ETHICAL PROBLEMS AND DILEMMAS IN THE INTERACTION BETWEEN SCIENCE AND MEDIA

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I. Introduction

Science and the media are not strange bedfellows since they both gather information, value accuracy and objectivity, and recognize their enormous social responsibilities. The public often benefits from interactions between science and the media, and these two institutions often complement each other. However, since they have different standards, goals, expertises, competencies, and funding sources, science and the media can sometimes interact in ways that produce unintended, adverse consequences for the public. Sometimes the public may become misinformed, deceived, or confused as a result of the media's coverage of science. This unfortunate effect can lead to poor policy decisions, ill-informed public opinion, and the inability to make appropriate use of scientific information. In order to prevent these adverse consequences, scientists need to pay special attention to their interactions with the media. This essay will discuss these interactions in order to suggest some ways that scientists can prevent ethical problems and solve ethical dilemmas in their dealings with the media.

II. What is the Media?

To set the stage for this essay, it is important to say what is meant by the word "media" since there are many different things that might be placed under this heading. For the purposes of this essay, the word "media" will signify professional news journalists, i.e. the group of people who are employed by newspapers, magazines, radio, television, and other communications industries to gather the news and convey it to the public. This group includes the journalists who write for New York Times, Time Magazine, Science News, and the wire services, as well as reporters who work for the Cable News Network, National Public Radio, ABC's Nightline, PBS' NOVA series, and so on. This group does not include columnists, opinion writers, features and entertainment writers, and other people who are not what we would call professional news journalists. Journalists who report the news for organizations with an explicit political, industrial, philosophical, or religious mission, such as writers for the Humane Society, Greenpeace, the Christian Broadcast Network, or conservative talk radio shows, and industry public relations (PR) people will also be excluded from the group of professional news journalists considered here. This essay will focus on professional news journalists because this group has as its primary aim the conveying of the news to the public. Other groups may also convey the news, but they have other aims, such as political, religious, or entertainment goals, that make their mission very different from the official mission of the professional news media. These other groups raise some interesting and important questions for science, to be sure, but for the sake of simplicity and brevity they will be left out of this discussion.

So what makes someone a professional news journalist? A news journalist is someone who reports the news, and a professional news journalist is someone who is a news reporter by profession. A profession is a type of social institution that 1) provides goods and services for society; 2) has standards of competence; 3) has standards of integrity (or professional ethics); 4) has a system for training and educating its members in the ways of the profession; 5) has a way of certifying its members' professional status, such as licenses, university degrees, and so on (Bayles, 1988). One need not be paid in order to be a professional, but most professionals make their living at what they do.

Professional news journalists provide information and news for society. They serve as important translators and intermediaries between the public and the rest of the world (Lippmann, 1946). Although the news can itself be news, journalists, for the most part, report about news events in the world; they do not make the news. Journalistic standards of competence specify the qualifications and requirements for reporting the news. Journalists go through a period of education and training in order to become professionals, and they earn college or university degrees to certify their professional status. Journalists, like scientists, have standards of conduct (or professional ethics) that provide guidelines for the kind of behavior that is expected of members of their profession. These standards can be justified in terms of general, ethical (or moral) principles as well as the goals of the media profession. For example, the duty to respect privacy can be justified in terms of general, moral obligations to respect personal autonomy and to not harm people, and it can be justified in terms of the media's goal of reporting the news because failure to protect privacy can have a "chilling effect" on news sources who wish to have their privacy protected (Meyer, 1987). The following is a short list of principles of ethical conduct in professional journalism (Klaidman and Beauchamp, 1987; Meyer, 1987):

(1) Objectivity: Report the news objectively.

(2) Accuracy: Report the news accurately.

(3) Newsworthiness: Report news that is newsworthy.

(4) Privacy: News reporters should respect the privacy of their news sources.

(5) Social Responsibility: News reporters have a duty to inform the public about issues of social concern for the good of society.

(6) Freedom: News reporters have the right to report all the news that's fit to print without fear of censorship.

Journalists have other principles and standards than the ones mentioned here, of course, but we shall only discuss these for the sake of simplicity and brevity.

A brief word of comment about some of these principles is in order before moving further. It should be noted that not all journalists in all countries adhere to objectivity, since the press in dictatorships, such as Iraq, or security minded republics, such as Israel, often serves a propaganda function. Even in the United States objectivity can lose its hold on journalists during times of war or national emergency (McArthur, 1992). Aside from these caveats, we should understand that "objectivity" in journalism may not mean the same thing as "objectivity" in science. Journalistic objectivity requires reporters to try to cover different sides of a story, even if one side is a minority (or mistaken) position (Newman, 1982). Objectivity also requires reporters to not slant the news, to use a neutral voice, and to not make editorial remarks in reporting. (One irony of journalistic objectivity is that it may actually contribute to misinforming the public about science, an issue that will be addressed later.)

Scientific objectivity consists in following the scientific method. One of the key assumptions of this method is that science is public knowledge: it is not the private, personal opinions of one scientist (Ziman, 1984). Science's methods are public in that scientific experiments should be able to be replicated, data are not kept secret, the rules of logic and statistics are impersonal and apolitical, and scientific hypotheses need to be able to stand the test of public scrutiny. Science's peer review system is the institutional embodiment of these methods of developing knowledge. Scientists have faith that their objective methods will produce results that are independent of the thoughts, beliefs, ideologies, or personal traits of people who conduct science. The speed of light is 186,000 miles per second is a fact that does not depend, in any significant way, on who discovers it. Light would still travel at the same speed even if human beings had never existed.

