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Ambivalent Modernity: Scientists in Film and the Public Eye

Stacy Evans
University of Massachusetts - Amherst, stacy.d.evans@gmail.com

AMBIVALENT MODERNITY: SCIENTISTS IN FILM AND THE PUBLIC EYE

A Dissertation Presented

by

Stacy Evans

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Approved as to style and content by:

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N. J. Demerath III, Chair

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Paul Hollander, Member

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Randall Stokes, Member

____
Donald deB. Beaver, Member

____
Joya Misra, Acting Department Chair
Sociology

DEDICATION

To two incredible women who, each in their own way, made this possible.

Eleanor Estelle Fowler Evans

and

Roberta M. Eldridge Miller

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ABSTRACT

AMBIVALENT MODERNITY: SCIENTISTS IN FILM AND THE PUBLIC EYE

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STACY EVANS, B.A., WELLESLEY COLLEGE

M.P.P., KENNEDY SCHOOL OF GOVERNMENT, HARVARD UNIVERSITY

PH.D., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor N. J. Demerath, III

Scientists are widely regarded as high status individuals, who are smarter than the vast majority of the population. Science holds a very high status as a discipline, both within and outside of academe. This notwithstanding, popular stereotypes of scientists are often highly negative, with the image of the socially inept or even mad scientist being commonplace. This apparent contradiction is worth exploring. Additionally, we see the label scientific being used to justify pseudoscience and other results that are flatly contradicted by the bulk of scientific research (e.g., links between vaccines and autism). This is not due, as some argue, only or even primarily to a lack of understanding of science. Ultimately, there are two "sciences": science defined by the scientific methodology of the scientists, and the broader cultural use of science as a truth-teller without real use of scientific methodology. This dichotomy is wrapped up in both the nature of modernity and the idea of post-modernity. This research uses a content analysis of film to examine the nature of stereotypical portrayals of scientists, and a factor analysis of NSF survey data to investigate the complex attitudes towards science and scientists.

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CHAPTER 1

SCIENCE AS METHODOLOGY VS. SCIENCE AS RITUAL: COMPETING UNDERSTANDING

Scientists are different - at least in the way they understand science. To a scientist, science is a methodology, a process, a system for getting the best possible answers to empirical questions. To the rest of society, science is much more and to some extent much less. Science is an ideology, a belief, not really about empirical questions, but definitely about truth. This is not to say that the general non-scientist public has no understanding of the underpinnings of science. However, science has become much more than a methodology. It has become a representation of modernity, of power, of access to knowledge, of perceived superiority. Science and scientists mean more to society than the knowledge they produce. They have become entangled with the way we think about the entire way we live. It isn't as simple as a person working on a problem. The social conception - the idea of the scientist and of science - is much larger than that.

Science is inherently mixed up with these broader issues because it maintains a high status position as purveyor of truth. We believe scientists (except when we don't) when they make a proclamation (more so when it fulfills our own current belief system). However, we also respond to scientists the way the rest of a class responds to the smart kid in class who makes an error, other kids are quick to correct, to laugh, to feel somewhat better, and to ultimately knock the smart kid down the ladder closer to their own position. Fundamentally, as a society that values individualism highly, we don't like people who know more than we do. We also don't like a discipline that tells us some of our deeply held beliefs are wrong. After years of teaching sociology, I am still frequently surprised at the anger that emanates from my students when an inconvenient fact conflicts with a deeply held belief about how the world works. Students will often argue simply, "No, that is wrong." Science tells people that the world is not always the way they want it to be.

Science runs into even more problems because it does not always get the answer right on the first try. Those who work in science know that it takes a while to settle a particular issue, to answer a question, or more frequently set of questions, that one study is generally not enough, that it may be able to examine only a piece of the puzzle. When reported through the distorting lens of the mass media, this tendency seems capricious. "Are pomegranates good for me or not?" Because the real complexity of the science does not get reported, those consuming the news can feel manipulated and wronged by later corrections. Clearly science does not know all.

Even so, when pseudo-scientific theories are put forth, they frequently use the perceived methods of science. Measurements are taken, statistics are given, and if you can get a credentialed scientist on your side, even better. So, when science looks at pseudoscience and declares it as such it looks like sour grapes. "Those scientists don't like this (ESP, Bigfoot, UFOs) because they are too closed-minded." Every article or TV segment about a rebel scientist who struggled on alone against all odds adds to this. We like stories about likable individuals who work outside of mainstream science and triumph. This resonates with our frontier nature, our societal myths about the lone struggle for success, the person who succeeds despite the ridicule of the wider scientific community. Clearly the institution of science is bad.

In this way, science has also become attached to notions of what is wrong with modernity. Pollution, bad food (genetically modified or filled with chemical preservatives), anything negative that comes from technology, can be seen as the result of science gone wrong. Our myths and tales from Mary Shelley's Frankenstein on contain many examples of science gone wrong, often through the arrogance of the scientist who takes on the perceived anti-human perspective of science, ignoring ethical or moral or humanistic issues in a blind pursuit of some irrelevant truth.

Simultaneously and paradoxically, society asks science to fix the problems it has created. This is not thrusting responsibility back upon the offending party, but a true belief in science that co-exists with our suspicion of it. As in the case of the smart kid, we laugh at mistakes to balance the perceived status differential, but then beg for help with our homework. This is not to say that science has never had any negative outcomes. However, this societal belief goes beyond a careful consideration of the real negative outgrowths of science.

For the most part we accept, even welcome science into our lives. We want the technological outgrowths of science - the better health, the great toys, the newest computer - and we expect science to always give us more, better, faster. Yet, we also blame science for many of the negative aspects of our society. We worry about genetic engineering in plants and humans, we blame preservatives in our food for various health complaints, We see science as a destructive influence and scientists as disconnected from society and the emotions that would make them fully human.

Ultimately, science is regarded as more powerful by the broader society than by scientists themselves. It is a belief about our ability to find truth not just for empirical questions, but for everything. Simultaneously, it also viewed as a status-driven, fatally flawed institution that is deeply undemocratic. As a result, science as culture is not wholly amenable to change via education. The science of the classrooms is separate from the science that is part of day to day life. Problems with specific scientific topics can be better managed through particular educational interventions, but the general concept of science, because it is tied up in wider cultural issues, will be a much more intransigent subject.

This allows us to believe in science and ghosts, to ignore results that are inconvenient, and to ask for more answers from those whom we criticize. Ultimately, science does not have one reputation even for one person. Like any broad cultural concept it is fuzzy, messy, and self-contradictory. This description could be used by scientists themselves, but it would have a very different meaning. For the scientist the discussion revolves around methods, results, and the nature of the people using and producing them. The cultural conception refers to an amorphous, abstract idea that is only connected to the real process and product at small moments as specific topics arise. It is for many a metaphor rather than a real practice.

Literature

One of the most active areas of research on science and the public centers around the public understanding of science. This field is primarily directed towards understanding who is scientifically literate in the general population, why, and what can be done to improve scientific literacy. This issue was important enough that the British Royal Society (1985) published a report regarding what should be done to improve public scientific literacy. A public statement regarding that report (1986), quoting the original, describes the central issue for this branch of research quite succinctly: "Would the world be a better, or even a different place if the public understood more of the scope and the limitations, the findings and the methods of science?" The British Royal Society answers a resounding "yes" to that question and, in a new report, describes how public understanding might be improved and who should be directly involved in that effort.

This type of call to improve the public understanding of science generally includes three approaches for doing so: improved education, improved media coverage, and increased public communication by scientists. These calls have been refined and restated (The Royal Society, 2008, 2000) Each of these three spawns an area of research seeking the proper methods for reaching that goal.

Some research has followed this model directly. These studies use relatively simple measures of science knowledge related to attitudes towards science. The measures include roughly ten to twenty questions, usually multiple choice, regarding facts such as the period of rotation of the earth, the relative speed of light and sound, and the evolutionary connection between humans and animals. (Durant et al., 1989, Evans, 1995, Miller, 1983, Miller, 1998, Miller, 2004, Moore, 1998).

Not surprisingly, issues have been raised regarding the construction of the entire enterprise. Sturgis and Allum (2004) point out that most of the work on the public understanding of science has been based on a deficit model. This model assumes that the public does not have enough scientific knowledge, which in turn leads them to doubt the value of science and be suspicious of technological advancements.

The field has debated the meaning of "public understanding of science" vigorously. One central issue has been the proper measurement of scientific literacy. Most studies use some form of knowledge question scale that is based on ten to twenty multiple-choice questions. These questions range from whether the earth goes around the sun to the relative size of electrons and atoms to how lasers work. They also can include, as does the NSF data used for this research (National Science Board, 2002), knowledge questions that are at the heart of the religion/science debate on evolution. For example, the NSF data includes questions about whether dinosaurs lived at the same time as humans and whether human beings developed from earlier species of animals. These questions can be criticized as indicators (e.g., Bauer, 1996, Pardo and Calvo, 2002, Pardo and Calvo, 2004), but they have remained in widespread use.

Some have argued that the popular knowledge questions need only better statistical techniques to analyze them (Miller, 1998). Others add new variables to the mix. Bauer, Petkova and Byadijeva (2000) argue that to truly analyze public understanding of science any analysis must include the degree to which people understand the workings of scientific institutions (Locke, 2001). Pardo and Calvo (2002) question the value of the attitudinal scales constructed from the European Union's semi-annual survey (Eurobarometer) data. These scales cover items ranging from whether science will improve technology to whether scientists are dangerous due to the knowledge they possess. The authors argue that the scales are at best weak indicators of attitudes regarding science, and consequently do not allow for a real understanding of the link between knowledge of science and attitudes towards it.

Others have questioned the manner in which the boundaries of the discourse have been drawn. Myers (2003) questions what is included as discussion of science and the relevant participants (scientists, media, lay people). There is also the issue of directionality of the discourse (Hilgartner, 1990): does the conversation only move from scientists to lay people? Michael (2002) argues that understanding of science is really only a part of understanding how knowledge is constructed in a much wider sense. In other words, we cannot understand public understanding of knowledge without understanding public understanding of everything.

The research has also been criticized (Dickson, 2000, Irwin and Wynne, 1996) for its assumption that distrust of science and technology is necessarily due to a lack of understanding, rather than valid concerns about the potential negative outcomes of science and technology. Due to this newer research and thinking (Miller, 2001), the House of Lords has asked that the enterprise be broadened to constitute a dialog about science, rather than focusing only on improvement of the knowledge of the lay public.

Despite the forgoing, there has been no real consideration of the image of the scientist. Occasionally, questions of image are included as an introduction to other issues (e.g. Nisbet et al., 2002), but even when the negative image embedded in popular culture is decried it is not empirically investigated. In fact, scientists are often called to become more involved in public discourse about science as a remedy (The Royal Society, 1986, Schnabel, 2003, van der Vink, 1997) and only rarely is the problematic public image of the scientist included as a consideration (Garfield, 1987, LaFollette, 1999). These discussions are prescriptive rather than analytical. However, most authors who have expanded on the initial knowledge measurement mode of the public understanding of science, (e.g., Dickson, 2000, Godin and Gingras, 2000, Hilgartner, 1990, Irwin and Wynne, 1996, Irwin and Wynne, 1996, Michael, 2002, Myers, 2003, Sturgis and Allum, 2004) ignore the public image of the scientist.

A second relevant field is a (mostly disconnected) literature that examines the image of the scientist in the media. Studies of film and fiction representations of scientists are generally more literary than sociological, and often are limited in either scope or methodology. Even so, none of the studies (Hirsch, 1958, Jones, 1997, Landy, 1993, Skal, 1998, Sobchack, 1997, Terzian and Grunzke, 2007) find much that is positive about the representation of scientists. Stereotypes do vary, but the variation is limited. They range from the knowledge-hungry evil scientist who ruins the world to the inept bungler who may inadvertently help or may harm.

I will deal with this literature and how my own research on scientists in films differ from it in Chapter two. Meanwhile, one example of this phenomenon comes from Weingart, (2003), who examined two hundred and twenty-two films for various aspects of the representation of science and scientists. Even where scientists are portrayed as relatively benevolent, they were likely to be manipulated by outside interests that take advantage of their naivete. Goldman (Goldman, 1989) concluded that most movies show suspicion towards technology and present it to a large degree as anti-human. Comstock and Tully (1985) examined technological innovation as a major theme and found that the innovator (forty percent of innovators were scientists) tends to be a loner and is as likely to be harmed as to be left unharmed by their own innovation. They found that forty percent of the films showed acts of innovation as harmful to others, thirty percent showed positive consequences and the remaining were neither positive or negative. Technology and science are often dealt with as if they are interchangeable in film which reflects the popular conflation of the two. Finally, Weart's (1988) interpretive investigation of movies, television, government reports, literature and newspaper finds that the stereotype of the scientist is that of a dangerous individual who may also be mad.

These negative stereotypes are softened when we move to an examination of television. Gerbner (1987) found that scientists on television are generally positively portrayed, but they are less positively portrayed than other professions. Thus, one out of five scientists are portrayed negatively, compared to one out of nineteen doctors, and one out of forty law enforcers. They are also more likely to fail: one out of two scientists, compared to one out of five doctors and one out of eight law enforcement personnel. Finally, they are the most likely to kill (5%) or be killed (10%). It is remarkable that scientists are more likely to kill than police. They are shown as stronger and smarter but also as the least sociable of the professions. Finally, while they are not portrayed as the stereotypical mad scientist, their image is somewhat foreboding and "touched with a sense of evil, trouble, and peril" (p. 112).

Beyond acting as a lead in to research on public understanding of science, these studies are not integrated into that literature. One study attempted to connect television or media viewing to the perception of science (Nisbet et al., 2002) but it focused on the image of science rather than the image of scientists.

Finally, there is a third body of literature that does deal with the public image of scientists outside of the media but, it is almost entirely disconnected from the previous two. This work attempts to assess the stereotypes that students in the public education system hold. It starts with Mead and Métraux's (1957) study of high school students' perceptions of scientists that found many negative stereotypes exist. For example, scientists neglect their families, have no social life, and may not believe in God. Conversely, they also found positive stereotypes that include hard work, patience, open-mindedness, and dedication.

Building on this research, the Chambers' Draw-A-Scientist Test (Chambers, 1983) and repeated use of this instrument (Barman, 1997, Barman, 1999, Bowtell, 1996, Demeis et al., 1993, Fung, 2002, Lannes et al., 1998, McDuffie, 2001, Newton and Newton, 1992) finds that stereotypical representation of the physical aspects of scientists develops at an early age. These studies, however, are limited. Little is said about the limits of drawing as a real indicator of a student's perception of scientists, and the implication of what is included in the drawing is often exaggerated. For example, much is made of the fact that scientists are most often shown alone. However, the standard prompt for the exercise ("Will you please draw a picture of a scientist doing science?") predisposes the subject to draw a single scientist. Additionally, this body of work assumes that there is a direct connection between ameliorating this stereotypical image of scientists and improving science education, without citing any evidence to support this assertion.

All three of these literatures could benefit from the others. However, direct integration is unlikely since the levels of rigor of the three vary highly and each speaks to different audiences. Schibeci and Lee (2003) do attempt to make a clear connection between the three literatures, but do not go beyond positing (but not testing for) a correlation between images of scientists, education, and the public understanding of science. Even within the public understanding of science literature there are areas that do not truly intersect. Ultimately, each assumes at least some of what the others are still investigating. Hence, the media image of scientists is currently a bogey man within the literature, whose job it is to scare people into worrying about how the public sees science. Similarly, the public interpretation of the stereotyped image of scientists is ignored by those who look at the media. Finally, the educational literature puts together practices that assume that the connection between images of scientists and science knowledge are understood.

All three discussions have some value, but all need to connect the image of the scientist to knowledge of science. Ultimately, all three literatures see science as a reasonably well contained sphere that is separable from society. Science in these models has clear boundaries, actors, and topics. Knowledge of science can be measured clearly (even if it is not done well now), and attitudes can be directly attached to the thing that is science.

Some analyses do bring in a notion of culture similar to Snow's (1959) *Two Cultures*. Godin and Gingras (2000) provide a useful reconceptualization of the problem of public understanding of science along this line. They argue that the current model is limited in that it does not take account of science's position within the wider culture. Their new model allows for both an individual and a social perspective as dimensions within scientific culture. However, their conceptualization is based on the diffusion of science from scientists to other groups. It does not allow for a notion of science that is disconnected from the production of science by scientists. (Gregory and Miller, 2000, Kirejczyk, 1999, Raza et al., 2002). Hence, the discussion revolves around bringing the general public into the culture of science. This leads back to the same discussions and solutions that plague the earlier PUS (Public Understanding of Science) discussions, although with an added level of sophistication. The solution to lack of scientific understanding and appreciation is better education through the school system and communication by scientists. What is still missing is an analysis of the wider culture itself beyond its response to the scientific establishment. In the broadest representations culture is used as an independent variable that influences understanding and acceptance of science (Allum et al., 2008, Durant et al., 2000, Gregory and Miller, 2000, Kirejczyk, 1999) rather than science itself being a cultural object.

In a broad examination of the research of the past 25 years, Bauer, Allum, and Miller (Bauer et al., 2007) lay out a future research agenda for PUS that does bring in a more complicated relationship between public understanding, knowledge, and culture. However, they still represent scientific culture as something that is hopefully transmitted from the scientist to the public. Scientific culture, used in this way, involves acceptance of the scientific method, but more importantly, acceptance of the results of science. The goal of PUS and the NSF and Royal Society studies is to spread that type of culture more broadly. The plan is that scientific culture should no longer be a perspective held by scientists and their intellectual allies, but by society as a whole.

However, what they overlook is that science is not an encapsulated object that belongs to itself. It is inherently part of the culture and is used and abused differently by different segments of the population. Science does not belong to scientist or intellectuals or academics alone. At least in the U.S., it has become a central part of the culture. It is the central engine of the idea of progress in the past years and is, hence, a central part of the concept of modernity. In these ways it is not a part of the scientific establishment, but part of the cultural ideology in a manner similar to religion, or the notion of the family, or the appropriate form of government. The way people understand, feel towards, and use the objects of science is as deeply involved in these other cultural objects as they are in the work of the scientific establishment. In fact, it is likely more connected to the wider culture than to the methodological process or results of scientific endeavors. Essentially, we have two sciences: the science of the scientific establishment and science as an idea in the greater public. Turning our gaze toward the role of science as an idea will greatly enhance our understanding of the processes.

The Research

This study investigates the nature of the cultural understanding of science in two parts. The first part examines the image of scientists in film. The themes associated with the critique of modernity and of science as the pinnacle of rationalism are clearly represented. The scientist becomes the embodiment of all of our concern, discomfort, and fear about science. The stereotype of the odd, socially inept scientist is alive and well. The destructive power of science is a constant theme. Even so, scientists are not wholly disparaged. They are often the protagonist. However, they cannot triumph using science alone, but must engage in other efforts to solve the central problem of the film, often to correct their own mistakes committed as a result of their own arrogance.

The second part examines data on attitudes toward and knowledge of science. This analysis breaks these perspectives into pro-science and anti-science attitudes. These attitudes are influenced, as one might expect, by the level of scientific knowledge and education of the respondent. However, this is only a small part of what comes together to predict these attitudes. Other attitudes and ideological perspectives, including the idea of scientific destruction and other themes from the critique of modernity, are as, if not more, important. Ultimately, this analysis clearly shows that the cultural construction of science is very different from the methodology of the scientist.

This research brings forth three contradictions. The first is the continuing fight over modernity. Science is a central and revered part of our society, but it is simultaneously seen as the source of the potential destruction of all that is good. Science alienates us from our families, it divides us from nature, and it creates destructive forces that can be loosed on the population. These themes can be seen in both the film and the survey data. Interestingly, post-modern themes do not play as large a role in either the film or the survey data. The ideas of decentered knowledge and the end of grand narratives are not widespread. They crop up occasionally in films, such as when the main character in *Medicine Man* gives up his scientific instruments to search for knowledge (the cure for cancer no less) with a native tribe, but are rare otherwise.

The second seeming contradiction is between the film representation of scientists and the public impression of them. The films in this study (and generally in other studies of scientists in film) present a very negative picture of scientists. They are nerdy, geeky, and often destructive when they aren't being ineffective. Their science is more often a hindrance than a help. This is, in part, an artifact of the medium. Science becomes a narrative tool and when the plot needs a problem to solve, it is easy to use a scientific disaster to create the problem. The same thing can be said for the recent spate of environmental destruction films. However, the question remains why the scientist is the stock character that is so often picked for this role. Clearly, the concerns about modernity are easily represented by science. Movies need characters and science becomes represented by a character in the form of a scientist. Hence, some of the negative representation can be seen to be a result of the easy use of common roles as necessitated by the modern mainstream movie.

In contrast to this cinematic representation, large scale public surveys and the NSF survey data used for this analysis show that scientists are seen quite positively. The 1989 General Social Survey scientists rated a very high prestige score of 73 out of 100 (Davis, 1991). Questions from the survey regarding positive aspects of scientists get very high levels of agreement. When asked if scientists are working for the good of humanity, 86% of respondents agree. The also respond that scientists are helping to solve challenging problems (97%) and are making life better for people (88%).

This positive impression seems at odds with the negative view we see in movies, though this should not be overdrawn. The movies do present scientists as creating more problems than they solve. However, they also present them as protagonists who could potentially be heroes which implies at least the possibility of positive work. Additionally, the outcome of their science is not always or entirely negative. It can be used along with other types of effort (e.g., physical force) to save the day. Even more important, however, is that the survey data shows a much more nuanced impression of scientists and science than do the movies. While there are broad positive attitudes, there are also complex negative attitudes towards scientists and science.

The third seeming contradiction is between positive and negative attitudes towards science. People are not always clearly pro or anti-science. It is possible to be highly supportive (as most people are) and still harbor a significant level of suspicion about science. This may sometimes take the form of a cogent critique of the science as practiced. However, it often represents a seemingly contradictory set of attitudes that assume that science will both improve our lives and destroy us.

These three apparent contradictions are a central part of the social understanding of science and the role of the scientist. We cannot think meaningfully about science without including all of the cultural concerns about the nature of science. Additionally, the way in which science is applied by the public is not aligned with the way it is applied by scientists. The superficial and stereotypical trappings of the scientific method are enough to convince people that something is scientific. As we will see, this is not simply a function of lack of understanding since understanding of and attitudes toward science are surprisingly associated with ideology more than knowledge. This helps explain why pseudoscience is broadly accepted. Hence, the methodology becomes a ritual to be performed to prove something true, rather than a set of rules for practice. Ultimately, science in the public is a cultural artifact. It is understood and used in ways that are not intended by scientists and that violate the fundamental principles of science. Yet, to the public it is science.

CHAPTER 2

IMAGES OF SCIENTISTS: EXAMINING FILMS

Everyone is familiar with the image of the mad scientist. The crazy man wearing a lab coat and concocting evil potions in a dark, dingy lab is such a cultural staple that many of the studies that examine the image of the scientist use this as their starting point for comparison. However, as is the case for many other simple stereotypes, the reality of the representation is much more complex. In addition, the meaning of the image that is constructed has much greater significance than the mad scientist figure would imply. We can elaborate both the full range of the scientist image and the underlying societal ideas by carefully examining how this image is constructed.

What follows here is an exploratory study of the ways in which movies portray scientists. This empirical analysis is a first step in uncovering the societal image or idea of scientists. When members of our culture think of a scientist we ascribe certain characteristics to the individual based on our expectations. Hence, our notion of the role of the scientist is in turn dependent on other ideas that are embedded in the social fabric of American society. Investigating the image of the scientist can not only elucidate the social conceptions of science but also help us recover, if not the origins, at least the elements perpetuating other underlying concepts, including some notion of our feelings towards knowledge itself. Our understanding of the place of science in the world comes, in part, from the images we see of scientists that come from many different locations: television, the news media, school, and movies among others. This research explores the images of scientists in movies as a first attempt to explain our society's ambivalent relationship to science.

Movies can be analyzed in many ways. One of the most common modes of analysis, related to the literary model, is a thematic study. In this type of study, most often seen in the context of film theory, the meaning of the film as a whole is investigated. Other studies have looked at the popularity of different types of movies; still others have focused on the very difficult task of attempting to discover the audience's interpretation of various movies. This work will look at movies as producing ideas, and hence their creators as producers of ideas. These ideas can be separated from the greater theme of the movie and examined in parts. While it is clear that not all members of the film industry would be considered intellectuals in the traditional sense, they are nonetheless responsible for constructing ideas that are then distributed to a wide audience. This group is closer to Mannheim's definition of intelligentsia as "social groups whose special task it is to provide an interpretation of the world for that society" (1936, p. 10). Thus, they are at least partly responsible for the public idea of science.

Clearly, there are "production of culture" (Peterson and Anand, 2004) issues involved in film representations of scientists. Most of the movies in this study come from large studios. As Peterson notes, "[o]nce consumer tastes are reified as a market, those in the field tailor their actions to create cultural goods like those that are currently most popular." (p. 317). This is not to say that the images of scientists are merely a reflection of consumer beliefs, but that stereotypical images of scientists in film, once accepted by consumers, become a resource that filmmakers can and do use.

There are a number of studies that investigate the portrayal of scientists in film. Steven Goldman touches on these issues in his study of technology as represented in film (1989). He concluded that most movies show suspicion towards technology and present it to a large degree as anti-human. His study only examines the scientist as the purveyor of technology; while this is a common representation of the scientist it does not include all of the ways in which scientists are represented. Additionally, since Goldman is attempting to elaborate the ways in which we are suspicious of technology he chooses films with a negative perspective and thus may miss ways in which technology is positively portrayed.

Comstock and Tully (1985) examined 4,541 films released in the United States from 1939 to 1976, using American Film Institute plot summaries that contained scientific or technological innovation as a major theme. Approximately forty percent of the innovators were scientists. An additional thirteen percent were doctors, five percent were engineers and four percent were professors. All of these categories might be defined as scientists, so their data, while not exactly parallel to the current study can be used to illuminate the study of images of scientists. They found that the innovator tends to be a loner and is equally likely to be harmed as to be left unharmed by their own innovation. They found that forty percent of the films showed acts of innovation as harmful to others, thirty percent showed positive consequences and the remaining were neither positive or negative.

