A SOCIAL SEMIOTIC DISCOURSE ANALYSIS OF CINEMATIC PORTRAYALS OF SCIENCE: IMPLICATIONS FOR PUBLIC LEARNING AND UNDERSTANDING

A Thesis

by

JEAN ANNE PARRELLA

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Holli Leggette
Committee Members,	Tobin Redwine
	Johanna Dunaway
Head of Department,	Mathew Baker

May 2020

Major Subject: Agricultural Leadership, Education, and Communications

ABSTRACT

Entertainment media play a significant role in the dissemination of science to the public. The persuasive ability of media texts, primarily film and televisions productions, can influence the public's understanding and retention of scientific information. Individuals who lack scientific literacy are defenseless to such influence because they often struggle to distinguish fact from fiction. Therefore, it is critical for science communication scholars to investigate the portrayal of science in cinema in an effort to better understand and prepare for interaction with diverse audiences.

The study is one of the first of its kind to use a social semiotic discourse analysis, containing both qualitative and quantitative components, to examine the representation of science and scientists within fictional films. Using the Internet Movie Database, I identified 39 culturally significant films and television programs released between 1980 and 2019 that included science as an integral component to the production's plot or setting. I eliminated television programs, documentaries, and biographies from the eligible sample to focus my analysis on fictional films.

Using a stratified random sample, I identified 16 culturally significant films—four released each decade beginning with 1980—to include in my final sample for analysis. Findings from a denotative analysis revealed nine themes: *unusual behavior, egotistical scientist, unethical decision-making, public distrust, genetic modification danger, government involvement, working conditions, innovation,* and *comradery.* Eight of the nine themes included sub-themes, supported by a variety of icons, indices, and symbols representing verbal and visual depictions of science and scientists. A quantitative analysis

of signs within each theme revealed scientists are most represented as antisocial, egotistical, and unhealthily obsessed with their work. In addition, scientists are often shown making unethical decisions in their research and working with futuristic inventions and developments that they maintain through genius-level thinking. Findings indicate that science fiction film viewers are likely to interpret science and scientists as unsociable, unapproachable, and untrustworthy. Viewers might also harbor unrealistic expectations of scientists relating to their progression of scientific inquiries.

Cinematic depictions of science have done a disservice to the American public by representing science and scientists poorly within science fiction films in all genres. To challenge these negative depictions and negate pre-existing beliefs, scientists should find relational elements to connect with their audience, approach discussing scientific awards or achievements carefully, and articulate the values and ethics they maintain when conducting research.

ACKNOWLEDGEMENTS

I feel extremely fortunate to have so many supportive people in my life who have contributed to my happiness and success. First and foremost, I would like to thank my parents, Michael and Debbie Parrella. Thank you for always giving me the courage and support to spreads my wings and fly. I have embarked on a journey I love, and I owe it all to you.

Next, I would like to thank my committee members, Dr. Holli Leggette, Dr. Tobin Redwine, and Dr. Johanna Dunaway for helping me with my research. To my committee chair, Dr. Holli Leggette, I am extremely grateful for your guidance throughout this process. The amount of time you invest into your graduate students and your commitment to our success is admirable. I am thankful to be working with you, and I am excited to see what we accomplish together over the next three years during my doctoral program. Dr. Redwine, your continuous support, encouragement, and positivity keep me motivated. I am grateful for your mentorship and look forward to continuing our projects together. Dr. Dunaway, I am grateful for your willingness to serve on my committee. You brought a unique perspective given your expertise regarding the impact of contemporary media environments, and I thank you for your time and commitment to my project.

I would also like to thank the graduate students who shared this journey with me. We developed such a welcoming and supportive environment in ALEC, and you became my family in Texas. Jessica Spence and Carrie Baker, we have gotten closer than most do in such a short amount of time, and I cannot imagine having gone through this process without you. I feel so fortunate to have spent two of the best years of my life with you both

by my side. We developed a lifelong friendship and I cannot wait to see what the future holds for us.

Last, I would also like to thank Francisco, my other half. I remember calling you and telling you that I was considering moving to Texas after graduating from the University of Idaho. You, waiting patiently for me to move back to California, were nothing but supportive and encouraging. Within a few days, you changed the conversation from “me” moving to Texas to “us” moving to Texas. You moved almost 2,000 miles from home to start a life with me in Texas so that I could follow my dreams. Thank you.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a thesis committee consisting of Dr. Holli Leggette and Dr. Tobin Redwine of the Department of Agricultural Leadership, Education, and Communications and Dr. Johanna Dunaway of the Department of Communication.

All work for the thesis was completed independently by the student.

Funding Sources

There are no outside funding contributions to acknowledge related to the research and compilation of the document.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

Scientific knowledge can help people navigate everyday situations—deciding what to eat or choosing to vaccinate (Kennedy & Hefferon, 2019). Americans mostly value science and recognize that it improves their quality of life (Pew Research Center, 2015). However, a 2007 survey conducted by Michigan State University researchers found that most Americans lack basic scientific knowledge and that only 28% are capable of understanding a scientific-based news story. Science literacy, as defined by The National Research Council (1996), is "the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (p. 192). Despite the importance of science literacy, many Americans do not understand science and its methods. The American Association for the Advancement of Science deemed more than 90% of Americans as scientifically illiterate and considered this statistic a possible threat to society's well-being (Maienschein, 1998). Similarly, the California Academy of Sciences (2009) found that only 21% of Americans are scientifically literate. Although the percentages within these reports differ, they suggest that the large majority of Americans are scientifically illiterate.

In addition, people are often resistant to learning about science because it is difficult for people to accept information that conflicts with their personal understanding of the world, or their "common-sense intuition about the physical and psychological domains" (Bloom & Weisberg, 2007, p. 996). Typically, resistance toward science starts with assumptions and biases people develop as young children and persists into adulthood

(Bloom & Weisberg, 2007). A child's resistance toward science often stems from two things—what they know before their exposure to science and how they learn about science (Bloom & Weisberg, 2007). Often, a negative educational experience with science, math, and technology during grade school can cause children to develop an aversion toward the science fields (Anderman et al., 2012). As children transition into adulthood, they continue to deepen their understanding of scientific phenomenon primarily by consuming information through different forms of media (Burakgazi & Yildirim, 2013; Falk et al., 2007).

Media producers, however, tend to be particular in how they choose to present science information to the public. Nowotny (2005) stated "through the ongoing proliferation of images and symbols, information overload and hi-tech–driven media, science increasingly communicates with the public in ways that are deliberately designed and intended to meet the public (and political) imagination" (p. 1117). The deliberate construction of information by media institutions is referred to as gatekeeping (Thorson & Wells, 2015). When considering news media, journalists strive to report information that is objective and accurate while also striving to maintain readers' attention (Dahlstrom, 2014). To remain economically viable in a competitive industry, journalists often shape media messages to maximize public consumption (Dahlstrom, 2014).

Unlike news media, entertainment media (e.g., films, television, novels, video games) does not always aim to inform audiences about a particular topic (Dahlstrom, 2014). Still, entertainment media use narrative formats, which means that information is strategically selected to craft a story. In addition, the goals of news media and entertainment media are the same—to maximize audience consumption. Therefore, the

information presented to people through entertainment media is also carefully crafted. A key difference between news media and entertainment media, though, is that entertainment media does not necessarily aim for accuracy and it is often fictional in nature. In 2013, Kirby interviewed David Berman, the science consultant for the television program *CSI: Crime Scene Investigation,* who explained that for entertainment media writers, "scientific realism is about authenticity and plausibility, not about accuracy" (p. 97).

Not only are people subjected to receiving information that media producers want them to receive, but people also encounter other factors that influence their ability to accurately consume information themselves. In an increasingly visual society, people struggle to identify fact from fiction which impedes how accurately information is consumed (Barnett & Kafka, 2007). The National Science Foundation (2000) expressed concern that visual media negatively impact the public's ability to think critically and impede society from increasing scientific literacy. The National Science Board (2004) further stated that the media "can be faulted for miscommunicating science to the public, by sometimes failing to distinguish between fantasy and reality, and by failing to provide scientific evidence when needed" (chapter 7). There is concern that some media sources, primarily television and online, practice poor quality reporting and, therefore, negatively affect how people perceive scientific phenomenon (Bubela et al., 2009).

People can be easily persuaded by non-factual information largely because they are inherently cognitive misers who rely on emotions to formulate their opinions of an issue and naturally navigate toward sources that reinforce their pre-existing beliefs, regardless of accuracy (Bubela et al., 2009). Media are powerful sources of cultural influence and, as a result, people often trust the media to make sense of scientific topics (Bubela et al., 2009).

For example, people tend to be particularly untrusting of biomedicine because the portrayal of genetics in popular media is often inaccurate (Bubela et al., 2009; Caulfield, 2004). Because people retain and believe information about biomedicine from fictional sources, it means they *integrate* the information presented with their other world knowledge without retaining a link to the original fictional source (Marsh et al., 2003). When people do not believe information presented to them through fictional sources, it means they *compartmentalize* the information as fictional facts into their memory and separate it from their other world knowledge (Marsh et al., 2003).

Marsh et al. (2003) conducted three experiments to investigate how people integrate knowledge from fictional sources with knowledge from real world scenarios and found that initially after reading fictional information, people were able to correctly attribute it to the appropriate source and recognize the information as fiction, but their ability to accurately attribute information declined after a delay, causing them to blur the lines between fact and fiction. Therefore, people often attribute misinformation to a knowledgeable source, even when it was generated from a fictional source (Frost et al., 2002). Similarly, Appel and Richter (2007) found that fictional narratives had stronger long-term persuasive effects than short-term persuasive effects in that "the belief induced by false information was more pronounced and the changed beliefs were held with a higher certainty after a 2-week delay" (p. 127–128). Green and Brock (2002) added that people often experience intense transportation into the narrative world people which causes one's memory of the content from fictional narratives to be relatively stable.

The widespread lack of science literacy among Americans in combination with the effects of gatekeeping and the public's tendency to be persuaded by non-factual

information indicates a critical need for science communication efforts designed to achieve societal impact. To develop innovative science communication practices, scholars need to conduct research that reveals how people learn from information presented to them through media. By understanding the origin of public perceptions of science and how attitudes and behaviors develop, scientists can implement strategic communication approaches and better prepare for interaction with lay audiences. These efforts primarily address the fourth goal for communicating science in the Science Communication Research Agenda, which states "To influence people's opinions, behavior, and policy preferences" (National Academies of Sciences, Engineering, and Medicine, 2017, p. 2). The Science Communication Research Agenda also acknowledges that "It is important to understand and track over time how science is covered in the media to determine how the media are affecting people's perceptions, understanding, and use of science in a dynamic communication environment" (National Academies of Sciences, Engineering, and Medicine, 2017, p. 7).

CHAPTER II

LITERATURE REVIEW

Davies and Horst (2016) define science communication as "organized actions aiming to communicate scientific knowledge, methodology, processes or practices in settings where non-scientists are a recognized part of the audience" (p. 4). This definition is meant to be broad to encompass media presentations of science (Davies & Horst, 2016). Science can be communicated through a multitude of media sources (e.g., newspapers, magazines, novels, banners, movies, television programs). Although some media sources are meant to educate (e.g., news, non-fiction novels, documentaries), others are designed to entertain (e.g., fiction films, television programs, video games). Learning, however, can result from non-fictional and fictional media sources (Marsh et al. 2003).

A Pew Research Center study conducted in 2017 found that a majority of Americans watch science-related entertainment. More specifically, 81% often or sometimes watch movies or television programs involving criminal investigation, medical settings, and science fiction (Pew Research Center, 2017). A majority of frequent viewers believe that watching these types of programs either made no difference, or helped their understanding of science, technology, and medicine. For example, 51% believe watching shows or movies about criminal investigations makes no difference to their understanding of science, 40% believe it helps their understanding, and only 9% believe it hurts their understanding (Pew Research Center, 2017). Forty-nine percent of viewers who frequently watch shows and movies about hospitals and medical settings believe it makes no difference to their understanding of science, while 38% believe it helps their

understanding, and 12% believe it hurts their understanding. Interestingly, 68% of Americans who frequently watch science fiction movies and television believe watching makes no difference to their understanding of science. Twenty percent believe watching science fiction helps their understanding of science, and 11% believe it hurts their understanding. Often, viewers learn from fictional films and television programs subliminally because they are unaware of the productions' influential abilities.

Film is perhaps the most influential of all modern media sources given its ability to influence people's beliefs by shaping and reinforcing science's cultural meanings (Kirby, 2008). More specifically, people might have different understandings of what constitutes science, or what causes something to be scientific (Gauchat, 2010), but cultural meanings of science are widespread and heavily influenced by filmic representations. Gauchat (2010) identified three prominent cultural meanings of science: 1) science is differentiated from other practices by its systematic methods, meaning "replication, unbiased interpretations, and solid evidence" make science unique; 2) science is differentiated by its credibility from being associated with university settings and professional credentials; and 3) science should align with other elements of society including commonsense thought and religious tradition (p. 759). Thus, films play a critical role in establishing cultural meanings of science because exposure to "fictional narratives exerts significant effects on attitudes and beliefs" (Igartua & Barrios, 2012, p. 514).

Films are capable of so much influence because of their persuasive characteristics. Igartua and Barrios (2012) stated the following:

> Fictional contents can be effective tools of persuasion because *involvement in the narrative* (narrative absorption or transportation) and *involvement with the*

> *characters* (identification with characters) are processes that limit counterarguing or make it incompatible, thus reducing individuals' *resistance* and favoring their acceptance of the message contained in the narrative. (p. 515)

Crawford (1998) explained the persuasive ability of films in that they "create their own world and although it is not a realistic one it is nevertheless useful to observe, especially for the issues and attitudes that the screen images suggest" (Crawford, 1988, p. 46). It is important to note that people not only experience this level of immersion when people watch fictional films, but also experience equally intense levels of engagement and feelings of empathy can occur when watching factual movies (Batat & Wohlfeil, 2009; Green & Brock, 2000). Despite their often fictional nature, "films can act as virtual witnessing technologies" because they allow large audiences to witness phenomena without them needing to directly experience the 'natural' phenomena (Kirby, 2003, p. 235). Films' ability to resemble virtual witnessing technologies increases their persuasiveness because fictional representations can mimic reality even when viewers have not witnessed the authentic science process (Kirby, 2003).

Weingart and Pansegrau (2003) noted that before 2000, few scholars examined science fiction films as a mode for science communication. Generally, media producers do not believe the narratives in fictional productions harm viewers' thinking (Carter, 1997; Crichton, 1999), but media scholars' findings indicate otherwise (Christidou, 2011; Haynes, 1994; Losh, 2006; Nisbet et al., 2002). Therefore, further investigation is warranted. It is important for science communication scholars to delve deeper into how specifically filmic productions represent science because this type of analysis can reveal how public perceptions of science might originate. Understanding how perceptions of

science originate can be useful for developing effective communication approaches for scientists.

Depictions of Science and Scientists in Films

Scientific film depictions have raised awareness and contributed to science policy debates on national issues (e.g., nuclear power; Sjöberg & Engleberg, 2010; and near-Earth objects; Kirby, 2011) because people often rely on representations of science in film to formulate their assumptions of science (Christidou, 2011). Cinematic depictions of science also contribute to people's negative stereotypes of scientists (Haynes, 1994) and their incorrect assumptions about who is capable of becoming a scientist (Losh, 2006).

Haynes (1994) identified six common stereotypes of scientists in cinema: 1) the alchemist/mad scientists, 2) the absent-minded professor, 3) the inhuman rationalist, 4) the heroic adventurer, 5) the helpless scientists, and 6) the social idealist. Mad scientists are the most well represented portrayal of scientists within films in Western culture (Pansegrau, 2008), and are typically featured in horror films (Kirby, 2014). Mad scientists are represented as socially irresponsible, are unknowingly headed for failure in their scientific work (Gerbner, 1981), and often care more about their research than patients' welfare (Flores, 2002). It is possible that these stereotypical depictions of science and scientists as mad and eccentric (e.g., Dr. Jekyll, Frankenstein) contribute to the public's aversion toward science (Christidou, 2011). Jackson (2008) similarly explained that depictions of mad scientists in films:

> Might affect who does science, specifically by furthering the image of science and the scientist as detached from society, unconcerned with or even antagonistic to

> addressing societal issues, and, therefore, portraying science as an unattractive career path for those who wish to better society. (p. 47–48)

Finally, mad scientists often transcend ethical boundaries to attain forbidden knowledge and fame (Weingart et al., 2003). Weingart et al. (2003) found that the horror genre is the most common genre to include films about science, indicating that mad, self-destructive, and murderous scientists dominate other scientist stereotypes. In contrast, very few comedies about science exist, indicating there is less to laugh about in science and more to fear (Weingart et al. 2003).

The absent-minded professor is generally shown in comedies (Kirby, 2014). These scientists are depicted as being so immersed in their research that they lack social responsibilities and make senseless mistakes, such as wearing two different socks or forgetting to cut their hair (Haynes, 2003; Stillion et al., 2010). The absent-minded professor is not in tune with reality (Jane et al., 2007) and often socially isolated (Weitekamp, 2017).

Inhuman rationalists most commonly appear in science fiction films (Kirby, 2014). These scientists are purposefully detached from others; they suppress emotion and avoid affection (Wardlow, 2017). Inhuman rationalists remain neutral in their thoughts and feelings and ignore moral aspects and consequences of their work (Rogers Public Library, n.d.; Wardlow, 2017).

Heroic adventurers are usually featured in action films (Kirby, 2014) and operate in both physical and intellectual realms (Williams, 2011). They emerge at times of scientific optimism and he or she “explores new territories, engages with new concepts full of resourcefulness that transcend human limitations” (Vega, 2018). The heroic adventurer

represents a utopian character because they are anticipated to improve society through science (Vega, 2018).

Social idealists predominantly appear in dramas (Kirby, 2014). These altruistic scientists are devoted to conducting research that will improve society's well-being (Stillion et al., 2010; Vega, 2018). Sometimes, social idealists also function as heroes who compete against the government (Pieri, 2006). Finally, helpless scientists most commonly appear in science fiction films (Kirby, 2014). These scientists lose control of their discovery, which causes social or environmental disasters (Vega, 2018). Helpless scientists are often well-intentioned (Wardlow, 2017) but cannot control the outcome of their work (Haynes, 2003).

Cinematic depictions of science also likely contribute to viewers misunderstanding research priority areas. For example, Barriga et al. (2010) explained that in the 1998 film *Armageddon,* a Texas-sized asteroid approaches Earth and is detected by scientists 18 days before impact, but in reality, asteroids of that magnitude are exceptionally rare and would be detectable by scientists much earlier (Plait, 2007). If viewers considered the events in *Armageddon* as scientifically accurate, then they might unnecessarily fear such a catastrophe or assume that scientists prioritize research on asteroid collisions (Kirby, 2003; Plait, 2007).

Representation of Women in Science Films

Flicker (2008) acknowledged that since the 1990s, male and female scientists in film have been shown as equals. However, female scientists are still blatantly subjected to media sexualization (Flicker, 2008). For example, it is common for popular media, specifically film and television, to portray science as a man's work (Flicker, 2003; Flicker,

2008). In 2003, Flicker analyzed 60 feature films and identified six prominent stereotypes of female scientists. First, the old maid is a woman married to her work. She is not necessarily old, but she does wear old-fashioned clothing (Flicker, 2003). Second, the male woman is often the only female member on a male team. "She has learned to be assertive within a male environment, has a rough, harsh voice, dresses practically and from time to time succumbs to an unhealthy lifestyle" (Flicker, 2003, p. 311). Women scientists who occupy this role often have asexual characteristics (Flicker, 2003). Third, the naïve expert might contribute some scientific knowledge but is not significance to the scientific theme in the film (Flicker, 2003). The young, good-looking women in this role, however, play a critical role in the film as their naiveté and emotions provide drama (Flicker, 2003).

Fourth, the evil plotter is young and attractive (Flicker, 2003). These women cooperate with villains and use their sexual attraction to get close to those they later betray. Fifth, the dependent daughter or assistant is in a committed relationship with a male scientist (Flicker, 2003). Her primary responsibility is to assist (Flicker, 2003). Sixth, the lonely heroine is highly qualified and is comfortable and confident in a male-dominated environment (Flicker, 2003). This woman exudes the positive qualities of science: "an insatiable curiosity, job as a calling, moral integrity, modesty, strong beliefs and visions" (Flicker, 2003, p. 315). These depictions of women working in scientific fields are often inaccurate but achieving scientific accuracy in films is not always a priority (Flicker, 2003).

Using Science Fiction Films in Education

Most forms of popular media are consumed for entertainment purposes and serve as powerful sources of non-formal education (Tisdell & Thompson, 2007). Given the

significance of entertainment media within society, an effort of science education is to increase the number of scientifically literate individuals, specifically by supporting and developing their understanding of scientific representations that appear in popular entertainment media (DeBoer, 2000). Dierking (2005) further explained that the media's role is science education continues to strengthen given media's prevalence in students' lives. For example, Pasek et al. (2006) interviewed 1,501 Americans aged 14 to 22 and found that 34.8% of participants watched movies on DVD or videotape on most days, and 44.9% watched movies on DVD or videotape once or twice a week. In addition, 27.1% said they watched movies on TV most days, and 36.4% watched movies on TV once or twice a week. These findings seem consistent with those of Roberts et al. (1999) who found that the average American student ages 10 to 22 watches movies an average of three hours per week and television shows an average of eight hours per week. Therefore, because college-aged students watch movies regularly, many media scholars deemed it important for college instructors to provide students with opportunities to develop their critical thinking abilities by analyzing visual media (Brake & Thornton, 2003; Dubeck et al., 2004; Efthiomiou & Llewellyn, 2004). By critically analyzing scientific movie portrayals, students increase their ability to identify falsity in media, and ultimately become more skeptical consumers of science (Efthimiou & Llewellyn, 2004).

Dark (2005) found that even scientific movies representing science poorly can serve as useful teaching tools. For example, "The Matrix" poorly represents physics, but students can recognize and articulate a comparison between the inaccurate representations in the film and concepts they learn in class (Dark, 2005). Scientific films can also be important teaching tools because they serve as fun visual connections between concept and

application (Dubeck et al., 2004). Brake and Thornton (2003) stated that showing students movie clips involving science increases their interest in the scientific field represented because movies often relate science to relevant social issues. However, students are subject to gaining misconstrued interpretations of science through fiction films. For example, Barnett (2006) found that students who watched the 2003 film *The Core* misunderstood the Earth's structure after watching the film. Science educators should be aware that students could bring their inaccurate interpretations of science to class that they gained from fictional media (Barnett & Kafka, 2007).

External Influence of Science Organizations

Scientific accuracy in popular media has been impacted by the use of science consultants or professional organizations established to influence the representation of science in film (Kirby, 2003; Szu, Osborne, & Patterson, 2017). Frank (2003) wrote:

> The value of science consultants to a production is based on reality: on their closeness to it, their ability to bring it into a production, and the ability of the studio to make use of the perceived gravitas their relation to it brings. (p. 433)

Most scientists who consult on fiction believe their assistance counteracts the negative portrayal of science, but do not consider it as part of the science process (Kirby, 2003). A science consultant ensures "that the scientific images are *not* 'fiction' but that they conform to 'natural reality'" (Kirby, 2003, p. 239). Scientists, however, do not have full control over how scientific images and processes are portrayed when they contribute because they simply offer advice but ultimately defer to film-makers' decisions (Kirby, 2003). Kirby (2003) further explained that scientists often view consulting for fiction films

as a method for promoting their field of research in an effort to increase public support and funding.

Films depicting science accurately have the ability to influence scientific funding opportunities, promote research agendas, and affect public controversies (Kirby, 2011). But, in opposition, inaccurate portrayals have the ability to decrease public support (Kirby, 2003). Fortunately, filmmakers are more frequently turning to scientists for advice during production because of their increased desire for 'realism' (Kirby, 2003). Barriga et al. (2010) acknowledged, however, that although there is large concern that movies misrepresent science to the public, little is known about how the presentation of science in movies affects people. Kirby (2014) similarly mentioned that the impact movies have on public opinion is unclear because "audience reception studies on science and films are limited" (p. 104). Szu et al. (2017) further confirmed that no studies have empirically examined whether the accurate or inaccurate representations of science in media actually influence public perception.

Theoretical Framework

Together, social cognitive theory and narrative transportation theory suggest that viewers' experience with narratives, particularly in movies and television shows, influences their attitudes and behaviors (Tukachinsky & Stokunaga, 2013).

