notes for a boy. |
| Inference 2: | If you are a boy, then you will perform experimental tasks (perhaps while standing up). |
| Inference 3: | If you are a girl, you will be very happy about performing secretarial tasks for boys. |
| Inference 4: | If you are a girl, you probably need to sit down while performing secretarial tasks. |

Clearly, boys do the work, whereas women help with the supporting activities. Perhaps most provocative in this photo is the fact that the boy is standing. Why? It may be easier for him to reach into the bags from a standing position, but it seems unlikely that the average kid would want to stand for the duration of a lab experiment; indeed, some teachers might not allow students to be out of their seats. Visually, the boy towers over the girl here, which puts her in a position of diminished power (she has to look up to meet his gaze) (Kress & Van Leeuwen, 1996, pp. 146–147).
Another noteworthy element is the facial expressions of the subjects. The boy smiles slightly, with his top teeth showing, suggesting a posed expression; whereas the girl’s mouth is open in a full smile that engages her cheeks, suggesting amusement, as though something about the item the boy is holding is quite funny. The girl’s reaction conveys the message that taking notes while boys perform activities is great fun—even though such tasks can be utter drudgery, particularly for intelligent students.
Fig. 126. Boy performs experiment as girl watches.

Fig. 126 features a boy and girl performing an experiment using bottles, a balloon, and some straws. In this photo, the table is shot at one end, rather than head on (as in the other photos), probably to ensure that the boy’s wheelchair is visible—after all, being inclusive comes to nothing if no one knows the editors are going out of their way to do it. This wheelchair is less visible, and the male more active, than the comparable subject in
the image in Chapter 4 (of the girl in a prominently featured wheelchair, with her fist clenched, sitting passively). Table 51 describes the possible enthymeme.

**Table 51. Visual enthymeme from Fig. 126.**

<table>
<thead>
<tr>
<th>Assumed premise:</th>
<th>Boys and girls can perform experiments together. These experiments are fun. They may require protective gear.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation:</td>
<td>White girl and African American boy perform an experiment. The boy is actively adding some substance to a bottle, as the girl passively watches. Both wear safety goggles, and both are smiling as they watch what the boy is doing. The boy is in a wheelchair.</td>
</tr>
<tr>
<td>Inference 1:</td>
<td>If you are a girl, you will wait while boys perform activities.</td>
</tr>
<tr>
<td>Inference 2:</td>
<td>If you are a child with disabilities, you can perform experiments in class.</td>
</tr>
<tr>
<td>Inference 3:</td>
<td>If you are a girl, it is not safe for you to perform dangerous experiments; therefore, you should watch while boys do the dangerous parts.</td>
</tr>
</tbody>
</table>

Compared with the image in the previous chapter, disability is less disabling.

Undercutting that “fact” is the situation here—the disabled boy is depicted as more active than the disabled girl in the previous chapter.

Here is one final example:
Fig. 127. The scientific method.

Fig. 127 illustrates the process of scientific research and communication, from coming up with a research question to sharing the results. Using visual elements of organization, the arrows help to illustrate how all stages of the scientific process lead to the posing of additional questions and formation of additional hypotheses, which then need to be tested. Table 52 describes the enthymeme in this image.
Table 52. Visual enthymeme from Fig. 127.

| Observation: | A boy wonders about something, forms a hypothesis, and draws conclusions. Girls participate in experiments (they are looking off to their left at a boy, who is actively doing the experiment—same as Fig. 110 but cropped), collect and interpret data, and communicate conclusions. |
| Assumed premise: | Boys come up with the scientific ideas; girls do the work to help Fig. out the answers. |
| Inference 1: | If you are a boy, you can ask scientific questions, form hypotheses, design experiments, and draw conclusions—in other words, you can do science. |
| Inference 2: | If you are a girl, you can help out with experiments, collect and interpret data, and give presentations about the results—in other words, you can be a lab assistant, technician, or science writer. |

Although it is clear the photo editor has tried very hard to represent both genders (four female appearances versus three male) and at least two races, it is unfortunate that the editor has not given much thought to the roles each subject plays in this process of scientific research. In this graphic, a boy does all the hard scientific thinking: he comes up with a research question while (evidently) lounging on the floor; he forms a hypothesis; he designs the experiments (we know this because we have seen this picture
before, and the boy, the active participant, has been cropped out of this version); and he
draws the conclusions. Girls, on the other hand, sit quietly by while the experiment goes
on; collect and interpret data (which one does not need to be a scientist to do); and
present the results in some form.

Summary
The Prentice Hall 2005 text, to a similar degree as the McDougal Littell 2005, visually
argues with rather mixed messages: Whereas women and girls appear quite often in the
visuals and sometimes even in nontraditional gender roles, they are likely to be cast in
passive or supporting roles, suggesting a lack of power. Thus, although science is no
longer strictly the domain of white males, males are still more likely than females to be in
charge of the proceedings in some way, whether by coming up with the ideas or by
working so slowly that the girls have to wait on them to finish. Females, on the other
hand, are more likely to perform superficial supportive or communicative tasks—the
scientific equivalent of, say, a secretarial role.

By no means am I suggesting that all photos in textbooks must work against
gender stereotype; rather, I am expressing hope that where possible, photo editors may
become aware of such visual arguments and work harder to present examples that reflect
not only the reality but also the ideal. For instance, the forestry worker in Fig. 123 could
have been a female; the nurse could have been a male (of any race, really). If children
are to imagine themselves in careers as forestry technicians, doctors, nurses, scientists, and so on, they need to see role models that resemble themselves.