There are differences in the frequency of representations of innovation based on historical periods. During World War II and its aftermath and during the 1970s, Comstock and Tully found innovation was relatively scarce as a movie theme (7.14% and 2.86% of movies respectively). It was more common during the Sputnik era and the 1960s (21.05% and 25.00% of movies respectively). Additionally, the type of film that portrayed innovation changed. Science fiction and horror films were the primary vehicle for innovation during the Sputnik era and the 1960s. Drama was more likely to present innovation during World War II and the 1970s. Finally, the success rate for innovation was significantly influenced by the era. During the World War II period there were no failures. In contrast, during the sixties there was a high failure rate (40%) for innovation. The other two periods had failure rates of approximately 15%. While the authors do not address these historical differences in any depth, they do attribute the differences to a combination of genre and historical era. Science fiction, according to the authors, "embodies conventions that encourage a negative portrayal of innovation." (p. 105) They link this genre effect to historical eras of "national malaise." (p. 105) Drama, they argue, allows for a more serious depiction of innovators and innovation. However, they do not address the question as to why this serious examination would not allow for a critical examination of the nature of innovation rather than the stereotypical picture that emerged.

An interpretive study of science fiction movies (Landy, 1993) notes that there have been changes in the images of scientists before and after WWII. Prior to the war scientists were portrayed, for the most part, as lonely geniuses who toiled in their laboratories, misunderstood by society. The creations of these scientists are often disruptive to society (e.g. Frankenstein's creature). After WWII the scientist becomes attached to institutions such as the government or the military. However, this integration into society does not imply acceptance of the work of the scientists. In fact, the authors argue that there is an increase in the tension between the potential benefits and the negative consequences of science.

Spencer Weart (1988) has investigated the image of scientists across a range of media. His interpretive investigation covers movies, television, government reports, literature and newspapers. His work finds that the stereotype of the scientist is that of a dangerous individual who may also be mad. He notes that there are positive images of the scientist (particularly in the first half of the 20th century). Specifically, scientists were seen as "noble geniuses working for the good of humanity." (p. 30) The stereotype changes over time from that of sorcerer (19th century) to scientist as spy (WWII) to scientist as tyrant or monster (post-WWII). Underlying these images are ideas about the nature of the scientist: the scientist as an authority who knows too much, or the scientist as holder of too much power over which society has no control.

One seemingly positive stereotype (popular during the 1930s and 1940s) portrays the scientist as self-sacrificing (e.g., Marie Curie ignoring the risks of radiation to continue her research). However, it was underlaid with the assumption that, along with sacrificing their health or time, scientists also sacrificed a portion of their humanity. Scientists came to be shown as unemotional. Thus, while the work done by scientists was considered valuable in many cases and the scientists were portrayed as generally good people, they were still seen as somewhat odd. While biography can be seen as a different genre than entirely fictional accounts, the film still depicts only a fraction of the story. In fact, the direction the story takes can be especially illuminating. When the person who is portrayed is well studied, and hopefully well understood, the aspects of life that are portrayed represent choices that may more clearly show the ideological base of the filmmaker. Ultimately, Weart argues that while there are many origins for these images of scientists, they are perpetuated by the fact that people are "bewildered and threatened by the advance of technology." (p.36)

David Skal's (1998) book *Screams of Reason: Mad Science and Modern Culture*, analyzes only the image of the mad scientist in movies. He connects these negative images of scientists to what he believes is the dehumanizing nature of scientific materialism. This is a primarily interpretive and non-systematic study that only examines the most extreme images of scientists and largely becomes an excuse for his own anti-science sentiments.

With the exception of the research conducted by Comstock and Tully, there have been no large-scale systematic studies of the representation of science or scientists in film. Additionally, none of the studies directly examined the image of the scientist as the central concern. There is a difference between the image of the scientist, the image of science, and the image of technology: while these three are clearly interrelated they are not interchangeable. There is also a limitation inherent in examining only science fiction films, a method used in several of these studies. While the current study certainly looks at a disproportionately large number of science fiction films compared to their representation among all films produced, nonetheless they do not represent all genres that use scientists as characters. Thus, examining only one genre (science fiction) will ignore potential differences in the representations of scientists.

There has been one systematic study of the image of scientists on television. Gerbner (1987) investigated scientists as portrayed in prime-time dramas from 1973-1983. He found that scientists are on the whole positively portrayed, but they are less positively portrayed than other professions. Thus, as noted earlier one out of five scientists are portrayed negatively compared to one out of nineteen doctors and one out of forty law enforcers. They are also more likely to fail: one out of two scientists compared to one out of five doctors and one out of eight law enforcement personnel. Finally, they are the most likely to kill (5%) or be killed (10%). It is remarkable that scientists are more likely to kill than police. They are shown as stronger and smarter but also as the least sociable of the professions. Perhaps most importantly, while they are not portrayed as the stereotypical mad scientist, their image is somewhat foreboding and "touched with a sense of evil, trouble, and peril" (p. 112). Thus, while the overall image of scientists on television is positive, the scientist has more negative characteristics than other professionals.

The current study examines movies during the period 1990-1994 and finds that the overall representation of the scientist is one of lack of efficacy. Scientists are portrayed as awkward, geeky, socially inept people whose obsession with science is misguided. They are very likely to cause some sort of problem that results from their scientific work. Unfortunately for the scientists in this sample, they are unable to use science alone to solve these problems. The result of this portrayal is a consistent theme: the impotence of science. The real solutions implied by these movies are provided by emotional connection, mystical forces, or (often violent) physical effort. While the stereotypical portrayal is somewhat modulated by the level of sophistication of the film, it exists across all movie types, from comedy to drama to science fiction.

Methodology

This research project used movies shown in the United States in the years 1990-1994. The duration of the period was chosen to allow for a deeper sampling of movies during that time period, while keeping the sample size manageable. A five year period allows for the inclusion of both popular blockbusters and smaller budget, more intellectual films. This scientific sampling method allows for a more balanced analysis than almost all of the previous research on scientists in film since only a fraction of the sociological studies randomly sample movies. Additionally, most other research examines only the representation of scientists without examining the actions of the scientist, and none examines the effect of the scientific endeavors. Finally, most do not use a content analysis instrument, but instead use a holistic interpretive method.

The population of movies was created by examining lists of the top hundred grossing movies according to U.S. ticket sales for each year. Each list was scrutinized to determine whether the movie contained scientists, and whether the movie was made substantially by a U.S. movie company or by a director based primarily in the United States. This process created an initial population list of forty four movies out of a list of five hundred movies (see Table 2.1).

To determine if a given movie contained any scientists I examined movie summaries and character lists. If the plot indicated the probable inclusion of a scientist among the characters the film was included in the population (see Table 2.1). Movies that clearly did not contain scientists or were made in a language other than English, or that were not made by U.S. companies or directors were excluded. The remaining movies were reexamined, where possible, by investigating more detailed summaries of the plot and character lists. This created the original population of forty-four movies that included scientists.

From this group twenty movies were randomly chosen to create the final sample for the study. Some of the plot descriptions for movies in this sample implied or stated that there was a scientist in the movie when there was not one or the scientist did not fulfill the criteria for inclusion described below.

Table 2.1: Original Population of Movies

Ace Ventura: Pet	Gremlins 2: The New Batch	Nell
Detective*	Highlander II: The Quickening	Richie Rich
Andre	Honey, I Blew Up the Kid	**The Rocketeer**
Awakenings	I.Q.	The Silence of the Lambs
Back to the Future Part III	Junior	Sneakers
Basic Instinct	Jurassic Park	**Star Trek VI: The**
Batman Returns	The Lawnmower Man	**Undiscovered Country**
Beauty and the Beast	Little Man Tate	Star Trek: Generations
Candyman	Man's Best Friend	Stargate
Darkman	Medicine Man	Street Fighter
Dracula	Memoirs of an Invisible Man	Terminator 2: Judgment Day
Falling Down	Milk Money	**Timecop**
Fire in the Sky	Naked Gun 2 1/2: The Smell of	**Total Recall**
Flatliners	Fear	**Toys**
Frankenstein	**Naked Gun 33 1/3: The**	Tremors
Freejack	**Final Insult**	
The Fugitive		

*Movies in bold were rejected from the sample.

Movies were considered to contain scientists based on two criteria. The first consists of screen time. If there were no scientists as main or supporting characters the movie was rejected. A main role is one where the character is central to the plot throughout the movie. A supporting role is one where the character is central to the plot of the movie in more than a few short instances. Secondary characters are ones that are seen only for a short while and not repeatedly. Even if the character is known to have been a scientist or had been previously portrayed as a scientist (e.g. Mr. Spock in *Star Trek*), if they were not designated or did not act as scientists in the movie viewed they were not considered to be scientists. This choice ensures that the intent of the director is to portray the character as a scientist.

Movies that only include scientists in secondary roles were not included. This is due to the difficulty in determining from plot summaries all of the movies that contained scientists who were effectively walk-on characters. These characters are generally not included in cast lists or plot summaries and thus, a reliable population of movies containing scientists only as secondary characters cannot be constructed using these methods.

The second criterion was the definition of a scientist. For the purposes of this project a scientist is defined as a person who has a degree in or does research in the physical, biological, or social sciences or mathematics. Medical doctors will be included as scientists only when their role is one of research rather than a purely clinical role, unless that role is central to the scientific endeavor in the movie. Psychologists who are performing the role of a therapist rather than a researcher will not be included. Finally, inventors and technologists (those people who create technology, e.g. a new form of matter transfer) will be included since our society does not make a clear distinction between science and technology. These two criteria produced a final sample of fifty scientists.

When the first examination of the original sample of twenty movies was completed, several films did not fulfill the above criteria. For example, the Plot summary for *Andre* describes one of the main characters as a marine biologist. However, while the real person the character is based on was a scientist this fact is not reflected in the film. Similarly, while *Timecop* supposedly includes the scientist that invented the time machine, there are no scientists in the film that fulfill the criteria for main or supporting characters.

After watching all twenty movies and rejecting five I resampled the population list so as to replace the missing movies. This process continued until the sample of twenty movies that fulfilled all of the criteria was completed. Ultimately, twelve movies were viewed that were rejected from the final sample; thus thirty out of the forty-four movies were viewed. This means that out of five hundred movies the population of movies with scientists over the period of 1990-1994 is thirty-two and the sample used in this study represents 63% of the population (see Table 2.2 the final population list and Table 2.3 for the sample). The entire population was not coded due to the amount of time each movie requires to code and because this is one part of a larger work that will include a broader population.

Table 2.2: Final Population of Movies

Awakenings	Honey, I Blew Up the Kid	Naked Gun 2 1/2: The Smell of Fear
Back to the Future III	I.Q.	Nell
Beauty and the Beast	Junior	Richie Rich
Bram Stoker's Dracula	Jurassic Park	The Silence of the Lambs
Candyman	The Lawnmower Man	Sneakers
Darkman	Little Man Tate	Star Trek: Generations
Fire in the Sky	Man's Best Friend	Stargate
Flatliners	Mary Shelley's Frankenstein	Street Fighter
The Fugitive	Medicine Man	Terminator 2: Judgment Day
Gremlins 2: The New Batch	Memoirs of an Invisible Man	Tremors
Highlander II: The Quickening	Milk Money	

Table 2.3: Sample of Movies

Beauty and the Beast	Highlander II: The Quickening	Naked Gun 2 1/2: The Smell of Fear
Bram Stoker's Dracula	Honey, I Blew Up the Kid	Richie Rich
Candyman	Little Man Tate	The Silence of the Lambs
Darkman	Man's Best Friend	Sneakers
Fire in the Sky	Mary Shelley's Frankenstein	Stargate
Flatliners	Medicine Man	
The Fugitive	Milk Money	
Gremlins 2: The New Batch		

The sample is reasonably representative of the population. When examined by genre there is an underrepresentation of science fiction films (see Table 2.4). Movies in this genre represent twenty-two percent of the population but only ten percent of the sample. Horror films are slightly over represented as they constitute twenty-two percent of the population and thirty percent of the sample. However, as several of these movies could be represented in more than one genre (many could be cross-listed as science fiction) this does not present any significant bias. Additionally, when examined by year released there is a reasonable distribution across all of the years (see Table 2.5). The year 1991 is slightly under sampled and the year 1994 is slightly over sampled. The movies did not show significant differences by year so this slight weighting should not create any bias.

Table 2.4: Sample Representation of Population by Genre

Genre	Proportion of Sample (n)	Proportion of Population (n)
Science Fiction	10% (2)	22% (7)
Action/Adventure	20% (4)	16% (5)
Horror	30% (6)	22% (7)
Drama	25% (5)	25% (8)
Comedy	15% (3)	16% (5)

Table 2.5: Sample Representation of Population by Year

Year	Proportion of Sample (n)	Proportion of Population (n)
1990	15% (3)	18% (6)
1991	25% (5)	18% (6)
1992	25% (5)	22% (7)
1993	15% (3)	15% (4)
1994	20% (4)	28% (9)

The movies were viewed using a content analysis instrument (see Appendix A). I divided the analysis into an examination of five general categories: movie attributes, basic demographics for scientists, scientist's role within the film, personality characteristics, and attitudes of other characters towards scientists. Since this is part of a larger research project, not all of the data collected by the content instrument will be used for this analysis. Specifically, the fourth and fifth categories (personality characteristics and attitudes of others) will not be included here. Most of the content categories are simply defined by the coding categories as listed in Appendix A. Those that are complex will be described here.

The first category, movie attributes, collected basic film level (as opposed to character level) information, themes and content. This includes aspects such as intellectual level, basic plot, the time and place the movie is set, and the role and the use of science and technology. Intellectual level is simply designated as high, mid and low. Films that are directed at a high intellectual level are more complex in plot and characterization and less likely to have a simple plot conclusion. Films at a middle intellectual level represent mainstream Hollywood movies. These films have more simple plots and characters but are not wholly formulaic or sensationalistic. Films at a low level are directed towards a juvenile audience and are formulaic with little character or plot development.

The centrality of science to the plot is determined by the degree to which science is the central issue of the story. Thus, in *Milk Money*, science is mostly irrelevant because the story is primarily about romance. The scientist (known primarily as Dad) could have had any other profession where he needed to have a just but possibly hopeless cause. The centrality of science is tangential when it helps move the plot along but is still not the central idea of the story, as in *Richie Rich*. In this movie science is used to help catch the bad guys but other means are used as well. Science is central to the plot when science is the story as in *Mary Shelley's Frankenstein*. In this movie the entire plot revolves around the use of science.

The second category, basic demographics for scientists, examines the general characteristics for each scientist. These include the nature of the scientific research, the type of scientist, their institutional affiliation, dress and types of research conducted. This section was completed for each scientist who appeared in the movie.

The third category, scientists' role within the film, examined the way in which the scientists and the work of the scientists fits into the structure of the movie. This includes the centrality of the character, which measures how important the character is to the plot (e.g. main, supporting or secondary). The character's centrality is determined by the importance of the character to the plot of the movie as well as their time on screen. Main characters are most often shown and are central to the plot. Supporting characters are important to the plot and are seen several times or for at least one extended scene. Secondary characters may appear only once and are generally seen for a short time. Members of crowd scenes who do not speak were not coded.

Summary

Most research on film representations of scientists to date have been unscientific in design and literary in analysis. While they provide us an insight into images of scientists, they suffer from significant selection bias. Films are often included because they include negative representations of scientists. While this is not a flaw if the purpose is to investigate negative representations of scientists, they do not tell us how scientists in film are generally portrayed.

This study does not presuppose a particular portrayal of scientists. The project was designed to give a relatively deep coverage of movies from one period to see the range of potential representations. The short time period avoids the common problem of investigating only box office hits which may miss more nuanced smaller films while allowing for an in depth examination of each film.

The inclusion of scientists as leading and supporting characters, rather than focusing on scientists as protagonists as most studies do, also provides a broader examination of film representations of science. As we will see in the next chapter, the broader examination, while there was some variation, did find a persistently negative image of scientists.

CHAPTER 3

MAD SCIENTIST, INCOMPETENT SCIENTIST: IMAGES IN FILMS

Despite the breadth and depth of examination of the films in this period, there is little variation in the representation of scientists. The movies examined here include images that parallel the stereotypical image of the scientist. Usually only parts of the image are used to construct the character, most often those of the destructive mad scientist and the nerdy, awkward scientist. While the use of these images tells us much about what scientists mean in the movies, there is more than these characteristics in their representations. Most interestingly, scientists are widely portrayed as the creators of problems that must be resolved using methods other than science. Ultimately, the scientist may even reject science.

Scientist Identification and Type

It is clearly evident from the movies in this sample that scientists need no introduction. Half of the scientists are not introduced directly as scientists; their role is generally assumed by location, dress or type of work. The white lab coat is so ubiquitous as a form of identification that cosmetic companies wanting to seem scientific put their sales people in lab coats. Placing a scientist in a room with equipment that is meant to look scientific (e.g. lab glassware, microscopes, black lab tables, various gauges and meters) is another way that scientists are often identified as scientists. Those that are directly identified as scientists are usually signified through address, whether as doctor or professor. This combined with location allows the viewer to identify the character as a scientist. In *Darkman*, for example, the two scientists are first seen in a room with varied technology and glassware. The main character, Dr. Payton Westlake, is seen taking pictures of his assistant. When he starts scanning the pictures into a computer he becomes a scientist to the audience.

Scientists are also rarely categorized directly into disciplines. One of the central organizing principles of the academic world is not of particular interest in these movies. Most of these scientists never introduce themselves or are introduced by others by discipline or make any real reference to their area of study. Only rarely is their research described as it would be by scientists in reality. Dividing scientists into types for the purposes of this research, hence, is based on the kind of equipment they are working with and extrapolation from verbal clues about their research.

Occasionally, as in *Highlander II: The Quickening*, the scientist's actual research is described in detail. In this particular case the protagonist's work in creating a shield to protect society from the harmful rays of the sun is described in voiceover. This is done not to make sure that the audience knows what type of scientist he is, but rather to shorten a discussion of this portion of the story. The primary character's role (Connor McLeod, the Highlander) is not really centered around his position as a scientist, so the voiceover provides an efficient way to establish this aspect without interfering with the more crucial aspects of his place in the film (as a supernatural superhero).

The general lack of specific details regarding the scientists' work is to be expected. The writers and directors include only that which is necessary to convey important information that moves the story along for the audience. The exact discipline, sub-discipline, or research project is not crucial information for the audience. However, this tendency accentuates the monolithic nature of science that is presented by these movies. The exact nature of the scientist is not the determining factor for the character. The most important information is merely the fact that the person is a scientist. Thus, the scientist becomes closer to a single type rather than a myriad of different types.

The resulting distribution of scientists into broad disciplines is indicative of the popular definition of a scientist as a physical or biological scientist, i.e., a chemist, biologist, or physicist. Few people outside of the academic world would consciously place social scientists into the scientist category, and this tendency is reflected in the movies in this sample. The largest number of scientists represented are "hard" scientists with chemists, biologists, and physicists making up 38% of all of the scientists. While this category does include one mathematician, he is represented as a researcher who creates military technology (*Sneakers*) rather than a mathematician only, and thus is also closer to the stereotypical view of a scientist. Social scientists and medical doctors represent 22% of the total each. The remaining scientists are technologists (10%) and unidentified scientists (8%).

There is an even greater trend towards stereotypical scientific disciplines when looking at the centrality of the scientist's role. Medical and hard scientists make up the majority of all main characters (38% each) as compared to social scientists (19%) and technologists (6%). All types of scientists are more evenly represented among the supporting characters, with a slight bias towards hard scientists. There is an even stronger tendency towards hard scientists in secondary roles (42%). All of the characters whose discipline is unknown are secondary characters. This is an unsurprising outgrowth of the lack of clear discipline designations for any of the scientists. Since secondary characters are only on screen for a few moments there is little opportunity to determine the type of research they do. They are usually easily designated as scientists by location (in a lab, for example), dress (wearing a lab coat) or address (being called Doctor).

Geeks and Nerds: Personal Characteristics of the Scientist

The breakdown of scientists by sex represents both reality and stereotypes. The majority of the scientists, not surprisingly, are male (72%). Female scientists are most likely to be social scientists: almost half of all female characters coded (45%) are social scientists. However, social scientist characters are evenly divided between males and females. Both pure and medical scientists are approximately 80% male, and technologists are entirely male.

There was little ethnic or racial diversity among the scientists. There was one black female supporting character and one Asian male secondary character. The only diversity in ethnicity was the large number of European scientists. However, this is the result of movies that were set in Europe (e.g. "*Mary Shelley's Frankenstein*") and not because many movies set in the United States included European scientists.

The physical representation of scientists is also stereotypical. A rumpled, physically unfit, awkward man with messy and often long hair fills the standard expectation and goes along with the lab coat as an easy identifier of position as scientist. This measure, appearance, is a compilation of dress, cleanliness and physique. While not all scientists were portrayed as unkempt, poorly dressed, overweight or awkward there was a clear tendency towards representing scientists in this manner. For example, the scientist in *Beauty and the Beast* (Belle's father) is portrayed as a short, fat man who wears bizarre clothes and is generally unkempt and awkward. Dr. Alan Neyman, co-creator of the shield in *Highlander* is overweight and ill dressed. Professor Keanbean in *Richie Rich* is oddly dressed, overweight and physically awkward. Approximately half (47%) of all the scientists in the sample had one or more of these negative physical characteristics. Technologists were most likely to be represented in this way, fulfilling the expectation of the crazy inventor. Three of the four characters in this category were portrayed with one or more physical attributes that would be seen as negative.

The ultimate representation is Dr. Wayne Szalinzki in *Honey I Blew Up the Kid*. He dresses poorly, is only minimally groomed (especially for the main character in a movie) and is usually wearing some strange invention on his head. It is important that Rick Moranis was chosen as the actor for this part. His physical type fulfills the stereotype of the oddball scientist. He is, as he represents himself in film, awkward and goofy. The role could not be the same if Tom Cruise were to play it. Hard scientists (69%) were also more likely to be portrayed in this way as well. Finally, the two categories of medical doctors and social scientists, people who are less likely to be identified as scientists in the minds of the general public, were much less likely to be represented with negative physical characteristics (27% each).

However, scientists' centrality in a film is also significant in the physical representation. Main characters were more likely to be represented without any negative physical traits (63%) than with them. They were also more likely to be physically neutral or attractive than were supporting characters. Over half (58%) of supporting role scientists were presented with negative physical characteristics. The secondary characters were very evenly split between positive/ neutral and negative physical types. It is more difficult to portray a protagonist as an unappealing character than to have his or her sidekick be odd or unattractive. Nonetheless, the protagonists are often a bit eccentric. Dr. Jackson in *Stargate* is the central character. He is clearly attractive (played by James Spader) but wears a long, odd looking scarf and has slightly messy hair and the obligatory glasses. His physical appearance is a signifier of his role as scientist.

There is also an important “movie level” effect. Movies directed at a low intellectual level are more likely to present stereotypical presentations of scientists than are movies at directed at a general level or a highly intellectual level. Scientists in low level movies are more likely to have at least one negative physical characteristic than in any other type. Sixty-two percent of scientists in these movies are portrayed with negative physical characteristics as opposed to only 33% of scientists in high level movies. Mid-level movies split the portrayal of physical type almost evenly between negative and positive/neutral portrayals of physical type.

Scientists Messing Up: Problem Creation

The scientists in these movies are overwhelmingly responsible for creating some problem that must be resolved. These range from small problems that delay the resolution of the larger problem, to creating the central problem of the movie. Three quarters of the scientists are directly responsible for at least one problem (large or small). Sixty percent of the scientists are at least partially responsible for the central problem of the movie.

Medical doctors (72%), social scientists (72%) and pure scientists (63%) are all very likely to be at least partially responsible for causing the central problem. Only forty percent of the technologists share some blame for the main problem; however, all of them create at least one serious problem in the film. Ninety percent of medical doctors, eighty-one percent of social scientists and sixty-eight percent of pure scientists create at least one problem.

When problem creation is examined at the level of the movie we see that fifty percent of the movies have central problems that are created by a scientist (see Table 3.1). Twenty percent have central problems that are partially created by a scientist. In only thirty percent of the movies is a scientist not responsible in any way for the central problem. When we look at the creation of any type of problem we are left with only two movies or ten percent of the sample where scientists don't create any problems (*Dracula* and *Milk Money*).

Table 3.1: Scientist's Responsibility for Creating the Central Problem

Fully Responsible	**Partially Responsible**	**Not Responsible**
Beauty and the Beast	Gremlins 2: The New Batch	Bram Stoker's Dracula
Candyman	Little Man Tate	Darkman
Fire in the Sky	Medicine Man	Milk Money
Flatliners	Sneakers	Naked Gun 2 1/2: The Smell of Fear
The Fugitive		Richie Rich
Highlander II: The Quickening		The Silence of the Lambs
Honey, I Blew Up the Kid		
Man's Best Friend		
Mary Shelley's Frankenstein		
Stargate		

The ways in which scientists create the main problem can be classified easily into three standard types: creation of a monster, scientific arrogance, and business misuses of science (see Table 3.2). The creation of the monster follows the all-too familiar Frankenstein theme: the scientist attempts to change nature and unleashes a monster on society. Scientific arrogance creates a problem by pursuing some scientific result without concern for the consequences to society or another individual. While the monster theme could fit under this heading I reserve it for those instances where there is no monster as such. Business is often portrayed as misusing science to further its own ends (usually monetary gain). This is not surprising, since as Lichter, Lichter, and Amundson (1997) report, over three decades television has represented business more negatively than other occupations. However, what is interesting is the degree to which the results of the scientist can be manipulated by business. In this category the worst tendencies of business and the scientist come together, and a monster created by a scientist is manipulated for business purposes.

Table 3.2: Type of Problem Creation

Monster	Scientific Arrogance	Business
Beauty and the Beast	Little Man Tate	The Fugutive
Candyman	Medicine Man	Highlander II: The Quickening
Fire in the Sky	Sneakers	Honey, I Blew Up the Kid
Flatliners	Stargate	Gremlins 2: The New Batch
Man's Best Friend		
Mary Shelley's Frankenstein		

Creating Monsters

This is the largest of the three problem creation types. Of the fourteen films where the scientist has some responsibility for creating the central problem, six are due to monsters that are created or unleashed by scientists. These range from the traditional Frankenstein story (as in *Mary Shelley's Frankenstein*), to modern day horror stories such as *Flatliners*. In these films scientists insist, often against the objections of others, on pushing their research agendas despite the clear danger they are unleashing on the public.