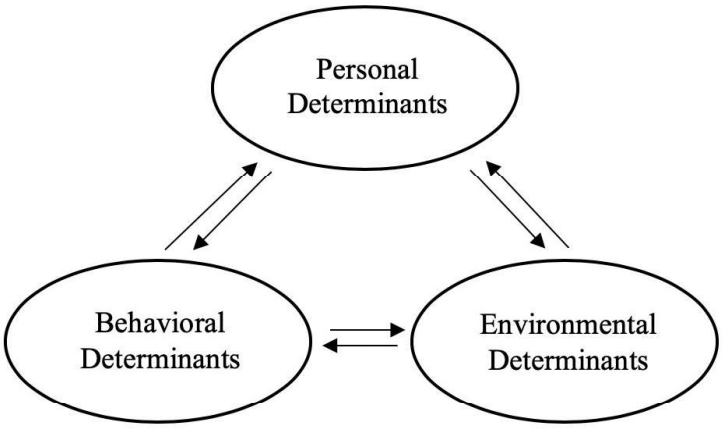
Social Cognitive Theory

Changing public perception is extremely difficult because learning is constantly reinforced in different social contexts from a variety of influences that people experience and observe (Bandura, 1986). Bandura's (1986) social cognitive theory, depicted in Figure 1 and adapted from Becker et al. (2012), lends itself to the idea that an individual's

behavior is caused by reciprocal action between personal, behavioral, and environmental influences. During these reciprocal actions, people experience internal and external stimuli that reinforce their learning (Bandura, 1986). More specifically, when deciding how to behave or engage in a specific behavior, people use their past experiences and observations from personal, behavioral, and environmental occurrences, and the consequences of such occurrences (Bandura, 1986).

Figure 1

Bandura's (1986) Social Cognitive Theory Adapted from Becker et al. (2012)



Social cognitive theory has six underlying constructs: 1) reciprocal determinism refers to the interaction between person, environment, and behavior; 2) behavioral capability is a person's knowledge and skills that enables or hinders their success performing a behavior; 3) observational learning refers to a person observing the behavior of another and then replicating the actions they see; 4) reinforcements are the internal and external reactions to one's behavior that affect whether or not a person will repeat or cease such behavior; 5) expectations are the anticipated outcomes of one's behaviors that largely

result from past experiences; and 6) self-efficacy refers to the confidence a person has in their ability to produce a behavior well (Bandura, 1986).

Reciprocal Determinism. Reciprocal determinism refers to continuous bidirectional relationships between an individual's personal factors, environment, and behavior (Schiavo et al., 2019). When an individual attempts to achieve desired outcomes or reduce the chances of undesirable outcomes, these three components influence and affect one another (Schiavo et al., 2019).

Behavioral Capability. Through lived experiences, people gain knowledge and skills they can use to complete or not complete a behavior (Bandura, 1986). An individual must have the ability to identify and evaluate the criteria to then accept or reject its influence (Langlois, 1999). Behavioral capability provides one with knowledge that helps them decide the appropriate course of action (Rogers & King, 2013).

Observational Learning. The concept of observational learning in social cognitive theory posits that people adopt behaviors they observe through media using appraisals of their own abilities, the perceived benefit of that behavior, and the costs of engaging (Limaye et al., 2013). This type of learning does not require reinforcements to occur, but a model is necessary (e.g., parent, sibling, friend, teacher; Schacter, 2011). The person who serves as a model facilitates cognitive process behavior, which helps the observer store their observations into memory and imitate what they see later (Schacter, 2011).

Reinforcements. Reinforcements are a form of positive or negative feedback generated by one's behavior (Pajares et al., 2009). They can intrinsic or extrinsic in nature, or more specifically, they can be physical, social, or self-evaluative (Bandura, 1986).

Expectations. An individual's outcome expectations of a behavior are dependent on efficacy beliefs, or how one perceives their ability to accomplish the intended behavior (Bandura, 1997). Expectation outcomes can be anticipated to occur in physical or internal domains (Anderson et al., 2000) and can be derived from personal beliefs or community-related beliefs (Chiu et al., 2006).

Self-Efficacy. Self-efficacy constitutes the opinions people have about their capability to perform a behavior in a certain manner (Pajares et al., 2009). Feelings of self-efficacy are predictive of one's accomplishments and can be "sensitive to contextual factors, such as the regulation of one's motivation, thought processes, affective states, actions, or environmental conditions" (Pajares et al., 2009, p. 7). Self-efficacy helps develop outcome expectations (Pajares et al., 2009).

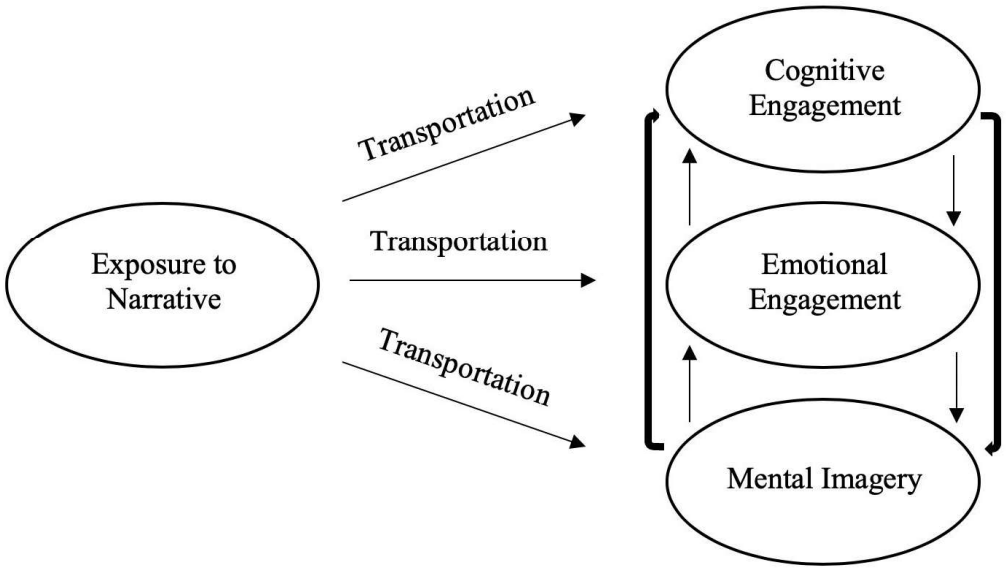
Social cognitive theory lends itself well to the present study because an individual's knowledge acquisition and behavior can be directly influence through media depictions and observing the experiences and social interactions of media characters through the screen. Social cognitive theory "claims that viewers use media characters as models, deriving ideas about what is beneficial and harmful from the consequences these characters experience" (Green & Clark, 2012, p. 477). A social semiotic analysis does not provide ready-made answers. Instead, it produces ideas for developing questions and interpretations. "It can only come into its own when social semiotics fully engages with social theory. This kind of interdisciplinary is an absolute essential feature of social semiotics" (Van Leeuwen, 2005, p. 1). Thus, I will use the social cognitive theory in my analysis of media when interpreting how the exposure to semiotics in entertainment media might affect an individual's attitudes and behaviors toward science.

Narrative Transportation Theory

Green and Brock's (2000) narrative transportation theory is an established approach in media research that "provides a theoretical framework for understanding the persuasive effects of entertainment media" (Green & Clark, 2012, p. 477; see Figure 2). When experiencing written, audio, or video narratives, viewers are transported into the narrative and become immersed in the story (Green & Fitzgerald, 2017). "They experience high levels of cognitive and affective engagement, and may form vivid mental images" (Green & Clark, 2012, p. 477). When people become transported into a narrative, they experience emotional and cognitive responses and their beliefs and behaviors in the real-world tend to match those displayed within the story (Green & Clark, 2012). Several factors that affect the extent of transportation one might experience include story quality, similarities between the narrative and the person experiencing the narrative, and connections with characters (Green & Fitzgerald, 2017). The experiential response to narrative transportation involves three primary components: 1) cognitive engagement; 2) emotional engagement; and 3) mental imagery (Green et al., 2008). Together, these three processes combined with enjoyment and character identification produce transportation effects (Green & Brock, 2000; Green & Fitzgerald, 2017).

Figure 2

Green and Brock's (2000) Narrative Transportation Theory



Cognitive Engagement. When an individual is transported, their mental processes concentrate on events occurring within the narrative. They lose track of time and become unaware of their surrounding environment (Green & Fitzgerald, 2017). Sometimes, when transported, people can forget real-world knowledge, which makes them more likely to adopt and mimic the beliefs and behaviors that occur in the story (Green & Fitzgerald, 2017).

Emotional Engagement. Transportation into narratives can cause people to experience powerful emotions evoked by characters and events that occur in the story (Green & Fitzgerald, 2017). Strong emotional responses to narratives have a particularly influential effect on an individual's attitudes (Green & Fitzgerald, 2017) because emotional connections to characters means "seeing the character's perspective as one's own, to share his or her experience" (Green et al., 2004, p. 319).

Mental Imagery. Van Laer et al. (2014) define metal imagery as the process when "story receivers generate vivid images of the story plot, such that they feel as though they are experiencing the events themselves" (p. 804). People experience mental imagery differently when interacting with various forms of media. For example, films and television provide viewers with rich visual images, whereas readers must create mental images themselves (Green et al., 2004).

Narrative transportation contributes to the present study because it emphasizes the persuasive effect films can have viewers beliefs and attitudes. The cognitive immersion processes that often occur when an individual experiences transportation can explain how they might gain meaning from scientific images depicted in films. "By illuminating the mental processes that occur during an immersive media experience, transportation theory allows researchers to make predictions about the specific effects of the given factors in media exposure" (Green & Clark, 2012, p. 477). Narrative transportation theory guided my analysis and allowed me to interpret how semiotics of science in films might influence public learning.

Weingart et al. (2003) recommended that research be conducted to identify patterns and stereotypes of science and scientists that films produce—a topic that lacks in the literature—but one that would aid in the development of science communication practices. Many scholars researching science communication—a line of inquiry at the intersection of science and communication—spend considerable time identifying best communication practices for scientists. However, to make these communication practices more effective, researchers must identify how the media has taught science to the public and explain which representations of science and scientists in popular media affect consumers. Understanding

this influence will help prepare scientists to address these pre-existing beliefs and assumptions during interaction.

Purpose and Research Objectives

The purpose of the study described herein was to explain how science fiction films convey science to the public using a social semiotic discourse analysis, and to understand how such depictions might influence public's attitudes and perceptions of the scientific community. Six research objectives guided the study:

RO1: Identify culturally significant films and television shows using the Internet Movie Database that incorporate science as a narrative device or as a fundamental setting to conduct a social semiotic discourse analysis.

RO2: Conduct a filmic analysis of the selected films using Geiger and Rutsky's (2005) procedural framework for disseminating the narrative and technical components of films to enhance trustworthiness of the social semiotic discourse analysis.

RO3: Identify thematic codes of visual and verbal semiotics inherent to scientific portrayals in films by conducting a denotative analysis of scientific representations in the culturally significant films.

RO4: Conduct a quantitative content analysis by identifying the number of icons, indices, and symbols that support each theme present in the culturally significant films that emerged through the denotative analysis.

RO5: Describe how the scientific portrayals in films might influence public perceptions of science and scientists by conducting a connotative analysis of emergent themes.

RO6: Explain how the portrayal of science differs by decade in the culturally significant films.

CHAPTER III

METHOD

This explanatory study involved conducting a social semiotic discourse analysis of popular, culturally significant films to examine the portrayal of science and scientists as visual and verbal messages play a critical role when understanding a concept.

Context of Study

I became inspired to conduct the study after reading Specht and Rutherford's (2014) article titled "The pastoral fantasy on the silver screen: The influence of film on American cultural memory of the agrarian landscape." The author's produced this article from Dr. Annie Specht's dissertation, "A social semiotic discourse analysis of film and television portrayals of agriculture: Implications for American cultural memory." I came across these publications in my graduate visual communications research methods class I took during the spring 2019 semester. Dr. Tobin Redwine, the professor and also a member of my thesis committee, used them as examples as we discussed semiotics and their application in visual communications research.

I conducted the study described herein through the lens of a graduate student research assistant studying science communication at a large, tier one research institution in the South. My parents are both scientists who study entomology, and I was raised with great academic influence, surrounded by research and scientific phenomenon from a young age. I grew up in California, in close proximity to the heart of the film industry—Hollywood—but had no connections to the industry itself.

I moved north to complete my undergraduate program at the University of Idaho where I studied public relations and agricultural education. I have lived in three states and, therefore, have developed unique perspectives through my diverse experiences with people. In addition, my experience conducting qualitative, quantitative, and mixed-methods research studies under the supervision of different mentors in various states has prepared me to undertake interpretative analyses with a critical viewpoint.

Study Design

The study described herein was an applied research study because it intended to help solve a specific problem within a group. Patton (2002) wrote that applied research should "contribute knowledge that will help people understand the nature of a problem in order to intervene, thereby allowing human beings to more effectively control their environment" (p. 217). I identified the problem in the study as the widespread mistrust and skepticism held by the public toward science. Because media are powerful sources of cultural influence, they play a significant role in shaping people's beliefs and opinions surrounding science, whether it be knowingly or subliminally. Thus, by understanding more about how entertainment media shape public perception, science communicators can train scientists to interact positively with those beyond the academy.

The study aligned with the qualitative research paradigm. Qualitative researchers aim to describe the contextual reasoning for a learned social behavior (Bryman, 2016; Merriam & Tisdall, 2016). Because the primary goal of my study was to identify depictions of science and scientists in films and explain how they could contribute to the public's attitudes and behaviors toward science, my study was primarily qualitative in nature, but included a quantitative analysis. Smith (1975) recommended that content

analyses, similar to semiotic analyses, should contain both quantitative and qualitative components to strengthen findings from the study. Therefore, my semiotic analysis included a qualitative description of the signs and emergent themes, and a quantitative count of the types of signs supporting each theme and the number of films in which emergent themes were present.

More specifically, within the paradigm of qualitative research, my study aligned with arts-based research, which is a phrase that gained attention in social science research during the 1990s (Riddett-Moore & Siegesmund, 2012). Finley (2008) explained that arts-based research includes different qualitative methodologies employing an art form as a method. Arts-based research expands beyond the traditional methods of exploring phenomena by enabling one "to find new richer ways of situating and understanding knowledge" (Greenwood, 2016, p. 89). Riddett-Moore and Siegesmund (2012) explained that sometimes, arts-based research has contradictory manifestations. Therefore, when researchers claim to conduct arts-based research, they must explicitly state which form they used. For the purpose of my study, I used semiotics as a form of arts-based research. Film productions are an art form within themselves, as are the signs used in their development. When examining semiotics, one considers specific elements of drama, including language, movement, narrative style, and manipulation of time and space (Greenwood, 2016).

Semiotics

Semiotics, or the science of signs, as a research methodology, is based on language that permits inquiry and analysis of symbolic systems (Chandler, 2007; Manning & Cullum-Swan, 1994) including Morse code, etiquette, mathematics, and highway signs

(Manning & Cullum-Swan, 1994). Semiotics focuses on studying the text, or the individual filmic, artistic, or linguistic work being examined, as opposed to the context of its creation (Chandler, 2007; Butler, 2002; Hodge & Kress, 1988). American philosopher Charles Sanders Peirce identified three types of signs, all of which have to be learned and take people varying lengths of time to understand: icons, indices, and symbols (Lester, 2006). First, icons are easiest to interpret because they can be seen and closely resemble what they represent (Lester, 2006; Berger, 2016). The image of a boy or girl above a restroom indicating which gender uses the facility is an example of an icon (Edgar & Rutherford, 2012). Second, indices, rather than directly looking like what they resemble, have a rational connection to what they represent (Lester, 2006) but one must figure out their meaning (Berger, 2016). An example of an index is a dark cloud approaching from the west, indicating that it might rain. Third, symbols, which are greatly influenced by cultural and societal factors, have no logical connection to what they represent and have to be taught more often than the others (Lester, 2006). Flags and religious images, such as a cross, are examples of symbols because their implications are determined using learned conventions (Lester, 1995; Berger, 2006). For the purpose of my study, I will consider images of science and scientists and dialogue of scientists as possible signs to interpret.

Social Semiotics

A social semiotic analysis "is a mode of social action rather than purely a formal theory" (Thibault, 1991, p. 9). It is an approach used to analyze elements of popular culture, placing emphasis on social dimensions of meaning (Hodge, 1988). Aiello (2016) stated that the primary goal of social semiotics "is to look systematically at how textual strategies are deployed to convey certain meanings (p. 90)." When identifying the

conveyed meanings of texts, a social semiotic inquiry encourages "situated praxis," which is the use of the researcher's personal attitudes and beliefs during the interpretation process (Iedema, 2001, p. 186; Van Leeuwen, 2005). I narrowed my inquiry to a social semiotic analysis because I analyzed culturally significant films, which are elements of popular culture, and used my beliefs to interpret the meanings of scientific depictions within them.

Sharp (2011) suggested that the positives of conducting a semiotic analysis outweigh the negatives. Semiotics "help us to realize that whatever assertions seem to us to be 'obvious', 'natural', universal, given, permanent and incontrovertible are generated by the ways in which sign systems operate in our discourse communities" (Chandler, 2017, "Strengths of Semiotic Analysis," para. 5). Furthermore, Hodge and Kress (1988) argued that semiotics provides a systematic and comprehensive method of inquiry into communications phenomena broadly, as opposed to only certain aspects of the field. They allow for analyses of "meaning-making practices which conventional academic disciplines treat as peripheral" (Chandler, 2017, "Strengths of Semiotic Analysis," para. 1). Thus, a semiotic analysis allows researchers to explore implications of their findings in-depth (Chandler, 2017, "Strengths of Semiotic Analysis," para. 1).

A weakness associated with a social semiotic analysis is that a sign is essentially incomplete without context or an interpretant, which can be thought of as the sign's effect on the mind. When the interpretant changes, signs can change meaning (Manning & Cullum-Swan, 2004). Therefore, because signs can be interpreted differently by different audiences, they cannot produce reality (Manning & Cullum-Swan, 2004). In addition, Crawford (1988) stated that a content analysis, similar to a semiotic analysis, is unable to

verify whether or not a text reflects reality. Instead, these types of analysis are meant to interpret texts within different sociocultural contexts (Crawford, 1988).

Some argue that semiotics is not yet a fully developed analytical method (Chandler, 2017). Some semioticians believe that semiotics can be applied across disciplines, but critics consider semiotics to be a general-purpose analytical method unsuitable to any given field (Sharp, 2011). Some scholars disagree that culturally significant phenomenon such as photography and film can be treated as languages (Sharp, 2011), and, therefore, think they cannot effectively be analyzed using semiotics.

Population

To identify my population, I identified culturally significant films and television programs. However, I focused on films in my analysis because I did not believe I could gain a holistic interpretation of a television program's portrayal of science by watching one or two single episodes. To identify my sample, I followed Specht's (2013) text selection process for her social semiotic analysis of agricultural portrayals among film and television programs closely because her work inspired the completion of this thesis. To be selected for inclusion in my study, the media had to meet two criteria: 1) incorporate science into the plot or setting; and 2) be culturally significant (Specht, 2013).

I used keywords to search the Internet Movie Database (IMDb), an online resource that accumulates information and statistics relating to films, television programs, and other production-based divisions. The keywords included science, scientist, research, researcher, and scientific research. Once the keywords generated a list of films, I read and analyzed the synopsis of each media text in the list to determine the accuracy and appropriateness of the keyword identification (Specht, 2013). Texts that incorporated science as a major plot

device or prominent to the movie's setting were further examined to determine whether or not they achieved cultural significance. Specht (2013) classified a film as culturally significant if it received wide viewership or recognition for aesthetic excellence. To measure viewership of films and television shows, I examined the total domestic gross earned. The media texts that fell into the top 50 films or television shows for domestic gross in the year of release, according to Box Office Mojo by IMDbPro, were eligible for inclusion in my study (Specht, 2013).

In addition, I included films nominated to receive an Academy Award or a Golden Globe award, or films that received one of these awards, in my sample because they met the standard for excellence as recognized by the American Academy of Motion Picture Arts and Sciences (Specht, 2013). Excellence in television is acknowledged by programs receiving or being nominated for an Emmy Award through the Academy of Television Arts and Sciences (Specht, 2013). Therefore, television series that received or were nominated for an Emmy Award or a Golden Globe Award were also deemed culturally significant (Specht, 2013). To identify films that received recognition for aesthetic excellence, I clicked on the title of a movie or television show in the IMDb platform, to view the awards that the media text had been nominated for or won.

The National Film Preservation Board (as cited in Specht & Rutherford, 2014) stated that films can only be considered culturally significant, therefore, capable of contributing to cultural memory, 10 years after their release. "'Cultural memory' is a theoretical construct that posits that, over time, ideologies embedded in cultural texts enter the collective memory and contribute to a culture's understanding of the world around it" (Specht, 2013, p. 50). Because Americans are becoming increasingly more conscious of

science (Sparks & Honey Cultural Strategists, 2013), I did not exclude films produced and released after 2009 from my study.

I included movies and television shows produced and released after 1980 in my sample of culturally significant media texts and analyzed four science fiction films released between 1980 and 1989, four science fiction films released between 1990 and 1999, four science fiction films released between 2000 and 2009, and four science fiction films released between 2010 and 2019. Therefore, I included 16 science fiction films in my final sample for analysis. I analyzed the four films released between 2009 and 2019 for future implications of public learning because they have not yet contributed to cultural memory (Specht, 2013).

Data Collection

Qualitative data collection "involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher wanting to make interpretations of the meaning of the data" (Creswell & Poth, 2018, p. 4). I began data collection procedures by identifying the texts to be included in my study with the selection guidelines explained on page 24. IMDb provides a suggested list of key terms to select from when searching for films. I selected five in the list that I thought were broad and would provide me with relevant films. My first search included all five keywords together—science, scientist, research, researcher, and scientific research—which resulted in a list of eight movie and television show titles. I wanted to end my IMDb search with the keywords "science" and "scientist" since they were the most relevant key terms to my study, and therefore chose to remove "researcher" which generated a list of 16 titles. Next, I removed "research,"

resulting in a list of 51 titles, and then I removed "scientific research," which produced a list of 444 titles. Finally, I removed "scientist," which generated a list of 2,318 titles. Therefore, I read the synopsis for a total of 2,837 movies and television shows, with some duplication. Once I identified culturally significant scientific films and television shows, I removed documentaries, biographies, and television shows from the sample eligible for analysis because I wanted to narrow my social semiotic inquiry to examine only science fiction films. Scholars theorize, however, that whether a narrative is fictional or nonfictional, the same transportation processes occur among viewers or readers (Batat & Wohlfeil, 2009; Green & Brock, 2000). As noted earlier, I still excluded television shows because gaining an accurate, holistic interpretation of television series' portrayal of science would be difficult by watching only several episodes.

Once I limited the sample to science fiction films, I used Microsoft Excel to randomly select four movies from each decade that served as my final sample for analysis. I watched each movie once from beginning to end using Netflix or Amazon Prime Video, and watched each scene representing science or scientists twice to ensure a thorough analysis.

Data Analysis

Filmic Analysis

I started by analyzing the genres of culturally significant media texts I identified to gain a general understanding how science was used in the narrative. Geiger and Rutsky (2005) developed a procedural framework for disseminating the narrative and technical components of films. Each film is to be divided and analyzed in four sections: 1) *context* to provide background information regarding the film's development; 2) *narrative analysis* or

description of the plot structure; 3) *thematic analysis; technique* is an examination of the technical styles used to develop the film; and 4) *close reading* is a detailed discussion of the film's key elements (Geiger & Rutsky, 2005). The narrative analysis is the most detailed section within the filmic analysis so that readers are able to holistically interpret how science is represented and how scientists' function throughout each of the films. Using the four criteria above, I conducted a filmic analysis of each science fiction film in the final sample to ensure I analyzed the entire text, and to increase trustworthiness.

Denotative Analysis

My social semiotic discourse analysis focused on the denotative and connotative features in images and dialogue to determine meaning. The denoted meaning of an image or dialogue is conveyed through the raw digital production; simply a report of what is present (Para, 2004). For the purpose of my study to complete the denotative analysis, I analyzed signs that were displayed during scenes in a movie depicting science and scientists, and signs that existed in dialogue during scenes in a movie depicting science and scientists. Therefore, I analyzed all elements of the raw digital production for icons, indices, and symbols to conduct the denotative analysis.

My analysis and descriptions of denotative features of scientific depictions contained the identification of icons, indices, and symbols. I used a Microsoft Excel spreadsheet to record the signs as I identified them in the films. The identification of icons occurred when I analyzed the manifest content, "obvious, surface content," of a movie (Fraenkel et al., 2019, p. 437). Second, identification of indices signs occurred when I analyzed manifest content and latent content, "the meaning underlying what is said or shown" (Fraenkel et al., 2019, p. 438). Third, the identification of symbols occurred when

I analyzed latent content alone. Therefore, I used both manifest and latent content to analyze icons, indices, and symbols to understand how the public is familiarized with science through semiotics in entertainment media.

The next stage of analysis involved open or axial coding to break apart the denotative descriptions collected in an effort to identify concepts (Corbin & Strauss, 2008). I identified a total of 335 icons, indices, and symbols representing science within the 16 films. I assigned each sign a code that included a movie identifying number, the time it appeared in the movie, and the type of sign presented, using an I for icon, Ind for index, and an S for symbol. Then, I printed the Excel spreadsheets containing the signs and cut out each sign so that it stood alone as its own unit for analysis. I conducted a comparative analysis by comparing concept to concept, or unit to unit, for similarities and differences, and placed units that were conceptually similar to one another under the same theme (Corbin & Strauss, 2008). Themes that emerge from social semiotic analyses categorize and frame relationships among sign meanings and contexts (Thibault, 1991).