Likewise, I am not suggesting that the enthymemes I have constructed from these examples are the only possible interpretations; rather, I submit that these are some interpretations young viewers may infer from the images in their textbooks, based on our cultural endoxa, and further, that some of these interpretations could be quite detrimental to children’s ability to identify with role models at a time in their young lives when they are unusually susceptible to outside influences.

In Chapter 6, I integrate the data from all three cases and analyze them in an effort to help determine what arguments are made about gender and science in the photographs and images included in life science textbooks from three of the biggest textbook publishers. I examine the representation of the naturalistic enthymeme in all three textbooks, and suggest what it means for readers of these texts. I discuss role models for middle school children: adults vs. other children, and same-gender vs. opposite-gender. Finally, I suggest some ways future editions of these texts can improve their representation of gendered people and point out avenues for further research in this area.
Chapter 6: Conclusions and Future Research

Summary
As stated in the opening chapter, the purposes of this study were twofold: to add to the expanding theories of visual rhetoric by applying the visual analysis method of Kress and Van Leeuwen (1996) to images from 7th grade life science books; and to apply rhetorical analysis (enthymemes and repetition) to these same images to look for visual arguments.

Research questions and hypothesis.
The following research questions emerged from my review of the existing scholarship:

1. How are gender roles presented in the photographs in science textbooks?
2. How do science textbooks present the occupational roles and activities of gender roles in these texts?

I developed the following hypothesis about gender representation in middle school science textbooks:

H₁: While girls and boys are photographically represented fairly equally in number in science texts published within the past decade, girls are still being represented in less-powerful and/or less-important roles than boys.
Conclusions

I now review the conclusions of the study as they relate to the research questions originally posed. Generally, $H_1$ was strongly supported by the data. First, I summarize the findings of the analysis of visuals and people to determine whether the naturalistic enthymeme was supported. Then, I summarize the visual arguments made by the three textbooks.

Naturalistic enthymeme.

Based upon Cara Finnegan’s (2001) notion of the naturalistic enthymeme supplemented by the theories of Kress & Van Leeuwen (1996) and Jeanne Fahnestock (1999), I developed a way of analyzing visual enthymeme. Accordingly, I first analyzed all 600 images to see whether they fall into the range of what Kress & Van Leeuwen (1996) consider naturalistic; I then performed rhetorical analysis on many of the visuals found in these three textbooks. Analyzing all the images using the “grammar of visual design” Kress & Van Leeuwen (1996) spell out, I found that the McDougal Littell images were the most naturalistic. I found that, generally, the elements are naturalistic; when they are abstract, they may acquire a cultural naturalism based on their use of advertising patterns. I then performed the rhetorical analysis that uncovered ways in which images in these textbooks argue that are not necessarily positive for girls and young women looking for role models in sciences.
More specifically, the categories in which the textbook images scored highest naturalism were brightness, color saturation, vertical angle, and color modulation. These results are not surprising; in all four of these categories, the most “photo-realistic” results were fairly straightforward. For instance, a naturalistic photograph generally contains a fairly high amount of saturation (but not too high), a fairly high brightness level (but not too bright), middle vertical angle, and well-modulated color (but not overly so). One could argue that these categories contain less of a “grey area” for interpretation than many of the others.

In contrast, the categories with more of that grey area for interpretation were also the categories in which the numbers of naturalistic photos were somewhat lower. These categories included coding orientation, illumination, depth, representation of detail, contextualization, and color differentiation. For the most part, the naturalism was strongly supported in all categories in all three books, with these exceptions (Table 53):
As indicated, these categories acquire naturalism because they conform to cultural norms of the visual endoxa of advertising. Clearly, even the Prentice Hall, which appeared to contain the least naturalistic images, still managed to be mostly in the naturalistic range.

Thus, these results seem to support my argument that the majority of photos in science books would be seen as naturalistic or photo-realistic and thus accepted as evidence of their realism.

Case studies of three major life science textbooks revealed that girls and boys are represented fairly equally in photos and images, but that adult men and women are not. And in cases of both youths and adults, males are generally pictured in more active roles than females and rarely break stereotype; females are generally pictured in support roles, although they do sometimes break stereotype. Finally, generic humans are portrayed
differently depending on the text: in one, they were almost always depicted as white males; in another, they were depicted more evenly; and in the third, generic children favored females, but generic adults favored males. I now explain these findings further.

**Male roles and female roles.**

In all three texts, males were more likely to be depicted in active roles. These roles included depictions of workplace, family life, and experimental situations. In situations portraying both genders, males were much more likely than females to be performing an activity, such as filling a beaker or measuring an object. Males were pictured doing traditionally male jobs, such as working outdoors, lifting heavy objects, getting dirty, and of course, doing science. They were much more likely to be pictured in jobs that required advanced education. When shown in family situations, they were much more likely to be the recipients of service than the providers of it.