Accuracy in professional journalism requires that journalists use reliable sources, that they do not misquote sources, that they present the facts without distorting them, and that they draw logical inferences (Klaidman and Beauchamp, 1987). Journalists who fail to report the news accurately may be viewed as sloppy, careless, incompetent, and unethical. Unfortunately, journalists often fail to give an accurate account of science, and this paper will address that issue in its later discussions.

What makes a story newsworthy? There are different answers to this question, but the three most convincing ones are: 1) a story's social value; 2) its interest to the public; 3) timeliness. A story might have social value because it has important social implications even if not that many people are interested in learning about the story (Morson, 1988). For example, reports on business mergers or changes in employment laws often have tremendous social implications even when they do not make front page news. A story might have interest to the public simply because it provides the public with information it wants to know (Morson, 1988). Stories about celebrities and sports reporting fall in this category. And of course, many stories have social value and also feed the public interest. Finally, time plays an important role in determining what stories are considered newsworthy: current events and developments are often considered more newsworthy than yesterday's news or slowly developing processes (Halberstam, 1987).

Social responsibility is based on the media's role as the "fourth estate." Journalists play a key role in our system of checks and balances and they help to prevent the first three estates -- the legislative, executive, and judicial branches of government -- from becoming too powerful, corrupt, or tyrannical (Lippmann, 1946; Mill, 1947; Meyer, 1987). Reporters may view themselves as "watchdogs" or "guardians of the public interest" when they identify with this special role. In this post-Watergate era, the public has become acutely aware of the media's adversarial, "watchdog" role.

Before concluding this discussion of the media's ethics, we should note that some of these principles may come in conflict at times. For instance, a concern for newsworthiness may conflict with objectivity or accuracy when a journalist biases the facts for the sake of an interesting story; and social responsibility may conflict with objectivity when a journalist slants the news as she attempts to expose corruption or she reports the objective facts with little or no thought to their social consequences.

III. The Ethics of Science

It will be assumed that readers of this essay already have some familiarity with ethical standards in scientific research, so they will be mentioned only briefly here. If we view science as a profession whose main goal is the advancement of knowledge (or justified, true belief), then scientific ethics, like journalism ethics, also has a dual foundation: responsible conduct in science can be justified in terms of general, ethical (or moral) standards and in terms of the goals of science (Resnik, 1994; Committee on Science, Engineering, and Public Policy, 1995). For example, dishonesty is unethical in scientific research because it violates moral standards and because it impedes the search for the truth (Resnik, 1994). A brief list of principles of scientific ethics includes the following (Resnik, 1994):

1. Honesty: Do not commit scientific fraud, i.e. do not fabricate, fudge, trim, cook, destroy, or misrepresent data.

2. Carefulness: Strive to avoid careless errors or sloppiness in all aspects of scientific work.

3. Intellectual Freedom: Scientists should be allowed to pursue new ideas and criticize old ones. They should be free to conduct research they find interesting.

4. Openness: I.e. share data, results, methods, theories, equipment, and so on. Allow people to see your work, be open to criticism.

5. The principle of credit: Do not plagiarize the work of other scientists, give credit where credit is due (but not where it is not due).

6. Social responsibility: Anticipate the consequences of research and be responsible for them; attempt to prevent harm to the public and promote social welfare through research.

Later on in this essay we shall see how some ethical problems and dilemmas can arise when scientific ethics conflict with journalism ethics in science/media interactions.

IV. The Interaction Between Science and the Media

Science and the media interact when professional journalists report on the news from science. Science is newsworthy in all respects mentioned above: scientific research often has important, timely social implications and the public is interested in science (Nelkin, 1987). Besides reporting on the results of scientific research, the media also gather news about social and political aspects of science, such as science funding, restrictions on research, copyrights and patents, and so forth. If we think of science as a primary source of information about the world, then the media serves as a secondary source of information when it conveys that information to the public. (Science and the media can interact in a very different way when scientific disciplines, such as psychology, economics, or sociology, take the media as an object of study, but this essay will not discuss this kind of interaction.)

There are many different ways that professional journalists gather information about science. These points of contact between science and the media include:

(1) Press conferences.

(2) News releases.

(3) Interviews.

(4) Media attendance at scientific meetings.

(5) Media summaries of journal articles, books, or electronic publications.

It is not at all unusual for scientists to actively seek media coverage of their discoveries through press conferences. In recent years pictures of the Hubbell Telescope and Shoemaker-Levy Comet, and the latest AIDS and cholesterol drugs have been major media events covered by all the major television networks and newspapers. There are several reasons why scientists seek the media spotlight. First, they may view a discovery or finding as so important that they want the public to know about it as soon as possible. Medical researchers often have urgent news that can be of vital importance in preventing death and disease or in promoting human health. Second, they may wish to impress the public with their results in an effort to increase public support for science in general or for particular research efforts. The pictures of the Shoemaker-Levy Comet were not urgent or vital -- no one would have died if they had been delayed a few weeks -- but they were very useful as a PR tool. Third, some scientists may want to release their results to the press to help establish priority. These scientists fear that they will lose their priority if they report their results through the normal channels, i.e. peer review, so they circumvent this slower process and take their results directly to the public. In many areas of research, priority gets linked to economic incentives, since in order to patent an invention one must establish its originality. If two competing research groups are both trying to perfect the same invention, the patents will belong to the group that can claim priority.

News releases are another common though less spectacular way of seeking media attention. Very often research institutions, such as universities or industrial laboratories, distribute press releases with PR goals in mind. A scientist who makes an important discovery can enhance her institution's public image and help the institution obtain support and funding. For industrial research, press releases can also serve as preliminary marketing tools that help to establish a product's usefulness before it reaches the market.