For example, *Flatliners* depicts a group of medical students who are eager to understand death. Each student in turn will be killed and then revived so they can understand death. As a result of their experiment they bring back evil beings that recreate sins they have committed in their lives. The evil that they retrieve through their work causes problems for them and others in the movie. In *Man's Best Friend*, a scientist creates a super dog who is exceedingly smart and especially vicious and when let loose kills. The anthropologist in *Candyman* is arrogant enough to disbelieve the local legend about calling a demon (the Candyman). She chants his name three times to show that her science is greater than their mythology; as a consequence she awakens a supernatural killer who haunts the Cabrini Green housing project in Chicago, where he proceeds to murder several innocent people (an interesting comment on the efficacy of social science research on poverty). The father in *Beauty and the Beast* gets lost on his way to a fair, disbelieves his horse's clearly greater good sense and ends up locked in the Beast's castle, eventually causing his daughter to be locked up by the Beast.

Scientific Arrogance

Scientists create problems through their own obsession with their research in four movies (29%). In this category, scientists become so enamored with their own scientific exploration that they neglect to consider the ramifications of their research. The scientist is separated from society by an obsession with the pursuit of answers that may not be of the greatest value. As in the monster category, these scientists neglect the effect of their work on the wider society or the group to which they supposedly owe loyalty.

For example, in *Stargate* the arrogant assumption is that the main character (Dr. Jackson) is smart enough to solve any puzzle that creates the main problem. In the film he decodes an alien artifact that turns out to be a gate to other worlds.

He then assures the military that he can solve the code on the other side that will allow a team to investigate and return. It is clear to the viewer that he is lying: he assumes that he can figure it out and get them back. However, once they get there he cannot find the solution immediately and they end up stranded on a planet that is attacked by a god-like alien. As a result his arrogance leads to the death of some members of the team.

Business Abuses Science

In four movies (29%) it is the effect of business on science that helps to create the problem. Business is clearly shown in these examples as a corrupting influence on science. In these movies the scientist or science is misused or even falsified to make money. This process always involves the corruption of one or more scientists who must take on the attitudes of the business establishment regarding the centrality of profit over the needs of society or even safety.

For example, in *Gremlins 2* the main scientist attempts to use the gremlins to gain money for the company. He wants to research the evil gremlins' abilities so that they can be harnessed for profit. In *The Fugitive* Dr. Kimball's wife is killed in an attempt to keep him from exposing fraudulent data regarding a drug study. Here, the entire problem is created by the chief scientist working on the research who wants to make money from a potentially dangerous and ineffective drug. In *Highlander 2* science creates a solution to ozone depletion, the shield around the world, which a businessman maintains long after it is unnecessary because it makes him enormous profit, despite the fact that the invention has seriously negative effects on the population.

The Environmental Exception

It is worth noting that the two movies that show the scientist in the most neutral or even positive light are movies with an environmental theme. In *Milk Money* and *Naked Gun 2 1/2* the primary scientists are environmental scientists. Neither of these characters are main characters and the scientific theme is a secondary one. Even so, in *Naked Gun 2 1/2* there is extremely stereotypical scientist. He works for the police department and is only referred to as Ted. He is almost the perfect portrayal of the inept, geeky scientist who spends valuable time discussing irrelevant information. His actions delay the investigation of the police into the attempted murder of the environmental scientist, Dr. Meinheimer. Despite the generally positive light in which we see this latter character, he is still portrayed as a bore. While he has a proposal that will provide cheap, safe energy for the world he cannot make a speech that does not cause the entire audience to fall asleep.

In *Bram Stoker's Dracula*, Dr. Von Helsing helps find Dracula. His research is responsible for understanding what has happened to the woman who was bitten and why. Thus, science helps solve the problem, although the final solution is dependent on physical action. Finally, in *Darkman* science allows for the resolution of the problem but it does so through violent means. The problem is created by corrupt business and Dr. Westlake's science allows him to impersonate people in ways that he knows will lead to their deaths.

Ineffectual Scientists: Problem Solution

While scientists are likely to cause a problem, science is not likely to be the solution of the problem. Science may be a small part of the solution, but the ultimate resolution of the problem typically relies on other means. While thirty scientists (60%) participate in creating the central problem of the film to some degree or another, only eighteen scientists (36%) participate in the solution of the main problem. These eighteen scientists come from thirteen of the twenty movies. Only three of these eighteen scientists did not participate in the creation of the central problem (Dr. Kimball in *The Fugitive*, Dr. Von Helsing in *Bram Stoker's Dracula*, and the father in *Milk Money*). Thus, in approximately one third of the movies the scientist is not at all responsible for the solution of the problem even though he or she is likely to have caused it.

There are three main categories for the ways in which scientists help solve the central problem of the film: science, physical effort, and emotional/spiritual changes. These categories can overlap, allowing a scientist to use two of these methods to solve the problem at hand. The Venn diagram (see Figure 3.1) represents the main method or methods scientists use to solve the central problem in the film.

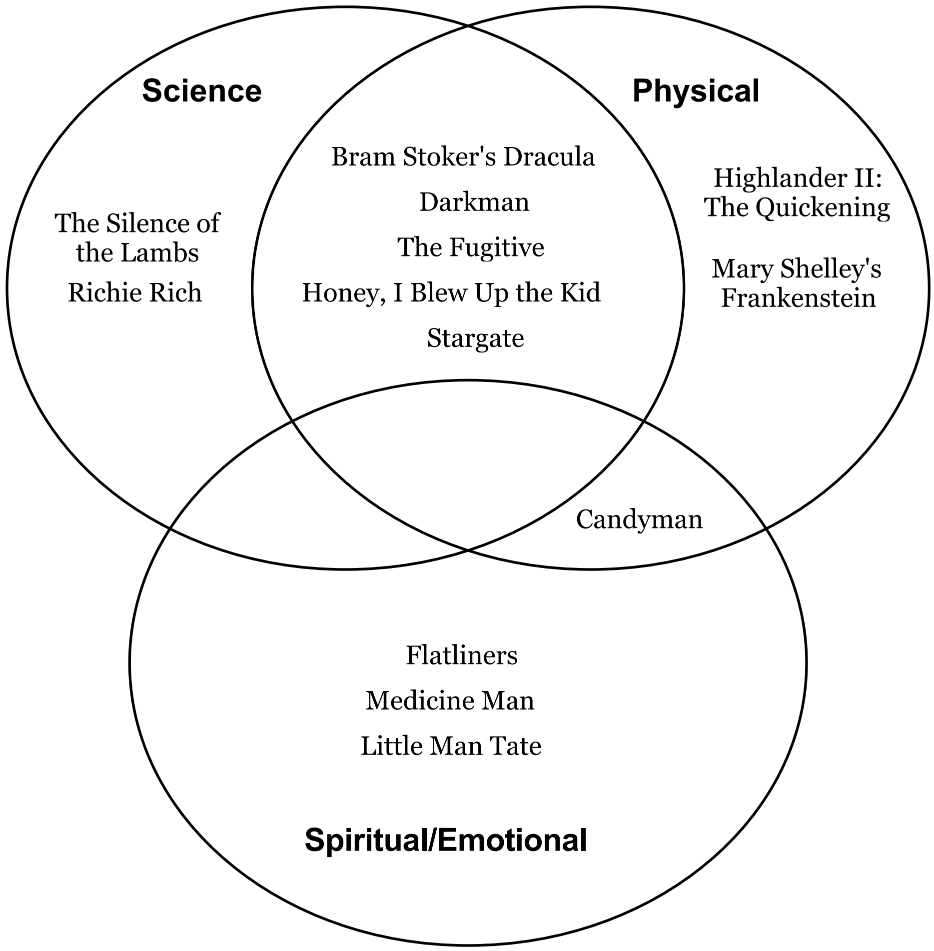

Figure 3.1: Central Problem Solution Types

Only three scientists (16%) participate in the solution of the central problem through the use of science alone. One of these characters is a supporting character (Dr. Keanbean in *Richie Rich*) and two are secondary characters (Dr. Pilcher and the graduate student in *The Silence of the Lambs*). In Dr. Keanbean's case his inventions help catch the people who are trying to steal the Rich fortune. However, they also almost prevent that capture as well when they misfire, capture the heroes instead of the villains and generally fail to work as intended. In *Silence of the Lambs* scientific knowledge is a partial solution to the main problem. While the two scientists are not immediately involved in the final solution themselves, they are instrumental in its resolution.

Science together with physical effort is another way that scientists participate in the solution of the central problem. Twenty-seven percent (five) of the scientists participate in the solution of the main problem through the use of a combination of science and physical effort by the scientists themselves. In this type of solution the science is generally secondary to the physical. Thus, science may help to solve the central problem (that it most likely created) but only as an adjunct to the physical prowess of the protagonist. In fact, in this category *Darkman* is the only movie that does not have a scientist protagonist who creates the problem. However, in this movie, science is used in negative ways (getting people killed or maimed) to help prevent the corrupt businessman from completing his plan.

In *Stargate*, the scientist solves the archeological puzzle that allows the people to return to their planet, but he must also save his companions who have been taken hostage. He solves this part of the problem through the use of physical force. He grabs a weapon and shoots the captors, allowing his companions to free themselves. This, rather than his discovery of the solution to the archeological puzzle, is shown as his triumphant moment.

In *Honey, I Blew Up the Kid*, Wayne Szalinski accidentally uses a ray gun on his toddler that makes him grow to building size. Several attempts to reduce the child fail and he goes on a giant toddler rampage. Only Dr. Szalizinski's physical effort (jumping into his son's giant pocket) that puts him in grave danger, coupled with his emotional connection to his son, allow him to apply the scientific solution to reduce the child to normal size.

Three scientists (17%) resolve the main problem through physical effort alone. In these films science is not a part of the solution in any significant way. All three of these movies are very distinct in theme and treatment. In both *Mary Shelley's Frankenstein* and *Candyman* the protagonists are clearly defined by their role as a scientist. However, in *Highlander II: the Quickening* the scientific aspects of the protagonist must be introduced as a side story to an audience familiar with the character in his role primarily as a superhero. Thus, it is the first two films that may be more predictive in this category. *Mary Shelley's Frankenstein* is the prototypical mad scientist film. While there are significantly deeper themes in the movie, the one that stands out (based on the almost constant popular culture references) is that of the scientist's project gone awry. This is also the theme of *Candyman*. In this case, as in the simplistic reading of any retelling of Frankenstein, the scientist creates a monster. The arrogance of the scientist is the reason the beast is unleashed on an unsuspecting and undeserving populace. The character then sacrifices him or herself to gain redemption. In *Candyman*, the anthropologist who calls the Candyman, Helen Lyle, must throw herself into a bonfire to defeat the demon. Her anthropological research uncovers the myth of the Candyman, but is unable to defeat it.

In the remaining forty-eight percent (seven movies), problems are solved through the use of emotional or spiritual methods. In this type of solution a scientist must either come to terms with an emotional problem, or alternatively turn the issue over to a spiritual power. For example, in *Medicine Man* the main character cannot find the chemical responsible for the cure for cancer he has discovered until he is shown the answer by the native medicine man, through the use of mind altering substances and a dream which the scientist must interpret. Only when he releases his grip on the scientific and accepts the mystical is he able to solve the problem. Dr. Jane Grierson, in *Little Man Tate*, cannot truly reach Fred Tate until she learns to connect with him emotionally. She is charged with the development of Fred, who is a genius, when his mother allows him to join Dr. Grierson's school for the gifted and talented. There is some irony here, in that Dr. Grierson as a psychologist would have studied child development and would therefore have some knowledge of the emotional needs of her students. However, such training would not fit with the overall picture of scientific geniuses who are emotionally disturbed as a result of their genius. The final scene of the movie shows Fred's birthday, where a reluctant Dr. Grierson learns to relax and have fun by wearing a party hat and dancing.

Giving Up Science: Recovery of Identity

Eleven of the scientists portrayed in these movies undergo an important transformation as a result of their scientific research. This transformation consists of a recovery of personal identity that encompasses at least a partial rejection of their role as a scientist. This rejection is often presented as if the character had been under the influence of some outside force, causing them to act inappropriately, ignore the needs of others or even place others in danger. Thus, to resolve the central problem of the film they must come out of their science-induced fog and see the world the way it is. This is not entirely surprising when the character is the protagonist, as he or she must undergo some transformation in the course of the film. However, it is telling that in eight out of ten movies (all but *Darkman* and *The Fugitive*) one or more of the main characters who are scientists reject science to some degree as a result of their transformations.

One of the most extreme examples occurs in *Stargate*. In order to save his comrades (whom he has trapped on a dangerous planet) Dr. Jackson must use physical force. When he transforms into the hero (by rejecting his scientist role) he moves more confidently and looks more heroic and less mousy. He walks and acts more like the military personnel he has traveled with, than the scientists he started the investigation with. As a scientist he was always behaving in awkward and inappropriate ways, seeming to be enveloped in a cloud of his own thought. He walked into people, took newspapers out of the hands of someone without asking, and wrote on computer monitors with permanent markers. These were all examples of how his scientific mind worked. He was focused on his science and not the needs of the people around him. This is a clear foreshadowing of how science, for him, overrides the needs of people. It effectively sets the audience up for the central problem he creates through his scientific arrogance.

However, once he has transformed into the hero he is more closely welcomed into the company of the soldiers. He becomes "one of the guys" and no longer maintains any of the attributes associated with his scientific persona. In the end he fully rejects his scientific personality by remaining on a primitive world from which there is no return since the military plans to destroy the gate on the earth side. Clearly, he cannot be an archaeologist on a pre-literate planet. His permanent exile prohibits him from communicating with any other scientists even were he to continue with his work. The implication is that he plans to "just live" rather than continue his work. Therefore, he can finally find happiness with a woman he loves while leading a simple, prescientific life.

Another fairly obvious example occurs in *Medicine Man*. Dr. Campbell is attempting to find a cure for cancer in a South American rain forest. We learn that on a previous expedition he allowed his quest for an answer to overwhelm his good judgment, and as a result many people died. His current research project produces interesting and very promising results that he cannot verify scientifically. The point of transformation occurs when he uses his only working sample of the anti-cancer drug (which is irreplaceable) on one of the children from the native tribe. As a result of his sacrifice he receives the wisdom of the local medicine man who gives him the answer to his quest in a dream. He and the female scientist who has been sent to monitor his work take on the ways of the local tribe and move deeper into the rain forest in the final scene, presumably to continue looking for the cure. The culmination of the movie makes it clear, that while he will still use some science, it is no longer his central tool. He becomes a nicer, more compassionate human being as he releases his grip on science and accepts the mystical.

Finally, a less extreme example of this phenomenon comes from *Honey, I Blew Up the Kid*. When Dr. Szalinski is able to shrink his child back to size he reunites with his entire family and promises to be more involved in their lives, rather than obsessed with his inventions. He does not reject his science as fully as in the previous two examples, but acknowledges its role as a potentially negative influence that could destroy his family.

Summary

The images of scientists in these movies will not simply be accepted at face value by a gullible public. Each viewer will adopt a slightly different perspective on the movies; however, all of those perspectives will include the central fact that scientists may be impotent with respect to solving the problems they construct. This transfers power from the scientist to the public who must regulate and manage the scientist. Furthermore, they will at least hear the message that scientific knowledge production is central to the construction of the ills of modern society. I am not attempting to evaluate the validity of these statements, but rather point out that they form a central and widely viewed portion of the discourse about society. The cultural dissonance that is managed through this countervailing discourse becomes not only an issue for the moviegoers, but also for our notion of science at a wider societal level. The images in these movies will influence how people think, and will affect at the very least the ways in which science must respond to the commentary from the outside. Ultimately, they provide a locus of negative images that pervade the discourse on science and hence affect its authority in society.

CHAPTER 4

UNDISCRIMINATING SUPPORT: POSITIVE ATTITUDES TOWARD SCIENCE

The National Science Board publishes a biannual report entitled *Science and Engineering Indicators*. The report is based, in part, on a broad public survey of attitudes towards science. The report examines attitudes towards science in a binary fashion; do people have positive or negative attitudes towards science? As the negative stereotypes seen in the film study imply, people's attitudes are much more complex than their potential position on a scale where one end represents positive attitudes, and the other negative attitudes. In fact, as this analysis shows people can hold both positive and negative attitudes simultaneously. We love science and hate it, we love scientists, and hate them. We rely on science to solve problems while condemning it for causing problems. This does not seem problematic when stated in this manner. Even when science is viewed as relatively monolithic, it may have successes in one area and failures in another. Hence, this type of attitude toward science is not unrealistic or contradictory. If it were merely a nuanced impression it would seem a mature way to understand science. However, as the data show, people have complex, self-contradictory attitudes towards science.

Methodology

The central analysis here revolves around a factor analysis of the NSF survey data. This method was chosen for its ability to find underlying associations in the data that form an implicit construct. It is particularly valuable for datasets with broad ranging questions to excavate complex and often unintuitive connections between the answers.

The NSF phone survey includes data on a wide range of questions from 1,574 adults. Questions range from attitudes toward science, to attentiveness to issues of the day (education, economics, foreign policy), to scientific knowledge questions, to media usage. This particular survey included questions regarding attitudes towards scientists that had not been included in previous years, and that are central to this analysis. The data for the 2002 report, collected in 2001, is the source for this analysis. The survey oversamples educated people; however, a weight has been used to correct for this where appropriate.

The analysis used exploratory factor analysis in STATA to develop a broad ranging group of variables that are associated with attitudes towards science and scientists. The process included most of the questions in the survey to allow for the widest possible influences. Items that did not contribute to well-formed factors were dropped. Some questions were tested in a grouped format. For example, science media usage was combined to form a single variable. However, none of the combined variables were retained in the final analysis. Variables that did not have factor loadings over 0.25 were dropped. A varimax rotation was used to ensure the diversity of loadings on the factors. This produced well formed factors. Only one variable loaded across two factors. The degree of harm (as opposed to the degree of benefit) caused by science (I2B) loaded on both the pro and anti-science factors.

Factors one and three represent pro and anti-science attitudes and will be discussed in depth in this chapter and the next. They represent the degree to which respondents have positive attitudes towards science and the degree to which they have negative attitudes towards science. Since these are separate scales, positive attitudes are not merely the absence of negative attitudes. People may have highly positive attitudes towards science or very low positive attitudes towards science. Separate from that measure, they may have very negative attitudes towards science or not very negative attitudes towards science. In fact, they may have highly positive and highly negative attitudes simultaneously.

The resulting analysis produced three well-formed factors (see Table 4.1) that explain the variance in the data well. Cronbach's alpha, a measure of how well the factor measures a unidimensional construct, for the pro-science factor is 0.75 (factor 1) which meets the standard test of exceeding 0.70. The anti-science factor (factor 3) is less internally consistent, but comes close with a value of 0.67.

Table 4.1: Factor Analysis

Method: iterated principal factors — Retained factors = 3
Rotation: orthogonal varimax (Horst off) — Number of params = 93

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.74451	0.58693	0.3966	0.3966
Factor2	2.15757	0.13895	0.3118	0.7083
Factor3	2.01863	.	0.2917	1.0000

LR test: independent vs. saturated: chi2(496) = 1.2e+04 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
H1	**0.2810**	0.0858	0.0193	0.9133
H3	-0.1473	-0.1010	**0.3328**	0.8573
H4	**0.2674**	0.1487	0.0520	0.9037
H7	0.0148	-0.0574	**0.3266**	0.8898
H8	-0.0990	-0.0947	**0.3454**	0.8619
H9	-0.1775	-0.0114	**0.3564**	0.8413
H11	**0.2718**	0.0511	0.0076	0.9235
H12	-0.0752	0.0126	**0.2854**	0.9128
H15	-0.1891	-0.0269	**0.2898**	0.8795
H16	0.1109	0.0359	**0.2610**	0.9183
I1	**0.5398**	0.2472	-0.1021	0.6371
I2A	**0.5836**	0.2285	-0.1875	0.5720
I2B	**-0.3432**	-0.0844	**0.3196**	0.7729
I3	**0.6196**	0.0266	0.2065	0.5727
I4A	**0.7351**	-0.0195	0.0668	0.4548
I4B	**-0.4909**	0.1025	0.1848	0.7144
L1	0.0395	-0.0008	**0.2765**	0.9220
L2	-0.0925	-0.1264	**0.3048**	0.8826
L4	0.0717	-0.0268	**0.4679**	0.7752
L6	0.0451	0.0028	**0.4523**	0.7934
L8	0.0932	0.0323	**0.3615**	0.8596
L9	0.1264	-0.0151	**0.4964**	0.7373
M9	0.1001	**0.3208**	-0.0030	0.8870
P3	0.0188	0.0339	**0.2692**	0.9260
P4	0.1452	**0.5446**	-0.0177	0.6820
P5	0.1070	**0.4978**	0.1005	0.7306
P6	0.0443	**0.6324**	-0.0969	0.5888
P7	0.0252	**0.7671**	-0.0081	0.4109
P8	-0.0033	**0.3926**	0.1328	0.8282
P10	0.1593	**0.3706**	-0.0758	0.8315
P11	**0.4275**	0.0636	0.0191	0.8128
P13	**0.4388**	0.1355	0.0555	0.7860
Cronbach's alpha	0.75	0.71	0.67	

A quarter of the respondents have high or moderately[1] high factor scores on both scales (see Table 4.2). We like science, but we are also concerned about it. Were these to be completely opposite characteristics, respondents would only align with one clear factor where one side of the scale represents positive views and the other negative views.

Table 4.2: Distribution of Pro and Anti-Science Factor Scores

	Anti-Science				
Pro-Science	Low	Moderately Low	Moderately High	High	Total
Low	3.0	3.5	5.2	4.5	16.2
Moderately Low	5.4	13.3	14.9	4.1	37.7
Moderately High	2.5	8.5	10.4	2.4	23.8
High	2.0	8.5	10.0	2.0	22.5
Total	12.9	33.8	40.5	13.0	100.2

Factor two is central to the formation of factors one and three, but is not central to the larger analysis. This factor represents the orientation of the respondents to science in the news and includes the following questions:

M9: The continents on which we live have been moving their location for millions of years and will continue to move in the future.
P4: Have you heard of magnetic therapy, or the use of magnets to cure pain and illness?
P5: Based on what you've read or heard, would you say that magnetic therapy is very scientific, sort of scientific, or not at all scientific?
P6: Have you ever seen, heard or read about the theory of global warming - that average temperatures are rising slowly and will continue to rise mainly because of the burning of coal, oil, and other fuels?
P7: Do you believe the theory that increased carbon dioxide and other gases released into the atmosphere will, if unchecked, lead to global warming and an increase in average temperatures?

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1. Low and high categories are scores one standard deviation below and above the mean. Moderately low and high are scores less than one standard deviation below or above the mean.

P8: De you think that the possibility of global warming should be treated as a very serious problem, a somewhat serious problem, or not a serious problem?

P10: How much have you hear or read about this issue (genetic engineering)?

These questions address issues that are widely covered in television shows about science. The first question regarding the continents is a staple of science shows. Magnetic therapy is a perennial topic on television shows that purport to investigate scientific claims for truth (although they often do not complete a real scientific analysis). Clearly, global warming has been a central news item for the past two decades. As we will see, genetic engineering is a topic that acts as a marker for controversy and the problems of science. This factor acts as an intermediary between the more complex pro and anti-science factors. It measures the degree to which individuals have an awareness of what is widely represented in the media. Ultimately, it represents the non-ideological aspect of science awareness.

The Pro-Science Factor

The fact that many people see science positively is not surprising, even given the negative media stereotypes. The idea of science is deeply embedded in the nature of modern society. Since the Sputnik Era, American status in science education has been a significant national concern. The NSF (2007) has recently created a national action plan for improving science and math education using the international PISA (Program for International Student Assessment) results that show that U.S. fifteen year old science literacy in 2006 ranks 19th out of 57 mostly industrialized countries as evidence for the need for improvement. While news coverage of this test and the TIMSS (Trends in International Mathematics and Science Study) results are not overwhelming, both are covered in national and major urban papers (e.g.,Dillon, 2007, Glod, 2007, Langland, 2008, Teicher, 2007, Toppo, 2007) which generally express concern about our position in international rankings. Occasionally there is a defense of U.S. schools based on the inapplicability of the rankings, or problems with the construction of the rankings (e.g.,Farhi, 2007, Gardner, 2007). All of the articles bring in the issue of the United States' economic competitiveness. Hence, it is not science knowledge that is necessarily the central concern, but rather science as an economic engine.

We know that our ability to understand, use, and apply science is central to continued economic competitiveness, but there is also a moral component to our reach for science education. Scientists are people to be lauded, to be admired, even as we see from their depictions in film that they can be targets to be knocked down. We think that knowing science is good for its own sake, not necessarily as a deep cognitive benefit, but at least as a status symbol.

The positive image of science is not in direct contradiction to the less positive view of scientists seen in the films. There is a clear difference between the acts of the scientist and the general notion of science. The scientist is the representation of the negative aspects of science as practiced, rather than the representation of the concept as a whole. It examines those places where science, generally seen as positive, is perceived to fall down on the job. It also addresses science not as a subject, but as a cultural concept. The scientist is the embodiment of the complexities of the public concept of science with all of the contradictions that implies.

Describing the Pro-Science Factor

The questions that load on this factor can be broken into three basic categories: science in the abstract, science in practice, and science in application. Both science in the abstract and science in practice are conceptual categories without specific references. Science in application deals with the specific subject of genetic engineering. It is interesting to note that the practical ways include the common conflation of science and technology. When science is seen as practical it is often confused with technology. As we will see there is a great deal of consensus that science is good both in both abstract and practical ways. It is only when we get to a specific application, the controversial topic of genetic engineering, that we start to see some differentiation in levels of support for science.

Science in the Abstract

There are four questions that deal with science in the abstract. The first deals with the problematic differentiation between science and technology. It (H4) asks if scientific research that does not bring immediate benefits, but advances knowledge is necessary and should be supported by the federal government. The next three questions are linked. The first (I1) asks whether the benefits or harmful results of science are greater. The second question in the group (I2A) restricts itself to people who say the benefits are greater and asks if the balance is strongly or slightly in favor of the benefits. The third (I2B) repeats the process for those who said the harmful results were greater. This takes us straight back into the question that divides science and technology. While clearly many scientific discoveries lead to potentially beneficial or harmful technologies, scientific knowledge does not control the manner in which they are implemented. In other words, the same scientific knowledge can be used to create a technology that is considered morally good or bad.