Females, on the other hand, were depicted somewhat unevenly. Many were shown in traditionally female roles, such as parenting, teaching, helping, and supporting (e.g., lab assistant, secretary, nurse, elementary school teacher). When they were depicted in roles requiring advanced education, they were often shown working with other women, or with children, rather than as equals to men (let alone in supervisory roles over men). They did appear in nontraditional roles on occasion, but too often, these appearances were given great fanfare (set apart in sidebars, plastered across two pages, or
otherwise drawn attention to) that seemed to argue, “Remember, women never used to do these sorts of things. This is still unique.” Or—perhaps worse—“Look what a good job our editors did of making sure women in science were represented in our textbook.”

Perhaps most puzzling, women and girls are almost always pictured as smiling, even when they are passively watching males doing all the fun stuff.

One surprising finding was the extent to which image captions may work with (or, indeed, against) an image’s visual enthymeme to argue. In several instances, I noted relatively neutral images which, with neutral captions, could have made very simple, unbiased arguments (for example: “Marie Curie” or “This is Charles Darwin at age 20”). Pozzer & Roth (2003) refer to photos without captions or with identifying captions as “supplementary” and assert that the picture itself is unnecessary; “it is a supplement to the text, adding details or specificity, or illustration of it” (p. 1110). Citing Derrida (e.g., 1981), however, they add that “a supplement is part of and not part of the text at the same time: It seems to be adding something to what is complete in itself, and the addition is thus implicitly a correction, sometimes to the point of recantation” (p. 1110). With the addition of biased caption text, an image of Marie Curie appears to be less a “supplement to the text” than a reminder to readers that Curie did not even come up with her own ideas—practically a recantation of her importance in the body of the chapter. With the addition of caption information, a photo identifying Charles Darwin at 20 may argue that
he was amazing and noteworthy even at that tender age (at which point he was already balding, going by the image). In one image of a NOAA scientist, readers see a woman doing science in the field; however, when they read the caption, they are told she was the first woman to do this job, and that she got the job only in 1990. This caption draws attention to the fact that she is unusual and away from the potential argument the picture could make, which is, simply, “Here is a woman doing science, and this is a perfectly normal, common occurrence in your world.”

In all, these three textbooks seem to make an effort to offer women equal representation, but they ultimately fail by perpetuating several stereotypes:

- Males are the norm, females are other
- Males do science, females take notes
- Males become Ph.Ds. and become book editors, females get lesser degrees and become teachers and book reviewers
- Males do dirty jobs, females do clean jobs
- Males are active, females are passive
- Males are doers, females are caregivers
- Science is objective
- Females are scarce in STEM (but is it a stereotype if it is also true?)
Generic humans.

The generic human form depicted in the McDougal Littell and Glencoe texts tended to be a cartoon or line drawing; however, the Prentice Hall featured many photographs of actual children, with drawings of the organ system (or other body element being studied) superimposed over the photograph. As discussed in Chapter 5, these tended to be children representing the same ages, races, and genders as readers in the intended audience. Anderson & Cavallaro (2002) point out that children are more likely to identify with people who resemble them; therefore, readers may find the Prentice Hall text easier to identify with than the other two. Then again, as stated previously, children are also more likely to see adults as role models than other children. The McDougal Littell and Glencoe texts were more likely to feature abstract generic humans, and the Glencoe, in particular, seemed to favor white males, except in cases in which the system being scrutinized was strictly female, such as the reproductive system. It is disappointing to note that, in so many images, the argument still seems to be that male is the norm, and female is something other. It is already well documented that this acceptance of the male-as-norm endoxa leads to poor scientific and medical research; as Jennifer Wider, M.D., of the Society for Women’s Health Research, puts it,

Despite the 1986 policy announcement by the NIH to include women in clinical research, little was done to enforce it. By and large, women
continued to be excluded from medical research studies. Things didn't really begin to change until 1990, when the federal GAO (Government Accountability Office) issued a report evaluating and criticizing the implementation and effectiveness of the 1986 NIH policy. (Wider, 2007, p. 1)

Medical science is just beginning to make up for the time lost in the assumption that women are just men with uteruses; “NIH-supported studies have expanded our knowledge about areas such as lung cancer, colon cancer, and cardiovascular disease—areas where scientists once thought women were not largely affected” (Wider, 2007, p. 1). For instance, it was not until fairly recently that scientists discovered women have a different set of heart attack symptoms from those of men, leading to women’s heart disease being misdiagnosed or ignored and treated as “hysterical” or “emotional.” My own mother, diagnosed in 2000 with asthma after chest pressure and tightness, died of a massive heart attack in

Fig. 128. Symptoms of heart attack. From clevelandclinic.org
2001. Her doctor may have missed the symptoms because he was looking for the ones men usually have: shooting pain up the left arm, for instance.

In the screen shot (Fig. 128) from the Cleveland Clinic Web site (2012), the male-as-norm, female-as-other assumption is fully on display, in both the text and the image. The list of symptoms evidently assumes the patient is male; immediately following the Symptoms section is a separate one, labeled, “Women’s symptoms sometimes differ” (there is even a separate hyperlink to “learn more about women and heart attack”—the Web equivalent of setting women off in a sidebar, as the textbooks analyzed in this project so often do). The graphic, although bathed in a shade of pink that jumps out visually from the page, is clearly of a male and features the heart in the place it generally appears in the male chest: slightly to the left of the breastbone. The entire page is constructed around the positivistic scientific notion of medicine as all-knowing, male, logical, rational. The status quo is thus perpetuated not only in textbooks but also in resources for patients.