Interviews can provide a very effective format for conveying scientific information to the media. Interviews may take place over the phone, in person, and sometimes by e-mail. For many years interviews have been the staple of the news story, and they also play a key role in stories about science.

Professional journalists regularly attend major scientific meetings, such the American Association for the Advancement of Science (AAAS) annual meetings, meetings of the American Medical Association (AMA), and the annual international conferences on AIDS research. Professional journalists also sometimes drop in on scientific meetings that draw less attention. For instance, the public outcry over the cloning of human embryos began when reporters learned of these experiments at a relatively "low key" meeting of the American Fertility Society (Kolata, 1993).

Finally, journalists can gather information about science in the same way that other scientists share information with each other; journalists can read professional journals and scientific books, and they can gather information about science by searching the world-wide web. Journalists regularly write stories about findings that appear in the most prestigious scientific journals, such as Nature, Science, and the Journal of the American Medical Association.

All of these different ways that the media may gather information about science can raise some difficult ethical questions for scientists, and these will be addressed in the next section.

V. Some Ethical Problems and Dilemmas with the Science/Media Interaction

V.A. Press Conferences

As one might expect, press conferences raise some very difficult ethical questions for science. The main problem with press conferences is that sometimes scientists report their results to the media before these results have been confirmed by other scientists. If it turns out that the results reported in press conferences are erroneous, then there can be harmful consequences for science and for the public. Science's image suffers when scientific findings reported in haste turn out to be mistaken. It makes scientists look foolish and erodes the public's trust in science. The cold fusion fiasco provides a timely example of this problem. The two scientists who "discovered" cold fusion, Stanley Pons and Martin Fleishman, held a press conference on March 23, 1989 to announce their discovery before it was verified. The main motivation for this conference was to establish priority so that their sponsor, the University of Utah, could obtain patents on their inventions. In the days that followed this stunning announcement, scientists tried to replicate the cold fusion experiments and failed. As it turns out, cold fusion was a classic case of carelessness and self-deception in science (Huizenga, 1992).

One of the lessons that scientists have learned from cold fusion is that scientists have an obligation to have their work confirmed by their peers before reporting their results to the media. Indeed, some journals will refuse to accept articles that contain results that have already been reported to the media. The main intention of this policy is to encourage scientists to not circumvent the peer review system by obtaining prior publication in the media. However, one might challenge this policy on the grounds that sometimes scientists have some good reasons for presenting results to the media before the results have been completely confirmed since the social consequences of some research might be so important that the public needs to know about the research as soon as possible. If research can save lives, why let people die while peers review the research? Thus, while scientists should not circumvent the normal, peer review process in most cases, there may be some circumstances when social responsibility requires scientists to present their results to the press before their work has been peer reviewed thoroughly.

V.B. Scientific Meetings

Most scientific meetings are open to the public, and scientists need to be aware that news journalists may attend scientific meetings. This can create some ethical conundrums for scientists, however. First, suppose that a immunologist wants to present some preliminary work at a meeting. She presents her preliminary work in order to get some feedback and criticism before publishing her work or continuing her research. She does not want to go public with her work yet, since it has not been well confirmed and she does not want to mislead her peers or the public. Should she be able to prevent the media from reporting on her work? Should she be allowed to present her work in a closed session of the scientific meeting?

A second issue raised by having journalists at scientific meetings is the question of whether results presented at these meetings that are covered by journalists should not be published in journals. If a reporter writes a story about a piece of scientific research based on what she learns about the research at a scientific meeting, does this count as prior publication in the media? This kind of prior publication in the media is not the same as calling a press conference since scientists who present results at meetings are not intending to circumvent the peer review process. Nevertheless, there can be some unfortunate outcomes for science and for society when the press gains access to research that has not been thoroughly peer reviewed.

Since it would be undemocratic and secretive to ban the press from scientific meetings, there are no easy answers to these questions. These questions result from the dilemma of the journalist's right to acquire information and the principle of openness in science vs. the scientist's right to protect preliminary research and the scientist's social responsibilities, and there are convincing arguments on both sides of this issue.

Though journalists have a general right to acquire information to inform the public, they must use discretion when invading "privacy." Journalists continually uncover private information and bring it into the public light, but the invasion of privacy requires a sound and convincing justification. If research is of great social value, journalists may have a good argument for invading privacy (Klaidman and Beauchamp, 1987). Although scientists follow a principle of openness, they may also have sound arguments for not allowing reporters to learn about ongoing research to protect their reputations and prevent damage to science and the public (Bok, 1983).

V.C. Interviews

Virtually anyone who talks to the press fears being misquoted or quoted out of context, and scientists share these concerns (Nelkin, 1995). Professional journalism's principle of accuracy implies that news reporters should make accurate and appropriate attributions, but journalists sometimes fail to live up to this ideal. Many scientists refuse to talk to reporters after only a single episode of irresponsible quotation. But scientists have obligations to science and to society to talk to the press, since media coverage of science can encourage public support of science and it can yield important results for society. For these and other reasons, the phrase "no comment" is seldom an appropriate response to a request for an interview. But saying very little to the press can be almost as bad as saying nothing at all if the few words that are said are quoted out context or misquoted.

The best way to for scientists to avoid being misquoted or quoted out of context is to cooperate with the media and give extensive, in-depth interviews. Interviews give scientists a chance to explain abstract concepts and theories and technical experiments and procedures. Scientists can stress their key ideas, interpret them, and place them in a broader context. By educating and informing the media, scientists increase the probability that their results will be understood and accurately represented and that they will not be quoted out of context. Media mistakes can still occur, of course, but scientists still have an obligation to minimize errors.