Science in Practice

The next two questions ask about the ways in which science and technology impact the daily lives of everyday people. In these questions both science and technology are included directly. The first (H1) asks if "science and technology are making our lives healthier, easier, and more comfortable." The second (H11) asks if they have created "more opportunities for the next generation." In fact, as Robert Wuthnow (1988) argues, technology has become, for many, a secular religion. He notes that we often confuse science and technology in nomenclature so that the word science becomes a substitute for technological advancement. Conversely, Florman (1981) notes the ways in which we have begun to blame technology for our social ills. We feel that technology is out of control: it has begun to control us rather than being under our control.

The complexity of attitudes toward technology aligns with the complexity of our attitudes toward science. We love it when it makes our lives easier and make it a scapegoat for the persistent problems inherent in any society. Since we don't separate technology from science, the presumed negative outgrowths of each become intertwined and ultimately confused.

Science in Application

The last set of questions asks about the clearly controversial topic of genetic engineering. The first set of questions asks about the benefits or harms due to genetic engineering research. First, as in the science question people are divided between those who say that the benefits are greater and those who say the harms are greater (I3). Then each group is asked if the benefits (I4A) or harm (I4B) are strongly or slightly greater. A more specific question (P11) asks whether respondents support or oppose the use of biotechnology in foods. The final question in this group (P13) asks whether respondents support or oppose cloning animals "whose milk can be used to make drugs and vaccines."

Genetic engineering has been widely covered in the news as a controversial subject. A recent poll by the Pew Research Center (2007) shows that half of the population (51%) when asked "All in all which is more important, conducting stem cell research that might result in new cures OR not destroying the potential life of human embryos involved in this research" said research was more important. Roughly one third (35%) said not destroying the potential life. The rest (14%) were unsure. Earlier research (Priest, 2000) found a comparable proportion (52.8%) with a positive view of genetic engineering in general. Significantly fewer people (Group, 2006) are in favor of genetically modified foods. Roughly one quarter of the population in 2006 (27%) were in favor and just under half (46%) opposed the introduction of genetically modified food into the food supply. A slightly smaller proportion (22%) are comfortable with animal cloning while almost two-thirds (64%) oppose it. Another survey (Urban and Huff, 2006) finds that roughly eighty percent of the population is opposed to human cloning.When the issue is framed in terms of medical research (Urban and Huff, 2006, Nisbet, 2004) roughly half of the population is supportive.

Overall Science Receives Overwhelming Support

Overall, the impression of science is very positive. Examining the questions (using weighted data) from the pro-science factor (see Figure 4.1) is telling. Respondents are overwhelmingly positive in both abstract and practical categories. It is only when looking at the genetic engineering questions that the negative opinions become stronger, peaking with the most controversial issue - cloning.

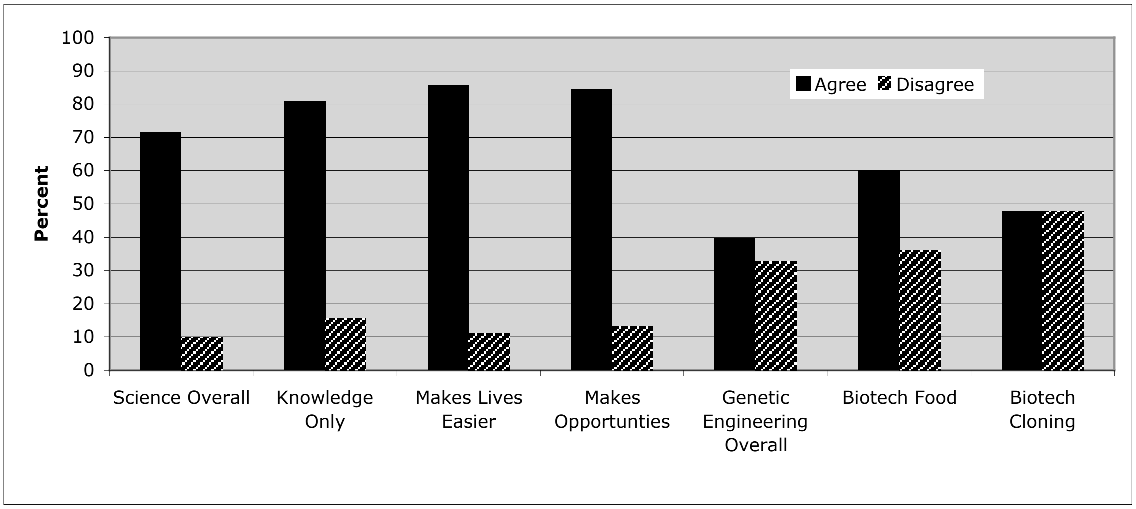

Figure 4.1: Selected Pro-Science Question Responses

We start to see the differentiation between types of science scores by looking at those people with high (one standard deviation above the mean) and low (one standard deviation below the mean) factor scores (see Table 4.3). Separating out these two groups allows a clearer look at those with strong, consistent attitudes. It shows the limits on both ends of the spectrum. Even those with low factor scores see value in both the abstract and practical aspects of science. However, they are much more likely to see harm in science than those with high scores. Again, we see that genetic engineering is a strong dividing line. No one with a low factor score responded that the benefits of genetic engineering outweighed the harmful results. However, some were able to see benefits in genetically modified food and cloning animals for the production of medicine. Even so, these responses are well below that of the general results for this survey and other surveys on the same issue. Clearly, the less positive impression of science has more to do with this controversial topic and a general assessment of the nature of science than any sense of real and immediate impact on their own lives.

Table 4.3: Agreement with Questions for Low and High Values of Anti-Science Factor Score

Categories	**Questions**	**Low Scores** (1 σ Below Mean)	**High Scores** (1 σ Above Mean)	**Difference**
Abstract	Science for Knowledge Only is Okay (H4)	60.8	94.1	33.3
	Benefits of Science Outweigh Harm (I1)	9.0	100.0	91.0
Practical	Science and Tech Make Lives Better (H1)	68.2	97.5	29.2
	Science and Tech Create More Opportunities (H11)	69.4	96.1	26.6
Application	Genetic Engineering Has Benefits (I3)	0.0	100.0	100.0
	Biotech in Food Acceptable (P11)	30.2	89.0	58.8
	Cloning Animals Acceptable to Make Drugs (P13)	18.0	86.7	68.7

Influencing the Factor: Attitudes, Beliefs, and a Bit of Knowledge

A multivariate regression was performed to examine what variables are associated with changes in the pro-science factor score. In what follows it is important to note that the current data set can only suggest, but not prove, causal connections.

The scored factor is bimodal (see Figure 4.2), representing two groups: one that scores lower on the pro-science scale (distribution A) and one that scores as very pro-science (distribution B). This score does not measure any anti-science attitudes (which are measured by the anti-science factor), but rather how positively they feel about science.The distribution was divided up into two roughly normal distributions (see Appendix E) which were analyzed separately.

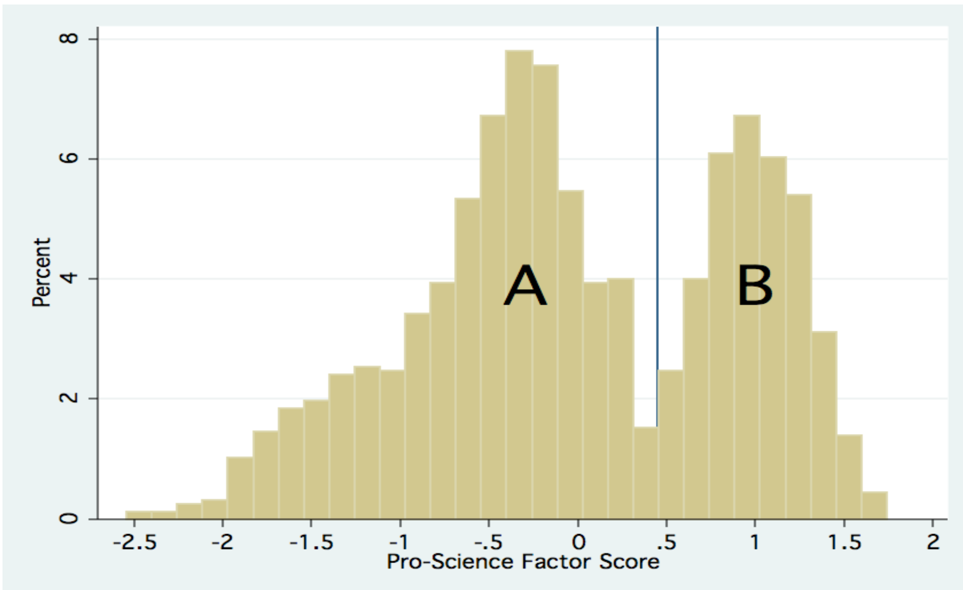

Figure 4.2: Distribution of Pro-Science Factor Scores

Lower Factor Scores: Distribution A

So what predicts lower range pro-science scores? We can divide the answers into four basic categories: knowledge, attitudes, belief in pseudoscience, and stereotypes of scientists. It is interesting to note that no demographic variables were significant. Age, sex, and race did not show any statistically significant effects on the factor score despite the fact that other research shows women generally have less positive attitudes towards science than men (National Science Board, 2008, 2002).

Table 4.4: Pro-Science Regression: Distribution A

Linear regression

Number of obs	= 1005
F(18, 986)	= 23.60
Prob > F	= 0.0000
R-squared	= 0.3114
Root MSE	= .48803

mfs1a	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
SMEDUC	**.0142096**	**.0037366**	**3.80**	**0.000**	**.0068771**	**.0215422**
G2Ar	**-.0511995**	**.0256911**	**-1.99**	**0.047**	**-.1016149**	**-.000784**
CorSum	**.0148023**	**.0060878**	**2.43**	**0.015**	**.0028557**	**.0267489**
P7	**-.0654346**	**.0175271**	**-3.73**	**0.000**	**-.0998293**	**-.0310399**
H10	.0531803	.0153554	3.46	0.001	.0230474	.0833133
MICE	.0828638	.017306	4.79	0.000	.0489029	.1168247
H3	-.0574769	.0157774	-3.64	0.000	-.088438	-.0265157
H9	-.1078643	.0175437	-6.15	0.000	-.1422915	-.073437
H15	-.0962657	.0156814	-6.14	0.000	-.1270385	-.065493
A6	.0693147	.0261325	2.65	0.008	.0180329	.1205965
J4	.039771	.0133636	2.98	0.003	.0135465	.0659954
K2	.1140665	.0366737	3.11	0.002	.0420991	.1860339
P12	.0874905	.0163069	5.37	0.000	.0554901	.1194908
H16	**.0302981**	**.0128446**	**2.36**	**0.019**	**.0050922**	**.055504**
L1	.0531461	.0204782	2.60	0.010	.0129602	.0933319
L2	-.0558335	.018536	-3.01	0.003	-.092208	-.0194589
L3	.0529282	.0183092	2.89	0.004	.0169986	.0888577
L9	.068649	.0156226	4.39	0.000	.0379916	.0993064
_cons	-2.136424	.2715162	-7.87	0.000	-2.66924	-1.603608

<u>Knowledge:</u>

The knowledge variables present an interesting picture of the respondents. The number of science and math classes taken (SMEDUC) has a small, but significant positive effect on the pro-science score. However, self-assessment of their understanding of DNA (G2Ar) has a stronger negative effect. Hence, people who think they have a clear understanding of DNA are more likely to have a lower pro-science score than someone who thinks they have little understanding.

Variable G2B measures the assessment of trained raters regarding the respondent's answer to the question "Please tell me, in your own words, what is DNA?". However, since this question was not asked of people who said they had little understanding of DNA, it cannot be used in this model because too many cases have to be dropped (see Appendix B). There is little difference in the effect of other variables on the dependent variable, using either their self-assessed understanding or the trained rater's assessments. However, the trained rater's assessment is positively associated with the factor score. This change in direction is likely due to the fact that only half (52%) of those who self-assess their understanding at the highest level (clear understanding) are also assessed as fully correct by the trained raters. Additionally, 34% of those who rated themselves as having a general sense of the nature of DNA were given the highest rating by the trained raters. Clearly, people are not always good at rating their own understanding since many who don't understand think they do and many who do understand think they don't. Ultimately, the self-assessment shows that an overly high opinion of one's own understanding is related to a less positive view of science.

Having a higher score on a twenty question (see Appendix C) science fact test (CorSum) has a positive effect. However, knowing that increases in carbon dioxide causes global warming (P7) is associated with lower pro-science scores. Overall, it appears that having greater science knowledge does generally increase one's score; however, the magnitude of the increase is not large. This lack of strong correlation is well known (Allum et al., 2008, Evans, 1995, Miller, 1997, Pardo and Calvo, 2002). Additionally, for highly publicized topics like global warming there may be a negative effect.

The next two categories (attitudes and pseudoscience) are ideological variables. They examine the ways in which people think about science as an idea rather than as a methodology.

Attitudes:

The attitude variables can be broken down into three sub-categories: positively, negatively and neutrally stated. The first positive variable (H10) asks if respondents agree with the statement that "Work is more interesting with the application of science and new technology." The second question (MICE) asks if the benefits from research outweigh the pain caused to mice. Both of these are positively associated with the pro-science score.

The three negatively stated questions are all negatively associated with the pro science scores. These ask if we depend too much on science and not enough on faith (H3), whether technological discoveries will destroy the earth (H9) and if people would do better living a simpler life with less technology (H15).

There are four neutrally phrased questions. All four of these questions are coded so that higher scores represent positive attitudes toward science and they are all positively associated with the pro-science factor. For example, respondents were asked if they are not interested or interested in news about issues related to the use of new inventions or technologies (A6). Those who said they were more interested had higher pro-science scores than those who were not. This group also included questions about the level of government spending on science (J4), whether the respondent would be happy if his or her son wanted to be a scientist

(K2), and whether the respondent supports using biotechnology to detect inherited diseases (P12). The question about sons was also asked for daughters and the answers were surprisingly virtually identical. Only fourteen (0.1%) people who would be happy if their sons wanted to become scientists did not answer in like fashion about their daughters. Seven people who were neutral about their sons would be happy for their daughters. There is little difference (see Appendix D) in the model when one is substituted for the other. However, they are clearly too highly correlated for both variables to be significantly associated with the dependent variable. This violates the linear regression assumption that the independent variables are independent of each other.

These attitudinal questions do not represent any significant surprises. Answers that represent positive attitudes towards science lead to higher pro-science factor scores and those that represent negative attitudes lead to lower scores. What is of note is the magnitude of the coefficients. Only the question about government spending (J4) is below 0.5. Several are 0.8 or above (MICE, H9, H15, K2, P12). In comparison, the knowledge questions range have a much smaller impact on the variable (coefficients are 0.01, 0.05, 0.01, and 0.7) Interestingly, the question about "faith" and religion (H3) does not have as large an influence as those questions about the harm from technology (H9 & H15). Clearly, the post-apocalyptic scenario is very present in at least a significant segment of the public mind. Additionally, all of the attitudinal variables have larger effects than either education (SMEDUC) or knowledge (CorSum).

Pseudoscience:

The second ideological variable is the pseudoscience variable (H16). The only question in this group asks if people strongly agree, agree, disagree or strongly disagree with the statement that "Some of the unidentified flying objects that have been reported are really space vehicles from other civilizations." Surprisingly, this is positively associated with higher pro-science scores. While only slightly over one quarter of the population (28.9%) agrees with this statement, it does show that there are unscientific attitudes behind people with pro-science attitudes. We will also see this issue when examining the B distribution which represents higher pro-science scores. Again, these ideological variables are larger in effect than the knowledge variables. Hence, these pro-science scores do not represent merely a greater knowledge of the scientific method, but are also importantly about people's perceptions of the overall value of science (mostly measured via technology) to society at large.

Stereotypes of Scientists:

There are four statements in this last category covering stereotypes. Lower scores represent disagreeing with the statement and higher scores with agreement. Three of the statements are positively associated with the pro-science score: scientists work alone (L1), scientists work for the good of humanity (L3), and scientists have few other interests beside their work (L9). One statement, scientific work is dangerous (L3,) is negatively associated with the factor score. People who score high tend to think that scientific work is much like the lone scientist in the lab who has no outside life and is trying to solve the ills of the world. This "Marie Curie" stereotype is divided between the noble, positive aspects associated with increased pro-science scores, and the sad, tragic aspects associated with decreased scores. While what this represents is not entirely clear, it does show that pro-science attitudes (at the lower end of the distribution) are somehow intertwined with the idea of the sacrificing (but not too sacrificing) scientist.

Higher Factor Scores: Distribution B

So what predicts higher pro-science scores (see Table 4.5)? We can divide the answers into the same five basic categories used for the lower pro-science factor scores (distribution A): knowledge, attitudes, belief in pseudoscience, and stereotypes of scientists. Again, demographic variables have no statistically significant influence.

<u>Knowledge:</u>

The knowledge questions present more complexity than they did for the first distribution. The only measure of education that is significantly associated with the pro-science factor is the number of high school science courses taken (HSSCI). Interestingly, taking a higher number of high school science courses are associated with lower scores in this part of the pro-science factor. All other measures of science and math knowledge were also negatively associated even though the association was not significant.

Table 4.5: Pro-Science Regression: Distribution B

Source	SS	df	MS
Model	14.9124057	17	.877200334
Residual	27.3739806	548	.049952519
Total	42.2863863	565	.074843162

Number of obs	= 566
F(17, 548)	= 17.56
Prob > F	= 0.0000
R-squared	= 0.3527
Adj R-squared	= 0.3326
Root MSE	= .2235

mfs1b	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
HSSCI	**-.0318896**	**.0103287**	**-3.09**	**0.002**	**-.0521783**	**-.0116008**
G3Ar	**.0512837**	**.0144958**	**3.54**	**0.000**	**.0228096**	**.0797579**
P10	**.0479836**	**.0120797**	**3.97**	**0.000**	**.0242555**	**.0717118**
P7	**-.0771923**	**.0109435**	**-7.05**	**0.000**	**-.0986887**	**-.0556958**
N2	**.0503432**	**.0164493**	**3.06**	**0.002**	**.0180318**	**.0826545**
APEC	**.0474407**	**.0126387**	**3.75**	**0.000**	**.0226144**	**.072267**
H10	.0427463	.0107927	3.96	0.000	.0215462	.0639464
H14	.0369634	.0110219	3.35	0.001	.0153131	.0586138
MICE	.0380156	.0111859	3.40	0.001	.0160431	.0599882
H9	-.0456543	.0133179	-3.43	0.001	-.0718147	-.0194938
H12	-.0491612	.0144007	-3.41	0.001	-.0774485	-.020874
H15	-.06362	.0126357	-5.03	0.000	-.0884402	-.0387998
J1	.0370106	.0125461	2.95	0.003	.0123663	.0616549
P12	.0645608	.0131884	4.90	0.000	.0386548	.0904668
H7	**.0285782**	**.0115722**	**2.47**	**0.014**	**.0058469**	**.0513094**
H16	**.0215345**	**.0081711**	**2.64**	**0.009**	**.005484**	**.0375851**
L4	.0353234	.0110287	3.20	0.001	.0136597	.056987
_cons	-.1809458	.1757194	-1.03	0.304	-.5261118	.1642202

In this distribution, the self-assessment of understanding of the term molecule is positively associated with the factor score. As before respondents are not very good at estimating their own knowledge. Only thirty-eight percent who stated that they had a clear understanding of the concept were coded by trained raters as being fully correct. Self-assessed knowledge about biotechnology (P10) is also positively associated with the pro-science score. But also as before, agreeing that carbon dioxide emissions lead to global warming was negatively associated with higher factor scores. The general knowledge questions compiled as a set (CorSum) were not significantly associated with factor scores in this distribution and only one of the questions was significant. People who know that the earth goes around the sun (N2) had higher factor scores. The final knowledge question is how attentive respondents were to economic and business conditions (APEC) which was positively associated with their pro-science score.

Clearly, accurate knowledge is not a necessary condition for high pro-science scores. The assumption on the part of the respondent that they are knowledgeable is important, but actual deep knowledge may not be. Hence, higher scores (particularly in the higher distribution) may not represent a measured evaluation of science, but rather represent a positive ideological approach to science. So, understanding global warming is not central, but paying close attention to other issues such as business, and feeling knowledgeable about science are crucial to high levels of support as measured by this factor.

Attitudes:

The first of the two ideological categories, attitudes, presents relationships between the variables and the dependent variable in the expected directions. The positive variables include science makes work more interesting (H10), new inventions will counteract the harmful consequences of other technologies (H14), and if the benefits of research outweigh the pain to mice (MICE). All of these are positively associated with higher scores. The negative variables include the idea that technology will destroy the earth (H9), that technology creates an artificial and inhuman way of living (H12) and that we would be better off living a simpler life with less technology (H15). All of these are negatively associated with the pro-science factor score. Finally, there are two neutral questions. Both support for government spending on space exploration(J1) and support for using biotechnology to find inherited diseases (P12) are positively associated with the dependent variable.

In contrast to the lower end of factor scores (distribution A), the attitudinal questions do not show a greater degree of influence on the factor score than do the knowledge questions. However, they still show that concern about the negative effects of science and technology decreases positive perceptions of science.

<u>Pseudoscience:</u>

There are also two pseudo-science questions that are positively associated with the factor score. The first is believing that some numbers are luckier than others (H7). The second is the same UFO question (H16) that was significant for distribution A (some UFOS are from other planets). Clearly, these attitudes are contrary to scientific fact, but they are still associated with higher pro-science scores. This is not entirely remarkable given that only 24% of the population reject all three pseudoscience questions on the survey (the third addresses the scientific nature of astrology). Ultimately, while the ideological variables don't overwhelm the knowledge variables to the same degree that they do in distribution A, they are relatively larger than the non-ideological variables in total effect. Again, we see that the pro-science attitude has a strong ideological component. While this result may seem contradictory, it is a large part of the divide between social and scientific conceptions of the nature of science. The social conception of science is not as innately tied to evidence and skepticism. It also allows for the rejection of scientific knowledge as long as there is alternate evidence that can be explained in a seemingly scientific manner.

Stereotypes of Scientists:

There is only one question that involves a stereotype of scientists. People who agree that scientists don't get as much fun out of life (L4) are more likely to score higher on the pro-science factor than others. This is consonant with the idea that scientists are lone workers that strive for knowledge. It is part of the Marie Curie stereotype. While scientists may be single minded, this is a characteristic that is often portrayed in literature and hte media as a necessary part of the genius psyche.

Summary

The pro-science factor measures the degree to which people have positive views about science. To a great extent, people do have positive views of science. When asked questions about science in general and as mixed with technology, respondents are likely to have relatively positive opinions. Bring in the controversial subject of genetic engineering, which can stand in for other controversial science topics of different eras, and opinions are more likely to diverge.

What makes this factor even more interesting is the degree to which it is less sensitive to measures of education and knowledge than one might otherwise expect. Beliefs about the nature of science, stereotypes of scientists, and belief in pseudoscience have a cumulatively much larger effect on overall attitudes towards science. Additionally, the relationship between knowledge and attitudes is not straightforward or even linear. Less knowledge can create more support in some cases. What this analysis points to is that there are strong ideological components to positive science attitudes. Support for science is wrapped up in ideas about modernity, including the post-modern rejection of absolute truths. It may even be the case that the most positive opinions of science do not come from those who are most knowledgeable about the subject, since this knowledge is likely to bring a more nuanced appreciation of the value and limits of science. The most highly positive and exceedingly optimistic representation may be limited to those who don't fully appreciate science as a methodology as practiced in the real world.

The impact of the cultural representation of science is clear here. The variables that impact positive attitudes toward science are not limited to those that are directly related to the science of the scientist. The effect of the pseudoscience variables provides one clear clue. The negative perceptions of the potential outgrowth of science and technology provides another. These are not part of what science is to a scientist. No matter how convincing a blurry photograph of a UFO may seem, it does not provide sufficient real evidence to prove the existence of extra-terrestrial life. However, machines and measures can be made up to look scientific and that "evidence" is convincing to many. Additionally, applications of science can go wrong, but that is a separate issue from the value of the enterprise as a whole. The cultural conception of science as different from that of the scientist will become even more clear by looking at anti-science attitudes in the next chapter.

CHAPTER 5

THE THREAT OF SCIENCE: NEGATIVE ATTITUDES TOWARD SCIENCE

The film study shows that there exist conflicted views towards scientists. Shown as the protagonists, they clearly are good enough to be worthy of the hero's quest. However, we also see that they are endowed with a significant number of negative characteristics. They are absent-minded, work-focused, anti-social, and anti-spiritual. They create problems that cannot be resolved through the use of science alone. These same themes are reflected in the anti-science factor. This factor mirrors all of the fears that are expressed in the movies and other forms of popular culture: that science will run amok, that it is anti-human, that it denies the reality the public experiences.

This factor clearly shows the negative side of the divided image that science and scientists maintain in this culture. It isn't an ambiguous image. People are clearly and coherently maintaining negative attitudes towards science at the same time that they maintain positive attitudes towards science. Some of these negative attitudes have to do with real and tangible concerns about a *technological* - rather than scientific - society and its ills. However, because technology and science are inextricably linked, people do not differentiate between the two and science becomes the symbolic representative of all that is negative about the organization of modern life. We see environmental destruction, technology that we perceive as ruling our lives, the rejection of religious beliefs, and even the destruction of community. We yearn for what we imagine to be a better life, a slower pace, and a greater sense of meaning. The lack of these is blamed on the nature of science.

Describing the Anti-Science Factor

The questions that load on this factor can be broken into five basic categories: religion vs. science, the dangers of science, science degrades our lifestyle, pseudoscience, and scientists as outcasts. The first four categories come together to signify attitudes that relate directly to concerns about modernity. This is where science is specifically and clearly attributed as the agent of negative change. The last category deals with scientists rather than science, and hence moves from production to producers. As the human representatives of an enterprise which clearly is more than the sum of its parts, scientists are seen as different and distant from the world of the normal and the normative.