Why divert attention from the current project to discuss a Web page about heart attacks? It seems to me that if the textbooks we expect our children to learn science from are still treating males as the normal or preferred gender of our species, then we cannot expect much better than what we see on the Cleveland Clinic sample in the near future, when our children grow up to be scientists. After all, they have been brought up with the
same endoxa about science and gender that produced the stereotyping evident in the above example.

I now discuss these findings as they compare to those reviewed in Chapter 1.

Comparison to literature review.

The findings of the present study seem to confirm those of related studies previously conducted on textbooks and in particular on science textbooks. Below, I enumerate some of the findings from the literature review that are corroborated by the present study.

First, the two studies by Whiteley (1996a and 1996b) that found males, particularly as adults, outnumbered females in science books are corroborated by my findings. Overall, girls and boys were fairly equally represented in all three texts; however, men tended to outnumber women.

Elgar’s (2004) finding that photos of women in textbooks in Brunei did not reflect the career opportunities currently open to them, instead picturing them in traditional roles and favoring males in both number and career choices, is also corroborated by the present study. Children reading any of the three textbooks analyzed for this project would see more men in roles requiring advanced education and more women in roles requiring less or no education, such as family care or secretarial roles. Girls, too, were more likely than boys to be featured taking notes than performing actual experimental tasks.
Gilbert and Calvert (2003) constructed a syllogism that is essentially reproduced in my findings (Table 54):

**Table 54.**

<table>
<thead>
<tr>
<th><strong>Major premise:</strong></th>
<th>Science (objective and positivist) is masculine.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minor premise:</strong></td>
<td>Masculine is the opposite of feminine.</td>
</tr>
<tr>
<td><strong>Conclusion 1:</strong></td>
<td>Science is the opposite of feminine.</td>
</tr>
<tr>
<td><strong>Conclusion 2:</strong></td>
<td>For girls to succeed in science, they need to become more like boys.</td>
</tr>
</tbody>
</table>

This argument was also the finding of Kelly (1985), who further argued that positivist science would benefit greatly from some of the traits we consider stereotypically feminine, such as working together for the betterment of all. The results of the present study support the notion of science as objective, and the prevalence of men doing science in these textbooks supports the notion that science is masculine.

In two projects on the inequity of science for girls, Sadker and Sadker (1994) and Sadker, Sadker, and Zittleman (2009) enumerate the ways in which science in general is unfair to females in the classroom through teacher bias, classroom sexism, and textbook bias. In textbooks, they argue (2009), boys are the “movers and shakers of history” who are “active, creative, brave, athletic, achieving, and curious”; whereas girls are
“dependent, passive, fearful, docile, and even […] victims, with a limited role in or impact on the world” (pp. 88–89). These findings are almost to the letter substantiated by the present study: I found males invisible in nontraditional roles; gender role stereotyping; imbalance and selectivity (for instance, the caption that diminished Marie Curie’s pioneering work); fragmentation (the sidebar or otherwise set-apart placement of stories of women); and superficial equity (boys and girls equal in number, but not in roles of importance).

Textbooks, too, appear to have made only limited progress toward gender equity. As Sadker, Sadker, and Zittleman (2009) state, females are appearing more frequently in textbooks, and they are being depicted with a wider range of career options and personal traits. However, male names and experiences still dominate:

Men are seen as the movers and shakers of history, scientists of achievement, and the political leaders. Boys are routinely shown as active, creative, brave, athletic, achieving, and curious. In striking contrast, girls are often portrayed as dependent, passive, fearful, docile, and even as victims, with a limited role in or impact on the world. (pp. 88–89)

Does it matter, though? Do these images in textbooks really affect the way children see themselves? Yes, say the authors: “Gender stereotypes and the lack of female characters contribute negatively to children’s development, limit their career aspirations, frame their attitudes about their future roles as parents, and even influence personality
characteristics” (p. 92). In short, seeing girls depicted in such limited roles and with such limited range contributes to girls’ feeling less worthy than boys.

The authors cite several ways in which subtle gender bias still exists in textbooks, in spite of recent reforms. An example of each follows in parentheses:

- Invisibility (little to no visible examples of females; no visual examples of males in traditional female roles)
- Stereotyping (all females depicted in family roles)
- Imbalance and selectivity (describing women as having been “given” the vote, as though they did not work for it)
- Unreality (romantic notions of the nuclear family that many students cannot relate to)
- Fragmentation (setting off women’s stories in sidebar text, for instance, as though women are somehow out of the mainstream of humanity)
- Linguistic bias (generic masculine pronouns to refer to all of humankind)
- Superficial equity (equal numbers of girls and boys in photos, but the girls are all performing “secretarial” tasks, while the boys are actively doing experiments)

In sum, earlier and concurrent findings of sexism in textbooks, and especially in science books, are overwhelmingly substantiated by the present study.
Implications

I see two major implications of the results of the present project. First, the results support the arguments in favor of visual rhetoric, the notion that visuals can argue alone and with accompanying text such as captions, through visual enthymemes. Second, the research method—analyzing visual categories such as color saturation, vertical and horizontal angles, and so on—appears to provide a plethora of rich data about images. This project was constructed within the framework of Finnegan’s (2001) naturalistic enthymeme, Fahnestock’s (1999) visual ploche and polyptoton, and Kress & Van Leeuwen’s (1996) grammar of visual design, which have established themselves as key theories for the understanding of gender bias in images.