Connotative Analysis

The connotative meaning of signs within films is the result of human intervention (Para, 2004). Therefore, a connotative analysis involves interpretation of how people could gain meaning from the denoted features. For the purpose of my study to complete the connotative analysis, I wrote a detailed description of how I thought people might interpret or gain meaning from the themes developed based on the signs identified through the denotative analysis. Working as the qualitative instrument in the interpretation process through a social cognitive theory and narrative transportation lens, I relied on my knowledge and skill gained from conducting previous studies on science communication—

some that specifically examined consumer perceptions. My philosophical viewpoint also helped frame my data collection and analysis procedures and influenced my interpretive conclusions and recommendations. I am a constructionist; therefore, I believe that a discoverable objective truth does not exist (Crotty, 1998). More specifically, I do not believe there is one *right* way to analyze data and develop themes because *truth* cannot be officially determined (Braun & Clarke, 2011). I also value and align with elements of constructivism because I believe that people's views and perceptions change overtime as their thinking processes develop (Hirtle, 1996), which I took into consideration throughout the interpretation process.

Difference in Scientific Representation by Decade

Using findings from the filmic, denotative, and connotative analyses, I identified the dominant scientific themes within the culturally significant films I analyzed by decade. The science fiction films in each decade, for the most part, had similarities regarding the type of science studied. Analyzing each decade as a whole, I explained how the depiction of science in entertainment media changed over time based on the films in my sample and what this progression might mean for public understanding in future years.

Trustworthiness

I used several strategies to ensure trustworthiness of my study. Trustworthiness is comprised of four criteria—credibility, transferability, dependability, and confirmability—that yield confidence in the data (Lincoln & Guba, 1985). To achieve credibility, I applied the principle of investigator triangulation, meaning several different researchers and evaluators were involved in the data-analyzing process comparing ideas and interpretations (Patton, 2002). Three graduate students—two studying agricultural communications who

conduct research in communications and one studying agricultural education who conducts research in education—helped me with this process to compare concepts and interpretations. I relied on intercoder reliability to ensure findings were credible, which "is a measure of the extent to which independent judges make the same coding decisions in evaluating the characteristics of messages" (Lombard, Snyder-Duch, & Bracken, 2002).

In addition, I evaluated the themes identified using two criteria: internal homogeneity and external homogeneity (Patton, 2002). Internal homogeneity requires an examination of how the concepts within compliment the other concepts and the theme as a whole in a meaningful, understandable way (Patton, 2002). External homogeneity requires an examination of the differences among themes to ensure each can evidently be independent from one another (Patton, 2002). Evaluating the themes using these criteria validated the coding processes employed and further enhanced trustworthiness.

Qualitative data typically provide an intimate view of the phenomena being investigated; therefore, it is often difficult to generalize the findings to larger populations (Lincoln & Guba, 1985). Transferability shows the depth of findings as opposed to just the vastness of the findings (Bryman, 2016). I achieved transferability by providing thick descriptions of the findings "to enable someone interested in making a transfer to reach a conclusion about whether transfer can be contemplated as a possibility" (Lincoln & Guba, 1985, p. 316).

Dependability and confirmability can both be achieved by recording an audit trail (Lincoln & Guba, 1985). To establish dependability, the researcher "examines the product—the data, findings, interpretations, and recommendations—and attests that it is supported by data" (Lincoln & Guba, 1985, p. 318). Further, confirmability is established

by keeping a reflexive journal as this verifies that the findings are supported by the data (Lincoln & Guba, 1985). Therefore, to ensure dependability and confirmability, I kept an audit trail to document all thinking processes and to clarify understandings and decisions (Creswell & Poth, 2018). I also used peer debriefing to achieve a dependable and confirmable study. "A peer reviewer provides support, play's devil's advocate, challenges the researcher's assumptions, pushes the researchers to the next step methodologically, and asks hard questions about methods and interpretations" (Creswell & Miller, 2000). Thus, my committee chair who is familiar with my line of inquiry and social semiotic analyses reviewed the data and research processes.

CHAPTER IV

FINDINGS

Research Objective One

To achieve research objective one, I identified and collected culturally significant films and television shows that incorporated science as a narrative device or as fundamental to the films' settings. I used IMDb and searched different combinations of five keywords—science, scientist, research, researcher, and scientific research—to identify films and television shows that involved science as an integral component of the production's plot or setting. I reviewed the synopsis of 2,837 media productions; some of which were duplicates and appeared in several of the keyword search combinations. I dismissed all productions released before 1980 because my timeline best suited a holistic analysis of four decades, causing my sample to consist of media texts produced and released between 1980 and 2019. When I came across a production that I interpreted as involving science as central to the movie or television show's theme, I analyzed it further to determine if it could be deemed as culturally significant. I identified 39 culturally significant media texts involving science (see Figure 3) and relied on IMDb to classify the films by genre.

I identified eight culturally significant scientific movies and one culturally significant scientific television show released during the first decade (1980–1989). Of the eight movies, three (37.5%) were categorized predominantly as horror films, two (25%) were documentaries, one (12.5%) was a drama, and one (12.5%) was a comedy. The

television production was categorized as an action series. Produced and released between 1990 and 1999, I identified nine culturally significant scientific movies and one culturally significant television series emerged. Of the nine movies, three (33.33%) were horror films, two (22.22%) were dramas, one (11.11%) was a comedy, one (11.11%) was an action film, one (11.11%) was a mystery, and one (11.11%) was a biography. The television production was categorized as a documentary. I further identified seven culturally significant scientific movies produced and released between 2000 and 2009 and one culturally significant television series. Of the seven movies, two (28.57%) were documentaries, two (28.57%) were dramas, one (14.29%) was a horror film, one (14.29%) was an action film, and one (14.29%) was a comedy. The television production was categorized as a drama. Finally, produced and released between 2010 and 2019, I identified 10 culturally significant scientific films and three culturally significant television series. Of the 10 films, three (30%) were biographies, three (30%) were adventure films, two (20%) were dramas, one (10%) was an action film, and one (10%) was an animated film. Of the three television series, two (66.66%) were documentaries, and one (33.33%) was a talk show (see Table 1). In Table 1, the number provided in the *significance* column represents the film's ranking in the list of top 50 for domestic gross earned in the year of release.

Table 1

Culturally Significant Scientific Films and Television Series

Decade	Title	Year Released	Genre	Rating	Significance
1980–1989	*Altered States*	1980	Horror, Sci-Fi, Thriller	R	Two-time Oscar nominee; Golden Globe nominee; #25
	*Cosmos**	1980	Documentary	TV-PG	Three-time Primetime Emmy winner; Two-time Primetime Emmy nominee
	*The Day After Trinity**	1981	Documentary biography	Not rated	Oscar nominee
	The Thing	1982	Horror, Mystery, Sci-Fi	R	#43
	Weird Science	1985	Comedy, Romance, Sci-Fi	PG-13	#35
	*MacGyver**	1985–1992	Action, Adventure crime	TV-PG	Four-time Primetime Emmy nominee
	The Fly	1986	Horror, Drama, Sci-Fi	R	Oscar winner; #23
	Day One	1989	Drama, History	Not rated	Primetime Emmy winner
1990–1999	*Flatliners*	1990	Horror, Drama, Sci-Fi	R	Oscar nominee; #16

Table 1 (continued)

Decade	Title	Year Released	Genre	Rating	Significance
	And the Band Played On	1993	Drama, History	PG-13	Three-time Primetime Emmy winner; Eleven-time Primetime Emmy nominee; Two-time Golden Globe nominee
	Jurassic Park	1993	Action, Adventure, Sci-Fi	PG-13	Three-time Oscar winner; #1
	*Bill Nye the Science Guy**	1993–1998	Documentary, Comedy, Family	PG-13	Nineteen-time Daytime Emmy Award winner; Seventeen-time Daytime Emmy Award nominee
	Mary Shelley's Frankenstein	1994	Horror, Drama, Romance	R	Oscar nominee
	Junior	1994	Comedy, Romance, Sci-Fi	PG-13	Oscar nominee; Three-time Golden Globe nominee; #46
	Species	1995	Horror, Action, Sci-Fi	R	#24
	12 Monkeys	1995	Mystery, Sci-Fi, Thriller	R	Golden Globe winner; Two-time Oscar nominee
	Contact	1997	Drama, Mystery, Sci-Fi	PG	Oscar nominee; Golden Globe nominee; #13
	*The Insider**	1999	Biography, Drama, Thriller	R	Oscar nominee; Golden Globe nominee

Table 1 (continued)

Decade	Title	Year Released	Genre	Rating	Significance
2000–2009	*Hollow Man*	2000	Horror, Action, Sci-Fi	R	Oscar nominee; #25
	Nutty Professor II: The Klumps	2000	Comedy, Romance, Sci-Fi	PG-13	#11
	Spider Man 2	2004	Action, Adventure, Sci-Fi	PG-13	Oscar winner; Two-time Oscar nominee; #2
	*Kinsey**	2004	Biography, Drama, Romance	R	Oscar nominee; Golden Globe nominee
	Proof	2005	Drama, Mystery	PG-13	Golden Globe nominee
	*Numb3rs**	2005–2010	Drama, Crime, Mystery	TV-PG	Primetime Emmy nominee
	The Fountain	2006	Drama, Mystery, Romance	PG-13	Golden Globe nominee
	*An Inconvenient Truth**	2006	Documentary, News	PG	Two-time Oscar winner
2010–2019	*Temple Grandin**	2010	Biography, Drama	PG	Golden Globe Winner; Golden Globe Nominee; Primetime Emmy Winner; Primetime Emmy Nominee

Table 1 (continued)

Decade	Title	Year Released	Genre	Rating	Significance
	*Through the Wormhole**	2010–2017	Documentary (Series)	PG	Primetime Emmy nominee
	Prometheus	2012	Adventure, Mystery, Sci-Fi	R	Oscar nominee; #20
	Frankenweenie	2012	Animation, Comedy, Family	PG	Oscar nominee; Golden Globe nominee
	Gravity	2013	Drama, Sci-Fi, Thriller	PG-13	Seven-time Oscar winner; Golden Globe winner; Three-time Oscar nominee; Three-time Golden Globe nominee; #7
	*Cosmos: A Spacetime Odyssey**	2014	Documentary (TV Series)	TV-PG	Four-time Primetime Emmy winner; Nine-time Primetime Emmy nominee
	*The Theory of Everything**	2014	Biography, Drama, Romance	PG-13	Oscar winner; Golden Globe winner; Four-time Oscar nominee; Golden Globe nominee
	Ex Machina	2014	Drama, Mystery, Sci-Fi	R	Oscar winner; Oscar nominee; Golden Globe nominee
	Interstellar	2014	Adventure, Drama, Sci-Fi	PG-13	Oscar winner; Four-time Oscar nominee; Golden Globes nominee; #15

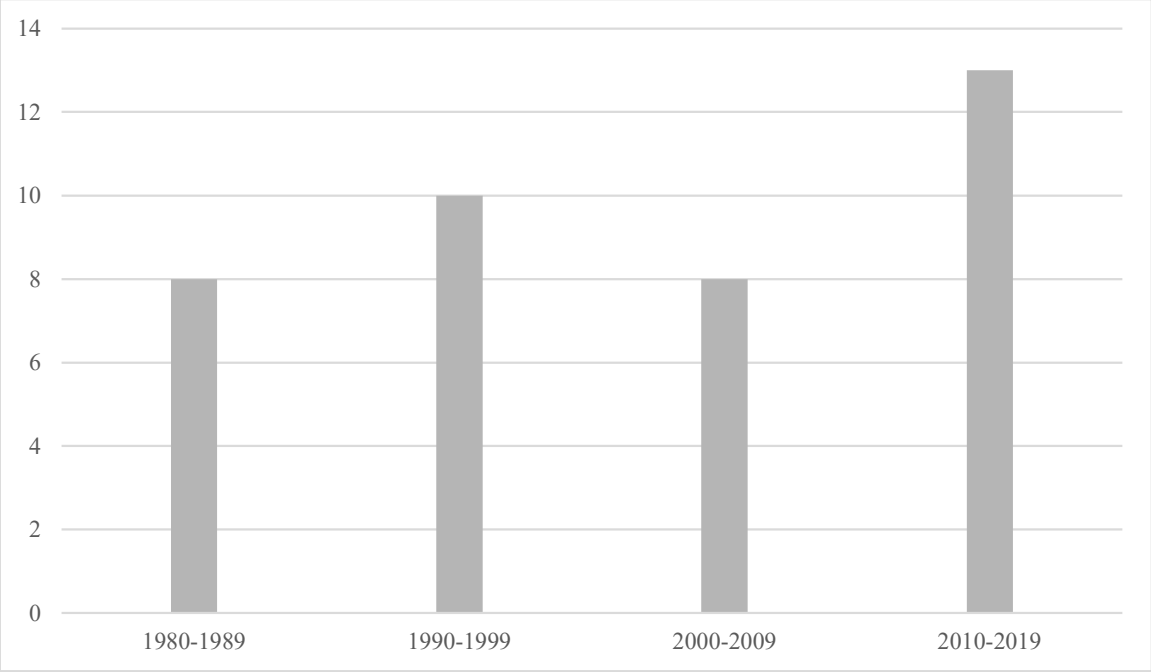
Table 1 (continued)

Decade	Title	Year Released	Genre	Rating	Significance
	The Martian	2015	Adventure, Drama, Sci-Fi	PG-13	Two-time Golden Globes winner; Golden globe nominee; Seven-time Oscar nominee; #9
	*Bill Nye Saves the World**	2017–Present	Comedy, Talk Show	TV-14	Three-time Primetime Emmy nominee
	Rampage	2018	Action, Adventure, Sci-Fi	PG-13	#33
	*First Man**	2018	Biography, Drama, History	PG-13	Oscar winner; Golden Globe winner; Three-time Oscar nominee; Golden Globe nominee

Note. * indicates ineligibility to be included in the sample for analysis due to identification as a television series, documentary, or biography. Films organized from earliest release date to most recent release date.

Figure 3

Number of Culturally Significant Films Identified Per Decade



To develop the sample of films for analysis, I removed television shows, documentaries, and biographies from the pool of eligible media texts. I used Microsoft Excel to select a stratified random sample of four films from each decade to use for conducting the social semiotic discourse analysis (see Table 2).

Table 2

Sixteen Culturally Significant Science Fiction Films Analyzed

Decade	Title	Year Released	Genre	Rating	Significance
1980–1989	*Altered States*	1980	Horror, Sci-Fi, Thriller	R	Two-time Oscar nominee; Golden Globe nominee; #25
	The Thing	1982	Horror, Mystery, Sci-Fi	R	#43
	Weird Science	1985	Comedy, Romance, Sci-Fi	PG-13	#35
	The Fly	1986	Horror, Drama, Sci-Fi	R	Oscar winner; #23
1990–1999	*Mary Shelley's Frankenstein*	1994	Drama, Horror, Romance	R	Oscar nominee
	Junior	1994	Comedy, Romance, Sci-Fi	PG-13	Oscar nominee; Three-time Golden Globe nominee; #46
	12 Monkeys	1995	Mystery, Sci-Fi, Thriller	R	Golden Globe winner; Two-time Oscar nominee
	Contact	1997	Drama, Mystery, Sci-Fi	PG	Oscar nominee; Golden Globe nominee; #13
2000–2009	*Hollow Man*	2000	Action, Horror, Sci-Fi	R	Oscar nominee; #25

Table 2 (continued)

Decade	Title	Year Released	Genre	Rating	Significance
	Nutty Professor II: The Klumps	2000	Comedy, Romance, Sci-Fi	PG-13	#11
	Spider Man 2	2004	Action, Adventure, Sci-Fi	PG-13	Oscar winner; Two-time Oscar nominee; #2
	Proof	2005	Drama, Mystery	PG-13	Golden Globe nominee
2010–2019	*Prometheus*	2012	Adventure, Mystery, Sci-Fi	R	Oscar nominee; #20
	Gravity	2013	Drama, Sci-Fi, Thriller	PG-13	Seven-time Oscar winner; Golden Globe winner; Three-time Oscar nominee; Three-time Golden Globe nominee; #7
	The Martian	2015	Adventure, Drama, Sci-Fi	PG-13	Two-time Golden Globes winner; Golden globe nominee; Seven-time Oscar nominee; #9
	Rampage	2018	Action, Adventure, Sci-Fi	PG-13	#33

Note. The number in the *significance* column indicates the films' ranking in the top 50 for domestic gross earned in the year of release. Films organized from earliest release date to most recent release date.

Research Objective Two

To achieve research objective two, I conducted a filmic analysis of the 16 films in my sample by means of Geiger and Rutsky's (2005) procedural framework for disseminating the narrative and technical components of films. Geiger and Rutsky's procedural framework includes the following: 1) *context* provides background information regarding the film's development; 2) *narrative analysis* is a description of the plot structure; 3) *thematic analysis; technique* is an examination of the technical styles used to develop the film; and 4) *close reading* is a detailed discussion of the film's key elements (Geiger & Rutsky, 2005). This analysis is meant to provide readers with a holistic interpretation of the films in an effort to enhance trustworthiness.

Altered States

Context. Written by Paddy Chayefsky and directed by Ken Russell in 1980, *Altered States* was inspired by the life of neurophysiologist John C. Lilly, who conducted research in sensory deprivation tanks while under the influence of psychoactive drugs (Kabil, 2016). Early in his career, Lilly contributed to many scientific fields, including biophysics, neurophysiology, electronics, computer science, and neuroanatomy (Kabil, 2016). He ended his career, however, unable to receive government funding or publish his work in academic journals because he spent his days experiencing altered states taking hallucinogenic drugs (Kabil, 2016). Chayefsky also wrote a book with the same title that was published in 1978 and told the same story.

Narrative Analysis. Edward Jessup, a Harvard scientist, uses himself as the subject to experiment with an isolation chamber as he searches for his "true self." He hallucinates during his experiences in the chamber, and he begins to think that other states

of consciousness are reality. When learns about an indigenous Mexican tribe that experiences similar illusion states, he travels to participate in one of the tribe's ceremonies and is fed a mixture that contains hallucinogenic drugs. After consuming the mixture, Edward experiences strange, intense hallucinations, and travels home with more to continue triggering altered states of consciousness. Edward experiments with the isolation chamber while taking the drugs, thinking it will enhance the effects of the substance. His visions become increasingly drastic, and he exits the isolation chamber bleeding from the mouth and unable to speak. He insists that his visions have "externalized," indicating he truly experienced a different state of consciousness in the isolation chamber. In later experiments, Edward achieves biological devolution. In doing so, he defied evolution and reverted to a primitive life form. At first, he exits the isolation chamber as a caveman, but later becomes a mass of conscious, radiating energy. By the end of the film, his regression to a primitive life form does not require him to consume hallucinogenic drugs or enter the isolation chamber. Fortunately, his remaining stream of human consciousness is able to fight the final transformation, and he returns to himself.

Thematic Analysis; Technique. Edward strives to discover his true self. He explores his urge to leave the human body behind to be born again. Elements of science, religion, and spirituality intersect throughout *Altered States.* Depictions of Jesus on a crucifix appear in Edward's hallucinations, and viewers assume he is envisioning the birth of the universe. Edward ultimately sought the truth, and in the end, he realizes that the final truth is without truth.

Close Reading. The key elements in *Altered States* are the science, the special effects used, and the relationship between Edward and his wife. Viewers quickly learn that

the purpose of Edward's scientific inquiry is purely selfish as he seeks to understand mankind's origin and role in the universe. Disregarding all safety procedures and the needs of his family, Edward uses his knowledge of genetics, genetic memory, sensory deprivation, and isolation tanks to repeatedly and obsessively risk his life and the lives of others. Viewers learn little about the scientific processes or broader purpose of science efforts in the film, aside from Edward's self-satisfaction. Viewers do witness, however, Edward's intense decay of metal and physical health. He is successful in his experimental efforts, but his success comes at a cost.

Special effects are used in the film to represent Edward's hallucinations. Collisions of strange, eerie sounds with bright colors and abstract shapes overload the viewers' senses and convey the intensity of his altered states, as they are meant to evoke the birth of the universe. These scenes occupy four long passages in the film and appear in a few short bursts. Finally, the relationship between Eddie and his anthologist wife, Emily Jessup, is unstable as it is unclear whether or not Eddie is ever capable of retuning her love. He clearly prioritizes his work over any sense of companionship she might provide to him, but her ability to trigger his human consciousness at the movie's end saves both of their lives and it is in that final moment that he tells her he loves her.

The Thing

Context. Written by Bill Lancaster and directed by John Carpenter in 1982, *The Thing* was based on the 1938 novel *Who Goes There?* written by John W. Campbell Jr. The movie was released during the final decade of the Cold War and represents the threat of nuclear annihilation as well as "the social psychosis [the Cold War's] media presentation masterfully created" (Malić, 2016, para. 23). *The Thing* tells the story of a

team of scientists stationed in Antarctica who encounter the "thing"—an extraterrestrial life form that imitates other organisms. The group struggles with conflict and paranoia as they learn they cannot trust one another, because the "thing" could be mimicking any one of them.

Narrative Analysis. *The Thing* takes place during the winter in Antarctica and begins with a helicopter from the Norwegian research base flying over a husky, and the passenger desperately attempts to kill it by shooting a rifle and dropping grenades. The dog escapes by making a beeline for the American research station, and the Norwegian passenger accidentally throws a grenade too close to the helicopter, destroying it and killing the pilot. The passenger continues to shoot his weapon frantically, and when he accidentally hits one of the American scientists in the leg, the station commander shoots and kills the man in self-defense. The American team's helicopter pilot, MacReady, and their doctor, Copper, travel to the Norwegian base to investigate. They find that the entire base has been burned to the ground, evidence of gruesome deaths, and the burnt corpse of an unrecognizable creature that they bring back to examine.

When Blair, the team's biologist, performs an autopsy, they learn that the creature could replicate the body of any living thing it kills. The Americans then watches a video retrieved from the Norwegian site and learn that the deceased Norwegian crew uncovered an alien spaceship from the ice that had been buried for at least 100,000 years. That night, the husky that fled to their camp transforms into an alien-like creature and consumes all of the other dogs. The team is able to kill the creature, but a piece of it manages to escape. As Blair continues to analyze the creature's cells, he realizes that there is a 75% chance that one or more members of the research team has already been infected. Meanwhile, the

creature comes back to life, and proceeds to kill some of the scientists and imitate others. Those remaining conduct scientific tests to determine who has been infected, while struggling to trust anyone and remain sane. The movie ends with the base being burned to the ground, and two of the scientists discuss what to do next while sitting outside in the snow. It is possible that one of them is infected.

Thematic Analysis; Technique. Paranoia infects the minds of all scientists at the American research base. When analyzing the creature's body, Blair discovers that if it were to reach civilization, the entire world's population would be infected within 27,000 hours from the first contact. Still, the crew members seem to be primarily concerned about their own survival and fight for themselves, while *the thing* aggressively struggles for its own self-preservation. The movie reflects a game of cat and mouse, although viewers can never be sure of exactly who is the cat and who is the mouse. Ultimately, the crew's scientific ability is unable to provide them a solution.

Close Reading. The film's key elements consist of the gruesome depiction of the alien creature itself, and the scientists' paranoia and mistrust. Time after time, the heads and bodies of dogs and humans would graphically split wide open and whip out tentacles that carried body parts. The slimy carcasses pulsated, squirted blood, and contained disembodied heads. As soon as the scientists learned that the alien could replicate all life forms it killed, the paranoia set in and the scientists became irrational. The trust that existed in their small community eroded because one's best friend might really be there enemy. Crew members conducted several scientific procedures to test whether or not *the thing* was present among them, such as blood tests and morphine injections, but each action resulted in more death and confusion.

Weird Science

Context. Written and directed by John Hughes in 1985, *Weird Science* is an American teen comic science fiction film. Hughes was known for creating films that represented the awkward years between childhood and adulthood (Collin, 2015). In *Weird Science,* two teenage boys use computer technology to design their ideal woman, and an electrical power surge brings her to life. She helps them navigate their awkward phase of life by increasing their popularity and their ability to be noticed by girls.

Narrative Analysis. Gary Wallace and Wyatt Donnelly, nerdy high school outcasts and best friends, are disappointed at their inability to be noticed by women. Alone for the weekend with Wyatt's parents out of town, the two watch the 1931 movie *Frankenstein*, and Gary brainstorms an idea. He convinces Wyatt to use his computer system to create a virtual woman. They hook up electrodes to a barbie doll, scan magazine images of women into the computer that programs similar qualities into its creation, and hack into a government computer system to gain more power. A powerful surge of energy creates Lisa, a highly intelligent and beautiful women with magical powers. She quickly conjures up a Cadillac and takes Gary and Wyatt to a bar where she convinces everyone they are of legal age.

The next day she accompanies them to the mall where they are picked on by popular bullies, Ian and Max. Lisa proceeds to tell Ian and Max about a party at Wyatt's house, and everyone attends gawking at Lisa and the possibility of her being romantically tied to Gary and Wyatt. During the party, Gary and Wyatt admit to Ian and Max that they used magic to create Lisa, and their tormenters convince them to try the experiment again. However, they forget to connect the electrodes to a doll and instead, the live electrodes are

resting on a magazine page that illustrates a missile. Thus, they accidentally create a real missile that crashes through the house.