Religion vs. Science

The religion versus science issue is well known. Science is often posited as the opposite of religion. This comes in part from the scientific community, most recently from Dawkins (2006), but also from many other sources (e.g., Freud, 1961; White, 1993; Draper, 2007). The religious community has also attacked the scientific community. Creation science is only the latest attack, although it involves the interesting use of the outward trappings of science to attack science.[2] The "Intelligent Design Network" argues on the front page of its website (http://www.intelligentdesignnetwork.org/) that the problem with the institution of science is that it lacks objectivity. The implication is that, were it to be objective it would recognize the validity of intelligent design. Ironically, this same page states that "[i]n a broader sense, Intelligent Design is simply the science of design detection -- how to recognize patterns arranged by an intelligent cause for a purpose." There is no sense of irony in this description. The fact that this statement carries with it an assumption about cause and effect that violates the nature of objective research is not acknowledged. Hence, science as practiced is attacked by an easy-to-explain tenet of science divorced from the larger method.

However, over the last half century the essential nature of this divide has been questioned, most notably by historians of science (e.g., Ferngren, 2002) and religion. They note that science and religion have had multiple modes of interaction including conflict, but they have also ignored each other, and at times collaborated. The common assumption that religion and science are inherently at odds and have always been at odds is an interesting cultural indicator. While it is not surprising that the general populace has not read the scholarly material on the issue, the persistence of this belief is yet another indicator of the conflicted view that this society has about science. What better to oppose the most visible

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2. One example of this can be found at the Center for Scientific Creation. www.creationscience.com

symbol of modernity than religion? Rationality and spirituality are easy to pit against each other in a simplistic dualistic manner.

In this survey there are two questions about religion. The first represents the central divide that is perceived to exist between science and religion. Question H3 asks whether respondents agree with the statement "We depend too much on science and not enough on faith." The second question (L8) explores perceptions regarding the practitioners of science by asking about agreement with the statement "Scientists are not likely to be very religious people."

The accuracy or inaccuracy of the latter assumption is not central here. It is unlikely that the vast majority of people are aware of the true religious beliefs of most scientists. What is important is that they perceive them to be less religious. While it is true that scientists are less likely to hold religious beliefs than to hold them, (Larson and Witham, 1998; Larson et al., 1999; Leuba, 2006), recent data show that roughly 40% (Larson and Witham, 1997) of scientists believe in God.

In contrast, it has been widely reported that Americans are highly religious. A recent Harris Poll (2005) reported that 82% of Americans believe in God. However, this number is likely to be overstated. Demerath (2001) notes that polls about religious beliefs are highly sensitive to question wording. This is because of the ambiguity of the nature of religious beliefs. He points out that the idea of religious belief is also about cultural identity, which is broader and more complicated than a rational assessment of whether one believes in God.

Ultimately, it could be argued that respondents who say that scientists are not likely to be religious are correct. However, that would miss the complexity and culturally symbolic nature of the belief. People's own beliefs and even church attendance (Hadaway et al., 1993; Smith, 1998) are likely to be tied up in social expectations for beliefs and behaviors. This relates directly to their attitudes towards science and religion. All three aspects here, science, religious beliefs, and social expectations, come together to enhance the notion of the science-religion divide.

The Dangers of Science

The danger category deals with another fundamental concern that is played over and over again in films: the destructive potential of science. There is an entire sub-genre of science fiction films that addresses the scientific experiment gone awry. In the film study in Chapter Three, examples of this type of film ranged from comedies (*Honey, I Blew Up the Kid*) to horror (*Man's Best Friend*). This theme is endemic, even though real lab accidents of this kind are almost non-existent. Hence, this theme is directly related to the larger issues behind such concerns about science, rather than any connection to reality.

The first danger question (H9) that loaded on this factor asked respondents to agree or disagree with the statement "Technological discoveries will eventually destroy the earth." This is a direct translation of the cataclysmic view of science. Additionally, respondents were asked if the harmful results of science were greater than the benefits (I2). Depending on the response to that question, people were asked a follow up question. Those who thought that the harm was greater were asked if the harm (I2B) was slightly or strongly greater than the benefits.

The same type of question was asked for those who thought the benefits were greater than the harm (I2A). Only the follow-up relative level of harm question (I2B) was part of the anti-science factor.

Science Degrades Our Lifestyle

We see yet another common theme with regard to science that expresses concern with the degradation of our lifestyle. It is here that science is most clearly blamed for the perceived negative outcomes of modernity. In the three statements in this group, "Science makes our way of life change too fast" (H8), "Technological development creates an artificial and inhuman way of living" (H12), and "People would do better by living a simpler life without so much technology" (H15), we see the longing for an idealized pre-industrial life (at least in part) that comes without some of the complications from technology. This theme of the pastoral, perfect life is no less alive than it was during the Industrial Revolution. The inhumane nature of clock watching, the dislocation of individuals from family, and the effects of industrial pollution are just some of the criticisms of the modern world. These criticisms are always made in comparison to some better past, without recognition of the improvements that have accompanied them.

Pseudoscience

The next group of questions that load on the anti-science factor is about pseudoscience. It is not surprising that lucky numbers, "Some numbers are especially lucky for some people" (H7), belief in aliens, "Some of the unidentified flying objects that have been reported are really space vehicles from other civilizations" (H16) and astrology, "Would you say that astrology is very scientific, sort of scientific, or not at all scientific?" (P3) are connected to other anti-scientific attitudes. While an anti-scientific attitude is not a prerequisite for maintaining these ideas, it does predispose the individual against looking skeptically at them.

Ironically, as in the case for science vs. religion, the trappings of science are often used to justify pseudoscience. As we saw in the pro-science factor, people who believe in these things can be pro-science. For example, the television show *Ghost Hunters* is a purported documentary of scientific investigations of haunted houses. The two investigators enter the house with "scientific" instruments to measure paranormal activity. Again, we see a potential separation between the ideology of science as practiced, and science as method. Despite the fact that there may not be a clear understanding of scientific methodology, people continue to use its outward trappings to "prove" or justify their beliefs. In fact, in the paranormal world one of the basic tenets of the scientific methodology is often violated when practitioners claim that the phenomena in question cannot be manifest in front of non-believers. This partial application of the scientific method is not seen as flawed by its adherents because they see science in a cultural, rather than methodological manner.

Scientists as Outcasts

Moving from science to the producers of science, the factor includes statements that show a similar stereotypical impression of scientists as outcasts - an impression that was already made clear by the film study. We see scientists as loners, "A scientist usually works alone" (L1), who engage in risky work, "Scientific work is dangerous" (L2), who are socially backward, "Scientists are apt to be odd and peculiar people" (L6), and are work obsessed, "Scientists have few other interests but their work" (L9) to the point where they miss the rest of life, "Scientists don't get as much fun out of life as other people do" (L4). The scientist as socially disconnected lab-rat is a powerful stereotype that separates the scientists into their role as "other." The work that they do makes them inherently different (or they do that work because they are different) and distances science further from the "average Joe."

Religion and Other Fears About Modernity Seen in the Factor

In effect, this factor is a compilation of anti-science beliefs that exist in the general populace. Anti-science is not a partisan phenomenon. There are right-wing social conservative perspectives in the religious questions. There are left-wing perspectives in the concerns about the pace of life, and the dangers of science. Using these two types of anti-science sentiments we can see overlapping, but still distinct, attitudinal groups. Not surprisingly, we see a clear split around the issue of religion.

Dividing the modernity questions[3] up by the response to the faith question shows that there are two strong groups. The first group is comprised of those who believe that we need more faith. For respondents who are highly anti-science (scored above the median on the anti-science factor), a strong majority (59.1%) agree that we need more faith. This compares to 36.7% of those who scored below the median.

The second group does not think we need more faith, but feels that there are other problems. Looking at the danger category, we see that there is great concern about the potential for destruction and the degradation of our lifestyle, 28.5% of those who are highly anti-science profess some degree of these concerns about the organization of our current society. This compares to 25.7% who scored below the median.

These are not minor worries that exist in one part of the population. They are widespread concerns about the nature of modern society that are being expressed through concerns about science. However, the religious concerns are clearly more aligned with an anti-science attitude than are the more general concerns about the way we live and our potential future.

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3. Religion vs. science, the dangers of science, science degrades our lifestyle, and pseudoscience.

Overall, there is fairly broad concern about science and the nature of modernity. Only one tenth of the weighted sample disagreed with all of the statements in all of the four categories (see Table 5.1 and Figure 5.1). Just under one fifth of the population (18.4%) have concerns about all four of the categories[4]. The mistrust of science and the belief that it may be taking us in the wrong direction is not a minority belief.

Table 5.1: Anti-Science Modernity Categories

Category	**Questions**
Religion vs. Science	H3: We depend too much on Science and not enough on faith.
	L8: Scientist are not likely to be very religious people.
Dangers of Science	H9: Technological discoveries will eventually destroy the earth.
	I2B: If I1 (Science causes harm or benifit) is harm, strongly or slightly
Lifestyle	H8: Science makes our way of life change too fast.
	H12: Technological development creates an artificial and inhuman way of living.
	H15: People would do better by living a simpler life without so much technology.
Pseudoscience	H7: Some numbers are especially lucky for some people.
	H16: Some of the unidentified flying objects that have been reported are really space vehicles from other civilizations.
	P3: Would you say that astrology is very scientific, sort of scientific, or not at all scientific?

We also see a high level of agreement with the stereotypical portrayal of scientists. Two thirds of the weighted sample (66.1%) agree with at least one of

4. Measured by agreement with one or more questions in that category.

the four statements. While only a small number (4.4%) agree with all four, there is a broad consensus with the image of a socially inept, lab-rat, atheistic, oddball scientist that exists in American film portrayals.

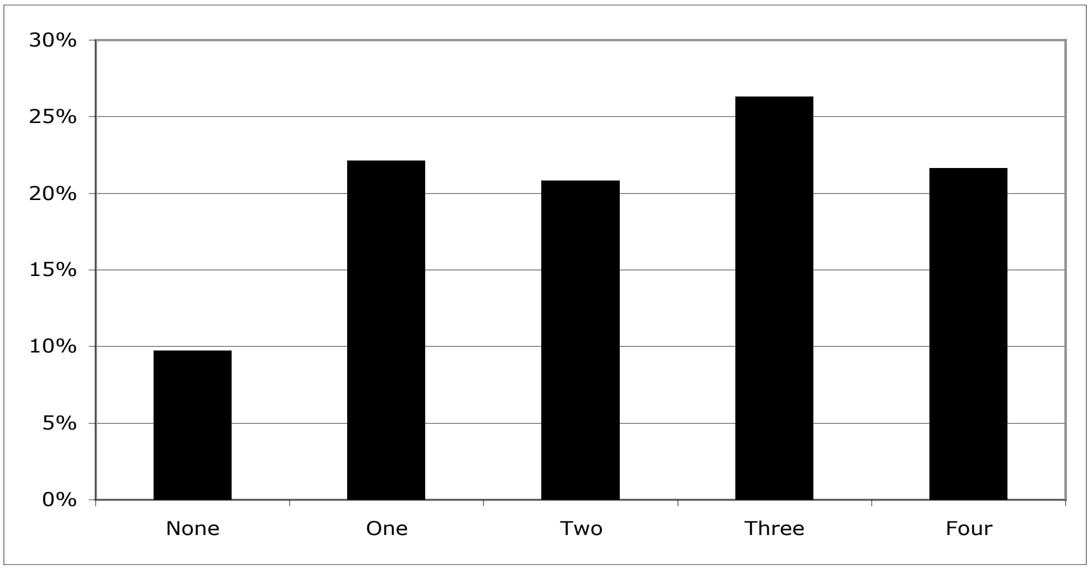

Figure 5.1: Modernity Categories Agreed with

When this factor is scored, those who are generally anti-science (score positively) is almost as great as those who (47% vs. 53%) generally disagree with the anti-science perspective (score negatively). In fact, 94% agree with at least one of the questions in this factor. Eighty-six percent of people who score negatively on this factor agree with at least one question. Looking just at the questions about the merits and dangers of science[5], 73% agree with at least one of

5. H3: We depend too much on science and not enough on faith.
H8: Science makes our way of life change too fast.
H9: Technological discoveries will eventually destroy the earth.
H12: Technological development creates an artificial and inhuman way of living.
H15: People would do better by living a simpler life without so much technology.
I2B: If I1 (Science causes harm or benefit) is harm, strongly or slightly

the questions. This breaks down into 57% for the negative scorers and 86% for the positive scorers. Hence, while the scores tell us that about half of the people have significant anti-science views, the individual questions show that parts of these views exist even in people who do not measure as highly anti-science.

While there is broad overall agreement with at least some part of the anti-science factor, there are differences that can be picked out of the data. Looking only at those people who have the highest and lowest factor scores, we can see differences in responses. As before, separating out these two groups allows a clearer look at those with strong, consistent attitudes. It shows the limits on both ends of the spectrum. In Table 5.2 respondents have been separated into those whose factor score is one standard deviation below the mean, and those whose factor score is one standard deviation above the mean. By looking at the agreement[6] for each question we can start to see some of what differentiates people with regard to anti-science beliefs.

The largest difference in the level of agreement (57.7%) between people who score low on the anti-science factor and people who score high involves whether life changes too fast. The speed of change in society has been an issue for a long time. Clearly, this is a dividing issue for people. The next largest spread between the two groups comes from impressions of scientists. Both the statement about scientists having few other interests (55.1% difference in level of agreement) and the statement about scientists being odd and peculiar (52.1%) have very different

6. Agreement here is the sum of the answers "agree" and "strongly agree."

responses from people who score high and low. High scorers are much more likely to have negative attitudes towards scientists as people who may in fact destroy the world. Danger is the next largest difference (49.1%), followed closely by religion (46.9%).

Table 5.2: Agreement with Questions for Low/High Anti-Science Factor Scores

Category	**Questions**	**Low Scores**	**High Scores**	
		(1 σ Below Mean)	**(1 σ Above Mean)**	**Difference**
Religion	Too Much Science Not Enough Faith (H3)	32.4	79.2	46.9
	Scientists Not Religious (L8)	15.7	55.4	39.8
Danger	Tech Destroys Earth (H9)	13.2	62.4	49.1
	Sci Research How Harmful (I2B)	1.5	42.1	40.6
Lifestyle	Science Makes Life Change too Fast (H8)	22.1	79.7	57.7
	Tech Makes Life Artificial (H12)	16.7	58.4	41.7
	Should Live Simpler Life w/o Tech (H15)	30.4	69.8	39.4
Scientists as Outcasts	Works Alone (L1)	8.8	31.2	22.4
	Work is Dangerous (L2)	37.7	80.7	43.0
	Don't Get as Much Fun (L4)	3.4	46.5	43.1
	Odd/Peculiar People (L6)	7.8	59.9	52.1
	Few Other Interests (L9)	9.3	64.4	55.1
Pseudo-science	Lucky Numbers (H7)	13.7	56.9	43.2
	UFOs (H16)	14.2	42.1	27.9
	Astrology (P3)	16.7	56.9	40.3

The key differences between those who score strongly as anti-science and those who score as strongly *not* anti-science include three of the modernity categories as well as the scientists category. This implies that those who are strongly anti-science see science as a significantly negative influence on the organization of society. It is not merely a critique of the weak points of science, but rather addresses how science influences our daily lives. Additionally, it is not just the method that is problematic, it is also the producers.

Influencing The Factor: Attitudes, Beliefs, and a Bit of Knowledge

A multivariate regression was performed to examine what variables are associated with changes in the anti-science factor score. The scored factor is roughly symmetrical and not quite normally distributed (see Figure 5.2), but close enough for the requirements of the model (see Appendix E).

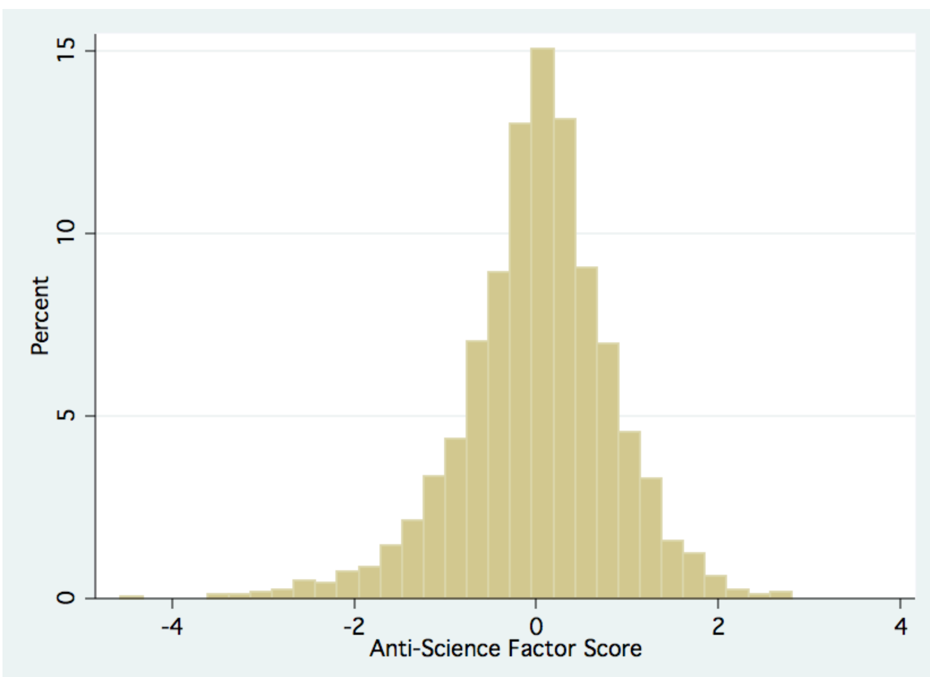

Figure 5.2: Distribution of Anti-Science Factor Scores

So what predicts the anti-science score? The independent variables can be broken down into four groups: knowledge, attitudes, pseudoscience, and demographics (see Table 5.3). The methodology vs. ideology divide is clearly represented here. Variables that measure knowledge have a negative effect on the anti-science factor score. The ideological variables (attitudes and pseudoscience) have a positive effect on the factor score.

Table 5.3: Anti-Science Factor Regression

```
Linear regression                                      Number of obs =    1539
                                                       F( 12,  1526) =   41.44
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.2641
                                                       Root MSE      =  .71923
```

mfs3	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
EDUC3r	**-.1397207**	**.0365648**	**-3.82**	**0.000**	**-.2114433**	**-.0679981**
CorSum	**-.0217804**	**.0074655**	**-2.92**	**0.004**	**-.036424**	**-.0071367**
G1Ar	**-.1152707**	**.0359001**	**-3.21**	**0.001**	**-.1856894**	**-.0448519**
G3Ar	**-.0858408**	**.0303241**	**-2.83**	**0.005**	**-.1453221**	**-.0263596**
I3	.1798427	.0149307	12.05	0.000	.1505558	.2091296
I4B	.1305986	.0135085	9.67	0.000	.1041014	.1570957
APEV	.1133201	.0286058	3.96	0.000	.0572093	.1694309
H14	.1003988	.0211896	4.74	0.000	.058835	.1419627
H17c	**.1535276**	**.0352184**	**4.36**	**0.000**	**.0844459**	**.2226093**
H18c	**.1956006**	**.0580775**	**3.37**	**0.001**	**.0816804**	**.3095209**
RESPAGE6r	-.0692996	.0123132	-5.63	0.000	-.0934523	-.0451469
Q5	.1074888	.03733	2.88	0.004	.0342652	.1807123
_cons	-1.050228	.2199326	-4.78	0.000	-1.48163	-.6188255

Knowledge

Not surprisingly education (EDUC3r) is negatively associated with anti-science sentiments. It would be strange if education had no effect, however its influence is not as overwhelmingly large as might be expected. The survey included a twenty-question test of scientific knowledge (see Appendix C). This measure (CorSum) is also negatively associated with the factor score. However, the effect is quite mild. This is not surprising since the scores on this test are reasonably high (mean 14.2, median 15).

People who score high on the anti-science factor also self-assess their understanding of the nature of a scientific study at a low level (G1Ar). In addition, the person's self assessment of their understanding of molecule (G3Ar) is negatively associated, so that people who feel they do understand the concepts are less likely to hold anti-science views.

There are additional variables that measure the assessment of trained raters (G1B-G4B) regarding the respondent's understanding of the concepts of scientific study, DNA, molecule, and the experimental method. However, since these questions were not asked of people who said they had little understanding of the concept, they cannot be used in this model since too many cases have to be dropped. Despite this issue, there is little change in the effect of other variables on the dependent variable using either their self-assessed understanding or the respondent's understanding assessed by trained raters.

As noted in the discussion of the pro-science factor, these self-assessments are largely not accurate. Only 33% of those who rated their understanding of scientific study highly were seen as having a strong understanding by trained raters. Respondents did somewhat better with the concept of molecule. In this case 58% who rated their own understanding highly were seen as having a strong understanding by trained raters, however this represents only 7% of the entire sample. This tells us that accurate information, contrary to the wishes of the NSF and the Royal Society, is not necessary for reducing anti-science attitudes; people only need to believe that they understand.

Attitudes

Moving to the ideological variables, people who think that genetic engineering presents more risk than benefit (I3: are the risks or benefits of genetic engineering greater) are more likely to have high anti-science scores. Additionally, seeing a higher degree of risk (I4B: if the risks are greater are they slightly or strongly greater) is associated with a high anti-science score. How attentive a person is toward environmental issues (APEV), measured by how attentive and informed they feel they are, is also associated with a higher factor score. The final ideological variable measures how optimistic people are about the ability to solve problems through technology (H14). People who do not think we will find new inventions "to counteract any harmful consequences of technological development" are more likely to have a high anti-science score.

As in the pro-science score, attitudes about genetic engineering are central influences in attitudes towards science. It is not entirely clear that this must be the case. While it is a controversial and difficult subject, it could be seen as a problematic aspect of this branch of science alone, rather than an indicator of problems with the entire enterprise. The environmental issue relates to the idea that science and technology, rather than the actions of everyday life, are responsible for environmental destruction.

Pseudoscience

Pseudoscience shows up again in the form of belief in ESP (H17). Those who agree that ESP exists are more likely to hold anti-science views. Because proponents use a modified version of the scientific method, and hence do not reject science entirely, this likely represents anger at the institution of science. It is not science in its entirety that they see as bad, but rather the implementation of it, and in particular, the anti-democratic nature of scientific truth. The results from the pro-science factor show that pseudo-scientific beliefs are not inherently connected only to anti-science attitudes. Pseudoscience can be seen as scientific in the wider culture. As noted earlier, there are multiple television shows that "scientifically" prove the existence of ghosts. In the pro-science factor this type of belief increased pro-science attitudes, while they work in the opposite direction here.

The degree to which people believe in alternative medicine (H18c) has a strong positive effect on the anti-science factor score. This result parallels the general perspective that mainstream science (and the pharmaceutical companies in particular) ignores the wisdom of traditional cultures and their medical cures. This links negative attitudes seen in this factor with the theme seen in films where science is corrupted by big business. Here, big pharma (as it is often called pejoratively), works in concert with the scientific medical establishment against democratic knowledge. Alternative medicine works because people "know" it has worked.

Demographics

There are only two demographic variables that are significant: age (RESPAGE6r) and sex (Q5). Older people are somewhat less likely to have high anti-science scores than are younger people. Whether this is a cohort or age effect is not determinable at this point. There are logical arguments for both. The older generation form a cohort that grew up in the Sputnik era and was presented with the idea of science as savior. The younger cohort that grew up in the era of ozone depletion and climate change were frequently presented with science as villain. Alternatively, more exposure to the vagaries of the public mind and debates could allow more perspective as we age. Interestingly, men were more likely to have higher anti-science scores than were women (Q5). This presents another contradiction to the notion that men have more positive attitudes towards science than do women (Board, 2008, Foundation, 2002).

Summary

The anti-science factor is the embodiment of the ideological perspective on science. It illuminates the complicated, conflicted, non-scientific representation and understanding of science. It is simultaneously a criticism of science and a misapplication of science. This way of viewing science is cultural, not logical.

The fact that the anti-science score is only partially responsive to education shows that there is more behind it than simple lack of knowledge. As we saw with the pro-science score, there are much more powerful influences on negative attitudes towards science than knowledge. Additionally, perceived understanding is important for reducing anti-science attitudes, but that understanding need not be accurate.

The anti-science factor is made up of many of the same issues that are inherent in the critique of modernity. The loss of community and religion, the destruction of the environment, and science as a danger are central aspects of these attitudes. These are not easily attacked by knowledge alone. They are ideas that are deeply embedded in our culture and are not based on rational thought so are not easily argued away through rational means. They are feelings about what should and shouldn't be and are wrapped up in what society believes science is, whether that perception is accurate or not.

Ultimately, despite the contradictions and complications, science is seen as truth. As a result it occupies a high status position in society. However, that high position is at odds with other cultural values and beliefs. The democratic ideal, yearning for an idealized past, and constant fears about the future all mix together to make science much more than a methodology in the minds of the public.

CHAPTER 6

CONCLUSION

Science is science, or so many people would argue. In introductory level courses in colleges across the country students learn that science is a method that revolves around falsifiability and replicability. The process requires continuous discussion and revision. All scientific results follow from these propositions; they are what gives science its special connection to truth.

The concept of science in the general public is vastly different from this notion. Science is truth. However, the intricacies of the method are irrelevant. Science is also the bully that tries to tell people how to live: what to eat, what is dangerous, and what is not. It also provides a complicated moving target by creating expanded and sometimes conflicting results. This complexity is normal to the scientist, but often deeply disturbing to the general populace. There is simultaneous anger at the presumed authority of the information and lamentations regarding changing conclusions.

If the broader society understood the scientific method there would be no autism-vaccine controversy (see, for example, (Chen et al., 2004, DeStefano, 2007, Honda et al., 2005, Hornig et al., 2008, Nicol, 2007). The scientific results are clear and have been for a long time, yet many people including celebrities (with Jenny McCarthy leading the way) are still arguing that vaccines cause autism. This is not a debate about the nuances of data or sampling method, but a discourse between science and feeling. People believe that vaccines cause autism and are immune to data to the contrary.

It also brings out a second conflict that revolves around the undemocratic nature of science: that scientific knowledge is privileged over the perceptions of the individual. This can also wrap into negative attitudes towards large scale institutions, particularly businesses. It is obvious to some that the reason science says that vaccines do not cause autism is that the vaccine manufacturers do not want to pay for the damage they have caused or spend the money they need to produce safe vaccines.