One caveat: As time goes on, the norms upon which the naturalistic enthymeme is based in Western culture will undoubtedly shift, as film disappears and digital manipulation becomes the norm; as the endoxa shift, so viewers may become more critical. Trust in the indexicality of the photograph may decline or even vanish completely as fewer and fewer people print their photographs on paper. On the other hand, perhaps our Western notions of “reality” will gradually change as our world becomes more computer generated and less about things we can touch or relate to actual
events—in other words, virtual interactions may *become* actual events. In this entirely possible future, a photograph of “reality” may mean something entirely different from what it means to us now.

In this project, I have shown that it is not enough simply to demonstrate that photographs are naturalistic; to show that they make arguments, they must be analyzed rhetorically. Through a combination of visual analysis using Kress & Van Leeuwen’s theory and rhetorical analysis of the visual repetition, I have established a method for evaluating the persuasive potential of photographs and gendered images.

In addition to the theoretical implications of the present study, some practical implications emerge. Perhaps most notably, the results suggest that bias lurks even where superficial equity exists; thus, if bias can be shown to exist in a textbook, then it likely occurs in other resources to which our children have access, such as television shows, the Internet, advertising, video games, and so on. Indeed, many other studies (too many to cite here) have already shown this to be the case.

It seems to me that academic research on bias is of little use if we as researchers are not able to put our methods into an accessible format, so that the general public can use them to uncover bias in day-to-day life. For instance, what good is this dissertation to

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22 I believe we will know this has happened when even the theorists stop referring to computer-mediated interaction as “virtual reality.” For many children and young people, the distinction may already have ceased to exist.
the parents of a 12-year-old girl who loves science but is being drawn away from it by various societal and cultural pressures? How can this research “trickle down” to that girl’s parents, her science teacher, that teacher’s curriculum director, the publisher’s rep who sells the curriculum director the textbook, the legislators who push for statewide science standards, and so on? We as researchers must find ways to let parents and educators know what role models their sons and daughters are being shown in school, and what they can do to improve the outlook. This is perhaps the most salient implication of the present study.

**Limitations**

One of the major ironies of a social science approach to bias in science is the embracing of scientific method as a way of understanding what is an inherently biased discipline. In other words, to understand the bias in positivism, I must study it using somewhat positivistic methods. Those whose work depends upon that positivistic worldview would likely not, however, treat this project with much seriousness if it did not “play the game by their rules”—basically, if I want to discover the holes in the ship, I have to be *on* the ship. I fear that little respect is afforded those who attempt to patch the holes from a comfortable position on the dock. Below, I briefly discuss what may be viewed as limitations in the traditional, positivistic view of research.
Sample.

The project sampled three textbooks from three different publishers. Whereas these were popular and commonly used textbooks, they are not the only texts available, and they are likely no longer in use as of the completion of the present study. Future studies should focus on newer editions and perhaps larger samples of images.

Methodology.

This study is, to my knowledge, one of the first (if not the first) to use Kress & Van Leeuwen’s (1996) “grammar of visual design” to analyze a large sample of images in an effort to verify the presence of naturalism. Whereas I believe the theory has proved extremely useful, it may need to appear in several future projects of similar size before it will be accepted as useful for this type of analysis. Likewise, the combination of this method of analysis with the rhetorical analysis of visual repetition is new; future application of the combined method promises to yield rich data, both quantitative and qualitative.

Another limitation is that sometimes, a certain amount of “imagination” was needed when coding a photograph in certain categories. Modulation, for example, is difficult to discern in photographs printed in textbooks due to the limited inks and the type of paper used. If textbooks were printed on expensive photo paper using the same
top-quality inks that professional studios and photographers use to showcase their best work, I suppose some of the “grey areas” in coding could be mitigated.

**Generalizability.**

Obviously, a study of about 600 images from three textbooks is not what most positivist science would consider generalizable. However, I did not design this project with the hope of generalizing the results; rather, I hoped to collect rich detail from three case studies in an effort to tell a story about those cases. Rather than generalizing my results to the entire cohort of science textbooks for seventh grade or beyond, I hope that these findings will encourage others to take up similar visual analysis to help root out bias.

**Recommendations for Future Research**

As mentioned above, I attempted this project in hopes that others would see the usefulness of visual analysis of photographs and images in textbooks. My particular interest is in STEM careers and uncovering inherent biases that may contribute to girls’ lack of interest in following their science dreams; however, I believe this combined method of analysis may be useful for many other types of textbooks, as well as other books and media.

Because the present study examined just three texts, I believe future research should focus on the most recent editions of these books, as well as on textbooks by other
publishers. I would also like to see research focus longitudinally on a single publisher, to find out in what ways the representation of gender may have changed over time. To that end, I also performed the same analysis on the 1988 edition of the Prentice Hall text. I plan to detail these findings in a future project.

Of course, research can, and should, look beyond just textbooks. As indicated in Chapter 1, the reasons girls turn away from science are manifold and complex; not having positive role models in textbooks is only one piece of this puzzle. Other pieces include cultural influences and pressures, teacher bias, peer pressure, parental pressure, advertising, and many others. As mentioned in Chapter 1, my research (Wells, 2009) suggests that high school girls believe women have achieved parity in STEM, at the same time their personal anecdotes tell a much different story (I am reminded of the male teacher who tells female students to go home and bake pies, with the excuse that this is the only way he can get them to talk in class). I also used Kress & Van Leeuwen (1996) in research on television advertising (2010): a visual analysis of the Swiffer and Pledge advertising campaigns of 2009–10 revealed bias reminiscent of that cited by Rossi (1965), the results of which are detailed in Chapter 1. These ad campaigns feature women in “marital” relationships with their cleaning implements (Swiffer) and mothers trapped in glass boxes that a British man orders them to clean completely before they will be allowed out (Pledge, by S.C. Johnson Wax, “A Family Company”). As of this
writing, neither company’s advertisements have featured a male using the cleaning product.