Meanwhile, Lisa decides Gary and Wyatt needs challenge to boost their confidence and conjures a gang of mutant bikers to invade the party. At first, the boys flee in fear, but end up confronting the bikers and scare them away, causing their love interests, Deb and Hilly, to fall in love with them. Gary and Wyatt escort the girls home the next morning, and Lisa is left alone with Wyatt's mean older brother, Chet. She uses her power to turn Chet into a mutant green blob and forces him to stop tormenting Gary and Wyatt. At this point, Lisa realizes her purpose is complete; she helped the boys gain confidence and popularity. Before leaving, she rids the house of all destruction, and when Wyatt's parents return, they do not suspect a thing.

Thematic Analysis; Technique. The underlying theme in *Weird Science* represented a teenage boy's fantasy, and a young man's navigation through the potentially awkward developmental years. Although quite unbelievably, Gary and Wyatt find an experienced, life mentor and maternal figure in their scientific creation, and Lisa teaches them to have confidence in themselves and to not live in the shadows of life.

Close Reading. The key element in *Weird Science* is Lisa's relationship with the Gary and Wyatt. When they use science to fulfill their wild, teenage boy fantasy and create the "perfect" women, she is loyal to them, and takes on a warm, maternal role. As her creators, the boys have full control over Lisa, but they do not take advantage of this power. Instead, they respect her and listen to her advice. By the end of the film, Gary and Wyatt have their dream girls, and they are no longer bullied by their peers or Chet. Lisa helps their fantasy become reality.

The Fly

Context. *The Fly,* written by George Langelaan, Charles Edward Pogue, and David Cronenburg, and directed by David Cronenburg, was released in 1986 when AIDS was prominent in the United States but still a relatively new disease. The film's grotesque nature was meant to reflect society's judgement of the virus infecting a human (Mathijs, 2003). Viewers experience a connection between bodily dysfunction and mutation, bodily fluids, sexuality, and science throughout the film; a clear metaphor to sexually transmitted diseases. References and ideological implications to AIDS throughout the film gave it cultural relevance (Mathijs, 2003). *The Fly* tells the story of a scientists who turns into a human-fly hybrid after one of his experiments using teleportation machines goes wrong.

Narrative Analysis. Scientist Seth Brundle falls in love with journalist Veronica Quaife who covers the development of his new invention: Telepods that can transport material from one location to another. After trying and failing to teleport a baboon, he discovers that his computer system is only able to recognize inanimate objects. Seth soon gains inspiration, and successfully transports living tissue. However, drunk and angry from an argument with Veronica, he recklessly attempts to teleport himself, but does not see the fly enter the pod with him. He emerges once the transaction takes place, not yet realizing his DNA has fused with the fly's DNA.

At first, Seth is stronger and has more stamina, but he quickly begins to intensely crave sugar, grow thick insect hair, climb on walls, uncontrollably replace his human limbs with insect limbs, and vomit on his food before eating. Seth becomes fascinated with his transformation, as Veronica watches with fear, horror, and heartbreak. She becomes truly frantic when she learns she is pregnant with Seth's baby and decides to abort it because she

does not know if she became pregnant before or after his mutation and feared what might be growing inside her. Before the doctor is able to perform the procedure, Seth swoops in and takes her back to his lab where he completes his final transformation into a fly and tries to use the telepods to fuse her and the baby with himself. Stathis Borans, Veronica's ex-boyfriend and boss, is able to remove her from the telepod just in time, and Seth becomes fused with the telepod itself, transforming into a metal-fly fusion. In pain, he silently begs Veronica to kill him, and she does.

Thematic Analysis; Technique. One of the most prominent themes in *The Fly* is fear of diseases, specifically sexually transmitted diseases. As explained earlier, the film resembles society's vision of the AIDS epidemic. The mental and physical changes Seth experiences are meant to mirror the changes one might experience with a severe AIDS diagnosis. In addition, Veronica tries to support him throughout the film, but is unable to help. She suffers tremendously as she helplessly watches his transformation unfold.

Another theme in *The Fly* is the inability of the mind and body to always coexist. People often take their bodies for granted pending disease or injury, and once they no longer have control, their mind must helplessly allow their body to run its course (Eggert, 2007). Sometimes, what people see in the mirror is unrecognizable, and not how their mind remembers them to look because they feel differently than what they see (Eggert, 2007). In the film, Seth's body decays more quickly than his mind, and every time he sees his reflection, he stares back in shock.

Close Reading. *The Fly's* key elements consist of the science, Seth's fascination with his transformation, and the relationship between Seth and Veronica. Seth, who conducts his research under the radar from the scientific community, seems to be amazed

with his mutation and studies himself. As his metamorphosis advances, what started as a passionate, loving relationship between Seth and Veronica results in her prolonged pain and disgust.

Mary Shelley's Frankenstein

Context. Written by Mary Shelley, Steph Lady, and Frank Darabont and directed by Kenneth Branagh in 1994, *Mary Shelley's Frankenstein* was based on Mary Shelley's 1818 novel *Frankenstein. Mary Shelley's Frankenstein* tells the story of a scientist who dedicates his life's work to finding a way to resurrect the dead. He assembles a creature using cadavers' body parts and brings the abomination to life. The scientist abandons the creature, which seeks revenge on its creator.

Narrative Analysis. In 1794, Captain Walton leads a difficult voyage through the Arctic Sea to reach the North Pole. With his ship stuck in the ice, his crew come across Viktor Frankenstein, who appears to be running in fear of something chasing him. Viktor boards the ship and shares with Walton his life story.

Viktor spends his childhood in Geneva, and at a young age, he is introduced to Elizabeth Lavenza, who later becomes his lover. Before leaving to study science at the University of Ingolstadt, Viktor's mother dies giving birth to his baby brother, William. Stricken with grief, Viketor vows to discover a way to conquer death. While at the university, Viktor meets Professor Waldman, who previously had similar interests and used his scientific ability to create life. Waldman admits to Viktor that he stopped his research because it resulted in abomination.

While Waldman and Viktor vaccinate members of the community, an untrusting and fearful patient murders Waldman, and his later hung for his crime. Viktor gathers the

murderer's body, Waldman's brain, and a leg from a fellow student who died, and uses his professor's notes to sew together a new being. Finally, Viktor gives his creation life, but soon regrets his decision. As he attempts to kill the life form he pieced together, it manages to escape.

The creature spends months secretly living in a family's barn in the wilderness, where he teaches himself to read and speak. In the night, he helps the family by using his strength to pull vegetables from the frozen ground, hopeful to earn their trust. He also murders a debt collector who threatened and abused the family. Finally, the creature peacefully interacts with the family's patriarch, an elderly blind man, but when the family returns and sees him, they react with fear and repulsion and abandon their farm. The creature finds Viktor's journal in the pocket of his coat and learns about the circumstances of his conception. He fills with rage and vows to seek revenge on Viktor.

Viktor, who believes the creature is dead, returns to Geneva to marry Elizabeth. Little does he know he is being hunted. The creature murders William and frames Justine, a servant in the wealthy Viktor household, for the murder. She is quickly hung by a lynch mob before her innocence can be proven. Finally, the creature finds Viktor and demands that he bring to life a companion for him. In return, the creature will disappear from Viktor's life. Viktor begins gathering his materials, but when he learns the creature wants him to use Justine's body, Viktor breaks his promise. The creature gruesomely kills Elizabeth in retaliation. Maddened with grief, Viktor stitches Lavneza's head onto Justine's body, and gives her life. Initially, Viktor and the creature compete for Elizabeth's love, but Elizabeth, horrified at her newfound animation, kills herself.

Viktor dies from pneumonia as he finishes telling his story to Captain Walton. The creature boards the ship and is saddened by Viktor's death. Although he hated him and sought revenge, he still considered Viktor to be his father. The creature burns himself alive with Viktor's body.

Thematic Analysis; Technique. One of the most prominent themes in *Mary Shelley's Frankenstein* is Viktor's complete disregard for the consequences of his actions. He uses his intelligence and scientific ability to give the creature life, who turns evil because of the way it is feared and abused by all. Viktor obsessively works to bring the creature to life, and then disregards its existence to focus on rebuilding his own life. Unfortunately, the consequences are severe, as the creature proceeds to kill all of Viktor's loved ones. When Elizabeth is killed, a guilt-ridden Viktor brings her back to life because selfishly, he cannot live without her. However, this action only brings about more pain and destruction as she must make the decision to die again. Ultimately, Viktor is unable to make rational decisions, which proves to be dangerous as a scientist of his magnitude.

Close Reading. The key elements in the film are the creature itself, and Viktor's obsession to defy nature's natural order. The creature, highly intelligent, sought acceptance and companionship, but was unsuccessful. His appearance made everyone he came into contact with fearful, and he quickly learned that society would never be accepting of him. Viktor's dismissal caused the creature to embrace his anger which turned him into a true monster. Regardless of numerous warnings to not pursue his line of inquiry, Viktor selfishly needed to succeed and create life where it was not meant to exist. He let nothing and no one stand in his way. Viktor's obsession caused him to sacrifice elements of his personal life, and he felt no regret until after it was too late.

Junior

Context. Written by Kevin Wade and Chris Conrad, and directed by Ivan Reitman in 1994, *Junior* follows the experience of a male scientist who agrees to become pregnant to prove the effectiveness of Expectane, a new drug designed to reduce the chances of a miscarriage.

Narrative Analysis. Geneticist Alex Hesse and his colleague Larry Arbogast, an OB/GYN, invent a fertility drug called Expectane. Proven to be successful on animals but not approved by the Food and Drug Administration, they lose funding and are unable to continue their research, never having experimented using human subjects. As Alex packs up his life and plans to return to work in Europe, geneticist Diana Reddin moves into his lab space. Larry informs Alex that a Canadian firm named Lyndon Pharmaceutical has agreed to fund them, assuming they can find a research subject. The likelihood of a pregnant women agreeing to take an unapproved drug is unlikely, therefore, Larry suggests they impregnate Alex. Finally, Alex agrees, and Larry steals a frozen egg labeled "Junior" from Diana, not realizing it is biologically her own. The procedure is a success and Alex becomes pregnant, unaware of the egg's origin.

When the time comes to terminate his pregnancy because they collected all required data to prove the drug a success, Alex secretly continues taking Expectane and makes the decision to carry the child full-term. Larry, initially upset at Alex's decision, agrees to be his doctor and keep their experiment a secret. Meanwhile, Alex develops a romantic relationship with Diana. When she learns about his pregnancy, and that he carries her child, she is initially furious. However, she agrees to be the mother, and he the father. As Alex grows more heavily pregnant, more people begin to take notice, including head of

the Food and Drug Administration's review board, Noah Banes. He tries to take credit for the experiment, given that is a success. Larry checks Alex into a retreat for expecting mothers to hide him from Bane. He travels to meet with Lyndon Pharmaceuticals, and when he shares with them the experimental data, they agree to join he and Alex as partners.

When Alex goes into labor, Larry and Diana rush him to the hospital, and Larry calls a fellow doctor to prepare a private room for an emergency caesarean section. A member of the hospital staff overhears the conversation and informs Banes, who summons the media and the college dean in hopes of taking credit for the world's first pregnant man. Diana sneaks Alex into the hospital through a fire escape, and Larry stages a decoy to distract the media. Alex gives birth to a baby girl, who he and Diana name Junior.

Thematic Analysis; Technique. The central theme in *Junior* revolves around scientific breakthrough surrounding controversial topics. Alex and Larry know they are onto something great with Expectane, but their hard work is invalidated when they no longer receive funding. Their passion and drive commit them to impregnating Alex; a controversial action not only because he is a man, but also because they initially planned to terminate the pregnancy after collecting data. Only after Alex became emotionally attached to his unborn child, did the science become his second priority. In the film, the two scientists achieved the impossible.

Close Reading. A key element in *Junior* includes the need for Alex and Larry to keep their science experiment a secret. Although the decision to test an unapproved drug on a human was unethical, as was the decision the two made to continue their research in the first place after losing funding, the experiment turned out to be huge success with the capability of changing many lives. The secrecy surrounding the situation provided humor

and suspense in scenes throughout the film. Another key element in the film was the relationship between Alex and Diana. Both brilliant geneticists who are unfamiliar with the dating scene, the two develop a romantic relationship while she is unaware that *he* is pregnant, or that it is with *her* child. This dynamic provides viewers with a sense of angst while rooting for the happy, obscure couple.

12 Monkeys

Context. Written by Chris Marker, David Webb Peoples, and Janet Peoples, and directed by Terry Gilliam in 1995, *12 Monkeys* was inspired by Chris Marker's 1962 28-minute film *La Jetée,* that shares a narrative about a post-nuclear war experiment using time travel.

Narrative Analysis. A deadly virus, allegedly released by a group called The Army of the Twelve Monkeys in 1996, killed most of humanity. To avoid Earth's toxic surface, survivors were forced to move underground. A team of scientists in 2035 select James Cole—a prisoner—to fulfill a special mission. He must travel back in time to 1996 and gather data about the virus so that the scientists can develop a cure. He is accidentally sent to 1990 instead of 1996, where he is deemed mentally insane by Dr. Kathryn Railly and committed to a psychiatric institution. There he meets patient Jeffery Goines, a conspiracy theorist with fanatical views. The scientists bring James back to 2035 and learn that they sent him to the wrong year. They play him a voicemail about the Army of the Twelve Monkeys and show him photographs of the people involved, one of which is a photo of Jeffery. The scientists then offer James another chance to complete his mission and they send him back in time.

Unfortunately, he appears in the middle of a World War I battlefield and is shot in the leg. Within minutes, he is properly teleported to 1996. James sees flyers publicizing a lecture given by Kathryn. During a book signing following her lecture, she meets Dr. Peters, who speaks to her about the apocalypse. When she departs from a consecutive book signing, James kidnaps her and forces her to drive him to Philadelphia. They learn that Jeffery is the founder of the Army of the Twelve Monkeys, and when he confronts him, Jeffery denies any involvement. In fact, he says that wiping out humanity with a deadly virus was actually James's idea that he originated during a conversation at the psychiatric institution in 1990.

Once again, James wakes up in 2035—the present—and is praised by the scientists for a job well done. Meanwhile, Kathryn finds evidence of James's time travel, and no longer believes he is insane. James convinces the scientists in 2035 that there is more to be done in 1996, and they agree to send him back, unaware that he plans to stay upon returning. He and Kathryn decide to travel to the Florida Keys before the virus is released, but in route to the airport, they discover that the Army of the Twelve Monkeys was not responsible for the epidemic. James calls the scientists in the future to let them know they made a mistake. Meanwhile, Kathryn recognizes Peters from her book signing headed through the security line. He is preparing to travel to a variety of major cities that match the locations of the viral breakout. At the same time, James is given a handgun by a fellow time traveler from 2035 and is ordered to kill Peters. Unfortunately, he is shot by police officers before fulfilling the deed.

Thematic Analysis; Technique. *12 Monkeys* reminds viewers that lessons can be learned from the past to make decisions for a better the future. Although the deadliest

threat faced by society today is not a virus, there are other problems that are prevalent because of widespread actions and decisions made in the past (i.e., climate change). Scientists are dedicated to mitigating the extremity of the climate disaster, but the disaster still exists and will continue to be an ongoing battle.

Close Reading. One of the film's key elements is the scientists' use of time travel to regain the ability to live safely on Earth's surface. They simply do not know enough about the virus to counteract its effects, and therefore must send people back in time to find where it originates to enable further exploration and analysis. Another related key element is that the scientists use prisoners to send back in time, likely because they are considered an expendable population who would be willing to take the risk given the opportunity to reduce their sentence. Viewers learn that once the time travelers locate the virus, scientists themselves will take their place in the past because they have the capability to further decipher required information about its contents, whereas the prisoners do not.

Contact.

Context. Written by James V. Hart, Michael Goldensberg, Carl Sagan, and Ann Druyan, and directed by Robert Zemeckis, the 1997 film *Contact* was adapted by Carl Sagan's 1985 novel by the same name. It tells the story of a scientist who has dedicated her life to the search of extraterrestrial life. When she finds evidence of its existence, she makes contact.

Narrative Analysis. Ellie Arroway, a scientist committed th the search for extraterrestrial life (SETI), works for the Arecibo Observatory in Puerto Rico searching for alien life. The SETI program loses funding because the endeavor is perceived as useless. However, Ellie manages to secure different funding from billionaire S. R. Hadden's

company, and she continues her work at the Very Large Array (VLA) in New Mexico. After several years, Ellie discovers a signal repeating a sequence of prime numbers being transmitted to Earth from the star system Vega. After further analysis, her team finds a video within the signal of Adolf Hitler at the 1936 Summer Olympics; the first television signal strong enough to reach Vega and be transmitted back. The world tunes into the project, which is placed under strict government regulation.

Ellie and her team struggle to decipher the data, until S. R. Hadden provides her with the means to decode the message. It reveals blueprints for a complex machine that has the ability to transport one individual to Vega. Funding agencies provide the means for the machine to be built, and construction begins immediately. A panel is assembled to select an individual to travel in the machine. When Palmer Joss, a Christian philosopher, reveals that Ellie is an atheist, the president's science adviser, David Drumlin, is chosen as a better representation of humanity. However, during testing procedures, a religious terrorist detonates a suicide bomb, destroying the machine and killing David.

Hadden informs Ellie that he secretly had another machine built in Japan that is ready for her departure. When she assembles in the machine's traveler pod, it descends into rapidly spinning rings of energy that transport her through wormholes. When she arrives on Vega, she sees signs of an advanced civilization, and then finds herself on a beach, similar to a picture from her childhood. A figure transforms into her deceased father as it approaches. She attempts to ask the life form questions, and it informs her that the familiar landscape and human appearance were used to make first contact with the alien civilization easier. Ellie then falls unconscious and begins traveling back to Earth through the wormholes. She regains consciousness in the pod and learns that it appeared to others as if

the pod never left. Ellie insists she traveled for 18 hours, but her communication devices only recorded static. A Congressional Committee speculates whether or not the original signal was a hoax designed by Hadden, but Ellie pleads for others to believer her. The film ends with a private conversation that reveals her recording device taped 18 hours of static.

Thematic Analysis; Technique. The most prominent theme in *Contact* is the conflict between science and religion. Ellie and Palmer discuss their contrasting views throughout the duration of the film, dividing the two belief systems and making it seem as though if you support science, you cannot have religious views, and vice versa. In the end, Palmer openly supports Ellie and claims that he believes in her experience. He states, "As a person of faith, I'm bound by a different covenant than Dr. Arroway. But our goal is one and the same: The pursuit of truth" (Zemeckis, 1997, 2:18:00). In this statement, Palmer and Ellie seem to accept their differences and understand each other's views.

Close Reading. The key elements in *Contact* include the relationship between Ellie and Palmer, and Ellie's commitment to a scientific field that is frequently criticized by others. Ellie and Palmer's relationship progresses romantically as the two struggle to find common ground in their beliefs. Meanwhile, Ellie remains passionate about her line of inquiry and never doubts herself or her efforts. Several instances occur that involve other's openly doubting the authenticity of her research. Still, she gracefully accepts the criticism and eventually watches her hard work pay off when she makes contact with an unknown life form.

Nutty Professor II: The Klumps

Context. Written by Jerry Lewis, Steve Oedekerk, Barry W. Blaustein, David Sheffield, Paul Weitz and Chris Weitz, and directed by Peter Segal in 2000, *Nutty*

Professor II: The Klumps tells the story of a college professor and brilliant researcher who attempts to remove his alter-ego through a gene-extraction procedure. Actor Eddie Murphy's plays seven prominent characters in the film, including the main character, Sherman Klump. The romantic comedy is a sequel to the 1996 film *The Nutty Professor.*

Narrative Analysis. Sherman, a college professor whose research and teaching focus on genetics, successfully creates a youth formula that reverts aging. He also falls in love with his colleague, Denise Gaines, who developed a method for isolating genetic material. Unfortunately, Sherman's alter-ego, Buddy Love exists inside of him and causes Sherman to act out inappropriately. Sherman tries proposing to Denise, but Buddy kicks in, makes a perverted joke, and scares Denise away. Determined to rid himself of Buddy permanently, Sherman uses Denise's extraction method to remove the gene from his DNA where Buddy manifested. The genetic material he removes falls to the floor and is not disposed of properly. A piece of hair from a Basset Hound falls into it, causing a reaction that turns Buddy into a human being. Shortly after, Sherman learns that, due to the extraction, his brain cells are deteriorating, and he begins to rapidly become less intelligent.

Sherman realizes that he must keep his youth formula hidden from Buddy, who is attempting to sell it to a different company, counter to Sherman's agenda. Sherman stores the formula at his parent's house, but Buddy finds it and secretly contaminates it with fertilizer. The next day, during Sherman's presentation to a funding committee, he tests the formula on a hamster, who grows to a monstrous size and becomes aggressive. The high-stakes presentation is disastrous, and the dean fires Sherman as a result. Sherman learns

that his brain is continuing to deteriorate at an exponential rate and breaks up with Denise, thinking he has no other option.

In a last attempt to foil Buddy's plan, Sherman uses the brain power he has left to quickly devise a more potent youth formula. He brings the new formula along with a tennis ball to Buddy's presentation to a funding agency where he is trying to sell Sherman's work. Remembering that Buddy contains dog DNA, Sherman throws the tennis ball that he soaked in the newer, stronger youth formula, and Buddy lunges after it, unknowingly consuming the concoction. Buddy quickly reverts to an infant, and then becomes a pile of liquid genetic material. Sherman attempts to drink the liquid in an effort to be reunited with Buddy to restore his intelligence, however, the liquid evaporates. Denise learns the truth about Sherman's experiment and that he is losing his intelligence, and quickly rushes to the location. She realizes that the liquid genetic material has combined with the nearby water fountain and encourages Sherman to drink the water from the fountain before the material dissipates. Sherman drinks that water and restores his original genetic sequence. The film concludes with Sherman and Denise's wedding reception.

Thematic Analysis; Technique. The primary theme in *Nutty Professor II: The Klumps* is encouraging of one to be true to themselves, and to never change to please others. Sherman completes a risky procedure to remove a part of himself by changing the sequence of his DNA. He quickly regrets his decision, as he soon loses himself entirely and the things most important to him, including his career and his fiancé. When he consumes the genetic material and returns to normal, he learns to embrace his true self.

Close Reading. The key elements in *Nutty Professor II: The Klumps* consist of Sherman's brilliant scientific ability, and his willingness to sacrifice a part of himself in

hopes of becoming a better person. In the beginning of the film, viewers learn that Sherman's genius is unmatched and that he is famous within the scientific community. He is even referred to as 'the best scientist in the world.' He proves his brilliance when he demonstrates his discovery of the youth formula that reverses aging.

Sherman has it all—a well-respected and successful career, a loving family, and a love interest who wants to marry him. His alter ego, however, impedes his quality of relationships when it causes him to speak out randomly and inappropriately. Sherman's solution is to impulsively use science to remove the component of his DNA that hosts his alter ego. He soon learns that his alter ego is critical to his identity, and once it is restored within him, Sherman learns to appreciate his natural flaws.

Hollow Man

Context. Written by Gary Scott Thompson and Andrew W. Marlowe and directed by Paul Verhoeven in 2000, *Hollow Man* was inspired by H. G. Well's novel *The Invisible Man.* A scientist volunteers to be the test subject for an invisibility serum. When his research team is unable to restore him back to normal, he becomes aggressive and violent.

Narrative Analysis. Sebastian Caine, a brilliant but arrogant scientist, developed a serum that makes a subject invisible, with the help of his research team which includes Linda McKay, Matt Kensington, and Sarah. Together, they successfully make a gorilla invisible, and visible once again. During a presentation to a committee representing the funding agency, Sebastian lies by saying that he has not yet been able to revert a subject back to normal once making them invisible. He then convinces his team to begin testing on humans and offers to use himself as the subject. They perform a successful procedure and

after enduring excruciating pain, Sebastian becomes invisible. In his new mystical state, he enjoys playing pranks on his colleagues in the lab.

They attempt to regain Sebastian's visibility, but the procedure fails, and he almost dies. As his team works toward a solution, they quarantine Sebastian and make him a latex mask to wear around the lab so that others are aware of his whereabouts. He struggles with being isolated and constantly monitored and decides to leave the building. While away, Sebastian engages in several unethical and illegal activities. Upon his return to the lab, Linda and Matt warn Sebastian that if he leaves the facility again, they will tell the committee of their experiment. Ignoring their threat, Sebastian assembles a loop video recording to the video cameras in his room, and once again leaves the building.

When the team discovers Sebastian escaped, Matt and Linda go to Kramer, the head of the funding agency committee, to inform him of their wrongdoings. Upon their departure, Kramer prepares to report them, but Sebastian kills him before he is able to talk to anyone. The next day, Sebastian waits until every member of the research team arrives to the lab before disabling the codes and elevator codes so they cannot escape. He begins to kill them one by one. Matt nearly dies, but Linda is able to kill Sebastian and save Matt's life. They are the only two survivors who emerge from the burning building in the films' final scene.

Thematic Analysis; Technique. The dominant theme in *Hollow Man* is power. Sebastian's scientific brilliance makes him feel powerful from the start of the film. He frequently mentions his leadership and dominance over the other members of his team and refers to himself as God. When he turns invisible, he becomes intoxicated with power. He realizes that his invisibility makes him untouchable, and justifies his decisions to conduct

unethical and illegal activities by asking himself, “Who’s gonna know?” (Verhoeven, 2000, 1:16:00). When Linda asks where Sebastian is, he tunes into the intercom and says, “You don’t know what it’s like, the power of it, the freedom” (Verhoeven, 2000, 1:16:00). His addiction to feeling powerful causes him to spiral, and results in his death.