The recent retraction by *The Lancet* (2010) of the paper (Wakefield et al., 1998) that sparked the controversy has reinvigorated the debate. In fact, Jenny McCarthy and Jim Carrey have issued a statement (2010) on their website, *Generation Rescue*, devoted to helping children recover from autism. This statement argues that the paper has been criticized and ultimately retracted because of a scientific conspiracy led by the pharmaceutical industry.

Dr. Wakefield has been found guilty (among many other things) of using funds for uses for which they were not approved, for performing some tests on children without ethics committee approval, and for performing tests that were not in the interest of a child (Council, 2010). The article had already been partially retracted in 2004 (Murch et al., 2004) by ten of the twelve authors because the conclusions were not supported by the data. Interestingly, the most recent retraction is being presented as scientific repudiation by both sides of the debate even though that had occurred in the first retraction and was not any part of the current one. Scientific papers need not be correct to be published and there are many unretracted papers where the conclusions do not hold up to further research. However, the complexities of the scientific method are irrelevant in this debate. Those who truly believe in a link between vaccines and autism see this only as a conspiracy to censor them. McCarthy and Carrey present Wakefield as that maverick scientist who is fighting desperately against the scientific establishment in addition to avoiding the control of the pharmaceutical industry.

In this world, evidence confirms what you believe to be true and alternate explanations are the work of conspiracies. The word "believe" is not used in typical bad application of the English language as it is when we say that scientists believe in evolution. When we say this we mean that scientists are assured that the evidence is good enough to show that evolution is an accurate description of how our world works. The more common use of the word believe, even in the case of science, implies faith rather than scientific proof. For those who believe in the vaccine autism link there is no reliance on real evidence. This violates the fundamental nature of science, but the science of McCarthy and Carrey and their followers is not the science of scientists. In this world, anecdotes rule and emotional connections (especially mother love) gives you a privileged view into the medical reality of disease. In this case belief is evidence.

This is just one example of how science is also the lightning rod for all of our concerns about the nature of modernity and its attendant rationalization of life. Ecological ills, perceived loss of community, and loss of the pastoral among other negative outcomes can all be attributed to science. Science is also the cause of impending doom. The iconic nuclear disaster is the most prevalent of these, but the lab accident by the careless scientist, or the engineered virus gone awry are common cultural themes.

Even so, we still valorize science. When we want to argue that soap, or toothpaste, or cleaners (Florman, 1981) are best we invoke science. When we want to prove that ghosts exist we gather scientific-looking instruments and measure irrelevant phenomena. The social conception of science is more than a love/hate relationship with the science of scientists. It is a new conception of science that includes, in some ways, the science of scientists, but in other ways rejects it entirely.

Inept scientists

The representation of scientists in film is one way in which our complicated and contradictory relationship to science is manifest. In film we most often see the scientist as the socially awkward outcast. Even when the scientist is the protagonist, he or she (although there are few women characters in the sample) has some sort of awkward characteristics, whether it is odd clothing or inappropriate social interactions. Scientists as secondary characters are often depicted as the stereotypical geeky scientist: disheveled, unkempt, and out-of-shape. This, as much as the white lab coat, mark them as scientists. The image has become iconic and serves to make scientists separate from the broader society. They stand out because they are seen as different from most people and these differences are not portrayed positively.

In addition to dressing and acting outside of societal norms, they also are highly likely to make life difficult for all those around them. Whether protagonist or antagonist, they are likely to create some problem through the use of their science. Whether they create a beast or unleash a supernatural murderer or cause the destruction of an entire village in the Amazon, scientists in these films frequently make bad judgments that have devastating consequences. Rarely can they fix these through the use of science alone. Often science is not even a part of the solution. In fact, scientists in film frequently reject part or all of their identity as scientists in the end.

This portrayal of the scientist as at best an inept geek and at worst a craven destroyer is a distancing mechanism. It demotes the problematic people who are more knowledgeable to a more equal level with the rest of society. This is particularly true when the main character replaces science with intuition or mysticism. The privileged knowledge is shown to be no more valuable than the "gut" feelings of people in touch with their emotions or a spiritual authority.

Additionally, these movies treat the scientist as the center point of the problems with modernity. Alienating hierarchical knowledge denies the emotional by being over-rational. The lack of differentiation between science and technology equates the lab scientist and the inventor, either of whom can create something that will bring large-scale destruction to society. *Medicine Man* is most emblematic of the struggle between the modern and the pre-modern and takes us into the equalized knowledge of the post-modern. A cancer researcher gives up his lab to go on a trip around the Amazon under the tutelage of the tribal medicine man as the only means to find a cure for cancer. In *Candyman*, an anthropologist arrogantly ignores local knowledge about a supernatural monster, preferring her science, and brings death and destruction to the poor.

The degree to which these images have an effect on audiences is still up for debate. However, it is clear that these are accepted cultural representations of scientists. We watch them and accept the general premises regarding the characters, so they are at the very least part of our iconography.

Films, Dissonance, and Modernity

This study of film falls in the vast grey area between the sociology of culture and of knowledge. Mannheim sees the sociology of knowledge as the tool for investigating how ideas are connected to the larger social system. In fact, he argues that ideas are only fully understood when their social origins are uncovered (1936, p.2). This investigation begins an examination of how the authority of scientific knowledge is constructed by the film maker and transmitted to society. The filmmaker translates ideas into film using a code that is familiar to the audience. Images that make sense (the man driving fast on a motorcycle implies his freedom and adventurousness) are used to transmit ideas. It is in this way that knowledge or ideas become cultural objects. These objects, in this case movies, become a part of the larger, often unexamined, sea of culture in which we live. In this way, this research falls in that place between Mannheim's conception of the sociology of knowledge and Burger and Luckman's (1966) notion of how this part of the wider discipline "must concern itself with everything that passes for “knowledge” in society (p.14).” Somewhere between the original idea of the film and the final transmission to the audience we have moved beyond the construction of an idea alone and created an idea embedded in a cultural object. I will not attempt here to draw a line that marks where the study of an idea ends and where the study of culture begins. The transition from idea alone to embedded idea is the important artifact here rather than the delineation of the stages of the transition.

In concrete terms this research examines one part of a greater discourse on scientists which has the potential to move us towards uncovering how the images of scientists in the movies influence the role of science in our society. Thus, using Mannheim’s perspective, the sociology of knowledge end of this work is not merely an unmasking of (incorrect) ideologies but rather an examination of the connections between ideas and the social relationships that influence them (1936,p. 267). By investigating ideas we can find the basic concepts within a society that underlie the ideas. These underlying concepts may not at first be obvious. For example, a scientist who is shown as uncoordinated and ill at ease socially implies something about the expected personality type of scientists. However, this idea of the scientist can also convey ideas about how we feel about science and even how we feel about knowledge acquisition itself. On the surface only the scientist is discussed, but when the image is fully explored it can be tied to larger ideas held by at least part of society, such as anti-intellectualism or anti-modernism. Only through investigating different loci can the social reproduction and social construction of ideas be determined. Looking at this one contributing factor - the images of science in film - we can begin to put together a broader understanding of science's larger role in our society.

This sample of movies shows clear commonalities in the treatment and portrayal of scientists. The aggregate presentation constructs an overall negative view of the scientist. For the most part, scientists are inept bunglers who constantly create difficulties for society. They are clearly different from the rest of the population and in some way more responsible for the ills of society than the average person. Some of this effect is due to the nature of mainstream movies, which require quick and easy characters that can be understood by the audience with minimal explanation. In this sense, the relatively stable portrayal of scientists is an effect of the medium. However, the fact that this portrayal is the standard makes real the presumed stereotype. If the stereotype did not exist the writers, directors and actors could not use it as a consistent type. They would have to create more complex portrayals that revolve around the nature of the scientist as a real and multifaceted individual. They do not need to do so because we recognize the stereotype. The movies then recreate and enhance this view of science.

This study is not intended to argue the intent of the producers. Nor is it designed to measure the effect of movies on audiences. Although there is no consensus on the effects of film on the viewer, there are many different types of research that show that media messages do have an effect on the audience. Whether one is arguing that constant exposure to similar messages has a cumulative effect on the beliefs and behaviors of the viewer (see Gerbner, 1984, for example) or that violent shows can influence the behavior of children (Felson, 1996), there is a reasonable consensus that media do influence how we see our world. On the particular issue of scientists in the media, Gerbner (1987) found that heavy viewers of television are more likely to to hold negative views towards science. They are more likely to see scientists as odd and peculiar, to see scientific work as dangerous and to see scientists as people with little connection to family and high connection to work.

While it is clear that film is not merely a reflection of our society, films can tell us something about societal views on the nature of science and scientists. Only two out of twenty movies had reasonably positive characterizations of the main character scientist. It is ironic that during this same time period at least three movies[7] portrayed lawyers as saviors or heroes. Lawyers are currently the prototypical disliked profession, even if one only takes into account the number of anti-lawyer jokes.

The portrayal of scientists in films of this era does not mean that scientists are loathed by society as a whole. From 1979 to 1999 the proportion of people who feel that the benefits from science outweigh the harm has been at least 70%, except for 1985 when it fell to 68% (National Science Board, 2000). This confidence in science as an institution also extends to the leadership of the institution. The proportion of those surveyed who expressed a great deal of confidence in science has fluctuated around forty percent between 1973 and

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7. *My Cousin Vinny*, *A Few Good Men*, and *The Pelican Brief* all were released during the same time period. All of these movies show lawyers protecting society in some way rather than destroying it, unlike the consequences shown of scientists performing their jobs.

1988. This places it second only to medicine among the institutions ranked (medicine, the scientific community, the supreme court, education, the press, television, and organized labor). Scientists themselves also enjoy a high level of prestige. As noted previously, in the 1989 General Social Survey scientists rated a prestige score of 73 out of 100 (Davis, 1991). This ranks them higher than clergymen (67 out of 100). These large scale measures show an overall positive view. The NSF data used for the public opinion portion of this work both reflects and moderates this data. This survey shows that there are widely positive attitudes towards scientists, even though there are significant negative impressions about the nature of scientists. This raises the question of why scientists are portrayed so negatively in film.

Scientists in film represent more than a stereotype of one specialized role; they are parts of a larger discussion about knowledge and the place it holds in society. In particular, they address common themes with regard to the nature of intellectualism and modernity. Our society has had an uneasy relationship with intellectualism throughout its history. Richard Hofstadter analyzed the roots and shape of this phenomenon and saw it as a result of tension between rationalism and evangelicalism, as well as between both the democratic and business tendencies within American culture (1962). Thus, the intellect is a source of suspicion and derision because the rationalist tendencies violate our belief in the mystical, and the possibility of ranking intellectual abilities violates our egalitarian tendencies. Also, the need for careful, often slow deliberation violates the needs of business to make quick decisions. All of these issues become embedded in the representation of scientists in films. In the depictions examined here physical force is of more value than scientific investigation, and scientists harm people through their inability to see the mystical.

It is interesting to note that the business tension is the only one negatively represented in these movies. Here the sympathy is partially on the side of the scientist. The need of business to create quick, profitable solutions deforms science rather than science deforming business. Thus, we have the corporation in *The Fugitive* manipulating the results of medical tests and a real-estate mogul attempting to kill a scientist in *Darkman*.

These movies also include anti-modern themes. The concern with the nature of modernity and its failings has been well documented (see for example Kolakowski, 1990). While most of the discussions of modernity occur at the scholarly level, these ideas also permeate the social system at many levels. One of the central tenets of concern about modernity is the reliance on rational thought rather than emotional connections. There is no better representation of rational thought than the scientist. We see this duality represented in several of the films in this sample.

Medicine Man is perhaps the best example of this. The scientist represents the modern way: technology, environmental destruction, loss of community. The medicine man represents the pre-modern way: mystical revelation, environmental equilibrium, community. These parallels are made abundantly clear in the movie. Progress is represented by the technology that prevents Dr. Campbell from seeing the mystical answer. Environmental destruction due to progress is represented bluntly by bulldozers knocking down the rain forest to build roads. Before his transformation Dr. Campbell inadvertently contributes to the destruction by accidentally helping to burn the home of the native tribe. He is the prototypical representation of the ills of modernity. Similar themes are part of *Candyman*, where the invasive scientist destroys the fragile community in the projects by evoking a demon. Finally, in *Little Man Tate* the overly rational scientist must learn to love before she can continue her work.

Through the issue of rationalism the themes of anti-intellectualism and anti-modernity intersect. Clearly, these concepts do not exist only in the realm of movies about scientists. A central concern about the negative effects of modernity, for example, is the loss of community: Celebration, Florida and other planned communities are physical representations of the ideological concern. Hence, what we see in these movies represents what exists in the wider society. The writers and directors, then, are not creating new ideas, but rather making ideas that are already extant more real through film.

These concerns about modernity move us into a post-modern frame of reference. In this view, science no longer holds a privileged position with regard to knowledge. Meta-narratives are discredited, local knowledge is privileged, and multiple types of knowledge are equivalent (or not comparable). While there is more concern about modernity represented in the films (perhaps a lag in transmission from academic to film writers), these themes do appear. Clearly, this is a central theme of *Medicine Man*. The native knowledge is equivalent to his. We also see strands of this in *Stargate* where the inhabitants of the alien planet use their knowledge to help the clearly scientifically and technologically superior team from Earth.

The ambiguity in public attitudes towards science and towards scientists parallels American attitudes towards technology. In fact, as Robert Wuthnow (1988) argued, technology has become, for many, a secular religion. He notes that we often confuse science and technology in nomenclature so that the word science becomes a substitute for technological advancement. Thus we claim to prefer a scientifically improved toothpaste when we in fact prefer a technologically improved toothpaste. Conversely, Florman (1981) notes the ways in which we have begun to blame technology for our social ills. We feel that technology is out of control: it has begun to control us rather than being under our control.

The representation of scientists within movies is part of a counterbalancing discourse. The high regard we hold for science and scientists is one part of the societal consciousness and the representation of scientists in film is another. We both love and hate what they can do for us and to us. This is in part because, as Hofstadter (1963) argued, we are uncomfortable with hierarchy and superior knowledge. These two elements conflict with our radical notions of equality; therefore, we must find ways to diminish the authority of those who may have knowledge that discomforts us. On the other hand, we still value knowledge and the intellect. In investigating these images we can start to illuminate the different forces that either enhance the reputation of science and scientists or devalue them.

This type of balancing is a result of two contradictory cultural values. In this case, equality conflicts with progress and the meritocracy inherent in the scientific world. The complexity, duration, and societal embeddedness of this type of discourse is related to the seriousness of the conflict. There is no way to reconcile these concepts. Hence, we are uncomfortable with contradiction, we need to manage the conflict. This occurs through the elaboration of the scientist as flawed. We need not fear the scientific world's rejection of all opinions as equivalent because we can see that they are not perfect. Additionally, we can see that science is not the all encompassing force because there are answers it cannot give. This allows the concept of equality to stand. Scientists are not better than other people and they are not better at dealing with the problems of the world.

This is similar to Festinger's (1957) concept of cognitive dissonance. He argues that when an individual is confronted with two conflicting options or concepts, that individual will face a psychological tension that motivates the individual to reduce that tension. Hence, in his classic example, a person who is planning a picnic only to find that it is raining faces an uncomfortable psychological state of conflict that he or she will attempt to resolve. This process can take many forms: changing a behavioral cognitive element, changing an environmental cognitive element or adding new cognitive elements. Thus, an individual may change a behavioral element by canceling the picnic plans, an environmental element by having the picnic indoors, or add new cognitive elements by getting a weather report that notes the rain will stop before it is time for the picnic. We can construct a similar concept for the societal, rather than the individual, level. There are conflicts at the societal level that parallel the conflicts at the individual level. The two values, for example, of freedom and safety often conflict. We want to feel safe in our cities but we do not necessarily like the idea of the constant surveillance that would increase our safety but reduce our freedom. Hence we have what I would call societal dissonance.

However, because society is made up of a mass of individuals that may place different weights on these two values we are unable to simply resolve this issue as an individual would. The techniques that work at the level of the individual will not necessarily work at the level of the society. I propose that the countervailing discourse is one mechanism that allows us to accept the societal dissonance of the two very different value systems inherent in our love/hate (or perhaps love/resent) relationship with scientists. We believe that science is a valuable asset to society and we give scientists a high level of status. On the other hand, the extremely hierarchical nature of scientific knowledge (not all viewpoints are equal and some answers are clearly better than others) contradicts our notion that every individual has an equal value in any situation. This dissonance can partially be resolved by placing a contradictory image of the scientist in the public view. I do not mean to imply that this is a purposeful attempt on the part of the movie makers, but that it functions to manage the dissonance. Clearly, this mechanism does not remove the original dissonance between the values of progress and individualism. It merely serves as a means to release some of the tension. Effectively, it allows the society to reject the tension by placing scientists in another category that makes them less problematic. Thus, while the original dissonance still exists, the countervailing discourse allows society to displace the conflict.

We can see this phenomenon in other places. The debate about the appropriateness of homosexuality deals with the values of our society but at a less fundamental level. I do not intend to imply that these are less deeply held values. Instead, I mean that the values involved in this debate are less central to the functioning of our society as it exists currently. Hence, while homosexuality is more prominent in our cultural representations than it has been in the past, we still see some counterbalancing discourse. *Will and Grace*, a television situation comedy about a gay man is an excellent example of this. The show contrasts the "normal" gay man, Will, with the stereotypical gay man, Jack. This allows the show to balance any tendency to offend by presenting homosexuality as normal and acceptable with the notion that gay men are in fact different. There is not the inherent conflict of values here that exists for the scientist and thus the dissonance could be resolved through a change in the value system of society. This could be accomplished either through a greater acceptance of homosexuality or by a greater degree of censure of homosexuality. Either way, the current tension between groups who find homosexuality acceptable and who find it unacceptable is moderated by maintaining both a new and positive image and a stereotypical image that maintains the idea of difference.

However, the representation of scientists goes beyond a simple reflection of concerns in society. First, it is a representation of scientists that says little in about the nature of science itself. The concerns presented really only represent the application of science. These films do not generally have the conceptual complexity to deal with issues about science. Interestingly, while level does moderate the degree to which scientists are stereotypically portrayed, it does not change the overall presentation of scientists as problematic outsiders.

Ultimately, the portrayals of scientists in these movies are part of a larger complex of discourses throughout society that act in different directions to either enhance the social authority of science and scientists or to decrease it. This conceptualization relates to the point made by Swidler and Arditi (1994) that the sociology of knowledge has not yet truly investigated the issue of the authoritativeness of different types of knowledge. They ask what it means for knowledge to be authoritative and, since we know that social authority structures knowledge, how authorities actually control knowledge. Along this line, we can investigate not only how authorities influence the authoritativeness of knowledge but how all participants in the process, from the scientists themselves, to the movie makers, to the politicians, to the general public, influence it. Thus, films become but one aspect of a greater phenomenon that determines to what degree science remains, overall, socially authoritative.

Science reporting in the news, government regulations and funding of science, science publishing, publishing about science, popular conceptions of science, the way science is taught and representations in film and television are all interconnected and construct a larger public discourse on science. The outcomes of this discourse determine the overall authority of science. Obviously, there is no end to the discourse, but if the overall magnitudes and directions of the different parts of this discourse were measured, we could create a multi-dimensional social authority scale. This scale could then tell us what segments of society see scientific knowledge as authoritative and to what degree. Thus, this work can be seen as part of a larger effort to understand the ways in which different discourses influence how scientific knowledge is perceived.

I use authority here not to mean an epistemological certainty, or even a scientifically proven fact. Rather, I am referring to the degree to which science is perceived within society as a subject that can reasonably tell us something about our world. We know that science has some social authority because it is seen by more people as authoritative than stories about witchcraft. Similarly, I am not referring to the authority of the individual who proclaims the knowledge. While this would be a fruitful outgrowth of this work (i.e., how authority of knowledge and authority of person interact), it is beyond its current scope.

Describing the ways in which formal knowledge maintains or loses its authority is still not a simple process. Knowledge gains or loses its authority in the wider sphere through a series of discourses that occur simultaneously. These discourses occur at different levels of authority and expertise. The discussion that is constructed by the scientists themselves is broken into many levels that, while difficult for the outsider to perceive, are significantly hierarchical. The discussion on the popular level is similarly divided and imbued with a hierarchy of authority. For example, *Nova* on PBS maintains a higher level of authority than does any science that may be seen in most of the movies in this sample. Despite the existence of these different levels of accuracy or authority, all of the discourses impact each other. Movies are often used in more authoritative sources. *Jurassic Park*, to cite an example that falls outside of this study, is often the starting point for serious programs on paleontology. *Star Trek* is used as a comparison for discussions of scientific and technological progress. Clearly, movies are not limited in their effect on the more wide ranging issue of authority of knowledge. Ultimately, we need to understand the interaction of these different levels of discourse to understand how knowledge gains authority with the producers of knowledge, with the intellectual elite and within the mass culture.

Some discourses will not impact significantly the production of knowledge because they come in “below the radar”. For example, when horoscopes are only seen on the amusements page of the newspaper next to the comics they are unlikely to affect science in any great degree. When astrologers and psychics are advertised on television on a regular basis, they are more likely to make an impact. Even if they only divert attention away from other matters, forcing scientists to discuss why and how astrology is not scientifically based, they have affected the discourse.

We must also be aware that there may be a difference between attacks on the culture of the knowledge producers and attacks on the knowledge itself. However, a concerted attack on the culture of one profession is most often also an attack on the knowledge or system they represent. Attacks on knowledge require a sophistication of analysis and presentation that are not always appropriate for particular forms of expression. Thus, we don’t expect an average Saturday morning cartoon to make a distinction between the crazy white haired scientist as odd and his ideas as troubling.

The audience studies cited earlier make it clear that viewers are influenced by what they see on screen. This alone implies that these movies influence at least the discourse of part of the viewing audience. It would surprise no one if a scientifically unsophisticated person saw *Jurassic Park* as a real possibility. It would probably be accurate to say that this person would have only a small effect on the societally perceived authority of science. However, the belief that science will restore dinosaurs will affect science if the number of people who believe it hits some critical level. Scientists will have to spend time explaining to the public why this cannot happen; even if the experts are reluctant to do so, journalists will approach them in order to get their opinion. Television shows will address this issue. In fact, this discourse even influences scientists. Dixon (1986) reports a conversation at a meeting of the American Society for Microbiology where a group of scientists confused the events that occurred at Three Mile Island with the movie The China Syndrome. Clearly, the information in movies about science will be even more difficult for non-scientists to separate from fact.

Conflicting attitudes

As noted above, scientists are more respected by the public than the film images would suggest. It is unclear exactly to what degree the film images overlap the real world images, but it is clear that the portrayal of scientists in film is more negative than that held by the general public. However, the themes that the movies represent do come across in the survey data. Concerns about modernity, about religion, and the moral and ethical outcomes of science (particularly with respect to genetic engineering) are well represented in the survey data. In this case they are not attributed directly to the scientist as they are in the film representations. The NSF question set does not entirely allow for a full test of the connection between these concerns and the public opinion of scientists.

The survey data shows that there are negative characteristics attributed to scientists along with the very positive images represented in more gross level measures such as occupational prestige. Scientists are seen as odd loners, who are exclusively invested in their work. However, in the survey data the concerns are better measured with respect to science and technology as a whole. Additionally, the fact that films direct their concern toward individuals is part of the nature of the medium. Large scale abstract concepts are difficult to represent outside the actions of a character and are highly unlikely to be found in mainstream movies. So, the apparent contradiction between the film and the public appreciation of scientists is both real and not real. The contradiction is real because films bundle all of the concerns about science into the role of the scientist. It is not real because there are very evident negative attitudes towards scientists that can be uncovered with a bit of digging. We know we respect scientists, but we also are deeply suspicious of them as different.

In addition to concern about these grand themes, we see that attitudes towards science are complex and multi-dimensional. They are not simply (as some would hope) a reflection of a person's knowledge of science. They represent a mix of broader attitudes, knowledge, stereotypes of scientists, and belief in pseudoscience. Science as a concept, science as practiced, and the perceived nature of the scientist underpins the complexity of these results.

Ultimately, attitudes towards science are not entirely rational. Belief in pseudoscience is connected to both positive and negative attitudes towards science. This is the ultimate contradiction if one assumes that attitudes towards science (or at least positive attitudes) are based in true understanding of science. The assessment of understanding by trained raters from the NSF data shows that the vast majority of the sample do not understand some of the most basic concepts behind science. This might point to a connection between knowledge and negative attitudes towards science. However, knowledge and education have only a small effect on both positive and negative attitudes towards science.

Not only are these attitudes not directly connected to scientific knowledge, they are also not mutually exclusive. Pro and anti-science attitudes, as measured here, can be held simultaneously. The factor analysis shows that people can be deeply supportive of science and its potential while still being highly concerned about the real and presumed negative effects of science. If the attitudes as measured here represented clearly rational assessments, or were largely connected to levels of education, then this could be representative of a coherent critique that might be made by scientists themselves. Since this is not the case it leaves the cultural understanding of science and its attendant ideological factors the underlying source.

Methodology vs. Cultural Conceptions

Science in the public eye is not just a methodology. It is a broader cultural concept that gets used as a measure of truth, but not necessarily in the way that scientists intend it to be. Invoking science is a quasi-mystical process that is used to justify what we want to be true regardless of the real state of the evidence. This is why the label "clinically proven" is included in every ad for diet supplements, vitamins, and other over the counter remedies. We do believe that science can give us accurate data, at least until it contradicts our deeply held beliefs, and then we reach for emotion or intuition - but we want to use science to prove that our intuition or emotion has led us to the correct answer. Often in these cases we reach towards other reasons for our conflict with science. Most often this comes down to institutional influences or the unwillingness of science to include emotion in the analysis (despite the implied contradiction).

The fact that science as a cultural construct is different from science as a methodology leads to some difficult results for the public understanding of science. The debate that is going on about how to increase the public's ability to understand, use, and evaluate scientific results (e.g., Allum et al., 2008, Bauer et al., 2007, Gregory and Lock, 2008, Miller, 1983, Miller, 2004) is missing an important component. Increasing knowledge or engaging the public more deeply in the dialog will provide some gains in support for science (although too much knowledge may in fact work in the reverse). However, these results are likely to be temporary as the larger cultural conception of science reinvades the consciousness of those who have been more educated.