Finally, it should be mentioned that some scientists, such as Carl Sagan, have used the popular media to educate the public about science. Scientists who can explain scientific concepts and theories to an audience of non-specialists deserve to be commended for their efforts to bridge the gap between science and the public. Unfortunately, science does not have enough of these "great communicators" and science's public image suffers from a lack of public understanding of science (Nelkin, 1995). There are several reasons why the scientific community has a shortage of scientists like Carl Sagan. First, to be a good scientist, one needs to devote a great deal of time to research, teaching, and other professional activities, and this leaves little time for educating the public. Second, since success in science demands that scientists acquire a great deal of knowledge in a specialized discipline, it may not encourage an interest in other, humanistic disciplines or the development of communication skills. To communicate with the public scientists need to appreciate the humanities and they need to know how to speak to laypeople. Third, there are some scientists who actually condemn people like Sagan for a variety of reasons, ranging from pettiness and jealousy to elitism. These attitudes prevail in many academic disciplines, but they can have destructive effects. Academicians who view their work as so "deep" or "important" that it should not be "watered down" for public consumption risk becoming irrelevant, ivory tower snobs. Thus, there are good reasons for encouraging scientists to follow Sagan's example rather than sneer at it.

V.D. Media Analysis of Journal Articles and Books

Since the media often report on scientific publications, scientists should be aware that their books, articles, and electronic communications may go beyond the scientific community and reach the general public. The computer and information revolution makes it easier than ever for non-specialists to gain access to specialized publications, since search engines, indexing systems, faxing services, and other technologies make it easier to find and access scientific information. Though articles that appear in obscure journals are "safer" than presentations at highly visible meetings, scientists need to realize that their work may be read or studied by non-peers. Awareness of this fact should not stifle scientific creativity or free expression, but it should give scientists some reasons for interpreting and explaining their ideas in some detail, since non-specialist readers may not understand the concepts, methods, or implications of a given piece of research. Journal editors may also need to revise policies that assume that readers will not require extensive explanation or interpretation of hypotheses, methods, and theories, since these policies are based on the notion that all readers share some common, background knowledge of the field.

VI. The Public's Misunderstanding of Science

Although it is not the aim of this essay to blame the media for the ethical problems and dilemmas of the science/media interaction, some of these issues do result from the media's failure to help the public understand science. These problems are not easy to avoid, since science is by its very nature often difficult to understand, and many laypeople know very little about science and do not care to learn more. Moreover, since professional journalists are not professional scientists, and the media industry stays in business by maximizing profit, there are some fundamental constraints on science reporting that can have a negative impact on the media's coverage of science. At best, we can only minimize these negative impacts. But before we can minimize them, we must understand how they can come about.

VI.A. The Public's Perception of Scientific Proof/Disproof

Confirmation in science is seldom definite and never instantaneous. Scientific theories and hypotheses are confirmed or disconfirmed based on a careful weighing of the evidence, which usually comes in bits and pieces. New evidence may support or undermine a theory or hypothesis, but no single piece of data ever absolutely proves or disproves a theory or hypothesis (Popper, 1963; Ziman, 1984). "Proof" in science does not mean "certainty" or "absolute truth" but only "proof relative to a given body of evidence." This does not imply, of course, that scientific theories and hypotheses have no support at all, since we have very good reasons for believing that the earth is not flat, that dinosaurs existed, and that DNA carries genetic information.

But the public often does not understand the nature of proof or disproof in science, and the media can perpetuate this lack of understanding (Nelkin, 1995; Wilkins and Paterson, 1991). News stories that begin with the phrases "scientists say" or "according to scientists" can mislead the public into thinking that the statements that follow these phrases are the absolute truth. Many of the same people who lack an understanding of science or an appreciation of scientific method nevertheless view science as authoritative (Ziman, 1984). Laypersons who do not view science as the arbiter of truth may nevertheless place an overinflated confidence in science, due to their lack of understanding of scientific "proof."

Debates about the extinction of dinosaurs illustrate how the public can place too much confidence in scientific theories. The "asteroid extinction hypothesis" was a fanciful hypothesis that has become a virtual dogma in only a decade or so. The idea that an asteroid impact could have killed off most of the dinosaurs gained acceptance when geologists found a layer of iridium -- an element commonly found in asteroids -- in 65 million year old sediments throughout the world. The "smoking gun" for this hypothesis was the discovery of evidence for an asteroid impact in the Yucatan Peninsula. Today, children's books, popular science books, television shows, movies, and science museums all present the asteroid hypothesis as the unqualified truth about what happened to the dinosaurs. However, there are many paleontologists who do not accept this hypothesis and who offer their own pet theories. It is not at all clear that the asteroid hypothesis is held by a majority of scientists who study fossils and extinction patterns. Nevertheless, the public is virtually unaware of these ongoing debates and does not understand the evidence for this hypothesis or its tentative support.

The public makes the opposite error as well. When someone disputes or criticizes an important hypothesis, the public may view this hypothesis as "unproven" or even "disproven" even if the vast majority of scientists happen to accept it. The debates about global warming provide a timely illustration of this point (Stevens, 1996). Most climatologists accept the idea that human activity can cause significant changes in the atmosphere and can affect the earth's temperature. Climatologists disagree about when global warming will occur, how temperatures have changed, what mathematical models best fit the data, and so on, but there is widespread agreement on the global warming hypothesis. Some prominent scientists have spoken out against global warming, and even those scientists who accept global warming often attack each other's models and ideas. Press coverage of this topic can lead the public to believe that there is no proof for global warming. Other examples of hypotheses and theories that are "unproven" in the eyes of many people abound: prominent politicians and laypeople have denied the link between smoking and lung cancer, for example.