Close Reading. The key elements in the film are Sebastian’s unethical tendencies and ultimate downward spiral, and the comradery between Sebastian and the rest of his research team. Early in the film, viewers learn that Sebastian is considered a genius, and that his scientific ability is far beyond his research team members’ capabilities. However, he often does not follow safety protocol when working, and on multiple occasions, he arrogantly references his genius, and refers to himself as God.

Sebastian spirals quickly after several failed attempts to restore his visibility. Unable to cope with isolation and the loss of his freedom, he begins to lose his mind and acts on his impulsive, unethical, and deviant desires. Sebastian’s team continues to support him until they finally convince themselves he has gone mad. They stand by him when he lies to the funding agency’s committee, and when he decides to conduct an illegal, unapproved experiment. Even when he sneaks away from the lab, and they are suspicious of his engagement in unethical, deceitful activities, his team remains supportive; perhaps because they are in denial until there is further evidence to prove him guilty.

Spider Man 2

Context. Written by Alvin Sargent and directed by Sam Raimi in 2004, *Spider Man 2* is a sequel to the 2002 *Spider Man* film and the second movie in the Marvel Comics *Spider Man* trilogy. In this particular installment, Peter Parker, who is secretly Spider Man, struggles to manage his personal life and his superhero duties. Meanwhile, he must battle

Dr. Otto Octavius, a mad scientist who is attempting to recreate a failed experiment that threatens to destroy the city.

Narrative Analysis. Peter Parker struggles with his identity and maintaining a balanced life. He feels estranged from his best friend, Harry Osborne, and his live interest, Mary Jane Watson. He is not doing well in school or at his job, and intermittently loses his superhero powers. Harry, who is head of Oscorp's genetic and scientific research division, is funding Otto Octavius's fusion power project. He introduces Peter to Otto, and the two become friends. During a public demonstration of Otto's experiment, he attaches eight mechanical limbs to his body using artificial intelligence. A power surge causes the fusion reaction to destabilize, but Otto refuses to pull the plug. The reactor kills his wife and destroys the inhibitor chip; a device that enabled Otto to remain in control of his robotic limbs. Spider Man shuts down the experiment and destroys the machine.

Doctors prepare to remove the mechanical limbs from Otto's body, but without the inhibitor chip controlling them, the limbs kill all of them. Otto escapes to a harbor, and the sentient, mechanical limbs convince Otto to re-try his experiment. He robs a bank to fund his next attempt. Coincidentally, Peter and his Aunt May are at the bank Otto robs, and Otto takes Aunt May hostage. Spider Man rescues her, but Otto escapes with the stolen money. Meanwhile, Mary Jane and her boyfriend become engaged, and Peter suffers an emotional breakdown. He loses his powers and throws his superhero suit in the garbage, abandoning his Spider Man identity.

To successfully complete his experiment, Otto needs the isotope tritium to fuel the reactor. He finds Harry and demands the product. Harry agrees to give it to him in exchange for Spider Man, who he believes is responsible for the death of his father. Harry

tells Otto to find, but not harm, Peter, as he believes Peter is friends with Spider Man and might know his whereabouts. Otto finds Peter, tells him to locate Spider Man, and takes Mary Jane hostage. Peter regains his Spider Man powers knowing Mary Jane is in danger and finds his superhero suit. He battles Otto on a subway train. Otto destroys the train's controls, leaving Spider Man to save all the passengers as it increases in speed toward an unfinished track. Spider Man successfully stops the train but is captured by Otto and delivered to Harry.

Harry prepares to kill Spider Man but is stunned when he finds his best friend under the mask. Fortunately, Peter convinces Harry to tell him the location of Otto's hideout. When he arrives, Spider Man attempts to rescue Mary Jane discretely, but is confronted by Otto, and the two battle as Otto's nuclear reaction swells. Spider Man subdues Otto and reveals his identity. Peter is able to convince Otto to use his power for the greater good, and Otto is able to regain control of his mechanical limbs which he then uses to destroy the experiment, while also sacrificing his own life. Mary Jane also sees Spider Man's true identity and understands why Peter remains distant. Still, she later abandons her fiancé at the alter and runs to Peter. Finally, Harry stumbles across his father's secret room, where he finds prototypes of the Green Goblin's equipment, which sets the stage for final installment in the *Spider Man* trilogy.

Thematic Analysis; Technique. One of the primary themes in *Spider Man 2* represents how one can struggle with their identity. Peter struggles to maintain any semblance of a normal life, which affects his health and happiness. Yet, he feels obligated to continue being Spider Man, because he thinks the world needs his superhero ability. He tries to abandon his Spider Man identity; which ultimately means he abandoned part of

himself. It does not take long for him to embrace his full identity and value his gifts.

Another theme in *Spider Man 2* represents good versus evil. Spider Man is driven by his desire to do good, and his perceived obligation to use his powers to help people in need. Otto, a mentor to Peter in the beginning of the film, is also initially motivated to do good. He tells Peter that the two of them are responsible for using their intelligence for the good of mankind. Briefly, Otto resembles a father figure to Peter, and he represents the image of happiness and success that Peter desires. Once he succumbs to the artificial intelligence in his mechanical limbs, however, Otto loses the ability to think for himself and nearly destroys the city because of his desire for power. Otto quickly embraces the mad scientist persona and represents evil and becomes a manifestation of Peter's greatest fear.

Close Reading. The key element in *Spider Man 2* include Peter's internal and external struggle to accept the responsibility associated with obtaining superpowers. He never wanted to be Spider Man; he yearned to live a normal life with Mary Jane. Instead, he is forced to lie to her about why they cannot be together so that he does not reveal his Spider Man identity. Still, he is unable to escape her presence as her face is plastered across the city on perfume advertisements and billboards.

Peter also feels disconnected from his aunt who he learns is struggling financially. His inner turmoil also effects his ability to be Spider Man. While swinging from skyscraper to skyscraper, his web-shooters stop working and he continuously falls to the ground. He cannot separate either of his identities, nor can he maintain them. Meanwhile, evil wreaks havoc in the city, and Peter must learn to integrate his conflicting identities to save the day.

Proof

Context. Written by Rebecca Miller and David Auburn and directed by John Madden in 2005, *Proof* was modeled after Auburn's Pulitzer Prize-winning play of the same name. It follows the story of Catherine, a 27-year-old student studying mathematics and grieving after the loss of her genius mathematician father whose mind deteriorated from mental illness.

Narrative Analysis. The narrative alternates in *Proof* between events that directly follow the death of Robert, a brilliant mathematician who suffered from mental illness, and flashbacks of Robert with his daughter Catherine, a mathematician who struggles with living in her father's shadow. Catherine manages to balance studying and caring for her father, while fearing she might have inherited his mental illness.

Hal, a former graduate student of Robert's, searches through all of Robert's notebooks that he filled with meaningless notes toward the end of his life in hopes of findings something significant. Catherine's paranoia kicks in when she thinks Hal is trying to steal some of her father's notebooks. She searches through his backpack, and finds that he did take a notebook, but he says he did so with no malintent—only because it had a heartwarming tribute to her inside. Still, Catherine gets angry and calls the police, forcing Hal to leave.

The next day Catherine's sister Claire flies in from New York to attend Robert's funeral. The sisters' relationship is tense; Catherine is upset that Claire did not care for their father as much as she did during his final years, and Catherine also becomes frustrated with Claire's constant harping on her appearance. At the funeral, Catherine causes a scene by interrupting the string quartet to give an impromptu speech where she

describes his descent into insanity expresses her frustration with all attendees for abandoning her father in his time of need. She then storms out of the church. Increasingly, Claire suspects Catherine to be struggling with mental illnesses.

Later that evening Claire hosts a wake at her father's house, and many academic mathematicians attend. Catherine and Hal become romantically involved, and the next morning, she gives him the key to unlock her father's desk. Inside, Hal finds a notebook that contains what he perceived to be a ground-breaking proof, that Catherine knew was there. After several minutes of discussing who would take credit for finding the work, Catherine admits to Hal and Claire that she wrote the proof, not her father. Hal believes that Catherine is not capable of achieving such work, while Claire thinks she is lying because of her allegedly deteriorating mental health. Unable to describe the proof without referencing the notebook due to its length and complexity, Hal asks other mathematicians in his department to verify its accuracy.

He returns the next day with news that other scholars believe the truth to be valid, and he acknowledges that Catherine is likely the author because the work employed newer mathematical concepts. Angry at his previous lack of trust, Catherine dismisses him and decides to move with her sister to New York. However, Catherine begins to feel more confident in herself with Hal's help, and she decides to leave the airport and stay in Chicago. The film ends with Catherine meeting up with Hal on the University of Chicago's campus to discuss the proof.

Thematic Analysis; Technique. The dominant themes in *Proof* involve identity and trust. Catherine struggles with her identity because she exhibits a mathematical gift similar to that of her genius father, but also wonders if she also inherited his mental health

illness. When Claire and Hal doubt her character and assume she lied about writing the proof, Catherine feels betrayed and unaccepted. Eventually, she builds confidence in herself, and in the end, viewers catch a glimpse of Catherine embracing her identity.

Close Reading. The primary elements in the film include Catherine's self-destructive mentality and the independence and success she sacrificed to take care of her mentally ill father. Throughout the film, Catherine doubts her mental health, and succumbs to her negative thoughts about her well-being. When the people she is closest to also doubt her mental health and intellectual ability, she hits an all-time low. With Hal's help and a newfound willpower, Catherine begins to regain her confidence. Catherine, who was close to her father, gave up school to provide him with full-time care because she refused to place him in a care facility. She sacrificed her independence and academia to ensure his comfortability.

Prometheus

Context. Written by Jon Spaihts, Damon Lindelof, Dan O'Bannon, and Ronald Shusett, and directed by Ridley Scott in 2012, *Prometheus* was the fifth installment in the *Alien* franchise. In *Prometheus,* two young scientists discover a clue to mankind's origin, and lead an expedition to a distant place in the universe where they anticipate to find their creators.

Narrative Analysis. In 2089, archaeologist couple Elizabeth Shaw and Charlie Holloway discover a star map in a hidden cave that looks similar to other maps from unassociated ancient cultures. They interpret the map as an invitation from "engineers," or creators of the human race. Peter Weyland, elderly CEO of the Weyland Foundation, funds an expedition among the USS Prometheus to the moon LV-223 identified in the maps. The

crew travels in hibernation stasis while the ship is piloted by David, an android. Once awakened in 2093, the crew explores a large, seemingly manmade structure.

Inside, they find cylinder-like stone structures, a giant statue of a humanoid head, and the decapitated corpse of what they assume to be an engineer. The crew then finds the head, which Elizabeth collects to study, as well as holographic footage of the engineers running through the tunnels during what appears to be an emergency situation. They assume the species is extinct. Still, crew members Millburn and Fifield begin to feel uncomfortable inside the structure, and attempt to return to Prometheus, but get lost. The rest of the crew is ordered to return to the ship due to an incoming storm, and upon their return, they realize the two have been stranded. Millburn and Fifield are forced to spend the night in the structure.

Back on board the ship, Elizabeth analyzes the alien's DNA and finds that it matches the DNA of a human, while David analyzes one of the cylinders found in the structure that he secretly boarded. He purposefully contaminates a drink with a drop of the dark liquid found inside the cylinder before giving it to Charlie to drink. While inside the structure, Millburn and Fifield come into contact with a snake-like creature that emerges from the water. It kills Millburn and sprays an acidic fluid onto Fifield, melting his helmet. When other crew members return to the structure, they find Millburn's corpse, and watch as Charlie grows violently sick. Mission director, Meredith Vickens refuses to let him back on board at the risk of contaminating the rest of the crew. At his request, Vickens kills him with a flamethrower. Meanwhile, David finds a control room in the structure that contains a live engineer in hibernation stasis, and a holographic star map pinpointing Earth.

Later, Elizabeth begins to feel a sharp pain in her abdomen, and a medical scan reveals that she is in the advanced stages of pregnancy, despite being infertile. The previous night, she spent intimate time with Charlie, and becomes fearful at the possibility of what is growing inside her. She climbs into an automated surgery machine that removes an alien creature from her abdomen. After surgery, she finds that Weyland has been aboard Prometheus all along in stasis, with the hidden agenda of having the engineers prevent his death.

A mutilated Fifield returns to the ship and kills several crew members before being killed. Weyland travels into the structure with a team, and they wake the engineer. David attempts to speak its language, but it decapitates David and kills Weyland. The engineer prepares a spacecraft that was also lying dormant in the structure. Elizabeth manages to escape and warns Janek that the alien is planning on releasing the liquid onto Earth to wipe out the human race. Janek and the remaining crew sacrifice themselves and crash their spacecraft into the engineer's spacecraft. David's head informs Elizabeth that the engineer is after her. She successfully feeds it to the alien creature she had removed from her abdomen that grew to an enormous size. Together, Elizabeth and Davis find and launch another engineer spacecraft and seek to answer why the engineer's intended to destroy humanity.

Thematic Analysis; Technique. The central theme in *Prometheus* revolves around the mythological Greek titan, Prometheus, who is believed to have created humanity. The film focuses on people's relationship with God, or their creator(s), and the consequences of not fulfilling their expectations. The expedition, led by Elizabeth and Charlie, intended to find God and reveal answers to questions regarding the origin of mankind. They

successfully find what appear to be God-like beings, but their questions remain unanswered and they suffer consequences for their pursuit.

Close Reading. The key elements in *Prometheus* include Elizabeth's ability to be a warrior and a survivor, and the agendas of different crew members. Elizabeth overcomes extreme hardship in the film; first when she loses Charlie after watching him suffer. When David tells her she is pregnant, but that they do not have the equipment to perform a safe abortion, she rushes to the automated surgery table and has the machine slice open her abdomen. Elizabeth then escapes the engineer multiple times and never gives up fighting.

Much of the crew did not know the reason for their mission until after waking up from hibernation stasis. Therefore, their commitment to the voyage lacked. Elizabeth and Charlie, however, felt as though they were fulfilling their life's work by venturing to the distant moon, and Elizabeth sought to gain confirmation about her beliefs. Later, we learn that Weyland funded the mission purely for his own self-interest. He yearned or immortality, granted by the engineers.

Gravity

Context. Written by Alfonso Cuarón and Jońas Cuarón, and directed by Alfonso Cuarón in 2013, *Gravity* follows the story of two astronauts who become stranded in space after debris destroys their space shuttle. One sacrifices himself for the other, who encounters numerous obstacles as she attempts to return to Earth. Visual effects used to develop the film occupy about 80 of its 91 minutes.

Narrative Analysis. The crew members of NASA space shuttle, Explorer, on Mission STS-157, are in orbit to service the Hubble Space Telescope and under the command of Matt Kowalski. Ryan Stone, who is aboard her first mission in outer space, is

installing hardware upgrades on the telescope when Mission Control in Houston orders the crew to immediately return to Earth due to approaching space debris. The crew are not able to relocate fast enough, and their communication satellites are destroyed, while both the shuttle and Hubble are struck. Ryan becomes detached from her safety tether and tumbles freely into space. Matt uses a manned maneuvering unit to rescue Ryan, but when they return to the Explorer, they find the rest of the crew dead after the shuttle suffered catastrophic damage. Ryan and Matt use the manned maneuvering unit to travel toward the Internationals Space Station (ISS) that resides nearly 900 miles away.

As they near, they discover that the crew aboard the ISS evacuated in one of its spacecrafts. Unfortunately, the other spacecraft is unable to return to Earth as its parachute prematurely deployed. However, Matt suggests the pair use it to travel toward the Chinese Space Station that resides about 60 miles away in hopes of using the re-entry capsule aboard its spacecraft to return to Earth. As they approach the ISS, the maneuvering unit runs out of air, and they are forced to try and grab onto it, but Matt's leg gets tangled in the spacecraft's parachute cords. Ryan grabs onto a strap on his suit to save him, but Matt soon realizes the cords will not support them both for long. In an effort to save Ryan, he detaches himself from the tether and sacrifices himself. Before he drifts out of communication range, he continues to speak to Ryan and calm her. Once Ryan enters the space station, a fire breaks out, and she hurries back to the spacecraft. As she tries to distance it from the space station, the tangled parachute tethers snag, and she must spacewalk to physically cut the cables. As soon as the two are disconnected, the debris returns as it has completed an orbit, and destroys the ISS.

Ryan positions the space shuttle toward the Chinese Space Station, before discovering it has no fuel. Feeling defeated, she turns off the oxygen in the cabin, and accepts defeat. As Ryan loses consciousness, she imagines that Matt returns and tells her to use the soft-landing rockets to propel the shuttle toward the station. To enter the Chinese Space Station, Ryan must exit the shuttle and use a fire extinguisher to boost herself closer. Finally, she enters the re-entry capsule and as it descends toward Earth, it is damaged by debris and catches fire. Ryan manages to free herself after the capsule lands in a lake, and she takes her first steps back on land.

Thematic Analysis; Technique. *Gravity* is a story of survival. Time after time, Ryan is faced with a new obstacle, yet is able to remain resilient in the face of overwhelming odds. After Matt dies, she becomes extremely isolated as the sole survivor of Mission STS-157 who cannot reestablish contact with Mission Control. This being her first mission in space, she must constantly refer back to her training since navigating space and space shuttle technology is a new phenomenon.

Close Reading. One of the key elements in *Gravity* is the presence of Murphy's law, or the idea that whatever *can* go wrong, *will* go wrong. Every time Ryan narrowly escapes death, she must improvise with her available resources and persevere. Another key element is selfless sacrifice. Matt first risks his life to save Ryan when her tether detaches after the space station is hit with debris. He continuously talks to her to keep her calm and collected as they try to stay alive. Finally, he sacrifices himself to save her when he realizes that the parachute cords are not strong enough to support them both. Even after he knows his death is inevitable, he still manages to keep her calm and talk her through the

next step until he drifts beyond communication range. Without Matt, Ryan would have been dead long ago.

The Martian

Context. Written by Drew Goddard and Andy Weir, and directed by Ridley Scott in 2015, *The Martian* was adapted from the novel written by Andy Weir of the same name. An astronaut becomes stranded on Mars and must utilize his botanist knowledge and spirit to survive on the barren planet while scientists at NASA work to bring him home.

Narrative Analysis. In 2035, a crew of astronauts aboard the Ares III mission to Mars is forced to abort their mission due to an incoming storm. As they evacuate, astronaut and botanist Mark Watney becomes unconscious and lost in the storm after he is struck with debris. Assuming Mark is dead, mission commander Melissa Lewis decides the crew must leave Mark and return to the orbiting vessel, the Hermes. After the storm passes, Mark wakes and makes his way to the crew's surface habitat (Hab) to perform surgery on himself as he must remove a piece of debris lodged in his abdomen. He lacks communication with Earth and realizes that his only chance of being rescued is to travel 2,000 miles to the location where the next Mars mission, Ares IV, will land in four years. Until then, he must increase his food supply. Using his botanist knowledge, Mark creates a suitable environment inside the Hab to grow food by using Martian soil fertilized with his own feces, water he produced by extracting hydrogen from rocket fuel, and potatoes that were part of the crew's original food supply. He also modifies a rover to prepare it for long distance travel.

NASA learns that Mark is still alive when they see satellite images of the rover in different positions. Teddy Sanders, NASA administrator, decides not to tell the Ares III

crew as he does not want to distract them from their journey back to Earth. Meanwhile, Mark is able to uncover the pathfinder probe that fell silent in 1997 and establish communication with NASA. He is told that the Ares III crew is unaware of his survival, and becomes angry, which convinces Teddy to inform them. Vincent Kapoor, director of Mars missions, and Bruce Ng, Jet Propulsion Laboratory director, work with their teams to prepare a space probe capable of delivering food to Mark. To speed up the process, the team skips conducting safety inspections, but the probe fails and explodes shortly after takeoff. Meanwhile, Mark's crops are destroyed when the Hab's airlock malfunctions. Mark fears that his death is inevitable.

Members of China's National Space Administration suggests NASA use their Taiyang Shen, a booster rocket, to provide Mark with sustenance. Rich Purnell, the Jet Propulsion Laboratory's astrodynamicist, proposes sending the Taiyang Shen to Hermes to supply food to the Ares III crew for an extended journey, and then enabling Hermes to gain a gravitational boost to return to Mars and rescue Mark. Teddy rejects the idea because he does not want to put the rest of the crew at risk, but the crew unanimously vote to extend their journey and rescue their stranded comrade.

As Mark prepares to launch the MAV, he must lighten it by removing weight to ensure it reaches Hermes' orbit. Still, it does not ascend high enough. Lewis uses a manned maneuvering unit with a tether but is unable to reach Mark. He decides to puncture a hole in his pressurized suit and propels himself toward Lewis with the escaping air. He is successfully reunited with the rest of the Ares III crew and they return safely to Earth.

Thematic Analysis; Technique. The primary themes in *The Martian* are sacrifice and perseverance. Mark remains calm and motivated and refuses to give up. Even when he

makes a mistake or his efforts fail, he repeatedly assesses the situation and works harder to achieve success. Although at times he feels hopeless, he reminds himself that the greatest minds on Earth are rooting for him and working alongside him to bring him home. The people at NASA make massive budgetary sacrifices to help Mark and dedicate all of their resources to planning his rescue. In addition, the Ares III crew make more personal sacrifices as they effortlessly decide to add 533 unplanned days in space to rescue Mark while understanding that space travel is dangerous, and many unforeseen problems can occur.

Close Reading. The most notable element in *The Martian* is how Mark uses science and limited resources to conquer the foreign, natural world. As the first man stranded on Mars, he is forced to improvise and use innovative techniques to create scientific solutions. He accomplishes the unthinkable, such as growing crops in Martian soil, generating water by extracting hydrogen from rocket fuel, and modifying the technical components of the rover to travel incredible distances.

Rampage

Context. Written by Ryan Engle, Carlton Cuse, Ryan Condal, and Adam Sztykiel, and directed by Brad Peyton, *Rampage* is based on a videogame series by Midway Games. The story involves a primatologist who must partner with a discredited genetic engineer to prevent a global catastrophe after a rogue genetic experiment goes wrong.

Narrative Analysis. Energyne, a gene mutation company, own a space station where they fund scientists to conduct secret research projects. Almost the entire crew is killed when a laboratory rat mutates and destroys the space station. The lone survivor is instructed by Energyne's CEO, Claire Wyden, to recover canisters that contain a pathogen

before she is granted access to the exit doors that lead to the escape pod. The survivor successfully launches the escape pod with the pathogen; however, it implodes and the containers land in different locations. One is swallowed by a crocodile in the Everglades, one is inhaled by wolf in Wyoming, who later is named Ralph, and another is released in an albino gorilla's habitat at a wildlife sanctuary in San Diego. The gorilla, named George, is cared for by primatologist named Davis Okoye and communicated with via sign language. The pathogen causes the animals to grow to enormous size and become increasingly more aggressive.

Davis, who fears for George's safety, is contacted by a genetic engineer named Kate Caldwell who previously worked for Energyne. She informs him that the gene-altering pathogen was created to use as a biological weapon. Kate helped develop the pathogen, however, she was under the impression that it would be used to help cure cancer. Meanwhile, George escapes from captivity. He is captured by a government team and loaded onto a plane. Claire and her brother and business partner, Brett Wyden, order a team of soldiers to kill Ralph. Each soldier is killed during the mission.

Claire, hoping to capture the wolf to extract its DNA and retrieve the pathogen and use George to kill Kate who knows of Energyne's illegal activity, uses a powerful transmitter to lure the animals to Chicago using a radio frequency. The animals aggressively make their way to the city. Davis and Kate, detained by the military, escape by stealing a helicopter, and arrive in Chicago to find Ralph and George destroying the city. All of a sudden, Lizzie, the crocodile, emerges from the water and joins the two in wreaking havoc.

Davis and Kate break into the Energyne headquarters in search of an antidote to cure the mutated animals. In the process, they are caught by the Wyden's, who inform them that the serum only eliminates the animal's aggressive behavior but does not return them to normal size. On the roof, Kate slides a vial of the serum into Claire's purse and pushes her toward George who then eats her, and therefore consumes the antidote. Brett is also killed by falling debris as the building collapses, after unknowingly giving up incriminating information. George, who is back to his normal, gentle self, helps Davis defeat Ralph and Lizzie.

Thematic Analysis; Technique. The central theme in *Rampage* involves the perseverance and heroism required to take down an evil, unethical scientific corporation. The Wyden siblings hurt many people, illegally developed biological weapons, and only cared about money. However, love and determination always win. Davis refused to give up on George, and the team were able to solve the scientific mishap.

Close Reading. The key elements in *Rampage* consist of Davis's favoritism toward animals and the perceived dangers of genetic modification. Davis's relationship with George is endearing throughout the film. Viewers witness and understand that Davis prefers to socialize more with animals than he does people, which adds a comedic element during his interaction with others. In addition, the science used to manipulate genes in the film is seemingly dangerous as the Wyden siblings use genetic modification to produce weapons. The secrecy associated with their work and the unethical decisions they make cast science in a negative light and ultimately, genetic modification is perceived as a threat to animals and humans.