With advertising images continually arguing that women are responsible for all the work at home and for keeping their children safe from germs and well fed with nutritious food (choosy moms choose Jif, after all), it is not difficult to see why young women, believing that STEM careers may be too demanding to balance with marriage and motherhood, give up on these lucrative careers in favor of jobs that they can schedule around family demands—or they choose not to work at all. I argue that no girl or young woman should be forced to choose, against her desires, to pursue a lesser career than she is capable of doing. Further, I argue that many girls and young women may never develop high expectations of themselves because of the dearth of role models available to them. Finally, I argue that for girls to see STEM careers as viable, we may need visuals to depict not just the reality, but the ideal: women and men working side by side, doing science.

One area in which research is desperately needed is the rhetorical choices made by photographers and photo editors. I argue that the composition of a photograph is a rhetorical choice made by the photographer, whether he or she is conscious of this choice or not; and I further argue that photo editors make rhetorical choices when they choose stock or custom images for inclusion in textbooks—again, whether they realize it or not.
I believe that research should identify these rhetorical choices and make clear to photographers and editors that their selections are anything but neutral.

We also need to know more about how children perceive photographs. The research cited in previous chapters focused mainly on younger children, but is not extensive; we know little about the way older children, particularly in the middle school years, interpret photographic images.

Future research, therefore, should focus less on empirically easy research questions, such as, “Are we representing boys and girls in STEM in equal numbers?” and more on the complex questions surrounding what it means to represent the genders equitably. These studies may take numerous forms, and should include visual analysis, owing to the importance of images in formulating children’s understanding of their world. Case studies of what works, in addition to what does not, should be undertaken: we need to know which girls do succeed in STEM and why. What accounts for their success? Do they succeed because of certain aspects or qualities, or in spite of them? Also, more research needs to be done on the importance of role models. Although it has previously been assumed that female role models are extremely important to girls’ success in STEM, current research suggests that gender of the role model may be less important than whether the role models embody current STEM stereotypes (Cheryan, Siy, Vichayapai, Drury, & Kim, 2011).
Clearly, the question of why so few women pursue STEM careers cannot be answered quickly or easily; it will require the work of researchers in several different fields using a variety of different methods. Making STEM attractive to girls and women will undoubtedly require our Western culture to change more than just our image of science, technology, engineering, and mathematics: we will need to change our attitudes about men and women. Such a change in our culture will benefit all; thus, research to address the gender disparity in STEM should go far beyond the confines of feminist critical studies and of the sciences.


http://www.dailyprincetonian.com/2005/01/31/11842/


http://www.britannica.com/EBchecked/topic/1688997/human-eye


National Science Foundation:


http://www.princetonol.com/groups/iad/lessons/middle/color2.htm


http://www.stanford.edu/class/linguist34/Unit_15/perspective.htm


The Cleveland Clinic. (2012). *Symptoms of heart attack*. Retrieved August 3, 2012, from Cleveland Clinic:

http://my.clevelandclinic.org/heart/disorders/cad/mi_symptoms.aspx


Washington, DC.


http://www.womenshealthresearch.org/site/News2?page=NewsArticle&id=6547
## APPENDIX A

Research Instrument

<table>
<thead>
<tr>
<th>PEOPLE CATEGORY</th>
<th>Uniform/Clothing</th>
<th>Vectors/Interactions</th>
<th>Age (Adult or Youth)/Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (M/F/Undetermined)</td>
<td>Wearing uniform of a particular science field:</td>
<td>□ No eye contact, or only one subject</td>
<td>Number of adults:</td>
</tr>
<tr>
<td></td>
<td>Males: ___ Females: ___ Undetermined gender: ___</td>
<td>□ Male subject(s) looking at female subject</td>
<td>Adult males:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Female subject(s) looking at female subject</td>
<td>Adult females:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Male subject(s) looking at male subject</td>
<td>Adult undetermined:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Female subject(s) looking at male subject</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Subjects looking at one another</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Subject(s) looking at object or task (all above are offer gaze)</td>
<td>___</td>
</tr>
<tr>
<td>Number of males: ___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of females: ___</td>
<td>Wearing street clothing:</td>
<td>□ Male subject(s) looking at viewer</td>
<td>Number of youths:</td>
</tr>
<tr>
<td></td>
<td>Males: ___ Females: ___ Undetermined gender: ___</td>
<td>□ Female subject(s) looking at viewer</td>
<td>Youth females:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Male and female subjects looking at viewer</td>
<td>Youth males:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(all above are demand gaze)</td>
<td>Youth undetermined:</td>
</tr>
<tr>
<td>Number of people of undetermined gender: ___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number undetermined:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undetermined-age males: ___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undetermined-age females: ___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undetermined age/gender: ___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VISUALS CATEGORY</td>
<td>Objects/Artifacts</td>
<td>Colors</td>
<td>Contextualization</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------</td>
<td>--------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>Number of science objects or artifacts being used:</td>
<td>□ Low</td>
<td>□ No background</td>
</tr>
<tr>
<td></td>
<td>What is the object? (List object(s) in photo, such as “microscope”)</td>
<td>□ Medium</td>
<td>□ Natural background</td>
</tr>
</tbody>
</table>
|                                   | Who is using them? (Answer for each object) | □ High | □ Highly detailed background | □ Maximum representation | □ Deep perspective | | | □ Abstract | (Parallel suggests involvement, inclusion. Angled suggests disengagement, detachment.)
|                                   | □ Male | □ Low | □ Natural perspective | | | | | □ Naturalistic | □ High |
|                                   | □ Female | □ Medium | □ Shallow perspective | | | | | □ Abstract | □ Middle |
|                                   | □ Both | □ High | □ Natural background | | | | | □ Naturalistic | □ Low |
|                                   | | □ High | | | | | | □ Naturalistic | (High makes subject appear small/insignificant & gives power to viewer. Middle is naturalistic/implies equality. Low angle implies power of represented person, making viewer feel less powerful.) |
APPENDIX B