How does the media contribute to the misperception of proof or disproof? Many science reporters do a fine job of conveying the tentative nature of scientific proof and disproof in their stories, but even well written news stories can be misinterpreted, especially when editors "slant the news," a topic we will address later. For now, we should mention that people often see what they want to see or hear what they want to hear. This phenomenon often goes by the name of confirmation bias: we tend to look for evidence for the things we are already inclined to believe (Stocking and Gross, 1987). Thus, when people do not want to believe a scientific theory or hypothesis, they will be more likely to take any criticism of the hypothesis as "disproof;" conversely, when they want to believe a theory or hypothesis, they will take any supporting evidence as definitive "proof."

Ironically, the media's ethic of objectivity can encourage the misperception of scientific proof and disproof, since objective reporting requires the media to present both sides of an issue, even if one side is a very small minority. One result of "journalistic objectivity" is that the public sees an evenly divided debate on many issues and does not understand why many scientists accept particular hypotheses or how they are supported (or undermined) by the evidence. The global warming debate provides a good illustration of this effect. A second result of objectivity in journalism is that journalists can contribute to confirmation bias by reinforcing ideas that people are inclined to believe, even if those ideas happen to have little evidential support. Global warming also provides a useful illustration of this effect since people who reject this idea can find plenty of evidence to support their views if they look for it in press.

VI.B. The Public's Understanding of Statistics

In the last two decades, an extensive body of psychological research has demonstrated how people make errors in statistical reasoning (Stocking and Gross, 1987; Wilkins and Paterson, 1991). First, research has shown that many people find vivid, anecdotal evidence more persuasive than well-documented statistics (Nisbett and Ross, 1980). A few reports of heinous crimes can lead people to believe that there is a "crime wave" even if law enforcement statistics contradict this perception. Those who rely on anecdotes may commit the statistical fallacy known as "hasty generalization" by forming beliefs on just a few cases (Kahane, 1980). News reporters can contribute to this problem by reporting sensational cases instead of reviewing dull statistics. The public misperception of statistics has caused serious problems for agriculture in the United States and elsewhere. For example, when a few dozen people got food poisoning from eating strawberries imported from Guatemala, the news of this incident led many people into believing that all Guatemalan strawberries are unsafe or even that all strawberries are unsafe. But these unfounded beliefs affect consumer choices and can have adverse economic impacts on people who grow, pick, and sell strawberries.

Second, research has also shown that many people have erroneous perceptions of risk (Stocking and Gross, 1987; Wilkins and Paterson, 1991; Slovic, 1986). Accident statistics show that it is safer to fly an airplane than it is to drive a car, yet many people view flying as very risky. Statistics also show that seatbelt usage dramatically reduces one's chance of being killed in an automobile wreck, yet many people do not view their failure to wear a seatbelt as a serious risk. Risk misperception can also lead to discrimination and prejudice against people with communicable diseases, such as HIV. Many laypeople believe that they have a significant risk of contracting HIV from health care workers even though the statistics show that this risk is exceedingly small. The problem of risk misperception is also related to the problem of anecdotal reasoning in that many people form their judgments about risk based on memorable examples rather than on statistical data (Slovic, 1986). All it takes is one highly publicized case of a patient contracting HIV from a health care worker to lead many people to overestimate the risk of HIV infection from health care workers.

Third, the public also does not have a good understanding of correlation, sampling errors, biases, and other key concepts in statistics. Thus, people may be quick to infer causal relationships based only on weak correlation, they may not understand an opinion poll's margin of error, and they may not understand how surveys and other statistics can be biased.

Given the public's misperception of statistics and the importance of statistics in making policy decisions, both scientists and professional journalists have a duty to inform and educate the public about statistical data so that laypeople can make sound decisions (Slovic, 1986). Unfortunately, the press can contribute to the public's misperception of statistics by "selling the news." Careful statistical analyses make uninteresting news stories but well-chosen, vivid examples sell newspapers and draw national audiences. The proliferation of television news shows can exacerbate this problem since the television medium lends itself to vivid, dramatic examples and stories.

VI.C. The Misinterpretation of Science

The public often views scientific theories, models, hypotheses, concepts, and methods as abstract, technical, jargonistic, and bewildering. Science far exceeds commonsense and ordinary ways of thinking and talking. Journalists must find some way of presenting the world of science to the public in an intelligible form. Very often the press (and scientists) must simplify or "dumb down" science so that people can understand it. But very often something is "lost in translation" or misinterpreted in the flow of information from science to public (Nelkin, 1995). For example, the public does not have a good grasp of the word "cancer." There are many different kinds of cancer, ranging from benign to terminal in their severity. But many people do not understand this fact and draw back in horror at the very mention of the word "cancer." Chaos Theory has made its way into popular discourse as people label all kinds of phenomena as "chaotic." Non-scientists have used the word "chaos" to describe politics, sports, crime, war, even the universe as a whole. The problem with this misinterpretation is that "chaos" has a very specific meaning in the sciences that study chaos theory that may have nothing in common with the popular interpretation of the word. But people invoke the word and appeal to its connections to scientific theories without even understanding what the word means in those theories. Other frequently misunderstood technical terms include "paradigm," "quantum leap," "genes," "species."

In addition to the misinterpretation of scientific ideas and words, people may misinterpret scientific recommendations and conclusions. For example, studies have shown that there is a correlation between drinking a moderate amount of wine (one to two glasses a day) and a reduced risk of heart disease, and many cardiologists recommend that people drink wine in moderation. But people can misinterpret this recommendation by reasoning as follows: "if one glass of wine reduces my risk of heart disease then several glasses or a whole bottle would benefit me even more." Similar areas of health research suffer from problems of misinterpretation and misapplication of results: we see people smoking in order to reduce weight, bingeing on "low-fat" foods, and so on.