Research Objective Three

Denotative Analysis

To complete the denotative analysis, I developed thematic codes of visual and verbal semiotics by identifying iconic, indexical, and symbolic representations of science within all elements of the raw digital production of the 16 films I analyzed. Nine themes—*innovation, working conditions, unethical decision-making, unusual behavior, egotistical scientist, public distrust, government involvement, comradery, genetic modification danger*—emerged through data analysis (see Table 3). Sub-themes for *innovation* included *genius-level thinking* and *futuristic inventions and equipment*. *Working conditions* included *secrecy, run-down facility,* and *clean lab space* as sub-themes. Furthermore, sub-themes for *unethical decision-making* included *neglecting safety procedures, animal testing,* and *manipulating life* and sub-themes for *unusual behavior* included *antisocial, incapable of love,* and *unhealthy work obsession.* Sub-themes for *egotistical scientist* included *defined by achievement* and *unable to admit fault. Public distrust* contained three sub-themes—*science versus religion, mad scientists,* and *skeptic attitude* Sub-themes for *government involvement* included *funding* and *hidden agenda,* and sub-themes for *comradery* included *sacrifice* and *international support*. Last, *genetic modification danger* did not include any sub-themes. In my descriptions of the emergent themes and sub-themes that follow, the supporting material I provide from films are examples of icons, indices, and symbols that helped construct each emergent theme. The images are examples of icons, and the dialogues are examples of indices or symbols.

Table 3

Themes and Sub-Themes Developed through the Denotative Analysis

Themes	Sub-Themes
Innovation	Genius-Level Thinking Futuristic Inventions and Equipment Unhealthy Work Obsession
Working Conditions	Secrecy Run-Down Facility Clean Lab Space
Unethical Decision-Making	Neglecting Safety Procedures Animal Testing Manipulating Life
Unusual Behavior	Antisocial Incapable of Love Unhealthy Work Obsession
Egotistical Scientist	Defined by Achievement Unable to Admit Fault
Public Distrust	Science Versus Religion Mad Scientists Skeptic Attitude
Government Involvement	Funding Hidden Agenda
Comradery	Sacrifice International Support
Genetic Modification Danger	

Innovation. Not only did scientists in the films I analyzed portray a seemingly unattainable level of intelligence, but they also frequently invented or discovered items that were capable of changing the world. Semiotics supported the *innovation* theme in 16 of the films I analyzed. Sub-themes for *innovation* included *genius-level thinking* and *futuristic inventions and equipment.*

***Genius-Level Thinking*.** Thirty-three indices supported the *genius-level thinking* sub-theme. Scientists in 11 films—*The Fly, Weird Science, Junior, Nutty Professor II: The Klumps, Proof, Hollow Man, Spider Man 2, Gravity, Rampage, Prometheus,* and *The Martian*—were often referred to as brilliant, or spoke about scientific topics in a complex manner that indicated they attained a certain level of intelligence. For example, in *Proof,* Catherine and her father discuss her work in mathematics, and he says to her, "You better get cracking, by the time I was your age I had already done my best work" (Madden, 2005, 5:05:00). Later in the film, when Hal does not believe that Catherine wrote the proof, he says to her, "I know how hard it would be to come up with something like this, I mean you'd have to be your dad at the peak of his powers" (Madden, 2005, 1:05:00). This statement indicates that Catherine's father was superhuman due to his mathematical ability.

In *The Martian,* as Mark contemplates his time on Mars, he says, "I got to figure out a way to grow three years' worth of food here, on a planet where nothing grows. Luckily, I'm a botanist" (Scott, 2015, 21:13:00). As he begins cultivating crops, he says:

> I have created 126 square meters of soil, but every cubic meter of soil requires 40 liters of water to be farmable. So, I gotta make a lot more water. Good thing is I know the recipe. You take hydrogen you add oxygen and burn. (Scott, 2015, 24:47:00)

He then talks through the complicated process of how he will direct energy and successfully create water from leftover rocket fuel. Throughout the film, his scientific brilliance keeps him alive.

***Futuristic Developments and Equipment*.** Thirty-one icons and seven indices supported the *futuristic developments and equipment* sub-theme. In 13 of films I

analyzed—*Altered States, The Thing, The Fly, Weird Science, Mary Shelley's Frankenstein, 12 Monkeys, Junior, Contact, Nutty Professor II: The Klumps, Proof, Hollow Man, Spider Man 2, Prometheus,* and *The Martian*—scientists made ground-breaking inventions or discoveries that seemed futuristic or impossible. For example, in *The Fly,* Seth invented teleportation (see Figure 4), while Gary and Wyatt in *Weird Science* used computer programming to generate a woman. Viktor in *Mary Shelley's Frankenstein* successfully brought the dead to life, and in *12 Monkeys,* scientists used time travel (see Figure 5). In addition, Alex and Larry in *Junior* discovered how to allow a male to carry and birth a child, and Ellie in *Contact* discovered and interacted with aliens. Catherine in *Proof* wrote a revolutionary mathematical proof, and Sebastian in Hollow Man learned how to turn people invisible. Last, Elizabeth and Charlie in *Prometheus* find the creators of mankind, and Mark in *The Martian* inhabits Mars and successfully grows food using Martian soil.

Figure 4

Icon of a Teleportation Pod in The Fly (1986) *Supporting the Innovation Theme and Futuristic Developments and Equipment Sub-Theme (Cronenberg, 1986)*

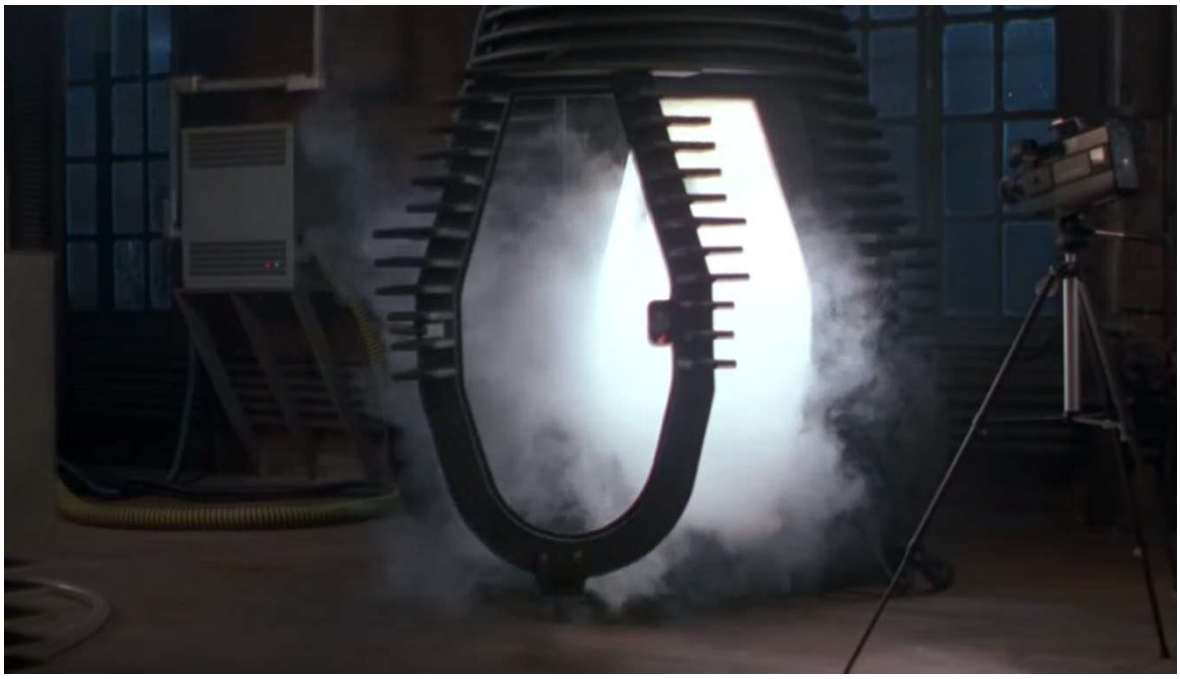
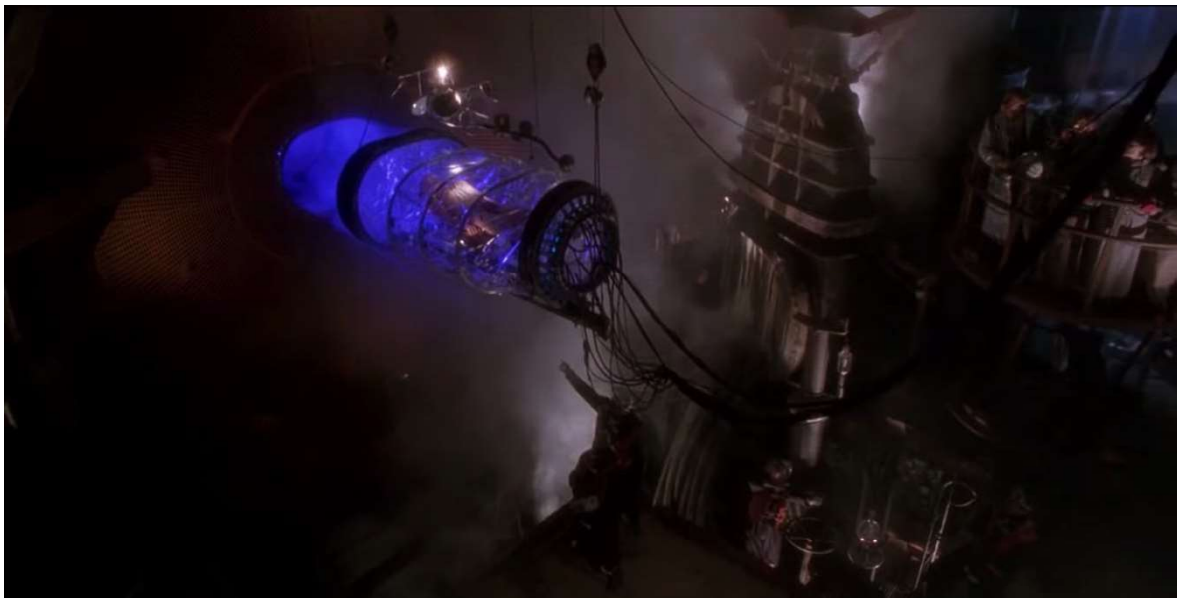


Figure 5

Icon of a Time Travel Machine in 12 Monkeys (1995) *Supporting the Innovation Theme and Futuristic Developments and Equipment Sub-Theme (Gilliam, 1995)*



Working Conditions. Scientists' working conditions varied from maintaining clean, sterile lab space to operating in dark, dirty facilities. Another element involved in scientists' place of work was the secrecy associated with the establishment and location of their work. Semiotics supported this theme in 14 films—*Altered States, The Thing, The Fly, Weird Science, Mary Shelley's Frankenstein, 12 Monkeys, Junior, Contact, Nutty Professor II: The Klumps, Hollow Man, Spider Man 2, Rampage, Prometheus,* and *The Martian.* Sub-themes for *working conditions* included *secrecy, run-down facility,* and *clean lab space.*

Secrecy. One icon and eight indices supported the *secrecy* sub-theme. In seven films, including *The Fly, Weird Science, Mary Shelley's Frankenstein, Contact, Hollow Man,* and *Rampage,* scientists maintained a level of secrecy about their work and the

establishment where they conducted research. For example, in *Hollow Man,* Sebastian arrives to his lab that is heavily guarded with security. The elevator is barred for extra security, and access to the elevator requires a code. The guard asks him if anything special was going on inside because the team arrived unusually early that morning (see Figure 6), and Sebastian smiled and said, "You know the rules" (Verhoeven, 2000, 8:50:00). In *Mary Shelley's Frankenstein,* Waldman takes Viktor and Henry to the private lab he uses to conduct illegal experiments. The dark, eerie workroom contains a severed ape arm that electricity can control. Viktor is fascinated by his inquiries, and says, "Let me help you, professor" (Branagh, 1994, 0:30:01). Waldman replies, "You shall of course tell no one" (Branagh, 1994, 0:30:06). In these examples, not only did the scientists not allow unauthorized individuals into their workspace, but they also kept their projects confidential.

Figure 6

Icon of a Guard Securing the Premises of Sebastian's Lab in Hollow Man (2000)

Supporting the Working Conditions Theme and Secrecy Sub-Theme (Verhoeven, 2000)

Run-Down Facility. Seven icons supported the *run-down facility* sub-theme. Scientists in four films, including *Altered States, The Fly, Mary Shelley's Frankenstein,* and *Spider Man 2* worked in deceiving establishments that one would not typically associate with science (see Figure 7). They were dark, dirty, and unorganized, and they sometimes looked abandoned from the outside. At first, Seth in *The Fly,* Octavius in *Spider Man 2*, and Viktor in *Mary Shelley's Frankenstein* worked in clean, orderly environments. But, as their obsession with work progressed and they rejected friends and loved ones, the quality of their working conditions diminished.

Figure 7

Icon of Viktor Frankenstein's Dark, Dirty, Unorganized Lab in Mary Shelley's Frankenstein (1994) *Supporting the Working Conditions Theme and Run-Down Facility Sub-Theme (Branagh, 1994)*

Clean Lab Space. Thirty-one icons supported the *clean lab space* sub-theme. Scientists in 12 films, including *The Thing, The Fly, Mary Shelley's Frankenstein, 12 Monkeys, Junior, Contact, Nutty Professor II: The Klumps, Hollow Man, Spider Man 2, Rampage, Prometheus,* and *The Martian* all worked in a clean, sanitary environment. Although some scientists' labs deteriorated over time, as stated above, they started well-lit and in good condition. Scientists working in clean lab space typically wore white lab coats and glasses (see Figure 8) and were surrounded by computers, complex machinery, examination tables, and networks of jars, flasks, and tubes containing colorful formulas.

Figure 8

Icon of Alex Hesse's Lab in Junior (1994) *Supporting the Working Conditions Theme and Clean Lab Space Sub-Theme (Reitman, 1994)*

Unethical Decision-Making. Many of the scientific procedures that took place in the films I analyzed involved unethical decisions and practices. I identified the *unethical decision-making* theme in 11 films: *Altered States, The Fly, Weird Science, Mary Shelley's Frankenstein, Junior, Nutty Professor II: The Klumps, Spider Man 2, Gravity, Rampage, Prometheus,* and *The Martian.* Sub-themes for *unethical decision-making* included *neglecting safety procedures, animal testing* and *manipulating life.*

***Neglecting Safety Procedures*.** One icon and 21 indices supported the *neglecting safety procedures* sub-theme. Scientists often neglected to follow safety procedures and protocol and chose to do so knowingly and willingly. For example, in *Nutty Professor II: The Klumps,* Dean Richmond, Sherman's boss, watches Sherman experiment with a dog, and acknowledges that he discovered the "fountain of youth" or a youth formula. He says

"This is unbelievable. We're rich! We're going to have every pharmaceutical company in the world lining up to throw money at us" (Segal, 2000, 10:57:00). Jason, Sherman's student assistant, interrupts and says the drug of course has to be properly tested. The dean, however, tells him to "shut up."

In *Hollow Man*, Sebastian suggests he and his team move on to phase three of their science project, which involves using the invisibility formula on human subjects. Matt yells, "Phase three, are you nuts? You can't just jump into human testing, there are rules, procedures" (Verhoeven, 2000, 24:53:00). Sebastian replies, "You don't make history by following the rules, you make it by ceasing the moment" (Verhoeven, 2000, 24:57:00). Linda chimes in and says, "Moving this fast is bad science, no matter who the guinea pig is" (Verhoeven, 2000, 25:02:00). Fortunately, this example from *Hollow Man* includes several scientists advocating to do the right thing; however, the lead scientist is the one who makes final decisions.

Another example takes place in *The Martian,* when Teddy asks the NASA team how long it will take them to ready the probe that will transport food to Mark. To save time, Teddy makes the decision to cancel the 10-day safety inspection procedures. As a result, the probe fails and explodes. I identified this sub-theme in the following 11 films: *Altered States, The Fly, Weird Science, Mary Shelley's Frankenstein, Junior, Nutty Professor II: The Klumps, Spider Man 2, Gravity, Rampage, Prometheus,* and *The Martian.*

***Animal Testing*.** Nine icons and six indices supported the *animal testing* sub-theme. Animal testing was present in seven films, including *Altered States, The Fly, Mary Shelley's Frankenstein, Junior, Nutty Professor II: The Klumps, Hollow Man* and

Rampage. Some of the experiments conducted on animals showed them being treated with care and compassion. For example, in a scene with a monkey on an examination table in *Junior*, Alex explains to a group of students that the animal suffers from a history of miscarriages, but because of the lab's treatments, she entering her seventh month of a healthy pregnancy. Other times, however, the experiments showed a grim depiction of testing on animals. For example, in *Hollow Man*, Sebastian and his team attempt to regain a gorilla's visibility. The animal writhes in pain and nearly dies, however, the procedure is successful (see Figure 9). In *The Fly*, Seth attempts to teleport a baboon, but the experiment fails, killing the baboon and turning it "inside out." Instead of showing remorse for the dead animal, he only appears to be saddened that his work did not progress.

Figure 9

Icon of Animal Testing in Hollow Man (2000) *Supporting the Unethical-Decision Making Theme and the Animal Testing Sub-Theme (Verhoeven, 2000)*

Similarly, in *Hollow Man,* Sebastian successfully restores a gorilla's visibility, and shortly after announces, "Let's schedule a vivisection for Monday. I want to check her neural pathways" (Verhoeven, 2000, 19:00:00). Sarah replies "You just brought her back and now you're going to slice up her brain?" (Verhoeven, 2000, 19:04:00). Sebastian says angrily in response, "I'm not running a […] zoo alright" (Verhoeven, 2000, 19:06:00). More often than not, the animals were treated poorly and subjected to dangerous experiments.

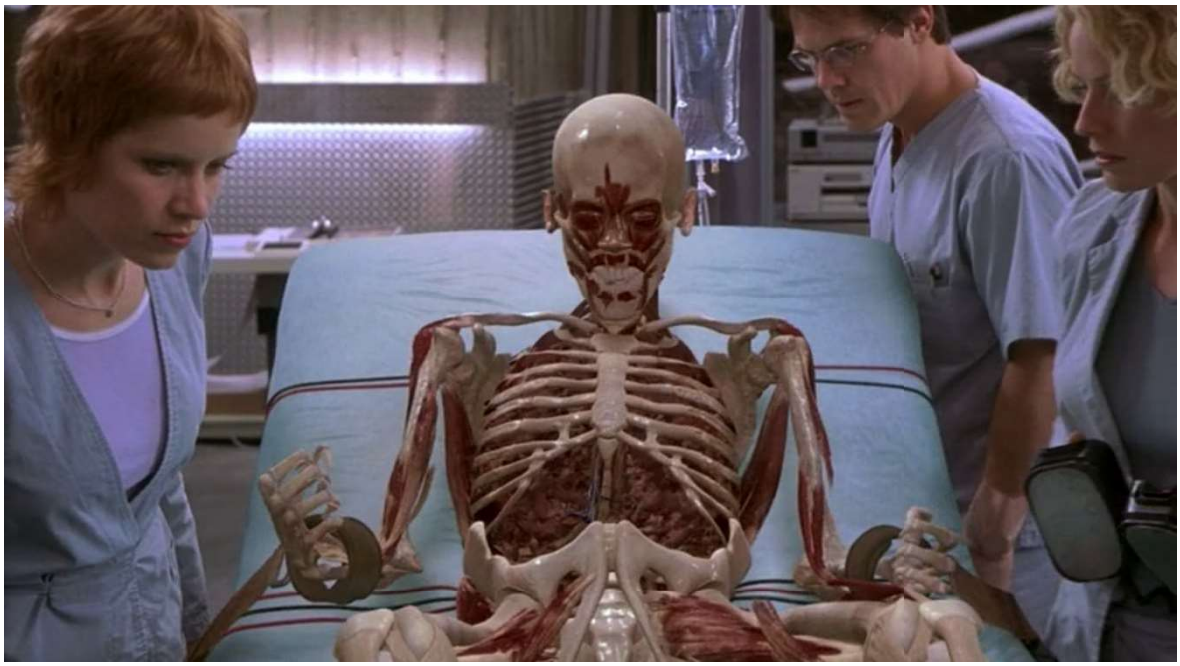
Manipulating Life. Three icons and 20 indices supported the *manipulating life* sub-theme. Scientists in five films—*Weird Science, Mary Shelley's Frankenstein, Junior, Hollow Man,* and *Prometheus* manipulated human or animal life, or created life where is would not naturally exist. For example, in *Weird Science,* Gary and Wyatt create Lisa through computer programming for their own selfish, fantasy-related purposes. Similarly, in *Mary Shelley's Frankenstein,* Viktor attempts to diminish the pain of his mother's death by pursuing a way to conquer death. Using cadavers' body parts, he brings to life a creature—a physical abomination—who feels confused, helpless, and alone in the world (see Figure 10). Furthermore, in *Hollow Man,* Sebastian instructs his team to use him as a test subject in an effort to turn him invisible (see Figure 11). The visibly painful procedure almost kills him but is successful. Sebastian's decision is likely guided by selfish curiosity and a desire to achieve the unknown, although the purpose of the team's government funded invisibility experiments is never conveyed.

Figure 10

Icon of the Creature Victor Frankenstein Created with Cadavers' Body Parts in Mary Shelley's Frankenstein (1994) *Supporting the Unethical-Decision Making Theme and the Manipulating Life Sub-Theme (Branagh, 1994)*

Figure 11

Icon of Sebastian's Invisibility Procedure in Hollow Man (2000) *Supporting the Unethical-Decision Making Theme and the Manipulating Life Sub-Theme (Verhoeven, 2000)*



In the film *Junior,* Alex and Larry also create life unconventionally. As Larry is convincing Alex to use himself in an experiment, he says "We fertilize the egg, we implant it in the perigone cavity, dose it with Expectane, tiny thing, grain of rice, you carry it through the first trimester, we get our data, boom it's over" (Reitman, 1994, 15:08:00). Before Alex became attached to his unborn child, they planned to abort the fetus after collecting enough data to prove the drug safe and effective. Although Alex birthed a healthy child in the end, they created the life in a manner that would have never occurred naturally.

Finally, in *Prometheus,* Peter introduces David to the team through a hologram message as "the closest thing to a son I'll ever have" (Scott, 2012, 16:30:00). He further explains that David is not human; therefore, he will never age and never die. Peter used science to create a life where one should not exist for his own personal agenda. Other examples of scientists manipulating life took place in *Hollow Man* when Sebastian became invisible and in *Prometheus* when viewers learn that Peter only funded the mission so that the Engineers could provide him with immortality.

Unusual Behavior. Scientists in 12 films—*Altered States, The Fly, Mary Shelley's Frankenstein, Junior, Contact, Proof, Hollow Man, Spider Man 2, Gravity, Rampage, Prometheus,* and *The Martian*—portrayed a variety of unusual behavioral characteristics, generating the *unusual behavior* theme. Sub-themes for *unusual behavior* included *antisocial, incapable of love,* and *unhealthy work obsession.*

Antisocial. Three icons and 16 indices supported the *antisocial* sub-theme. Scientists deemed antisocial had a difficult time integrating into social groups or preferred to spend time alone. Some described themselves as lonely, and others made comments about or were told that they did not have a life outside of work. For example, in *Mary Shelley's Frankenstein,* Viktor's mother tells Viktor that there is more to life than just studying. Shortly after, he is seen outside flying kites with others and a woman says, "We should be grateful to Viktor for abandoning his experiments for one afternoon" (Branagh, 1994, 0:14:00). This statement indicates that it is a rare occasion for Viktor to leave his work to spend time with family and friends.

Furthermore, in *Rampage,* Davis tells a woman named Amy that he was unable to get a drink with her later that night. Nelson is shocked, and as a justification for his

decision, Davis says “I need my me time” (Peyton, 2017, 0:12:00). Davis proceeds to explain that he prefers to spend time with animals as opposed to people because he feels they understand him. Finally, in *Hollow Man,* Linda asks Sarah if she is sure she can take the night shift to monitor Sebastian when he first became invisible. Sarah replies, “Yes, it’s not like I have a social life anymore” (Verhoeven, 2000, 38:09:00). Linda ends the conversation with, “I know, the workaholics’ curse” (Verhoeven, 2000, 38:15:00). This interaction directly indicates that due to their work schedules and commitment, the two scientists lack a social life. I identified this sub-theme in eight films—*Altered States, The Fly, Mary Shelley’s Frankenstein, Junior, Contact, Hollow Man, Gravity,* and *Rampage.*

Incapable of Love. Four indices supported the *incapable of love* sub-theme. The only movie that portrayed a scientist as being incapable of love was *Altered States.* Edward committed himself to Emily, a biological anthropologist, because he felt as though that was the normal thing to do, not because he felt lovingly toward her. For example, when he and Emily discuss marriage, he tells her, “OK we’ll get married, I don’t want to lose you” (Russell, 1980, 15:24:00). Emily says in response, “That’s the closet thing I’ll get to a love declaration out of you” (Russell, 1980, 15:33:00). Later in the film, when they contemplate divorce, Edward tells his friend:

> She insists she’s in love with me whatever that is. What she means is she prefers senseless pain we inflict on each other to the pain we would otherwise inflict on ourselves. But I’m not afraid of that solitary pain. (Russell, 1980, 23:04:00)

In addition, Edward’s engagement with his two children was minimal. He loved his work but was unable to show similar feelings toward the people closest to him.