Samples of Enthymeme Analysis

Visual enthymeme of single image:

Step 1: Make observations.
- Two women demonstrate the Heimlich maneuver. One woman is white, and the other is Asian or perhaps Native American. They wear plain, baggy clothes. They appear calm.

Step 2: Decide what premises can be assumed from these observations.
- Women can perform the Heimlich maneuver.
- Women can perform calmly under stress.
- Women wear plain, baggy clothes.

Step 3: Make inferences.
- If you are a woman, you can perform the Heimlich maneuver.
- If you are a woman, you should dress in plain, baggy clothes.
- If you are a woman, you can be calm in a stressful situation.

*These are not the only possibilities. Due to space limitations, they are select examples.
**Visual Repetition:** When images with similar subject matter appear more than once in a text, they can argue through visual ploche or polyptoton (Fahnestock, 1999).

**Step 1: Make observations.**
- In both photos, a woman performs the Heimlich on another person. In the first, she appears calm. In the second, she looks a bit more concerned. The male victim looks much more stressed than the female victim. The second photo has context. The male appears to be much larger than the female. The woman’s grip on the male appears to be lower on the abdomen (stomach area) than the other woman’s grip on the female (closer to sternum).

**Step 2: Decide what premises can be assumed from these observations.**
- Women can perform the Heimlich maneuver on either men or women.
- Men panic more than women when choking.
- The proper positioning for the Heimlich is lower on men than on women.
- White females are uniquely qualified to perform the Heimlich maneuver. (Goes against endoxa)

**Step 3: Make inferences.**
- If you are a white female, you can perform the Heimlich.
- If you perform the Heimlich on a male, place the hands closer to the stomach.
- (Maybe) If you are male, you should not perform the Heimlich on a female victim.

* These are not the only possibilities. They are select examples; my analysis usually included more.
APPENDIX C

Inter-rater Reliability

<table>
<thead>
<tr>
<th>Variable</th>
<th>Matches</th>
<th>% Matching</th>
<th>Cohen's Kappa (k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Photos</td>
<td>51</td>
<td>85%</td>
<td>0.4118</td>
</tr>
<tr>
<td>Themes</td>
<td>49</td>
<td>97%</td>
<td>0.4828</td>
</tr>
<tr>
<td>Colors: Modulation</td>
<td>54</td>
<td>82%</td>
<td>0.3878</td>
</tr>
<tr>
<td>Colors: Saturation</td>
<td>54</td>
<td>90%</td>
<td>0.4444</td>
</tr>
<tr>
<td>Colors: Differentiation</td>
<td>42</td>
<td>70%</td>
<td>0.2857</td>
</tr>
<tr>
<td>Contextualization</td>
<td>55</td>
<td>92%</td>
<td>0.4545</td>
</tr>
<tr>
<td>Representation of Detail</td>
<td>36</td>
<td>60%</td>
<td>0.1667</td>
</tr>
<tr>
<td>Depth</td>
<td>34</td>
<td>57%</td>
<td>0.1176</td>
</tr>
<tr>
<td>Illumination</td>
<td>41</td>
<td>68%</td>
<td>0.2683</td>
</tr>
<tr>
<td>Brightness</td>
<td>52</td>
<td>87%</td>
<td>0.4231</td>
</tr>
<tr>
<td>Coding Orientation</td>
<td>36</td>
<td>60%</td>
<td>0.1667</td>
</tr>
<tr>
<td>Horizontal Angles</td>
<td>38</td>
<td>63%</td>
<td>0.2105</td>
</tr>
<tr>
<td>Vertical Angles</td>
<td>54</td>
<td>90%</td>
<td>0.4444</td>
</tr>
</tbody>
</table>

Notes:

1. To determine the number of matching photos, calculated the group average of the 10% sample and the standard deviation. Then, the matches were determined by looking at one standard deviation below the group average (55% of the categories matched per picture). This resulted in 51 of the 60 sample photos being designated as matches, or 85% of the 60-photo sample.