How can we avoid these misinterpretations of science? As we have already seen in our discussion of other problems in the public's misunderstanding of science, education holds the key to overcoming communication difficulties. Thus, journalists and scientists both have a responsibility to educate and inform the public in order to avoid misinterpretations and misapplications of science. Later on in this paper we will address a different kind of method for solving communications problems, the strategy of simplifying and softening results and recommendations.

VI.D. Unreliable Sources

In order to avoid errors, inaccuracies, and innuendo journalists need to obtain the news from reliable sources. It is not always easy to determine whether a news source is reliable, and it takes years of experience for reporters to develop their skills in judging the reliability of various sources. This is also the case in the reporting of science: in order to accurately report the news from science, journalists need to determine the reliability of scientists as news sources. Although it is often not difficult for reporters to find reliable sources, several problems in determining the reliability of sources can arise. One problem is the prevalence of fringe science. Although there are usually a number of different positions on various scientific questions, there are also some positions that are far removed from the mainstream. Journalists need to be able to determine when a viewpoint is so far on the fringe of science that it should not be included in science news stories. Although journalists need to use some discretion in reporting on fringe science it would be unwise to report only on mainstream science, since some of the most important scientific theories and hypotheses were once considered out of the mainstream.

The presence of junk or pseudo science presents a far more serious problem for scientists and the media since junk science has all the trappings of real science; it has style without substance, rhetoric without proof. Examples of junk science include astrology, cold fusion research, UFO research; the list goes on and on. Although most people agree that we can distinguish between good science and junk science, the phrase junk science is not easy to define, and it unlikely that we can develop a set of uncontroversial criteria to allow us to detect junk science, since many legitimate sciences have unscientific beginnings (Ziman, 1984). However, the following criteria can serve as rough guidelines for distinguishing between junk science and good science:

(1) Junk science does not make progress (Thagard, 1978).

(2) Junk scientists do not make a sincere effort to address outstanding problems and anomalies (Thagard, 1978).

(3) Junk science is not testable (Popper, 1963).

Although many legitimate sciences may meet some of these criteria, junk sciences will meet most of them.

Junk scientists present a serious problem for science, the media, and society because their words and writings are sometimes taken seriously. Since it is often difficult to recognize junk science -- junk scientists look like real scientists -- junk science can influence court decisions and legal proceedings, governmental policies, and consumer choices. Junk science can have very adverse societal impacts when people are convicted of crimes based on fallacious expert testimony, when people buy quack cures, and so on. Therefore, a concern for the public good requires both scientists and journalists to debunk, discredit, and disrobe junk science wherever it occurs (Gardner, 1957). For scientists, this responsibility implies a duty to educate the press and the public about disreputable science and to expose quacks, charlatans, and sophists.

VI.E. Time/Space Constraints

Journalists, editors, and media managers work under severe time and space constraints, and these impose definite limits on when a story is covered, how much space it takes up in print, its airtime, etc. Due to time constraints, journalists often must write their stories while the stories are in progress. Journalists have to give an instantaneous accounting of current events and they can rarely afford to watch a story unfold or review its entire history. The news must be reported when it happens, the quicker the better. This rush to publish can result in inaccurate reporting as journalists write about scientific findings that have not been well confirmed. The cold fusion story also serves as a useful example of what happens when reporters cover a story before it completely unfolds. An added effect of the media's rush to publish is that scientists may also rush to do research in order to meet demands from the press. When cold fusion was discovered scientists and journalists frantically tried to replicate this phenomena and report the results to the public.

The media's emphasis on reporting the news as it happens can also obscure and obfuscate ongoing scientific debates. When a story is important to the public, it is not unusual for the press to report each additional study or key finding relevant to the story. Since these stories often present evidence and arguments for and against various ideas or recommendations, the public sees a continual back and forth on important issues, and this adversely affects the public's understanding of science. For example, consider stories about the role of vitamin A in cancer prevention. Some studies suggested that vitamin A can help prevent cancer by serving as an anti-oxidant in the bloodstream. This suggestion is based on the hypothesis that an excess of free radicals in the bloodstream can cause cancer; anti-oxidants reduce levels of free radicals. So the manufacturers of vitamin A touted its anti-oxidant properties. Then the press reported a study that found that vitamin A did not significantly lower the incidence of cancer among a group of Swedish men, who also happened to be heavy smokers. But after this study hit the newsstands, other studies came out that challenged the Swedish study and offered more evidence for the vitamin A's health benefits. What does the public make of this back and forth debate? Though some people may understand that all scientific debates have different sides and that confirmation takes some time, most people will conclude either that we know nothing about the benefits of vitamin A or they will be utterly confused.

Another final ill effect of time constraints is that many important stories do not get reported. The press often fails to follow-up stories once they are no longer breaking news. The result of this lack of follow-up is that many important science stories disappear from the public spotlight. How many people can remember reading a story about hot fusion or solar power? Scientists are still conducting research on these subjects, but they are no longer as newsworthy as they were in the 1970s. The press also does not have enough time to cover stories that take a long time to unfold. Though one sometimes finds some special reports or analyses in the news, the press does not do a good job of covering ongoing, meticulous research. For example, it will take decades to analyze the data collected from probes that have visited Jupiter, Saturn, and Uranus. Will the press carry out a careful summary of this data analysis? Probably not. The press will display the spectacular photographs and even interview some of the scientists from these missions, but the methodical analysis of data will go on behind the scenes. Philosopher/journalist Walter Lippman captured the problems and ironies of time constraints when he said that the press is like the beam of a searchlight that moves restlessly about, bringing one episode and then another out of darkness into vision. Men cannot do the work of this world by this light alone (Lippman, 1992, p.170).î

The press also faces severe space constraints that can adversely affect the public's understanding of science. There is a limited amount of newspaper or magazine space or television or radio time for reporting the news. Space limits affect the quantity and quality of science reporting. Quantitative effects include the amount of science stories that get reported and the length of those stories.