Unhealthy Work Obsession. One icon and 32 indices supported the *unhealthy work obsession* sub-theme. Scientists in 11 films—*Altered States, The Fly, Mary Shelley's Frankenstein, Junior, Contact, Proof, Hollow Man, Spider Man 2, Rampage, Prometheus,* and *The Martian*—all seemingly had an unhealthy obsession with their work. In *The Fly*, for example, as Seth slowly transforms into a physical fly, he seems nothing but fascinated with his new bodily functions. Although he can no longer be seen in public and ultimately sacrificed every 'normal' element of human life, he continues studying himself excitedly and neglects all social implications. In *Mary Shelley's Frankenstein,* Viktor's friend Henry informs Viktor that the city is being quarantined due to a deadly cholera outbreak, but Viktor refuses to leave. He simply tells Henry to leave without him and proceeds to work. Among other work-obsessive traits Viktor depicts throughout the film, this particular incident indicated that he would not hesitate to die for his work.

Similarly, in the film *Contact,* Palmer and Ellie discuss the implications of journeying to Vega, and the extremely low chances of survival. Ellie explains that she fully understands the risk but deems it necessary given the historic opportunity. Palmer asks her, "By doing this, you're willing to give your life; you're willing to die for it. Why?" (Zemeckis, 1997, 1:21:00). She responds by saying that she has been searching for answers regarding the purpose and origin of mankind her entire life and the presented journey might provide her with answers. Therefore, it is worth a human life. Additionally, in the film *Prometheus,* David asks Charlie, "How far would you go to get what you came all this way for? Your answers? What would you be willing to do?" (Zemeckis, 1997, 53:16:00). Charlie says in response, "Anything and everything" (Zemeckis, 1997, 53:23:00). These

indices indicate that the scientists in the films described would let nothing stop them from finding answers and fulfilling their life's work.

Another prominent element of the *unhealthy work obsession* sub-theme consisted of people observing the scientists using the word 'obsessed' to describe them in relation to their work. For example, in *Mary Shelley's Frankenstein,* Viktor is told "You're completely obsessed" (Branagh, 1994, 0:13:23) as he uses science to generate energy. In *Contact,* Kent Clark, an astrophysicist, describes a conversation he once had with someone about Ellie who said she was "Obsessed with a field of study that he considers […] professional suicide" (Zemeckis, 1997, 10:00:00). Therefore, not only did semiotics depict scientists acting in an obsessive manner toward their work, but they were also blatantly told that they were obsessed. Indices primarily supported the *unhealthy work obsession* sub-theme; however, I identified several support icons as well. For example, Diana in *Junior* fell asleep at her computer and spent the night at work (see Figure 12), indicating she was exhausted from working too much.

Figure 12

Icon of Diana Reddin Sleeping in her Lab in Junior (1994) *Supporting the Unusual Behavior Theme and Unhealthy Work Obsession Sub-Theme (Reitman, 1994)*

Egotistical Scientist. Scientists in the 10 films—*Altered States, The Thing, The Fly, Mary Shelley's Frankenstein, 12 Monkeys, Proof, Hollow Man, Spider Man 2, Gravity,* and *Prometheus*—sometimes appeared arrogant and demonstrated themselves to be over-confident in their scientific ability. Sub-themes for *egotistical scientist* included *defined by achievement,* and *unable to admit fault.*

Defined by Achievement. Four indices and four symbols supported the *defined by achievement* sub-theme. In all of the films I analyzed, scientists strived to achieve greatness. But sometimes, their achievements defined who they were and represented their value and self-worth. For example, in *The Fly,* Seth says "Interestingly, at the exact same moment I achieved what will probably prove to be my life's work—that's the moment I

start being the real me finally" (Cronenberg, 1986, 44:32:00). In several films, characters compared themselves to some of the greatest scientists of all time. In *Spider Man 2,* Otto's wife tells him he needs a restful night's sleep before he presents his work the next day. He says to her in response, "Did Edison sleep before he turned on the light? Did Marconi sleep before he turned on the radio?" (Raimi, 2004, 20:57:00). Similarly, in *Hollow Man,* Sebastian calls Linda in the middle of the night after he cracked reversion. She says, "Sebastian, do you have any idea what time it is?" He responds, "DaVinci never slept, said it was a waste of time" (Verhoeven, 2000, 5:38:00). In his response, Sebastian compared himself to one of the greatest scientists of all time, indicating sleep inhibits one from achieving greatness because it takes time away from work.

Scientists in several films also mentioned winning a Nobel Prize—one of the most significant scientific accomplishments. For example, in *The Fly,* when Seth accepts his genetic transformation, he says:

> I seem to be stricken by a disease with a purpose, wouldn't you say? May not be such a bad disease after all. I'm becoming something that never existed before. Don't you think that's worth a Nobel Prize or two? (Cronenberg, 1986, 1:08:00)

Similarly, in *Hollow Man,* Sebastian makes a comment as he is working about calling the Nobel committee to get his prize ready. Scientists in the films often considered their research to involve some of the most important scientific breakthroughs in history. Semiotics existed to support this sub-theme in the following six films: *The Thing, The Fly, Mary Shelley's Frankenstein, Junior, Spider Man 2,* and *Prometheus.*

Unable to Admit Fault. Eight indices supported the *unable to admit fault* sub-theme. Scientists in five films—*Altered States, The Fly, Mary Shelley's Frankenstein, 12*

Monkey's, and *Gravity* allowed their arrogance to result in stubborn behavioral traits, including the inability to admit fault. For example, in *12 Monkeys,* James returns to 2035 and tells scientists they sent him to the wrong year. To deflect blame, they act as if it were impossible that they made a mistake, and one scientist assumed James wasted his time in the past on drugs and women and, therefore, could not remember correctly.

In *Spider Man 2,* Parker asks Otto if he is sure he can stabilize the fusion reaction. Octavius says "This is my life's work. I certainly know the consequences of the slightest miscalculation" (Raimi, 2004, 20:30:00). Sure enough, he is unable to stabilize the fusion reaction, which starts a disastrous chain of events. His system reads 'unstable' and people are told to evacuate. The crowd runs screaming and Harry yells at Otto to shut off the fusion reaction. Still, Otto refuses, and when Spider Man attempts to pull the plug, Otto pushes him away. Within seconds, his wife is killed, all because he was unable to admit he made a mistake. Last, in *Gravity,* as Ryan is attempting to fix a problem with the telescope, people at Mission Control tell her through her headset, "Engineering admits you warned us that this could happen. But that's as close to an apology as you're going to get from them. We should have listened to you, doc" (Cuarón, 2013, 5:16:00). In this instance, responsible parties admitted fault to some extent, but did so in a stubborn manner.

Public Distrust. A variety of characters in eight films, including *Altered States, The Thing, The Fly, Mary Shelley's Frankenstein, 12 Monkeys, Contact, Proof, Hollow Man,* and *Prometheus* showed distrust toward science and scientists. Several characters did not trust science because of their religious beliefs, while others did not trust scientists because they considered them crazy and often displayed their unsupportive feelings in

public for others to see. Sub-themes for *public distrust* included *science versus religion, mad scientists,* and *skeptic attitude.*

Science Versus Religion. Eighteen symbols supported the *science versus religion* sub-theme. The disconnect between science and religion was evident in six films—*Altered States, Mary Shelley's Frankenstein, 12 Monkeys, Contact, Hollow Man,* and *Prometheus*. In *Contact,* the division appeared most severe. For example, Palmer tells Ellie about the first time he experienced God, and she questioned if he had the experience just because he "needed" to have it. In this conversation, Ellie depicted the skepticism and disbelief that some scientists harbor toward God's existence.

During one scene in the film, Palmer is criticized as being a man "on the crusade about the evils of technology" (Zemeckis, 1997, 15:00:00), indicating that, because he is religious, he is unsupportive of science. Palmer defends himself by saying that he is not against science but is against scientists who use science "at the expense of human truth" (Zemeckis, 1997, 15:03:00). Several more events broaden the gap between religion and science later in the film. In one scene, a religious activist is heard saying to a group of thousands:

> They had their chance. But they have failed. It's the same people who again and again have brought us to the brink of destruction; who have polluted our air; who poisoned our water. Now these scientists had their chance. Are these the kind of people that you want talking to your God for you? (Zemeckis, 1997, 58:40:00)

In another scene, Ellie and Palmer continue their science-religion debate. Ellie says to him, "It's like you're saying that science killed God. What if science simply revealed

that he never existed in the first place?" (Zemeckis, 1997, 1:13:00). She proceeds to ask him if he has heard of Aikman's Razor, "a basic scientific principle," then explains:

> All things being equal, the simplest explanation is the right one. So, what's more likely, an all-powerful mysterious God created the universe and then decided not to give any proof of his existence, or that he simply doesn't exist at all, and that we created him so that we wouldn't have to feel so small and alone? (Zemeckis, 1997, 1:16:00)

Although an amicable, constructive conversation, Ellie and Palmer divide the two entities so severely that they make it seem as though one cannot support both science and religion simultaneously.

Sometimes, religion was used as a metaphor to describe science figuratively. For example, in *Mary Shelley's Frankenstein,* when Henry explains to Viktor who Waldman is, he says "They say in his youth he could break into heaven and lecture God on science" (Branagh, 1994, 0:24:50). This phrase is meant to convey Waldman's brilliance and his ability to effectively teach even those who represent and uphold differing principles. In *12 Monkeys,* Kathryn admits she is in trouble when she believes James could be telling the truth. She realizes that, although what he says seems impossible, it might not be. She says to a colleague, "And what we say is the truth is what everyone accepts, right Owen? I mean psychiatry, it's the latest religion. We decide what's right and wrong; we decide who's crazy or not" (Gilliam, 1995, 1:23:00). In this statement, Kathryn uses religion to discredit psychiatry as a scientific field.

***Mad Scientists*.** Sixteen indices supported the *mad scientist's* sub-theme. As noted above, mad scientists are the most well represented portrayal of scientists within films in

Western culture. They are depicted as evil, dangerous, and insane. In the context of my analysis, however, this sub-theme represented occasions in the films when members of the non-science community referred to scientists as crazy, weird, nuts, or another similar term or phrase. On occasion, the scientists would refer to themselves in such a manner as well. This occurred in six films, including *Altered States, The Thing, Mary Shelley's Frankenstein, 12 Monkeys, Contact,* and *Proof.* In *Altered States*, for example, Edward is referred to as "a little nuts but brilliant," a "wacko," a "mad man," and a "foust freak." Similarly, during a scene in *Contact*, Ellie refers to herself as "nuts." In *Spider Man 2*, the newspaper's editor brainstorms headlines for the story about Otto's experiment. He says, "Crazy scientist turns himself into some kind of monster. Four mechanical arms welded right onto his body. Guy named Otto Octavius winds up with eight limbs. What are the odds?" (Raimi, 2004, 43:20:00). Finally, in *Proof*, Catherine tells her professor, "Not all the mathematicians in my family are crazy" (Madden, 2005, 51:07:00). In this particular instance, she is referring to her father who suffered from declining mental health; therefore, the context here is interpreted differently than in previous examples.

Skeptic Attitude. Two icons and 16 indices supported the *skeptic attitude* sub-theme. Characters in the films who were disconnected from science often showed or voiced their distrust toward science and scientists. For example, in *Mary Shelley's Frankenstein,* Waldman attempts to vaccinate a member of the community, who aggressively refuses. Waldman tries to explain that the vaccination is a necessary precaution, but the man will not listen. He stabs and kills Waldman (see Figure 13), and as he prepares to be hung, he yells toward the crowd that doctors are killers and murder people. This instance was a particularly grim depiction of the public fearing science, and

the source of fear—vaccinations—is still a relevant scientific debate today. In *12 Monkeys,* a video about animal cruelty in medical research plays on a television in the mental institution, and Jefferey yells "We're all monkeys!" (Gilliam, 1995, 30:23:00), indicating that he does not trust scientists or their research.

Figure 13

Icon of Man Stabbing and Killing Waldman Due to Fear of Being Vaccinated in Mary Shelley's Frankenstein (1994) *Supporting the Public Distrust Theme and Skeptic Attitude Sub-Theme (Branagh, 1994)*

Finally, in *Contact,* Ellie gives a presentation to stakeholders in hopes of receiving funding, and they refer to her line of work as "science fiction" instead of "science." They blatantly discredit her work because they do not understand it. Semiotics existed to support the *skeptic attitude* sub-theme in six films, including *The Fly, Mary Shelley's Frankenstein, 12 Monkeys, Contact, Proof,* and *Prometheus.*

Government Involvement. Different government agencies played a fundamental role in five of the films I analyzed: *The Thing, Junior, Contact, Prometheus,* and *The Martian*. In these films, the government either provided funding for scientists to conduct research or characters working for the government assumed covert involvement. Sub-themes for *government involvement* included *funding* and *hidden agenda.*

Funding. Eight indices supported the *funding* sub-theme. Scientists in three films—*Junior, Contact,* and *The Martian*—either sought or received money from governmental agencies. For example, in *Junior,* Alex meets with the Food and Drug Administration seeking to renew is funding for Expectane. In *Contact,* David, the president's science adviser, informs Ellie and Clark that he is pulling their funding. It is unclear the particular source of funding referenced, but given David's position as the president's science adviser, it clearly comes from the government. In another instance that occurred in *The Martian,* Teddy says "Congress won't reimburse us for a paperclip if I put a dead astronaut on the front page of the Washington Post" (Scott, 2015, 30:24:00). Although NASA is a government agency in itself responsible for science and technology in space, this statement indicates further involvement within other governmental sectors. As another example in *Hollow Man,* Sebastian lies to what appears to be a funding agency by telling a board he has yet to successfully bring an animal back from being invisible. As he and Linda leave the meeting, she tells him, "You just lied to the […] Pentagon" (Verhoeven, 2000, 24:41:00), and confirms their project is government funded.

Hidden Agenda. Six indices supported the *hidden agenda* sub-theme. In five films, including *The Thing, Contact, Hollow Man, Rampage,* and *Prometheus,* characters believed that the government was involved in top-secret scientific missions. For example,

in *The Thing,* several of the scientists reflect on their experience with the alien creature, and one of them says they do not believe in "voodoo." Another researcher says in response, "It happens all the time, man, they're falling out of the skies like flies; government knows all about it" (Carpenter, 1980, 41:09:00). During a scene in *Hollow Man,* one scientist says, "Imagine what the world is going to be like when the military gets their hands on this" (Verhoeven, 2000, 43:38:00) in reference to their discovery capable of turning human beings invisible.

As another example, during *Rampage,* Davis and Kate ask a man named Harvey who employs him, and he says the OGA—Other Government Agency. He says, "You see, when science […] the bed, I'm the guy they call to change the sheets" (Peyton, 2017, 0:38:20), indicating that a secret government agency is dedicated to cleaning up scientific endeavors that go sideways. Finally, in *Prometheus*, Janek says to Elizabeth, "Those Engineers, this ain't there home. It's an installation. Maybe even military. And they put it out here in the middle of nowhere because they're not stupid enough to make weapons of mass destruction on their own doorstep" (Scott, 2012, 1:31:00). Janek initially thought of the military because he associated that entity with weapons of mass destruction and secrecy.

Comradery. In five films—*Contact, Nutty Professor II: The Klumps, Proof, Gravity,* and *The Martian*—an alliance was evident between scientists that showed they care for and support other members of the scientific community. Sub-themes for *comradery* included *sacrifice* and *international support.*

Sacrifice. Eight indices supported the *sacrifice* sub-theme. In four films, including *Nutty Professor II: The Klumps, Proof, Gravity* and *The Martian,* scientists made sacrifices

for fellow scientists. Sometimes, scientists paid the ultimate price for their colleagues. For example, in *Gravity* when debris strikes the shuttle and Ryan becomes detached, Matt risks his life by using the MMU to navigate freely through space to save her. Later in the film, he sacrifices his life in order to save Ryan's. In *The Martian,* the Hermes crew discusses whether or not they want to defy NASA's orders and return to Mars to rescue Mark. They acknowledge the risks of making the decision, including the possibility of numerous deadly mistakes that could be made, adding 533 days to their mission, being court marshalled, never being allowed to return to space, and having to wait longer to be reunited with their families. Still, the crew makes a unanimous vote to save Mark.

International Support. Three indices supported the *international support* sub-theme. Two films—*Contact* and *The Martian*—depicted scientists receiving help from other scientists overseas. Even when no personal relationship existed, scientists from afar sometimes offered assistance to other scientists in need.

For example, in *The Martian,* after NASA's supply probe failed, a woman at the Chinese space program says to her male colleague, "The Taiyang Shen booster. Our engineers have run the numbers, and [the booster] has enough fuel for a Mars injection orbit" (Scott, 2015, 1:19:00). The man replies, "Why hasn't NASA approached us?" (Scott, 2015, 1:22:00). She says "They don't know. Our booster technology is classified" (Scott, 2015, 1:25:00). He responds, "So, if we do nothing?" (Scott, 2015, 1:27:00). She says, "The world would never know we could have helped" (Scott, 2015, 1:29:00). He continues the conversation with, "For the sake of argument, let's say we decide to help them" (Scott, 2015, 1:32:00). She answers, "We'd be giving up a booster and effectively cancelling Taiyang Shen" (Scott, 2015, 1:35:00). Without hesitation, he says, "We need to

keep this among scientists, a co-operation between space agencies" (Scott, 2015, 1:38:00). By sacrificing their own project, the Chinese Space Station offers their equipment and technology to help NASA. Last, in *Contact,* Ellie is shown communicating with scientists in Australia via a video call, further indicating international support within the scientific community.

Genetic Modification Danger. Scientific experiments in two films—*Nutty Professor II: The Klumps* and *Rampage*—involved genetically modifying people or animals, which resulted in disaster. *Genetic modification danger* did not include any sub-themes.

For example, in *Nutty Professor II: The Klumps,* Sherman impulsively removes a gene from his DNA sequence and gradually loses his intelligence. In *Rampage,* a message at the beginning of the film reads:

> In 1993, a breakthrough new technology, known as CRISPR, gave scientists a path to treat incurable diseases through genetic editing. In 2016, due to its potential for misuse, the U.S. Intelligence Community designated genetic editing a 'Weapon of Mass Destruction and Proliferation.' (Peyton, 2017, 0:0:36)

As *Rampages* progresses, evidence of genetic modification being deadly is prominent. For example, as the scientist in the beginning scene attempts to flee the destroyed spaceship, viewers see the mutated rat that was part of an experiment using the pathogen. The animal's genes were manipulated, which resulted in abomination (see Figure 14). Later, the pathogen has the same devastating effect on George the gorilla; Ralph, the wolf; and Lizzie, the crocodile. In one scene, Davis is holding the container that the pathogen once resided in, and Kate says, "Please tell me you had that tested for residual particulates?"

(Peyton, 2017, 24:49:00). Her statement suggests that the formula capable of genetically modifying organisms can negatively affect humans as well.

Figure 14

Icon of a Mutated Rat Resulting from Genetic Engineering in Rampage (2017) *Supporting the Genetic Modification Danger Theme (Peyton, 2017)*

Research Objective Four

Quantitative Analysis of Identified Signs Within Themes

I identified 335 signs—90 iconic, 224 indexical, and 21 symbolic—that contributed to the emergent themes in research objective three. The number and type of sign varied per film and, therefore, supported each theme differently.

Innovation was the most prevalent theme, present in all 16 films and supported by 31 icons and 40 indices. The second most prevalent theme was *working conditions,* which I identified in 14 films. *Working conditions* was supported by 39 icons and eight indices. *Unethical decision-making* and *unusual behavior* were both present in 12 films. *Unethical decision-making* was supported by 13 icons and 47 indices, and *unusual behavior* was

supported by four icons and 52 indices. I identified *egotistical scientist* in 10 films, supported by 12 indices and four symbols, and I identified *public distrust* in nine films, supported by two icons, 32 indices, and 18 symbols. In addition, I identified *government involvement* in six films, supported by 14 indices. Last, I identified *comradery* in five films, supported by 11 indices and *genetic modification danger* in two films, supported by one icon and six indices.

If prevalence was based on the number of signs associated with emergent themes, *innovation* would still be the most prevalent supported by 71 signs, followed by *unethical decision-making* supported by 60 signs and *unusual behavior* supported by 56 signs. *Public distrust* would be the fourth most prevalent theme supported by 52 signs, followed by *working conditions* with 47 signs, *government involvement* with 14 signs, and *egotistical scientist* supported by 16 signs. *Comradery* was supported by 11 signs, followed by *genetic modification danger*, which was supported by eight signs.

Indices were the most common type of sign present in the films I analyzed. Icons had to be physically depicted. Therefore, unless a sign was visually present (e.g., clean lab space, animal being used for testing purposes) then it could be not deemed as iconic. In addition, symbols must be culturally learned. Therefore, the only signs that I interpreted as symbolic involved religion and supported the *science versus religion* sub-theme or involved the Nobel Prize and supported the *defined by achievement* sub-theme. Culturally, religious connotations must be learned as must the value and level of achievement associated with winning the Nobel Prize. I categorized all other signs as indices because their presence indicated something that was not physically seen and was not culturally learned. Seven themes included more than one type of sign. For example, when animal

testing was shown, I deemed it an icon, and when it was verbally mentioned or discussed, I categorized it as an index. Table 4 depicts a quantitative analysis of the number of films emergent themes were identified in and the number of signs supporting each theme, Figure 15 contains a quantitative analysis of the types of sign supporting the emergent themes, and Table 5 contains a quantitative analysis of the types of sign supporting the themes and sub-themes present in each film.