In order to understand the full nature of the cultural conception of science we need to look more deeply into what influences how these attitudes are formed. The current data sets are designed for examining attitudes towards science as something separate from science. They see these attitudes only as a misunderstanding of science. This is clearly reflected in the debate over what is the right set of science content questions to ask (Pardo and Calvo, 2004). Often the implication is that if we can get the right set of questions we could connect knowledge to attitudes toward science more strongly than we have been able to. People who know science, by this way of thinking, would presumably have more positive attitudes toward science or at least support important research, a proposition that I would argue is quite unlikely. What many see as mere misunderstanding are really part of what the culture sees as science.

Hence, we need to develop data that starts with the notion that there is a different use of the term science than that used by the scientist. This type of question would focus not on the level of scientific knowledge of the respondent, but would look at how they think science works. The questions that ask people to explain scientific methodology are a good start, but they need to be directed towards examining the patterns of differing conceptions rather than solely measuring their correspondence to the scientific definition. Connecting this to how people perceive the results of scientific research both in general and for specific well-known cases would start to show how the common use of science functions.

The next logical step is to move towards finding varieties of the cultural conception as I discuss in more detail below. Two clear themes emerge from this data: religion and anti-technology. These two represent different, possibly overlapping cultural conceptions of science that are largely negative. Are there other themes that can be associated with different varieties of positive and negative perceptions of science? Are any of these more or less influenced by education?

The issue of religion is particularly salient with the growing appropriation of the name, but not the methodology, of science to combat the theory of evolution. The Intelligent Design (ID) movement has been able to at least introduce the notion of ID as an alternate theory in many school districts, most notably in Dover, Pennsylvania. This is the culmination of the cultural use of science. It combines both misunderstanding of science and the appropriation of the idea, but not the methodology. The Dover School District required that all ninth grade biology teachers read a statement about ID as a competing theory to evolution which included the following:

> Because Darwin's Theory is a theory, it continues to be tested as new evidence is discovered. The Theory is not a fact. Gaps in the Theory exist for which there is no evidence. A theory is defined as a well-tested explanation that unifies a broad range of observations. (Kitzmiller v. Dover Area School District)

This statement both correctly and incorrectly defines the idea of a scientific theory. The final statement is an accurate representation of a scientific theory. It is directly contradicted by the understanding of theory implied in the first sentence. The idea that something is "just a theory" is a common misconception that is frequently applied to evolution (Branch and Mead, 2008). Describing any scientific theory in this way implies that it is an hypothesis rather than a large collection of substantially tested results that are collected together to form an explanation of a phenomena. While scientific theories can be challenged, they are challenged based on significant data that also been substantially tested and validated. Hence, a scientific theory is not easily or trivially dismissed by some alternate data, nor can it be characterized as an hypothesis.

This cultural use of the word theory is only the beginning of the complex relationship between the science of evolution and the cultural conception of science. Teaching evolutionary theory is far from a guarantee that people will see evolution as true. Students who understand evolutionary theory do not always acept that it is true (for example, BREM et al., 2003 Shtulman, 2006, Sinatra et al., 2003) and people who accept evolution as true often don't understand it (Shtulman, 2006).

More recent research by Shtulman (2008) shows that targeted teaching can increase the level of acceptance, although not perfectly. This together with Brem's (2003) research that finds that students who understand, but do not believe in evolution are concerned about the impact of the ideas behind evolution, linking them to "decreasing spirituality, increasing selfishness and racism, and interfering with one’s sense of purpose and self-determination." (p. 181) What is clear here is that there is a strong cultural aspect to understanding and believing in evolution even outside of Biblical literalism. Additionally, people may be resistant to scientific ideas if there is a significant cultural ideology that is seen as common sense that conflicts with the scientific information (Bloom and Weisberg, 2007).

In fact, the entire notion of belief in evolution is telling. The question is more properly stated as whether evolution is scientific fact. However, we persist in defining the debate between intelligent design and evolution as one of belief which equalizes the two perspectives. This relates back to the issue of evolution as "just a theory" that may or may not have sufficient evidence to support it. This is, in fact, where the multiple knowledges of postmodernism come into play. Science becomes just one possible way of knowing that does not necessarily have a privileged position as more likely to be correct in its own domain. This postmodern perspective on science fits right into the individualist anti-intellectualism pointed out by Hofstadter (1963). In fact, these two ways of thinking interlock quite nicely to allow science its triumphs, but disallow its primacy when it is not convenient to the world view of the individual or groups that are concerned.

When science is caught between the left's suspicion of business and the right's religious fundamentalism, science cannot help but lose. Business, as seen in the film study can manipulate science for its own ends. Suspicion of business can also be seen in public opinion polls (Ipsos, 2007), This is particularly pertinent when the environment or drug research are involved. This suspicion is clearly represented in the public consciousness as well as in film. Pharmaceutical companies have only a 35% favorable rating and a 32% unfavorable rating. These results compare poorly to information technology (65% favorable and 6% unfavorable) and electronic goods (65% favorable and 7% unfavorable). We learned from tobacco companies (12% favorable and 63% unfavorable) that research can be and is suppressed for the corporate good. This does not, however, create an entirely rational questioning of the data, but rather can create a nihilistic rejection of scientific data in its entirety. Ironically, the left wing critique of fundamentalism includes a large degree of derision about the lack of understanding of the science behind evolution and the age of the earth even as it ignores science inconvenient to its own point of view by labeling it as corrupted by business whether there is evidence of this or not.

Mapping The Paths

While the goals set by the NSF and the Royal society for greater public understanding of and participation in science are reasonable and worthy, they are also missing a major component of the problem. Attitudes towards science are not as malleable as one might hope. Science is a cultural concept. Hence, it is not a matter of simply correcting erroneous information, but rather understanding how science has become deeply embedded in our society as something separate from what scientists mean by science.

There are several steps that need to be taken to understand the full nature of the cultural conception of science. The most central one looks directly at the how individuals conceive of science. What do they think it means to be scientific and how does the process work? Do they use scientific data and how do they decide that something is scientific? What type of information do they use to make decisions? How do they weigh different types of information (e.g., emotion based, scientific, folk wisdom)? What do they do when these sources of information conflict?

The next step would be to look at how science is presented in the media. While there are many good studies (see for example, Bauer, 2000, Clemens, 1986, Dixon, 1986, Dornan, 1990, Nisbet et al., 2002) that examine how science is presented in the media, they tend to focus on news media and on direct representations of science. Broadening both the source and the definition of science would be very valuable. We need to understand how the idea of science is used outside of science as an institution. In fact, we need to understand what the idea of science outside of science as an institution is. Clearly, this is likely to vary by source. Articles in the *New York Times* will look more like the science of the scientific institution than will an episode of *Ghost Hunters*. Oprah will most likely include more emotion based knowledge in her coverage than will the show *Mythbusters*. Once these two issues are reasonably well understood, we are left with the complicated issue of examining how the popular understanding interacts with the media understanding and the complex historical cultural concept of science.

This issue, however, is not just one that is central to sociology. Most of what is written in the public understanding of science literature implies a policy response. Both the NSF and the British Royal Society are working to improve the public understanding of science. The common assumption underlying these efforts and much of the research in this area is that improving understanding will improve attitudes towards science. There has been some good research (see for example, Bauer, 2000, Evans, 1995, Sturgis and Allum, 2004) that has questioned this assumption and found it to be false. Greater understanding can lead to better attitudes, but also raises the complexity of the criticism of science simultaneously.

Provided that the goal is not just more positive attitudes toward science, the first task should be to look at interventions like those used by Shtulman and Calabi (2008) that take into account cultural conceptions of science when teaching science. Their teaching intervention provided opportunities for students to discuss their cultural conceptions of the process of evolution while working toward a scientific understanding. There is also a need to look more carefully at the way in which science is communicated. This research is already started (see for example, Clemens, 1986, Gregory and Miller, 2000, Nisbet et al., 2002), but it tends to look at how to communicate science to present truth so that it will be accepted. We need to look at how the presentation of scientific information becomes complicated by these pre-existing cultural uses of science.

The overarching policy goal with regard to science is to genuinely improve the democratic process. Much of what people need to know to make good decisions is complex data often based in science. Public policy, through entities like the NSF and the Royal Society, is really directed towards these ends. What needs to happen is to examine and revise some of the assumptions regarding how that can be brought about.

Ultimately, culture is difficult to manipulate to reach a desired end. The pervasiveness of ideas as they are embedded in everyday life make them resilient. They are familiar and understandable and not readily discarded by most. In this instance, this is even more the case since the ideas of science and the ideas that work against a public who fully understand science are embedded in the very nature of modernity and the notion of post-modernity. The rationality of science conflicts with the religious and emotional knowledge of anti-modern tendencies. It also directly contradicts the presumption of multiple equivalent knowledges inherent in post-modern ideas. Finally, as noted by Hofstadter (1963), it conflicts with the individualism and egalitarian nature of our type of democracy. These complexities also make it a fruitful place to examine the nature of ideas as suggested by Mannheim (1936), an examination that should help us understand how these ideas in specific, and ideas in general, can be influenced by the social.

APPENDIX A

FILM CONTENT ANALYSIS INSTRUMENT

Revision 6

Name of Movie:

A. Movie Attributes

Basic plot line:

I. time Movie takes place

II. location of Movie (earth, NYC, etc.)

III. Technology Present
   - A. computers
   - B. currently available scientific equipment
     1. high tech (NMR, spectrometer, etc.)
     2. low tech (bunsen burners, microscopes)
   - C. fictional scientific equipment
   - D. new invention
     1. high tech
     2. low tech
   - E. other

IV. Centrality of science to plot
   - A. central
   - B. tangential
   - C. mostly irrelevant

V. Role of science within plot (as a discipline)
   - A. positive (e.g. science benefits society)
   - B. negative (science creates problem to be solved)
   - C. neutral
   - D. ambiguous (both positive and negative aspects)

VI. Role of use of science within plot (science as an institution)
   - A. positive (e.g. use of science benefits society)
   - B. negative (use of science creates problem to be solved)
   - C. neutral
   - D. ambiguous (science creates both positive and negative aspects)

VII. Role of technology within plot
   - A. positive (e.g. technology benefits society)
   - B. negative (technology creates problem to be solved)
   - C. neutral
   - D. ambiguous (both positive and negative aspects)

VIII. Role of use of technology within plot
   - A. positive (e.g. use of technology benefits society)
   - B. negative (use of technology creates problem to be solved)
   - C. neutral
   - D. ambiguous (use of technology creates both positive and negative aspects)

IX. Science conflicts with
   - A. environment
   - B. societal needs
   - C. life of individual
   - D. group

X. Science saves
   - A. environment
   - B. societal needs
   - C. life of individual
   - D. group

XI. Underlying messages of movie

II. Basic Demographic for Scientist **Name of Scientist:**

I. Age
   A. in school (graduate or undergraduate student),
   B. young (20s, just out of school),
   C. mid-career (30s, 40s, established but not senior),
   D. late career (50s and older or well established).
   Note: If age can be separated from status each will be coded separately. If career and apparent age contradict these categories both will be coded.

II. sex of scientist
   A. M
   B. F

III. marital status of scientist
   A. married
   B. divorced
   C. widowed
   D. single
   E. unknown

IV. race/ethnicity of scientists (multiple may apply)
   A. black
   B. white
   C. Hispanic
   D. Asian
      1. Indian
      2. Japanese
      3. Chinese
      4. Other
   E. European
   F. Soviet Block
   G. non-human

V. personal appearance (dress, cleanliness, neatness)
   (coding 1: all of the time, 2: most of the time, 3: about half of the time, 4: once or twice, 5: never.
   A. dress
      1. neutral
      2. out of fashion (e.g. excessively short pants, clashing colors or patterns)
      3. well (in fashion, expensive suits)
      4. eccentric
   B. Cleanliness
      1. neutral
      2. obsessively clean/neat
      3. dirty/unkempt
   C. Physique
      1. neutral
      2. attractive
      3. overweight
      4. awkward/geeky
      5. deformed

VI. Type of Scientist
   A. Physical Scientist
      1. physicist
      2. chemist
   B. Biological Scientist
      1. plant/animal
      2. geneticist
      3. ecological
      4. paleontologist
   C. Social Scientist
      1. sociologist
      2. anthropologist
      3. research psychologists
      4. archeologist
   D. Mathematician
   E. Medical doctor
      1. type
   F. Computer Scientist
   G. Technologist
      1. inventor
      2. engineer
      3. other (specify)
   H. unknown physical or biological
   I. unknown social scientist
   J. unknown

VII. institutional affiliation
   A. Research Institute
   B. Government Agency
   C. Military
   D. College/University
   E. Business
   F. None
   G. Museum
   H. Unknown

VIII. Types of Research Conducted
   A. library Research
   B. lab work
   C. interviews
   D. other

III. Scientists Role within Film

Name of Scientist:

I. First View of scientist (description)

II. Point at which scientist is disclosed as scientist to audience

III. Method of disclosure
   A. direct mention
   B. indirect assumption
      1. dress
      2. location
      3. knowledge
      4. actions

IV. Centrality
   A. main character
   B. supporting character (not primary character but is seen multiple times)
   C. secondary character (appears alone but for short time)
   D. member of large group

V. Role in plot
   A. protagonist
   B. antagonist
   C. neither
   D. adjunct to protagonist
   E. adjunct to antagonist

VI. Relationship of character to protagonist
   A. direct relationship
      1. friend
      2. rival
      3. co-worker
      4. supervisor
      5. consultant
         a. requested by protagonist
         b. requested by opposition
      6. relative (specify)
      7. none
   B. attributes of relationship
      1. emotionally attached
      2. cordial
      3. combative
      4. neutral

VII. Continuity of character's position
   A. No Change
   B. character starts out against protagonist changes to
      1. side of protagonist
      2. side of protagonist and switches back
      3. third position
   C. character starts out with protagonist changes to
      1. side against protagonist
      2. against protagonist and switches back
      3. third position

VIII. Intended Effect of Scientific work
   A. none
   B. positive benefit (saves lives, kills monster)
   C. negative consequences (kills people, harms environment, destroys property)
   D. knowledge

IX. Actual Effect of Scientific work
   A. none
   B. positive benefit (saves lives, kills monster)
   C. negative consequences (kills people, harms environment, destroys property)
   D. knowledge

X. Scientific Discussions (# of incidents)
   A. discuss ethics
   B. discuss methodology
   C. discuss conflicts between science and values
   D. value of research
   E. purpose of research

XI. Scientific Dilemmas implied

XII. Importance of role as scientist
   A. central to character's function
   B. secondary to character's function
   C. mostly irrelevant to character's function

XIII. Function of character within plot

XIV. Nature of Research (brief description)

IV. Personality Characteristics for Scientist: Initial Evaluation

Name of Scientist:

coding 1: all of the time, 2: most of the time, 3: about half of the time, 4: once or twice, 5: never, N/A: not applicable

Negative Types

Absent Minded (misplaces things, forgets names, loses belongings)	1	2	3	4	5	N/A
Socially Inept (awkward physically, makes inappropriate statements, poor conversationalist, cuts others off in conversation)	1	2	3	4	5	N/A
Detached from society (doesn't make conversation, ignores social greetings, apparently has few or no close friends)	1	2	3	4	5	N/A
Science Focused I (ignores social conventions in pursuit of science)	1	2	3	4	5	N/A
Science Focused II (ignores safety in pursuit of science)	1	2	3	4	5	N/A
Egotistical/Arrogant (insists on own interpretation, ignores input of others)	1	2	3	4	5	N/A
Power Hungry (harms others to gain power and position)	1	2	3	4	5	N/A
Emotionally detached (has little affect, may directly eschew emotional displays)	1	2	3	4	5	N/A
Foolhardy (makes choices that are dangerous to self or others without concern or without realizing)	1	2	3	4	5	N/A
Angry (subject to angry emotional outbursts)	1	2	3	4	5	N/A

Cowardly (runs away from danger when could help,)	1	2	3	4	5	N/A
Greedy (wants more money or material goods)	1	2	3	4	5	N/A
Indecisive (finds it difficult to make decisions, hesitates prior to acting)	1	2	3	4	5	N/A
Positive/Neutral Types						
Compassionate (concerned with emotional and physical well being of others)	1	2	3	4	5	N/A
Kindly (goes out of way to assist with problems of others)	1	2	3	4	5	N/A
Heroic (consistently behaves in ways that help others to possible detriment of self)	1	2	3	4	5	N/A
Decisive (makes decisions easily, acts immediately when necessary)	1	2	3	4	5	N/A
Neutral (no extreme positive or negative characteristics)	1	2	3	4	5	N/A

I. Behaviors with positive consequences (count of incidents)
   A. altruistic behaviors
   B. heroic behaviors

II. Behaviors with negative consequences (count of incidents)
   A. harmed another individual
   B. killed another individual
   C. destroyed property

II. Change in Personality Habits due to
   A. personal crisis
   B. scientific crisis
   C. external event
   D. influence of other individual
   E. other

IV. Personality Characteristics for Scientist: Post Change **Name of Scientist:**

coding 1: all of the time, 2: most of the time, 3: about half of the time, 4: once or twice, 5: never, N/A: not applicable

Negative Types						
Absent Minded (misplaces things, forgets names, loses belongings)	1	2	3	4	5	N/A
Socially Inept (awkward physically, makes inappropriate statements, poor conversationalist, cuts others off in conversation)	1	2	3	4	5	N/A
Detached from society (doesn't make conversation, ignores social greetings, apparently has few or no close friends)	1	2	3	4	5	N/A
Science Focused I (ignores social conventions in pursuit of science)	1	2	3	4	5	N/A
Science Focused II (ignores safety in pursuit of science)	1	2	3	4	5	N/A
Egotistical/Arrogant (insists on own interpretation, ignores input of others)	1	2	3	4	5	N/A
Power Hungry (harms others to gain power and position)	1	2	3	4	5	N/A
Emotionally detached (has little affect, may directly eschew emotional displays)	1	2	3	4	5	N/A
Foolhardy (makes choices that are dangerous to self or others without concern or without realizing)	1	2	3	4	5	N/A
Angry (subject to angry emotional outbursts)	1	2	3	4	5	N/A
Cowardly (runs away from danger when could help,)	1	2	3	4	5	N/A
Greedy (wants more money or material goods)	1	2	3	4	5	N/A
Indecisive (finds it difficult to make decisions, hesitates prior to acting)	1	2	3	4	5	N/A
Positive/Neutral Types						
Compassionate (concerned with emotional and physical well being of others)	1	2	3	4	5	N/A
Kindly (goes out of way to assist with problems of others)	1	2	3	4	5	N/A
Heroic (consistently behaves in ways that help others to possible detriment of self)	1	2	3	4	5	N/A
Decisive (makes decisions easily, acts immediately when necessary)	1	2	3	4	5	N/A

Neutral (no extreme positive or negative characteristics)	1	2	3	4	5	N/A

I. After Change: Behaviors with positive (count of incidents)
   A. altruistic behaviors
   B. heroic behaviors
II. After Change: Behaviors with negative consequences (count of incidents)
   A. harmed another individual
   B. killed another individual
   C. destroyed property

V. Attitude of Main or Supporting Characters Toward Scientist
Name:

I. Centrality
   A. main character
   B. supporting character (not primary character but is seen multiple times)
   C. secondary character (appears alone but for short time)
   D. member of large group

II. Role in plot
   A. protagonist
   B. antagonist
   C. neither
   D. adjunct to protagonist
   E. adjunct to antagonist

III. Age
   A. in school (graduate or undergraduate student),
   B. young (20s, just out of school),
   C. mid-career (30s, 40s, established but not senior),
   D. late career (50s and older or well established).
   Note: If age can be separated from status each will be coded separately. If career and apparent age contradict these categories both will be coded.

IV. Sex
   A. M
   B. F
V race/ethnicity (multiple may apply)
   A. black
   B. white
   C. Hispanic
   D. Asian
      1. Indian
      2. Japanese
      3. Chinese
      4. Other
   E. European
   F. Soviet Block
   G. non-human

VI. Character's role in Movie
   A. function of character in plot (brief summary)
   B. relationship to scientist
      1. friend
      2. employer
      3. acquaintance
      4. stranger
      5. relative (specify)
      6. enemy

VII. General attitude toward scientist
   A. antagonistic
   B. friendly
   C. neutral

VIII. Negative Actions by character against scientist
   A. type of action
      1. killed
      2. attempt to kill
      3. court trial
      4. jailed
      5. loss of job
      6. physically abused
      7. maimed
      8. verbally abused or denigrated
         a. in person
         b. to another

LI. Positive actions by character towards scientist
   A. character acted against (name)
   B. type of action
      1. solved problem
      2. saved life
      3. gave material assistance
      4. gave emotional support

.

Also Coded for categories II and III: at the time of action does character know the person is a scientist. Each action will be coded separately with a one or zero for this category

VI. Secondary Characters (small roles and group scenes)
Name or Description:

I. type of character
   A. group
   B. passing stranger
      1. specific type recorder (e.g. waitress, co-worker)

II. function in plot (brief summary)

III. attitude toward scientist
   A. strong emotional attachment
   B. antagonistic
   C. friendly
   D. neutral

LV. Actions by others against scientist
   A. character committing act (name)
   B. type of action
      1. killed
      2. attempt to kill
      3. court trial
      4. jailed
      5. loss of job
      6. physically abused
      7. maimed
      8. verbally abused or denigrated
         a. in person
         b. to another

LVI. Positive actions of other characters towards other scientist
   A. character acted against (name)
   B. type of action
      1. solved problem
      2. saved life
      3. gave material assistance
      4. gave emotional support

Also Coded for categories IV and IV: at the time of action does character know the person is a scientist. Each action will be coded separately with a one or zero for this category.

APPENDIX B

PRO-SCIENCE DISTRIBUTION A: COMPARISON OF SELF AND OTHER EVALUATION OF UNDERSTANDING OF DNA

Including Trained Rater's Assessment (G2BS):

The trained rater's assessment of the respondents understanding of DNA does not change the model significantly (see the final model below), but reduces the cases from 1005 to 795 and excludes people unsure of their own knowledge.

```
Linear regression                                      Number of obs =     795
                                                       F( 19,   775) =   20.41
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.3185
                                                       Root MSE      =  .48144
```

mfs1a	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
SMEDUC	.0150487	.0039852	3.78	0.000	.0072256	.0228717
G2Ar	-.088648	.0367821	-2.41	0.016	-.1608525	-.0164436
CorSum	.010406	.0073565	1.41	0.158	-.004035	.024847
P7	-.0637225	.0206175	-3.09	0.002	-.1041953	-.0232496
H10	.0480054	.0171983	2.79	0.005	.0142445	.0817662
MICE	.0604242	.0191873	3.15	0.002	.022759	.0980893
H3	-.0723278	.0179705	-4.02	0.000	-.1076045	-.0370511
H9	-.1084942	.0205174	-5.29	0.000	-.1487705	-.0682178
H15	-.0811278	.0170974	-4.75	0.000	-.1146905	-.0475651
A6	.0663921	.0303666	2.19	0.029	.0067815	.1260026
J4	.0437757	.0149544	2.93	0.004	.0144198	.0731315
K2	.1431939	.0406692	3.52	0.000	.063359	.2230287
P12	.0939167	.0175269	5.36	0.000	.0595108	.1283226
H16	.0279982	.0140051	2.00	0.046	.0005057	.0554907
L1	.0625171	.0265474	2.35	0.019	.0104037	.1146304
L2	-.0665601	.0210671	-3.16	0.002	-.1079155	-.0252048
L3	.0654154	.020672	3.16	0.002	.0248358	.1059951
L9	.0756656	.0174847	4.33	0.000	.0413426	.1099886
G2BS	.0095684	.015818	0.60	0.545	-.0214829	.0406196
_cons	-2.128064	.3188778	-6.67	0.000	-2.754031	-1.502098

The Final Model:

Linear regression

Number of obs	= 1005
F(18, 986)	= 23.60
Prob > F	= 0.0000
R-squared	= 0.3114
Root MSE	= .48803

mfs1a	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
SMEDUC	.0142096	.0037366	3.80	0.000	.0068771	.0215422
G2Ar	-.0511995	.0256911	-1.99	0.047	-.1016149	-.000784
CorSum	.0148023	.0060878	2.43	0.015	.0028557	.0267489
P7	-.0654346	.0175271	-3.73	0.000	-.0998293	-.0310399
H10	.0531803	.0153554	3.46	0.001	.0230474	.0833133
MICE	.0828638	.017306	4.79	0.000	.0489029	.1168247
H3	-.0574769	.0157774	-3.64	0.000	-.088438	-.0265157
H9	-.1078643	.0175437	-6.15	0.000	-.1422915	-.073437
H15	-.0962657	.0156814	-6.14	0.000	-.1270385	-.065493
A6	.0693147	.0261325	2.65	0.008	.0180329	.1205965
J4	.039771	.0133636	2.98	0.003	.0135465	.0659954
K2	.1140665	.0366737	3.11	0.002	.0420991	.1860339
P12	.0874905	.0163069	5.37	0.000	.0554901	.1194908
H16	.0302981	.0128446	2.36	0.019	.0050922	.055504
L1	.0531461	.0204782	2.60	0.010	.0129602	.0933319
L2	-.0558335	.018536	-3.01	0.003	-.092208	-.0194589
L3	.0529282	.0183092	2.89	0.004	.0169986	.0888577
L9	.068649	.0156226	4.39	0.000	.0379916	.0993064
_cons	-2.136424	.2715162	-7.87	0.000	-2.66924	-1.603608

APPENDIX C

NSF SURVEY KNOWLEDGE QUESTIONS IN CORSUM

M1: The center of the Earth is very hot.
Is that true or false?
1> true
2> false

M2: All radioactivity is man-made.
Is that true or false?
1> true
2> false

M3: The oxygen we breathe comes from plants.
Is that true or false?
1> true
2> false

M4:It is the father's gene that decides whether the baby is a boy or a girl.
Is that true or false?
1> true
2> false

M5: Lasers work by focusing sound waves.
Is that true or false?
1> true
2> false

M6: Electrons are smaller than atoms.
Is that true or false?
1> true
2> false

M7: Antibiotics kill viruses as well as bacteria.
Is that true or false?
1> true
2> false

M8: The universe began with a huge explosion. Is that true or false?
1> true
2> false

M9: The continents on which we live have been moving their location for millions of years and will
continue to move in the future.
Is that true or false?
1> true
2> false

M10: Human beings, as we know them today, developed from earlier species of animals.
Is that true or false?
1> true
2> false

M11: Cigarette smoking causes lung cancer.
Is that true or false?
1> true
2> false

M12: The earliest humans lived at the same time as the dinosaurs.
Is that true or false?
1> true
2> false

M13: Radioactive milk can be made safe by boiling it.