2. The standard deviation is used to adjust the lower boundary of the group average and accounts for independent rater's lack of formal education in the field.
APPENDIX D

Occurrences of Themes in Enthymeme Analysis

<table>
<thead>
<tr>
<th>THEME NUMBER</th>
<th>DESCRIPTION</th>
<th>NO. OF APPEARANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>women are/can be</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>men are/can be</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>looks/dress/other physical attributes</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>outdoors/indoors</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>attractive/plain</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>leadership/support</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>work with/work alone</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>scientist/doctor</td>
<td>19</td>
</tr>
<tr>
<td>9</td>
<td>danger</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>animals/pets</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>writing/administrative</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>assumption of maleness (when no positive indicators of gender are present)*</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>muscle/athletics</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>enjoyment/lack thereof</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>hard science/life science</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>hard manual tasks/soft indoor tasks</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>eating</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>talking on the phone</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>field work/indoor work</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>race/disability</td>
<td>11</td>
</tr>
<tr>
<td>21</td>
<td>jobs requiring high education &amp; thought/jobs requiring tech skill &amp; taking direction</td>
<td>9</td>
</tr>
<tr>
<td>22</td>
<td>young/old (ageism)</td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>work w/children</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>work with opposite gender</td>
<td>2</td>
</tr>
<tr>
<td>THEME NUMBER</td>
<td>DESCRIPTION</td>
<td>NO. OF APPEARANCES</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>25</td>
<td>food prep/kitchen work/domestic chores</td>
<td>2</td>
</tr>
<tr>
<td>26</td>
<td>family/kids (non-work-related)</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>laboratory work/experiments</td>
<td>11</td>
</tr>
<tr>
<td>28</td>
<td>amazement/lack of emotion</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>stress</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>caring/nurturing</td>
<td>4</td>
</tr>
<tr>
<td>31</td>
<td>betterment of humankind/changing history</td>
<td>5</td>
</tr>
<tr>
<td>32</td>
<td>science = fun/science = not fun</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>delicate things</td>
<td>2</td>
</tr>
<tr>
<td>34</td>
<td>building on someone else's work</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>male = generic human</td>
<td>2</td>
</tr>
<tr>
<td>36</td>
<td>person doing stereotypically opposite-gender job</td>
<td>1</td>
</tr>
<tr>
<td>37</td>
<td>plants/gardening/botany</td>
<td>3</td>
</tr>
<tr>
<td>38</td>
<td>active/passive</td>
<td>1</td>
</tr>
<tr>
<td>39</td>
<td>overcoming adversity</td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>de-emphasis of female(s)</td>
<td>1</td>
</tr>
<tr>
<td>41</td>
<td>art/posters/artistic pursuits</td>
<td>2</td>
</tr>
<tr>
<td>42</td>
<td>elderly = illness, weakness</td>
<td>1</td>
</tr>
<tr>
<td>Stereotypes about Women</td>
<td>Stereotypes about Men</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td></td>
</tr>
<tr>
<td>3   Women scientists aren't attractive</td>
<td>4   Prefer the outdoors</td>
<td></td>
</tr>
<tr>
<td>5   See above</td>
<td>6   Are born leaders</td>
<td></td>
</tr>
<tr>
<td>6   Support roles</td>
<td>7   Work alone</td>
<td></td>
</tr>
<tr>
<td>7   Work with others, partic. other women</td>
<td>8   Are scientists and doctors</td>
<td></td>
</tr>
<tr>
<td>9   Avoid dangerous jobs</td>
<td>9   Like dangerous jobs</td>
<td></td>
</tr>
<tr>
<td>10  Love pets, esp. cats</td>
<td>13  Are strong and athletic</td>
<td></td>
</tr>
<tr>
<td>11  Administrative tasks/secretarial</td>
<td>15  Do the hard sciences</td>
<td></td>
</tr>
<tr>
<td>15  Prefer the life sciences</td>
<td>16  Do the hard manual tasks</td>
<td></td>
</tr>
<tr>
<td>16  Prefer indoor tasks</td>
<td>21  Do jobs requiring high ed. &amp; thought</td>
<td></td>
</tr>
<tr>
<td>18  Talk on the phone a lot</td>
<td>27  Do lab work and experiments</td>
<td></td>
</tr>
<tr>
<td>21  Better at taking direction than thinking</td>
<td>28  Are not emotional</td>
<td></td>
</tr>
<tr>
<td>23  Work with children</td>
<td>29  Cope well with stress</td>
<td></td>
</tr>
<tr>
<td>25  Like domestic work</td>
<td>31  Discover things that help the world</td>
<td></td>
</tr>
<tr>
<td>26  Are interested in family issues</td>
<td>35  Are the exemplar for humanity</td>
<td></td>
</tr>
<tr>
<td>28  Are emotional</td>
<td>38  Are active</td>
<td></td>
</tr>
<tr>
<td>Stereotypes about Women</td>
<td>Stereotypes about Men</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>29 Can't handle stress (&quot;hysterical women&quot;)</td>
<td>39 Are able to overcome adversity (&quot;self-made man&quot;)</td>
<td></td>
</tr>
<tr>
<td>30 Are naturally nurturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 Can't do things by themselves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37 Like plants and gardens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38 Are passive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41 Are more into the arts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**

- **LOOKS**
- **NUPTURING/INTEREST IN LIVING THINGS**
- **WEAKNESS**
- **NEEDINESS**
- **ARTISTIC**

- **STRENGTH**
- **GENERIC HUMANS**
- **LEADERS**
- **ABSTRACT THOUGHT**