The public's understanding of science will be adversely affected when people do not learn about important science stories or when they only receive a paragraph of information or even worse, a factoid. An additional quantitative consideration relates to a story's place in a publication or broadcast: there is not only a limited amount of total space, but there is also a limited amount of prime, media real estate, i.e. space on the front page, at the top of the network news, etc. If an editor decides to cover a science story but buries it in some obscure place in the paper, then the public will be less likely to read the story or even see its headline. The same point applies to television and radio news as well.

But space constraints also affect the quality of reporting and the quality of the public's understanding of science. Even when a story is reported in the news and it receives more than a paragraph or two of coverage, the public's attention span will filter the story. Most readers of the news may only scan the headlines or read through the first paragraph (Epstein, 1981). For people who hear the news on the radio or see it on television, they may also lose interest quickly. Because the audience loses interest so quickly, editors attempt to put the most important, most newsworthy aspects of a story at the beginning. Headline writers attempt to compose phrases that will capture the reader's or listener's attention. However, all of these factors can conspire to distort or slant the news as headlines, first paragraphs, and language mislead the public. For example, when astronomers discovered additional evidence of primal, background radiation, Time Magazine ran a cover with a quote from an astronomer saying we have seen the face of God. Of course, there is nothing new in the realization that the press can distort or slant the news, but it is important to understand that news slanting can also affect the reporting of science and the public's perception of science.

VII. A Summary of Ethical Problems in the Science/Media Interaction

We have seen how many different ethical problems can arise from the interaction between science and the media. The following is a summary of these problems:

I. The Public

A. The public may lack information about science.

B. The public may be misinformed about science.

C. The public may fail to understand scientific concepts or recommendations.

D. The public may misinterpret science.

E. The public may be completely confused about science and the nature of scientific debates.

F. The public may be exposed to junk science.

II. Science

A. Scientists may rush to publish in the press.

B. Scientists may maintain secrecy in order to protect preliminary research or avoid controversy.

C. Scientists may fail to educate the press or public about their work.

III. The Media

A. The media may have trouble gaining access to scientific meetings and news sources.

B. The media may succumb to various logical and statistical fallacies, such as the use of anecdotal evidence, biased samples, etc.

C. The media may misquote or quote out of context.

D. The media may use unreliable or fringe sources.

E. The media may sensationalize, distort, or slant stories.

F. The media may fail to cover important stories or fail to follow-up stories.

All of these different problems can have negative impacts on the public, science, and the media. The public suffers from its lack of understanding of science insofar as personal and political decisions should be based on sound, scientific findings. When a person lacks an understanding of the scientific facts relevant to a decision, the person is more likely to make a poor choice. When it comes to scientific information, ignorance is usually not bliss. The media can suffer ill effects from these problems in that reporters perpetuate confusion and ignorance. Reporters who pride themselves in contributing to the advancement of mankind and the search for the truth will not want to take part in activities that conflict with their career objectives and goals. Journalists may also wish to not alienate scientists since they need to use scientists as news sources. For the most part, journalists can do a better job of reporting science news when they maintain the trust of the scientific community, but trust can only be maintained if journalists make a sincere attempt to avoid the ethical problems discussed above. Finally, science can be harmed when the publicís support for science is undermined or when science policies are based on a poor understanding of science. For the most part, scientists are better served by an educated rather than an ignorant public. Scientists also benefit from a trusting relationship with journalists, since journalists can help to promote science and serve as a voice for scientific findings. But this trust can only be maintained if scientists make a sincere effort to educate and inform reporters.

VIII. Conclusion: Some Guidelines for Scientists

Although both scientists and journalists should take responsibility for avoiding and mitigating some of the ethical problems inherent in science/media interactions, the goal of this paper is to address the ethical obligations of scientists in this context. Before tackling this issue, we need to head off a potential objection: why should scientists be held accountable for the undesirable effects of their interactions with media? Scientists do not need to worry about how their findings may be misinterpreted or misunderstood because they are not responsible for these problems. The blame for these problems falls on professional journalists and the public, not on scientists. This objection can be understood as an application of the principle of double-effect in ethics, which holds that people do not have to be held responsible for the unintended consequences of their actions (Beauchamp and Childress, 1994). If a fireman saves a man from a burning building who goes on to poison twenty people, the fireman is obviously not responsible for these poisonings, even though his act helped to make them possible. Likewise, scientists are not responsible for the public’s and media’s abuse, misapplication, misinterpretation, distortion, and misunderstanding of science.

But scientists cannot use this argument to evade their social responsibilities in their communication with the media and the public. Although scientists usually do not intend for their findings to produce bad consequences for society, they can often anticipate the consequences of their actions, and they should attempt to prevent harmful results and promote good ones (Committee on Science, Engineering, and Public Policy, 1995). Thus, the principle of social responsibility implies that scientists should attempt to minimize social harms and maximize social benefits when reporting their results to the media and interacting with journalists. Social responsibility would seem to imply the following prima facie obligations for scientists:

Prior Confirmation: Except in unusual circumstances, results should not be reported to the press before they have been confirmed by scientific peers.

Openness: Except in unusual circumstances, scientific information and confirmed results should be open to the public, including the media.

Education: Except in unusual circumstances, scientists should strive to inform and educate journalists and the public about scientific theories, methods, discoveries, etc.

Freedom: Except in unusual circumstances, scientists should be allowed to educate and inform the press and public about their research without fear of reprobation, punishment, etc.