Is that true or false?

1> true

2> false

N1: Which travels faster: light or sound?

1> light

2> sound

2> both the same

N2: Does the Earth go around the Sun, or does the Sun go around the Earth?

1> Earth goes around Sun

2> Sun goes around Earth

N3: Ask if N2 = 1

How long does it take for the Earth to go around the Sun: one day, one month, or one year?

1> one day

2> one month

3> one year

4> DO NOT READ: other time period

Now, think about this situation. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness.

O1: Does this mean that if their first three children are healthy, the fourth will have the illness?

1> Yes/True

2> No/False

O2: Does this mean that if their first child has the illness, the next three will not?

1> Yes/True

2> No/False

O3: Does this mean that each of the couple's children will have the same risk of suffering from the illness?

1> Yes/True

2> No/False

O4: Does this mean that if they have only three children, none will have the illness?

1> Yes/True

2> No/False

APPENDIX D

PRO-SCIENCE DISTRIBUTION A: COMPARISON OF PARENTS WISHES REGARDING SCIENCE FOR MALE AND FEMALE CHILDREN

SUBSTITUTING FEMALE FOR MALE

Changing from how someone would feel about their son becoming a scientist (K2) to how they feel about their daughter (K1) has very little effect on the model (see below for the final model).

```
Linear regression                                      Number of obs =    1571
                                                       F( 18,  1552) =   53.60
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.3582
                                                       Root MSE      =  .72349
```

mfs1	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
SMEDUC	.0122175	.0044261	2.76	0.006	.0035357	.0208993
G2Ar	-.0098588	.0312049	-0.32	0.752	-.071067	.0513494
CorSum	.0439655	.0068956	6.38	0.000	.0304399	.0574911
P7	-.1265248	.021257	-5.95	0.000	-.1682202	-.0848294
H10	.0941037	.0184966	5.09	0.000	.0578228	.1303846
MICE	.1414998	.0193731	7.30	0.000	.1034995	.1795
H3	-.0666343	.0180764	-3.69	0.000	-.1020911	-.0311776
H9	-.1346326	.0213132	-6.32	0.000	-.1764384	-.0928269
H15	-.1328761	.0203527	-6.53	0.000	-.1727979	-.0929543
A6	.1610693	.0306109	5.26	0.000	.1010262	.2211123
J4	.0757995	.0173247	4.38	0.000	.0418172	.1097818
K1	**.0998532**	**.0433948**	**2.30**	**0.022**	**.0147346**	**.1849717**
P12	.1562834	.0197902	7.90	0.000	.117465	.1951019
H16	.0620442	.014481	4.28	0.000	.03364	.0904485
L1	.0341903	.023457	1.46	0.145	-.0118205	.0802011
L2	-.0692835	.0213744	-3.24	0.001	-.1112093	-.0273577
L3	.105556	.0219903	4.80	0.000	.0624222	.1486899
L9	.093947	.0193778	4.85	0.000	.0559375	.1319564
_cons	-3.367151	.3166125	-10.63	0.000	-3.988184	-2.746117

The Final Model:

Linear regression			Number of obs	=	1005
			F(18, 986)	=	23.60
			Prob > F	=	0.0000
			R-squared	=	0.3114
			Root MSE	=	.48803

mfs1a	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
SMEDUC	.0142096	.0037366	3.80	0.000	.0068771	.0215422
G2Ar	-.0511995	.0256911	-1.99	0.047	-.1016149	-.000784
CorSum	.0148023	.0060878	2.43	0.015	.0028557	.0267489
P7	-.0654346	.0175271	-3.73	0.000	-.0998293	-.0310399
H10	.0531803	.0153554	3.46	0.001	.0230474	.0833133
MICE	.0828638	.017306	4.79	0.000	.0489029	.1168247
H3	-.0574769	.0157774	-3.64	0.000	-.088438	-.0265157
H9	-.1078643	.0175437	-6.15	0.000	-.1422915	-.073437
H15	-.0962657	.0156814	-6.14	0.000	-.1270385	-.065493
A6	.0693147	.0261325	2.65	0.008	.0180329	.1205965
J4	.039771	.0133636	2.98	0.003	.0135465	.0659954
K2	.1140665	.0366737	3.11	0.002	.0420991	.1860339
P12	**.0874905**	**.0163069**	**5.37**	**0.000**	**.0554901**	**.1194908**
H16	.0302981	.0128446	2.36	0.019	.0050922	.055504
L1	.0531461	.0204782	2.60	0.010	.0129602	.0933319
L2	-.0558335	.018536	-3.01	0.003	-.092208	-.0194589
L3	.0529282	.0183092	2.89	0.004	.0169986	.0888577
L9	.068649	.0156226	4.39	0.000	.0379916	.0993064
_cons	-2.136424	.2715162	-7.87	0.000	-2.66924	-1.603608

APPENDIX E

NORMALITY OF THE PRO-SCIENCE FACTOR SCORE DISTRIBUTIONS

Distribution A (lower pro-science scores) is not fully normal, it is clearly skewed left (skewness -0.74) and the peak of the distribution is a bit too high (kurtosis 2.9), but is reasonably close enough that no transformation of the distribution to a more normal form gave improved regression results. Distribution B (higher pro-science scores) is much closer to normal (skewness 0.08 kurtosis 2.4) and also did not transform in any way to improve the the regression results. The error terms for distribution A do not have common variance so the robust option was used to relax the assumption of independence in error terms which will resolve the issue of this heteroskedasticity. The functional form of the model was examined using component-plus-residual plots for all independent variables and was found to be sufficiently close to linear in alignment with the assumptions of linear regression.

APPENDIX F

NORMALITY OF THE ANTI-SCIENCE FACTOR SCORE

The distribution anti-science factor scores is not quite normal. It is slightly skewed left (skewness -0.55) and the peak of the distribution is a bit too high (kurtosis 4.8). Several transformations to make the distribution closer to normal, including a Box-Cox transformation, were attempted, but were unsuitable for this data. No transformations provided an improvement in the model. The error terms do not have common variance so the robust option was used to relax the assumption of independence in error terms which will resolve the issue of this heteroskedasticity. To ensure that the the data was linear, as is the assumption for multivariate regression, the functional form was examined using component-plus-residual plots for all independent variables and was found to be sufficiently close to linear.

References

Allum, Nick, Patrick Sturgis, Dimitra Tabourazi, and Ian Brunton-Smith. 2008. "Science Knowledge and Attitudes Across Cultures:a Meta-Analysis." *Public Understanding of Science,* 17:35-54.

Barman, Charles R. 1997. "Students' Views of Scientists and Science: Results From a National Study." *Science and Children,* 35(1):18-23.

———. 1999. "Completing the Study: High School Students' Views of Scientists and Science." *Science and Children,* 36(7):16-21.

Bauer, Martin. 1996. "Socio-Demographic Correlates of Dk-Responses in Knowledge Surveys: Self-Attributed Ignorance of Science." *Social Science Information,* 35:1:39-68.

———. 2000. "Science in the Media as a Cultural Indicator: Contextualizing Surveys With Media Analysis" in M. Dierkes, and C. Von Grote (Eds.), *Between Understanding and Trust: The Public, Science and Technology* Amsterdam: Harwood Academic Publishers.

Bauer, Martin W., Nick Allum, and Steve Miller. 2007. "What Can We Learn From 25 Years of Pus Survey Research? Liberating and Expanding the Agenda." *Public Understanding of Science,* 16(1):79-85.

Bauer, Martin W., Petkova, Kristina; Boyadjieva, Pepka. 2000. "Public Knowledge of and Attitudes to Science: Alternative Measures That May End the "Science War"." *Science, Technology, and Human Values,* 25(1):30-51.

Bloom, Paul, and Deena Skolnick Weisberg. 2007. "Childhood Origins of Adult Resistance to Science." *Science,* 316

Bodmer, W. 1985. *The Public Understanding of Science*. The Royal Society.

Bowtell, Evelyn. 1996. "Educational Steroetyping: Children's Perceptions of Scientists: 1990's Style." *Investigating: Australian Primary and Junior Science Journal,* 12 (1)

Branch, Glenn, and Louise S. Mead. 2008. ""Theory" in Theory and Practice." *Evolution Education Outreach,* 1:287-89.

Brem, Sarah K., Michael Ranney, and Jennifer Schindel. 2003. "Perceived Consequences of Evolution: College Students Perceive Negative Personal and Social Impact in Evolutionary Theory." *Science Education,* 87(2):181-206.

Chambers, D.W. 1983. "Stereotypic Images of the Scientist: The Draw-a-Scientist Test." *Science Education,* 67:255-56.

Chen, W., S. Landau, P. Shaman, and E. Fombonne. 2004. "No Evidence for Links Between Autism, MMR and Measles Virus." *Psychological Medicine,* 34:543-53.

Clemens, Elisabeth S. 1986. "Of Asteroids and Dinosaurs: The Role of the Press in the Shaping of Scientific Debate." *Social Studies of Science,* 16(3):421-56.

Comstock, George And Heather Tully. 1985. "Innovation in the Movies, 1939-1976." *Journal of Communications,* spring:97-105.

Davis, James, A., Tom W. Smith, Robert W. Hodge, Keiko Nakao, And Judith Treas. 1991. "Occupational Prestige Ratings From the 1989 General Social Survey." First Release ed, vol. 1991 Inter-university Consortium for Political and Social Research

Dawkins, Richard. 2006. *The God Delusion*. Houghton Miffllin.

Demeis, L, R Decassia, P Machado, and P Lustosa. 1993. "The Stereotyped Image of the Scientist Among Students of Different Countries - Evoking the Alchemist." *Biochemical Education,* 21(2):75-81.

Demerath, N. J. 2001. *Crossing the Gods: World Religions and Wordly Politics*. New Brunswick, NJ: Rutgers University Press.

Destefano, F. 2007. "Vaccines and Autism: Evidence Does Not Support a Causal Association." *Nature,* 82(6):756-59.

Dickson, David. 2000. "Science and Its Public: The Need for a 'Third Way'." *Social Studies of Science,* 30(6):917-23.

Dillon, Sam 2007, November 14. "Study Compares States' Math and Science Score With Other Countries'." *New York Times*, pp. 21.

Dixon, Bernard. 1986. "Books and Films: Powerful Media for Science Popularization." *Impact of Science on Society,* 144:379-85.

Dornan, Christopher. 1990. "Some Problems in Conceptualizing the Issue of 'Science and the Media'." *Critical Studies in Mass Communication,* 7(1):48-71.

Draper, John William. 2007. *History of the Conflict Between Religion and Science*. BiblioBazar.

Durant, J., Bauer, M., Gaskell, G., Midden, C., Liakopoulos, M., and Scholten, L. 2000. "Two Cultures of Public Understanding of Science and Technology in Europe." In M. Dierkes, and C. Von Grote (Eds.), *Between Understanding and Trust: The Public, Science and Technology* (pp. 131-56). Amsterdam: Harwood Academic Publishers.

Durant, John R., Geoffrey A. Evans, and Geoffrey P. Thomas. 1989. "The Public Understanding of Science." *Nature,* 34(6):11-14.

Evans, Geoffrey, Durant, John. 1995. "The Relationship Between Knowledge and Attitudes in the Public Understanding of Science in Britain." *Public Understanding of Science,* 4:57-74.

Destefano, F. 2007. "Vaccines and Autism: Evidence Does Not Support a Causal Association." *Nature,* 82(6):756-59.

Farhi, Paul 2007, January 1. "5 Myths About U.S. Kids Outclassed By the Rest of the World." *Washington Post*, p. 02.

Felson, Richard, B. 1996. "Mass Media Effects on Violent Behavior." *Annual Review of Sociology,* 22:103-28.

Ferngren, Gary B. 2002. *Science and Religion: A Historical Introduction*. Baltimore: The Johns Hopkins University Press.

Festinger, Leon. 1957. *A Theory of Cognitive Dissonance*. Stanford California: Stanford University Press.

Florman, Samuel, C. 1981. *Blaming Technology*. New York:St. Martin's Press.

Freud, Sigmund. 1961. *The Future of an Illusion*. New York:W. W. Norton.

Fung, Yvonne Y. H. 2002. "A Comparative Study of Primary and Secondary School Students' Images of Scientists." *Research in Science and Technological Education,* 20(2):199-213.

Gardner, Walt 2007, December 27. "The Good News About U.S. Schools." *Christian Science Monitor*, pp. 9.

Garfield, E. 1987. "The Image of Scientists Matters." *The Scientist,* 1(17)

Gauhar, Raza, Surjit Singh, and Bharvi Dutt. 2002. " Public, Science, and Cultural Distance." *Science Communication,* 23:3:293:309.

General Medical Council. 2010. Fitness to Practice Hearing. from www.gmc-uk.org/static/documents/content/Wakefield__Smith_Murch.pdf

Gerbner, George. 1987. "Science on Television: How it Affects Public Conceptions." *Issues in Science and Technology,* 3:109-15.

Gerbner, G., Larry Gross, Michael Morgan, And Nancy, Signorelli. (1984). "Growing Up With Television: The Cultivation Perspective" in Jennings Bryan And Dolf Zillmann, eds.*Media Effects: Advances in Theory and Research* Hillsdale, NJ: Lawrence Erlb.

Glod, Maria 2007. "U.S. Teens Trail Peers Around the World in Math Science Tests*." Washington Post*, pp. 7.

Godin, Benoit, and Yves Gingras. 2000. "What is Scientific and Technological Culture and How is it Measured? A Multidimensional Model." *Public Understanding of Science,* 9:43-58.

Goldman, Steven, L. 1989. "Images of Technology in Popular Films: Discussion and Filmography." *Science, Technology, and Human Values,* 14:275-301.

Gregory, Jane, and Simon Jay Lock. 2008. "The Evolution of 'Public Understanding of Science': Public Engagement as a Tool of Science Policy in the Uk." *Sociology Compass,* 1252-65.

Gregory, Jane, and Steve Miller. 2000. *Science in Public: Communication, Culture, and Credibility*. New York, NY: Perseus Publishing.

Hadaway, C. Kirk, Penny Long Marler, and Mark Chaves. 1993. "What the Polls Don't Show: A Closer Look At U.S. Church Attendance." *American Sociological Review*, 58:741-52.

The Harris Poll. 2005. The Religious and Other Beliefs of Americans 2005. from www.harrisinteractive.com/harris_poll/index.asp?PID=618

Honda, Hideo, Yasuo Shimizu, and Michael Rutter. 2005. "No Effect of Mmr Withdrawal on the Incidence of Autism: A Total Population Study." *Journal of Child Psychology and Psychiatry,* 46(6):572-79.

Hilgartner, Stephen. 1990. "The Dominant View of Popularization: Conceptual Problems, Political Uses." *Social Studies of Science,* 20(3):519-39.

Hirsch, W. 1958. "The Image of the Scientist in Science-Fiction: A Content-Analysis." *American Journal of Sociology,* 63(5):506-12.

Hofstadter, Richard. 1963. *Anti-Intellectualism in American Life*. New York: Vintage Books.

Hornig, Mady, Thomas Briese, Timothy Buie, Margaret L. Bauman, Gregory Lauwers, Ulrike Siemetzki, Kimberly Hummel, Paul A. Rota, William J. Bellini, John J. O'Leary, Orla Sheils, Errol Alden, Larry Pickering, and W. Ian Lipkin. 2008. "Lack of Association Between Measles Virus Vaccine and Autism With Enteropathy: A Case-Control Study." *PLoS ONE,* 3(9):3-8.

House of Lords Select Committee on Science and Technology (2000). Science and Society: Science and Technology, Third Report. from http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm

Intelligent Design Network: Seeking Objectivity in Origins Science. from http://www.intelligentdesignnetwork.org/

IPSOS. 2007. Pharmaceutical Companies Need To Raise Awareness Of Their Social Investments To Improve Industry's Image. from http://www.ipsos-na.com/news-polls/pressrelease.aspx?id=3435

Irwin, Alan, and Brian Wynne. 1996. *Misunderstanding Science? : The Public Reconstruction of Science and Technology*. Cambridge University Press.

Jones, Ra. 1997. "The Boffin: A Stereotype of Scientists in Post-War British Films (1945-1970)." *Public Understanding of Science,* 6(1):31-48.

Kirejczyk, M. 1999. "Parliamentary Cultures and Human Embryos: The Dutch and British Debates Compared." *Social Studies of Science,* 29(6):889-912.

Kitzmiller V. Dover District Area School. " 2005. 04-Cv-2688. 2005 Wl 578974 (M.D. Pa. 2005)."

Kolakowski, Lesek. 1990. *Modernity on Endless Trial*. Chicago: University of Chicago Press.

Lafollette, M. C. (1999). *The Changing Political Image of Scientists in the United States*. In A. H. Teich, S. D. Nelson, C. Mcenaney, and T. M. Drake (Eds.), Science and Technology Policy Yearbook American Association for the Advancement of Science.

The Editors of the Lancet. 2010. "Retraction—Ileal-Lymphoid-Nodular Hyperplasia, Non-Specific Colitis, and Pervasive Developmental Disorder in Children." *The Lancet,* 375:455.

Landy, Marcia And Stanley, Shostak. 1993. "Postmodernism as Folklore in Contemporary Science Fiction Cinema." *Rethinking Marxism,* 6:25-45.

Langland, Connie 2008,April 13ß. "Looking to the Future." *Philadelphia Inquirer*, http://www.philly.com/inquirer/education/school_report_card/17478584.html

Lannes, D., L. Flavoni, and L. De Meis. 1998. "The Concept of Science Among Children of Different Ages and Cultures." *Biochemical Education,* 26(3):199-204.

Larson, Edward J., and Larry Witham. 1997. "Scientists Are Still Keeping the Faith." *Nature,* 386:435-36.

Larson, Edward J., and Larry Witham. 1998. "Leading Scientists Still Reject God." *Nature*, 394:313.

Larson, Edward J., and Larry Witham. 1999. "Scientists and Religion in America." *Scientific American*, 281:88-93.

Leuba, James H. 2006. *The Belief in God and Immortality: A Psychological, Anthropological and Statistical Study*. Kessinger Publishing, LLC.

Locke, S. 2001. “Sociology and the Public Understanding of Science: From Rationalization to Rhetoric.” *British Journal of Sociology,* 52(1):1-18.

Mannheim, Karl. 1936. *Ideology and Utopia*. Chicago: Harcourt, Brace & World, Inc.

McCarthy, J., and Carrey, J. (2010). Andrew Wakefield, Scientific Censorship, and Fourteen Monkeys. from http://www.generationrescue.org/wakefield_statement2.html

Mcduffie, Thomas E. 2001. “Scientists - Geeks & Nerds.” *Science and Children,* May:16-19.

The Melman Group. 2006. Review of Public Opinion Research. from http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Public_Opinion/Food_and_Biotechnology/2006summary.pdf

Michael, Mike. 2002. “Comprehension, Apprehension, Prehension: Heterogeneity and the Public Understanding of Science.” *Science, Technology, and Human Values,* 27(3):357-78.

Miller, Jon D. 1983. “Scientific Literacy: A Conceptual and Empirical Review.” *Daedalus,* 112(2):29.

———. 1998. “The Measurement of Civic Scientific Literacy.” *Public Understanding of Science,* 7:203-23.

———. 2004. “Public Understanding of, and Attitudes Toward Scientific Research: What We Know and What We Need to Know.” *Public Understanding of Science,* 13(3):273-94.

Miller, Jon D., Rafael Pardo, Fujio Niwa. 1997. *Public Perceptions of Science and Technology of Science and Technology: A Comparative Study of the European Union, the United States, Japan and Canada*. Bilbao:Fundación BBV.

Miller, Steve. 2001. “Public Understanding of Science At the Crossroads.” *Public Understanding of Science,* 10(1):115-20.

Moore, John H. 1998. "Public Understanding of Science--and Other Fields." *American Scientist,* 86(6):498-500.

Murch, Simon H, Andrew Anthony, David H Casson, Mohsin Malik, Mark Berelowitz, Amar P Dhillon, Michael A Thomson, Alan Valentine, Susan E Davies, and John A Walker-Smith. 2004. "Retraction of an Interpretation." *The Lancet,* 363:750.

Myers, Greg. 2003. "Discourse Studies of Scientific Poularization: Questioning the Boundaries." *Discourse Studies,* 5(2):265-79.

National Science Board. 2008. *Science and Engineering Indicators 2008*. Arlington, VA: National Science Foundation.

———. 2007. "A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology and Mathematics Education System." NSB-07-114 Arlington, VA: National Science Foundation.

———. 2002. *Science and Engineering Indicators 2002.* Arlington, VA: National Science Foundation.

Newton, Douglas P., and Lynn D. Newton. 1992. "Young Children's Perception of Science and the Scientist." *International Journal of Science Education,* 14(3):331-48.

Nicol, Caitrin. 2007. "Autism and the Vaccines Controversy." *The New Atlantis: A Continuing Survey of Technology and Society,* Fall:107-15.

Nisbet, Matthew C. 2004. "Public Opinion About Stem Cell Research and Human Cloning." *Public Opinion Quarterly,* 68(1):121-54.

Nisbet, Matthew C., Dietram A. Scheufele, James Shanahan, Patricia Moy, Dominique Brossard, and Bruc V. Lewenstein. 2002. "Knowledge, Reserevations, Or Promise? A Media Effects Model for Public Perceptions of Science and Technology." *Communication Research,* 29(5):584-608.

Pardo, Rafael, and Félix Calvo. 2002. "Attitudes Toward Science Among the European Public: A Methodological Analysis." *Public Understanding of Science,* 11:155-95.

———. 2004. "The Cognitive Dimension of Public Perceptions of Science: Methodological." *Public Understanding of Science,* 13:3:203.

Peterson, Richard A., and N. Anand. 2004. "The Production of Culture Perspective." *Annual Review of Sociology,* 30:311-34.

Pew Research Center. 2007. Religion in Campaign '08. from http://people-press.org/reports/pdf/353.pdf

Priest, Susanna Hornig. 2000. "Us Public Opinion Divided Over Biotechnology?" *Nature Biotechnology,* 18 (Sept):939-42.

The Royal Society. 2008. Royal Society's response to a vision for Science and Society: a consultation on developing a new strategy for the UK. from http://royalsociety.org/document.asp?tip=0&id=8077

———. 1986. "Public Understanding of Science: The Royal Society Reports." *Science, Technology, and Human Values,* 11(3):53-60.

Schibeci, Renato, Lee, Libby. 2003. "Portrayals of Science and Scientists, and 'Science for Citizenship'." *Research in Science and Technological Education,* 21(2):177-93.

Schnabel, U. 2003. "God's Formula and Devil's Contribution: Science in the Press." *Public Understanding of Science,* 12(3):255-59.

Shtulman, A., and Calabi, P. (2008). Learning, Understanding, and Acceptance: The Case of Evolution. In B. C. Love, K. McRae, and M. Sloutsky (Eds.), *Proceedings of the 30th Annual Conference of the Cognitive Science Society* (pp. 235-40). Austin, TX: Cognitive Science Society.

Shtulman, Andrew. 2006. "Qualitative Differences Between Naïve and Scientific Theories of Evolution." *Cognitive Psychology,* 52:170-94.

Sinatra, Gale M., Sherry A. Southerland, Frances Mcconaughy, and James W. Demastes. 2003. "Intentions and Beliefs in Students' Understanding and Acceptance of Biological Evolution." *Journal of Research in Science Teaching,* 40(5):510-28.

Skal, David J. 1998. *Screams of Reason: Mad Science in Modern Culture*. New York: W. W. Norton & Company.

Smith, Tom W. 1998. "A Review of Church Attendance Measures." *American Sociological Review*, O : 63 1:131-36.

Snow, C. P. 1959. *The Two Cultures and the Scientific Revolution*. Cambridge [Eng.]:University Press.

Sobchack, Vivian. 1997. *Screening Space: The American Science Fiction Film*. New Brunswick: Rutgers University Press.

Sturgis, Patrick, and Nick Allum. 2004. "Science in Society: Re-Evaluating the Deficit Model of Public Attitudes." *Public Understanding of Science,* 13(1):55-84.

Swidler, Ann, and Jorge Arditi. 1994. "The New Sociology of Knowledge." *Annual Review of Sociology,* 20:305-29.

Teicher, Stacy 2007, November 14. “World’s Schools Teach U.S. A Lesson.” *Christian Science Monitor*, pp. 13.

Terzian, Sevan G., and Andrew L. Grunzke. 2007. “Scrambled Eggheads:Ambivalent Representations of Scientists in Six Hollywood Film Comedies From 1961 to 1965.” *Public Understanding of Science,* 16:407-19.

Toppo, Greg 2007, November 14 . “U.S. Schoolchildren Are ‘Middle of the Pack in Global Terms; Asian Nations Outdo Top States.” *USA Today*, pp. 9D.

Urban, D. J., and Huff, T. F. (2006). 2006 VCU Life Sciences Survey. from http://www.vcu.edu/lifesci/images2/ls_survey_2006_report.pdf

Van Der Vink, Gregory E. 1997. “Scientifically Illiterate Vs. Politically Clueless.” *Science,* 276:1175.

Wakefield, A. J, S. Murch, A. Anthony, J. Linnell, D. M. Casson, M. Malik, M. Berelowitz, A. P. Dhillon, M. A. Thomson, P. Harvey, A. Valentine, S. E. Davies, and J. A. Walker-Smith. 1998. “Ileal-Lymphoid-Nodular Hyperplasia, Non-Specific Colitis, and Pervasive Developmental Disorder in Children.” *The Lancet,* 351:637-41.

Weart, Spencer. 1988. “The Physicist as Mad Scientist.” *Physics Today,* June:28-37.

Weingart, P., C. Muhl, and P. Pansegrau. 2003. “Of Power Maniacs and Unethical Geniuses: Science and Scientists in Fiction Film.” *Public Understanding of Science,* 12(3):279-87.

White, Andrew Dickson. 1993. *A History of the Warfare of Science With Theology in Christendom*. Amherst New York:Prometheus Books.

Wuthnow, Robert. 1988. *The Restructuring of American Religion*. Princeton, NJ: Princeton University Press.