If scientists adhere to these principles in dealing with the media, they should be able to avoid many of the ethical problems that can arise from their interactions with the press. Of course, one still needs to clarify what is meant by unusual circumstances. The main point for including this escape clause is to allow scientists to not follow these principles in all cases and to allow for special exceptions based on sound justifications. For example, national security might be a sound reason for refusing to educate the public about certain kinds of military research; the prevention of imminent harm might be a sound reason for circumventing the normal peer review process; trade secrecy might be a sound reason for not allowing a scientist working for industry to inform the public about particular aspects of a manufacturing process, etc.

Thus, by following these rough guidelines, scientists should be able to avoid or prevent many of the ethical problems discussed in this paper. However, this does not mean that scientists will not face some difficult choices or ethical dilemmas in some circumstances. (An ethical dilemma is a situation in which a person must choose between one or more alternatives that appear to be equally sound from a moral or ethical point of view. The choice may be choosing between the greater of two goods; it is often a matter of choosing the lesser of two evils.) These dilemmas can arise when the principles discussed above conflict with one or more other ethical principles. Consider a possible conflict between the principle of education and a principle of social responsibility: suppose that medical researchers establish a strong statistical connection between drinking one to two glasses of wine per day and a reduced rate of heart disease. How should they go about educating the media and the public about this finding without encouraging people to drink excessively? Education requires scientists to inform the media and the public about these findings; social responsibility requires scientists to prevent harmful effects from the findings (i.e. excessive drinking). This dilemma exemplified by this situation is by no means unique; scientists often must balance their duty to educate and inform against their other social responsibilities.

To help us think about these kinds of dilemmas, it will be useful to draw an analogy between the science-media-public relationship and the doctor-patient relationship. Although the doctor-patient relationship does not include an intermediary, i.e. the media, these relationships are very similar in that they involve the gathering and transmission of information, education, and the promotion of specific values or goals. Scientists gather and transmit information and educate in order to promote the advancement of knowledge and to promote the social good; doctors gather and transmit information and educate in order to promote the health of the patients (Beauchamp and Childress, 1994). In these relationships, we normally assume that the parties are rational (competent) individuals, but they might not be, and communication with incompetent individuals adds additional complications. If we think of the science/media interaction in this way, then we can discuss several different ways of presenting information to people. These are:

Strong Paternalism: Present information in order to promote good and prevent harm; withhold or distort information or lie to competent individuals in order to promote good consequences and prevent harm.

Paternalism for Incompetents: Only withhold information from or lie to incompetent people in order to benefit them or prevent harm.

Weak Paternalism: Same as strong paternalism except only withhold or distort information or lie to competent people in order to prevent harm.

Autonomy: Present all information without distortion so that competent people may make their own decisions; the truth, the whole truth, and nothing but the truth.

The main idea behind paternalism (or father knows best) is that someone should be allowed to make decisions for someone else because they are better qualified to make those decisions. Since information is often an important part of decision-making, paternalism often involves the manipulation or interpretation of information by one person in order to benefit another person or prevent harm. Most ethicists regard strong paternalism as very controversial and rarely, if ever justified, since rational individuals should be allowed to make their own decisions and act on them (Beauchamp and Childress, 1994). Paternalism may be justified in times of war or national emergency, but we should not restrict autonomy simply because with think that we know what's best for people. However, weaker versions of paternalism would seem to be morally sound. For instance, it would seem to be acceptable and perhaps desirable to lie to or misinform a child about his medical condition for the child's own benefit. Children are not competent and we therefore need to control the information they receive in order to make decisions for them. We may also be justified in withholding information from competent individuals in order to prevent harm to them. For instance, a person who has just survived an automobile accident may not be medically or psychologically stable enough to absorb the impact of finding out that their spouse and children were killed in the crash.

How does this apply to science? Scientists, like physicians, may decide to withhold information, distort information, or even lie in order to promote good consequences and prevent bad ones. For example, a scientist who wants to inform the public about his smoking research might decide to withhold research relating to the benefits of smoking so that people will not be misled by these results. (Believe it or not, smoking seems to help abate symptoms for many Parkinson's patients.) Scientists may also decide to simplify and/or soften results in order to make them easier for the public to understand and accept. For example, scientists studying the health effects of weight might decide to simplify their research by glossing over certain factors, such as muscle mass, fat location, and percentage body fat when presenting their results to the public. Instead of including all of these different factors, the scientists might decide to instruct people to eat a balanced diet and to maintain their ideal weight. They might make this recommendation because they believe that it is easier for people to maintain their ideal weight than it is for them to decrease their percentage body fat, increase muscle mass, and so on. (The results would be softened in order to make it easier for the public to accept and act on their guidelines.) They might also believe that it is easier for people to understand a concept like ideal weight and a weight chart than it is for them to understand all of the other weight control factors associated with health. (The results would be simplified in order to make them easier to understand.) Finally, scientists might lie to the public for national security or other reasons. For example, a scientist might lie about the success of a military project in order to prevent enemies from learning that it has not been as successful as advertised. So long as enemies believe that the project is likely to work, it will have an important deterrent effect.

Although it might seem that no kind of paternalism would be justified in science, and that manipulating, distorting, or withholding information has nothing to do with science, some forms of paternalism may be justified once we realize that scientists have an ethical responsibility to prevent harmful consequences and promote beneficial ones. So when are paternalistic communications justified? It is not the aim of this paper to answer this question, since a great deal depends on the details of the situation at hand, such as the kind of information to be shared, how it might be withheld or distorted, its possible effects on the public, etc. However, given the importance of education and openness in science, we should assume that the burden of proof falls on those who would manipulate, withhold, or distort information for the good of the public.

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