Table 4

Quantitative Analysis of the Number of Films Emergent Themes were Identified in and the Number of Signs Supporting Each Emergent Theme

		Type of Sign			
Theme	Identified in Films	Icon	Index	Symbol	Total
Innovation	16	31	40		71
Working Conditions	14	39	8		47
Unethical Decision-Making	12	13	47		60
Unusual Behavior	12	4	52		56
Egotistical Scientist	10		12	4	16
Public Distrust	9	2	32	18	52
Government Involvement	6		14		14
Comradery	5		11		11
Genetic Modification Danger	2	2	6		8

Figure 15

Quantitative Analysis of the Signs Supporting Each Emergent Theme

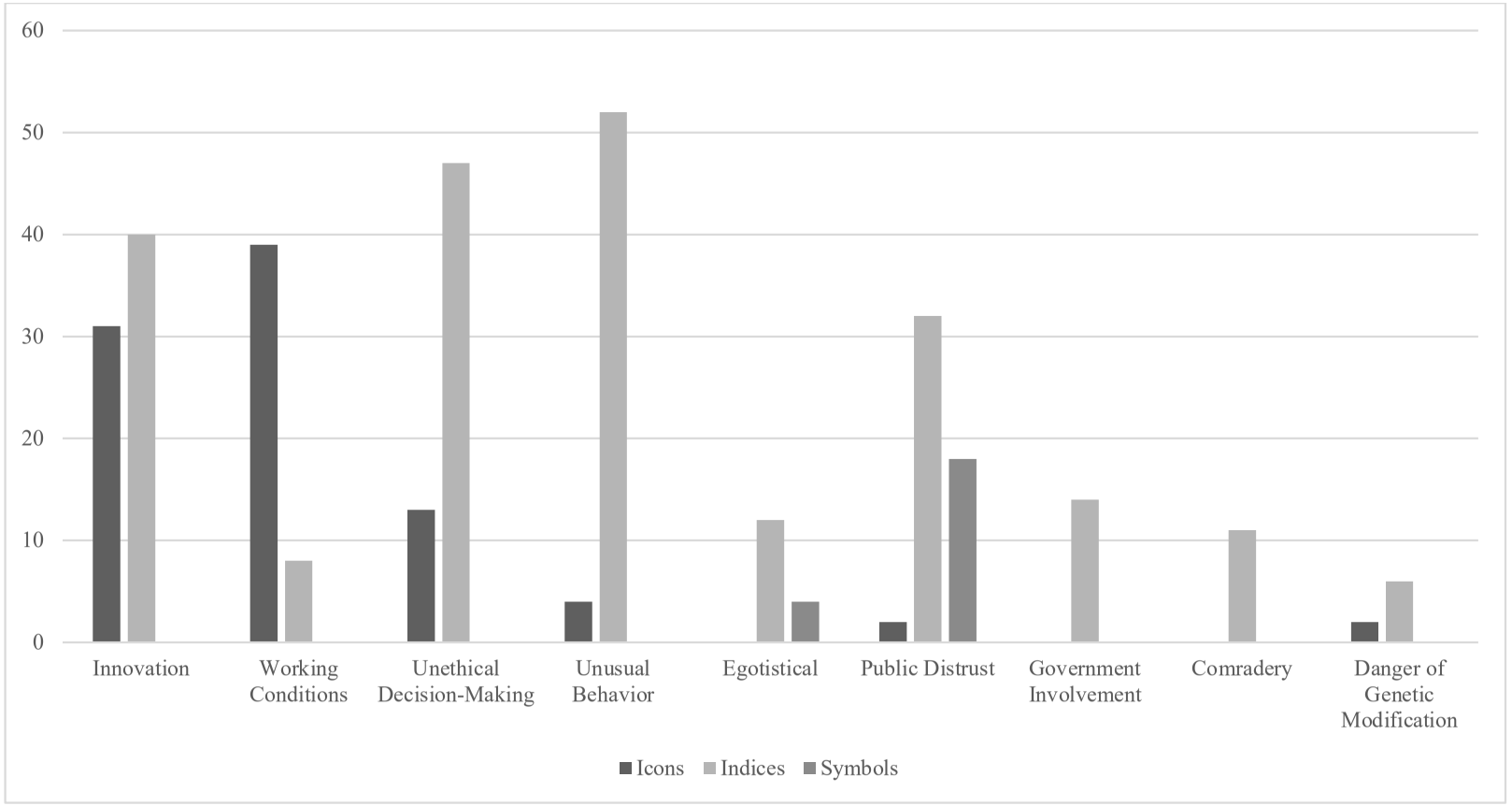


Table 5

Quantitative Analysis of Sign Types Supporting Each Emergent Theme and Sub-Theme in Films

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
Altered States	Unusual Behavior	Antisocial	1	4	
		Incapable of Love		4	
		Unhealthy Work Obsession		5	
	Egotistical Scientist	Unable to Admit Fault		1	
	Unethical Decision-making	Neglecting Safety Procedures		3	
		Animal Testing		1	
	Public Distrust	Science versus Religion			4
		Mad Scientists		8	
	Working Conditions	Run-down facility	2		
	Innovation	Genius-level Thinking		2	
The Thing	Egotistical Scientist	Defined by Achievement			1
	Public Distrust	Mad Scientists		2	
	Government Involvement	Hidden Agenda		1	
	Working Conditions	Clean Lab Space	1		
	Innovation	Futuristic Developments and Equipment	4		

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Unusual Behavior	Unhealthy Work Obsession		2	
	Egotistical Scientist	Defined by Achievement			1
		Unable to Admit Fault		1	
	Unethical Decision-making	Neglecting Safety Procedures		2	
		Animal Testing	2		
	Public Distrust	Skeptic Attitude		2	
	Working Conditions	Secrecy		1	
		Run-down Facility	1		
		Clean Lab Space	1		
	Innovation	Genius-level Thinking		1	
		Futuristic Developments and Equipment	3		
Weird Science	Unethical Decision-making	Neglecting Safety Procedures	1		
		Manipulating Life	1	1	
	Working Conditions	Secrecy		1	
	Innovation	Genius-level Thinking		2	
		Futuristic Developments and Equipment	1	1	
Mary Shelly's Frankenstein	Unusual Behavior	Antisocial		4	
		Unhealthy Work Obsession	1	4	

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Egotistical Scientist	Unable to Admit Fault		1	
	Unethical Decision-making	Neglecting Safety Procedures		3	
		Animal Testing	1		
		Manipulating Life		6	
	Public Distrust	Science versus Religion			1
		Mad Scientists		1	
		Skeptic Attitude		3	
	Working Conditions	Secrecy	1		
		Run-down Facility	3		
		Clean Lab Space	1		
	Innovation	Futuristic Developments and Equipment	3	1	
12 Monkeys	Egotistical Scientist	Unable to Admit Fault		1	
	Public Distrust	Science versus Religion			1
		Mad Scientists		1	
		Skeptic Attitude		5	
	Working Conditions	Clean Lab Space	2		
	Innovation	Futuristic Developments and Equipment	2	1	
Junior	Unusual Behavior	Antisocial		5	
		Unhealthy Work Obsession		2	

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Unethical Decision-making	Neglecting Safety Procedures		3	
		Animal Testing		1	
		Manipulating Life		6	
	Government Involvement	Funding		3	
	Working Conditions	Clean Lab Space	8		
	Innovation	Genius-level Thinking		1	
		Futuristic Developments and Equipment	2		
Contact	Unusual Behavior	Antisocial	2		
		Unhealthy Work Obsession		4	
	Public Distrust	Science versus Religion			8
		Mad Scientists		1	
		Skeptic Attitude	2	6	
	Government Involvement	Funding		3	
		Hidden Agenda		2	
	Working Conditions	Secrecy		2	
		Clean Lab Space	2		
	Innovation	Futuristic Developments and Equipment	5	1	
	Comradery	International Support		2	

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Unethical Decision-Making	Animal Testing	2		
	Genetic Modification Danger			2	
	Working Conditions	Clean Lab Space	2		
	Innovation	Genius-level Thinking		1	
		Futuristic Developments and Equipment		1	
	Comradery	Sacrifice		1	
Proof	Unusual Behavior	Unhealthy Work Obsession		5	
	Egotistical Scientist	Defined by Achievement		1	
	Public Distrust	Mad Scientists		3	
		Skeptic Attitude		2	
	Innovation	Genius-level Thinking		6	
		Futuristic Developments and Equipment		2	
	Comradery	Sacrifice		1	
Hollow Man	Unusual Behavior	Antisocial		1	
		Unhealthy Work Obsession		2	
	Egotistical Scientist	Defined by Achievement		1	1

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Unethical Decision-Making	Animal Testing	3	1	
		Manipulating Life	2	3	
	Public Distrust	Science versus Religion			2
	Working Conditions	Secrecy		2	
		Clean Lab Space	4		
	Innovation	Genius-level Thinking		5	
		Futuristic Developments and Equipment	2		
Spider Man 2	Unusual Behavior	Unhealthy Work Obsession		3	
	Egotistical Scientist	Defined by Achievement		1	1
		Unable to Admit Fault		3	
	Unethical Decision-making	Neglecting Safety Procedures		1	
	Working Conditions	Run-down Facility	1		
		Clean Lab Space	2		
	Innovation	Genius-level Thinking		2	
		Futuristic Developments and Equipment	3		
Gravity	Unusual Behavior	Antisocial		1	
	Egotistical Scientist	Unable to Admit Fault		1	

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Innovation	Genius-level Thinking		4	
	Comradery	Sacrifice		3	
Rampage	Unusual Behavior	Antisocial		1	
		Unhealthy Work Obsession		2	
	Unethical Decision-making	Neglecting Safety Procedures		1	
		Animal Testing	1	3	
	Government Involvement	Hidden Agenda		2	
	Genetic Modification Danger		1	4	
	Working Conditions	Secrecy		2	
		Clean Lab Space	3		
	Innovation	Genius-level Thinking		1	
Prometheus	Unusual Behavior	Unhealthy Work Obsession		2	
	Egotistical Scientist	Defined by Achievement		1	
	Unethical Decision-making	Neglecting Safety Procedures		4	
		Manipulating Life		4	
	Public Distrust	Science versus Religion			1

Table 5 (continued)

Film	Theme	Sub-Theme	Type of Sign		
			Icon	Index	Symbol
	Government Involvement	Hidden Agenda		1	
	Working Conditions	Clean Lab Space	2		
	Innovation	Genius-level Thinking		1	
		Futuristic Developments and Equipment	5		
The Martian	Unusual Behavior	Unhealthy Work Obsession		1	
	Unethical Decision-making	Neglecting Safety Procedures		4	
	Government Involvement	Funding		2	
	Working Conditions	Clean Lab Space	3		
	Innovation	Genius-level Thinking		7	
		Futuristic Developments and Equipment	1		
	Comradery	Sacrifice		3	
		International Support		1	

Research Objective Five

Connotative Analysis

To achieve research objective four, I conducted a connotative analysis of the denotative features of science and scientists in the films I analyzed. Thus, to complete the connotative analysis, I described how I believe people are likely to interpret or gain meaning from the emergent themes identified in research objective three. I created the headings that follow in this section to categorize the overarching ideas based on my interpretation of how viewers of science fiction films might learn from cinematic depictions of science.

Scientists Versus Society. The *unusual behavior, innovation,* and *working conditions* themes likely cause viewers of science fiction films to believe that scientists are not normal or average people. The antisocial, obsessive, and brilliant qualities that scientists portray in the films could cause viewers to believe that scientists are a rare breed and that few people are capable of becoming a scientist.

Representations of scientists in films create a divide between scientists and members of society. It appears that scientists' values differ from those held by non-scientists. Gallup Inc. reported in 2013 that only 30% of the U.S. workforce is committed to their work, meaning they feel passionate about their job and a sense of devotion toward their company (as cited in Weir, 2013). The other 70% of the workforce, however, are actively disengaged with their work (Weir, 2013). Given that most scientists in the films defined themselves based on their career achievements and disengaged with every other aspect of their lives to focus on work, viewers might assume that they personally have little in common with scientists. In addition, viewers might perceive interaction with scientists

to be difficult given the antisocial and egotistical qualities scientists so frequently exude. It is apparent that scientists in the films preferred to communicate with other members of the scientific community as opposed to conversing with non-scientists, which also might cause viewers to perceive interaction with scientists negatively.

The science process in the films is denoted as a ground-breaking and quickly paced endeavor guided by intelligence and an unnatural, unhealthy commitment. In each of the 16 of the films I analyzed, scientists managed an invention or discovery capable of changing the world. Therefore, although scientific inquiries often slowly progress and rely on trial-and-error practices that allow scientists to slowly work toward solutions, science fiction films demonstrate science with an unrealistic progression, which likely contributes to viewers having unrealistic expectations of science and scientists. *Proof* was the only film I analyzed that, in one scene, accurately depicted science's slow progression. Speaking to Catherine about his research, Hal says "The big ideas aren't there" (Madden, 2005, 34:00:00). She replies, "It's not about big ideas it's, it's work. You gotta chip away at a problem" (Madden, 2005, 34:02:00). Viewers of science fiction likely believe that, if one's work does not aim to solve or discover phenomena capable of changing the world, then it is not science.

Untrustworthy. The *unethical decision-making, public distrust, egotistical scientist,* and *government involvement* emergent themes likely cause viewers to doubt scientists' commitment to bettering mankind. Their frequent abuse of power, disregard for safety, and inability to admit fault depict science and scientists as unpredictable and dangerous. In the films I analyzed, scientists often pursued their research in secrecy, away

from academic institutions and peers. Weingart et al. (2003) similarly interpreted this disassociation as a narrative tactic to dramatize viewers' perceived threat of science.

In addition, in the films I analyzed, members of the non-science community protest scientists and their work or blatantly show their disapproval. Members of the public were also often negatively impacted by the results of science experiments in many films, which likely contributes to viewers having an aversion toward science and feelings of distrust. Narrative transportation theory posits that viewers experience high levels of engagement when watching films and adopt beliefs and behaviors in the real-world that match those displayed by the story (Green & Clark, 2012). When viewers are transported into a narrative, they likely relate more to characters representing members of the general public and relate less to the characters representing scientists. Therefore, viewers might tend to embrace the same skepticism and antipathy toward science portrayed by the characters most representative of themselves in the films.

Furthermore, science and religion were sometimes deemed as adversaries in the films and unable to operate in tandem. In 2015, Pew Research found that 59% of Americans consider science and religion to often be in conflict with one another. However, 68% of American adults indicated that they personally do not feel conflicted between their religious beliefs and their perceptions toward science (Pew Research Center, 2015). Therefore, people more often perceive a conflict to exist between science and religion but do not believe conflict exists within themselves. Strong religious convictions, however, "can affect some Americans' willingness to accept certain scientific theories and discoveries, such as evolution, and new, life-changing technologies, such as genetic engineering" (Pew Research Center, 2009, para. 1). The evident divide between science

and religion in the films likely influences viewers with stronger religious convictions more than it influences those without by strengthening their beliefs and reaffirming their distaste toward science and scientists.

In several films, scientists treated the animals they used for testing purposes with care and compassion. In other films, however, scientists disregarded the well-being of test animals and showed no remorse when the animals felt pain, became mutated, or lost their life to a scientific experiment. From such films, viewers likely learn to not trust animals at the hands of scientists and to not favor or support animal testing. The portrayal of animal testing in science fiction films often reflects negative connotations.

Furthermore, scientists' working conditions varied in the films I analyzed (from clean, sanitary lab space, to dark, dirty, and cluttered workrooms). Typically, evil scientists conducted dangerous experiments in run-down facilities. Therefore, viewers likely associate dark, dirty, secretive labs with unethical, dangerous science, and associate clean, white lab space and lab coats with safer scientific practices. Scientists affiliated with a university in the films always worked in the latter environment, which likely causes these scientists to be perceived as more trustworthy compared to scientists affiliated with non-academic institutions. Brewer and Ley (2013) stated that university scientists are among the most trusted sources of scientific information by the public. This trust could originate from depiction of university scientists in science fiction films working in clean, stereotypical science labs that are associated with safer scientific practices.

Finally, government involvement was a contributing factor to the advancement of scientific agendas within the films I analyzed. Many of the science experiments that resulted in death and disaster received funding from the government, which likely

contributes to the public's lack of trust in the government. A long-running survey conducted by Pew Research Center (2015) that public confidence in the government was at an all-time low. Although this widespread distrust held by the public toward the government is the result of many things (e.g., politics, economics, healthcare, education, etc.), the origin of much doubt stems from 71% of Americans believing that elected officials are dishonest and 74% of Americans thinking they prioritize their own interests above the nation's interests (Pew Research Center, 2015). Therefore, when the government funds scientists to conduct research, viewers of science fiction might perceive that the transaction occurs with the best interest of government officials in mind, and not the best interest of the general public.

Furthermore, when scientists received funding from the government to conduct research, the purpose of the project and societal impact in the films was rarely addressed, possibly leading viewers to think that selfish, dishonest government officials work with mad scientists to complete risky, potentially hazardous experiments. As an example, in *Hollow Man,* when Sebastian reports his progress to the government agency funding him, he describes the project by saying, "Four years ago this committee gave me a very specific and challenging task: Successfully phase shift a human being out of quantum sink with the visible universe and return him safely with no after effects" (Verhoeven, 2000, 22:46:00). Considering the secrecy surrounding Sebastian's project throughout the film, this interaction, in addition to similar instances that took place in other films, could cause viewers to believe that the government dedicates valuable funds to advancing secret agendas as opposed to investing money for Americans' benefit.

Genetic Modification Danger. Genetic modification was highlighted in only two of the films I analyzed, which I found interesting. Given the topic's relevance in today's society, and my position as a budding scholar studying science communication in the context of agriculture, I took special notice to this theme. Genetically modified organisms (GMOs) have sparked significant controversy in recent years (Motta, 2014). Individuals who support GMOs believe that genetically modified plants and animals are a technological advancement that will help increase the world's food supply (Feldman et al., 2000). Opponents of GMOs, however, believe that genetically modified plants and animals are substances significantly different from organisms that occur naturally and pose "a threat to the character and quality of the food supply" (Feldman et al., 2000, p. 8).

The genetic modification of organisms—animals and people—that took place in the films created a life form that was clearly abnormal compared to anything that naturally exists. In several films, scientists mentioned that things should not be done against the "natural order," which is how many people interpret genetic modification. In addition, because all genetic modification procedures resulted negatively, viewers might perceive genetic modification to be dangerous and unnatural, therefore contributing to the anti-GMO sentiment. Part of the public's fear and uncertainty surrounding genetic modification is likely caused by the negative depictions of genetic modification in science fiction films.

Comradery. Scientists portrayed unusual behavioral characteristics the films, which often caused scientists' social abilities to be perceived as poor. However, the interaction between scientists in several films clearly indicated strong support and cooperation between members of the scientific community. Scientists not only sacrificed their own projects and success for one another but also sacrificed their lives. Therefore,

although viewers might often believe that scientists are antisocial, egotistical, and difficult to interact with given their unmatched brilliance and dedication to work, viewers also likely interpret the relationship between scientists to be friendly and widespread.

Research Objective Six

Difference of Scientific Representation in Films by Decade

For research objective four, I compared how science was depicted in the films released between decades.

1980–1989. Three of the four films I analyzed released between 1980 and 1989 were categorized as horror films. Thus, I interpreted that producers used science in the 1980s films to solicit fear more than they did in decades to follow. Films in this decade also focused on the individual responsibility of scientists, which Kirby described in 2008. In addition, computer science emerged as a strong theme within the films released during the 1980s, which Kirby (2008) also noted about films within the same decade. Scientists in *Weird Science, The Thing,* and *The Fly* all relied heavily on computer technology in their scientific efforts.

1990–1999. In the 1990s, female scientists were featured more frequently than in films released during the previous decade, and they generally did not conform to traditional gender stereotypes. Kirby (2008) similarly noted that female scientists depicted in films during the 1990s embraced traditional feminine qualities in terms of appearance but were career-driven and single with no children. For example, Ellie in *Contact*, Diana in *Junior,* and Kathryn in *12 Monkeys*—three of the four films I analyzed in this particular decade—were feminine, single female scientists with their own research agendas and labs who played a key role in the films' plot. Ellie, however, often had male scientists or elected

officials take credit for her work, which was typical during this time period (Steinke, 2005). Often, when female scientists in science fiction operate as authoritative scientific figures, male colleagues or supervisors perceive them as a threat and try to steal credit for their accomplishments (Steinke, 2005). Furthermore, films in this decade focused on group or communal responsibility of scientists, instead of the individual responsibility of scientists.

2000–2009. Films released between 2000 and 2009 focused on biomedical research, a finding similar to that of Kirby (2014). This was evident in three of the four films I analyzed—*Hollow Man, Nutty Professor II: The Klumps,* and *Spider Man 2.* Similar to the previous decade, films released between 2000 and 2009 featured female scientists who also embraced traditional feminine qualities. Linda in *Hollow Man,* Catherine in *Proof,* and Denise in *Nutty Professor II: The Klumps* were all single women dedicated to their careers. Linda and Catherine, however, operated scientifically in the shadows of men. For example, Linda answered to Sebastian, and throughout *Proof,* Catherine had to defend her honor as the people close to her doubted her ability to perform mathematics. Hal and Claire gave credit for Catherine's work to her deceased, genius father.

2010–2019. Literature does not yet exist that examines the types of research prominent within science fiction films from the last decade, however, the science of space and air emerged as a strong theme in my analysis. I found science of space and air as prominent themes in all of the films released between 2010 and 2019. *The Martian, Prometheus,* and *Gravity* all focus on scientists in space or scientists exploring distant moons or planets. Even the beginning scene in *Rampage* depicts scientists working in

space as a way to keep their research project a secret. Similar to the two previous decades, prominent female scientists were also frequently featured.

Summary

Conducting the denotative and connotative analyses in combination with interpreting the differences in scientific depictions by decade since 1980 provided me with a holistic understanding of how science fiction films convey science to the public. I identified nine emergent themes: *unusual behavior, egotistical scientist, unethical decision-making, public distrust, genetic modification danger, government involvement, working conditions, innovation,* and *comradery*, eight of which were supported by sub-themes. A quantitative analysis of the icons, indices, and symbols that constituted each emergent theme revealed that scientists are most represented as geniuses who are antisocial, egotistical, and unhealthily obsessed with their work. Frequent unethical research practices likely cause viewers of science fiction films to believe scientists are untrustworthy and feel resistant toward science. Common depictions of the public protesting or resisting science in films also likely causes skepticism among people in real life. In addition, viewers might harbor unrealistic expectations of scientists relating to their progression of scientific inquiries. Last, science fiction films in the 1980s focused on computer technology as a scientific theme, whereas science fiction films in the 1990s focused on the communal responsibility of scientists and frequently depicted successful female scientists. Science fiction films in the 2000s highlighted biomedical research, and science fiction films in the 2010s focused on the science of space and air.

CHAPTER V

CONCLUSIONS

The primary goal of the study described herein was to investigate fictional films' representations of science through the use of a social semiotic discourse analysis and to understand how such depictions might influence public perceptions toward science and scientists. To meet this goal, I established six research objectives: 1) identify and collect culturally significant films and television shows that incorporate science as a narrative device or as a fundamental setting; 2) conduct a filmic analysis of the movies selected for analysis to enhance trustworthiness; 3) identify thematic codes of visual and verbal semiotics inherent to scientific portrayals; 4) conduct a quantitative analysis by identifying the number of icons, indices, and symbols that support each theme and sub-theme; 5) describe how the scientific portrayals in films might influence public perceptions of science and scientists; and 6) determine how the portrayal of science has differed by decade since 1980.

As the base of my study, I identified 39 culturally significant film and television media texts that fulfilled the criteria for inclusion (incorporate science into the plot or setting and culturally significant). This process achieved research objective one. I completed research objective two by using Geiger and Rutsky's (2005) procedural framework for dissecting the narrative and technical components of films. This filmic analysis provides readers with a holistic interpretation of each film analyzed to enhance trustworthiness of the study. I conducted a denotative analysis of scientific representations in the films to achieve research objective three. After identifying a total of 335 icons,

indices, and symbols, I used axial coding to develop themes and sub-themes. Then, I conducted a quantitative analysis of the signs identified within the themes to complete research objective four. The quantitative analysis allowed me to identify the prevalence of themes within the films analyzed or, more specifically, the strongest and weakest themes. In addition, I conducted a connotative analysis of the themes developed through the denotative analysis to achieve research objective five. Last, for research objective six, I holistically interpreted the representation of science in the films to identify key differences in how scientific portrayals differed in films by decade. The conclusions for the study described herein will focus primarily on findings generated from the third, fourth, fifth, and sixth research objectives.

Cinematic portrayals of science have done a disservice to the American public by representing science and scientists poorly within films of all genres. The immoral and malicious denotations of procedures and people in science within the films I analyzed reflect the public's consistent anxiety and mistrust toward the scientific enterprise. Unfortunately, Crichton (1999) explained that media producers believe inaccurate and negative depictions of science and scientists are inevitable within fictional productions. Although media producers insist that their narratives are harmless (Carter, 1997; Crichton, 1999), media scholars disagree (Nisbet et al., 2002).

For example, similar to the results described herein, Nisbet et al. (2002) found that people learn to fear scientists because of media depictions. More specifically, Weingart et al. (2003) found through an analysis of 222 fiction films that the modification to the human body, violation of human nature, and risks to human health are the most common depictions of scientific practice. In the majority of films, they found that "the depiction of

science reveals the fundamental uneasiness, distrust, and even mystification of science" (Weingart et al., 2003, p. 281). In the current study, the modification of the human body and violation of human nature were also particularly prevalent. The negative portrayals of people and practices within the scientific community strongly outweigh positive, accurate depictions that exist in fiction films. Those who lack scientific literacy—90% of Americans (Maienschein, 1998)—are defenseless to the media's influence and are, therefore, more likely to learn and understand science through the inaccurate representations.

Results from the denotative and connotative analyses indicate that viewers of science fiction films might feel negatively toward scientists and science processes. Haynes (1994) similarly found that cinematic portrayals of science contribute to people believing negative stereotypes of scientists and causes them to have incorrect assumptions about the type of people who become scientists (Losh, 2006). The most common portrayals of science and scientists within the films I analyzed include scientists equating to geniuses and working with advanced, futuristic inventions and specific working conditions, or scientists working in a run-down, dirty facility versus operating in clean, sanitary lab space. Next, scientists frequently used unethical science practices (e.g., neglecting safety procedures, testing on animals, and unnaturally manipulating animal or human life), and exhibited unusual behavior (e.g., being antisocial, being incapable of love, and having an unhealthy obsession with their work). Thus, in my conclusions, I expand on findings from the connotative analysis and provide conclusions based on the most dominant themes—the stronger the themes the more will likely they are to have a greater influence on public learning and understanding.

Representations of science and scientists in science fiction films create a divide between scientists and members of society. Science fiction audiences likely assume that scientists are antisocial, egotistical, unapproachable, and difficult to communicate with because of their perceived level of intelligence. They might also assume that scientists have an unhealthy obsession with their work and sacrifice other important elements of life (e.g., friends, family, sleep, free time) to achieve success. In addition, those who watch science fiction films might perceive science to be dangerous because scientists starring in the films under study frequently dismissed safety procedures, which could be deemed as untrustworthy.

Furthermore, viewers likely assume that scientists often use unethical practices in their research, which further builds upon their likelihood of harboring distrust. More specifically, science fiction audiences might think that scientists, given their perceived obsession, brilliance, and access to necessary equipment and materials, do not always use science for the betterment of mankind. Such content could further signify that scientists pursue dangerous, unethical projects to fulfill a fantasy or obsessive need within themselves. Much of the unethical research scientists conducted in the films I analyzed negatively impacted members of the public who were uninvolved with science. Through a social cognitive theory lens, viewers use media characters as models and gain an understanding of positive and negative behaviors based on the consequences these character's experience. Therefore, viewers of science fiction are likely to believe that sometimes, scientific advancements can provide them with more harm than good.

Likewise, science fiction films likely contribute to people being unsupportive of animal testing for the advancement of science because audiences frequently witness

procedures that negatively impact animals involved. Viewers likely do not trust scientists to work with animals because they interpret them as indifferent to the animals' well-being and safety. Given the prevalence of these characteristics within the denotative analysis described herein, cinematic portrayals of science likely have had a profound impact on public learning and understanding of science in these contexts.

Furthermore, the rate of scientific achievement and breakthrough in all of the 16 films analyzed occurred at an unrealistic progression. Given that films must encompass a short narrative that contain a beginning, middle, and end, it is expected that they represent scientific inquiries as fast-paced. In reality, however, science progresses slowly. Those who are unfamiliar with science might misinterpret scientific progression and develop unrealistic expectations for scientists regarding the rate at which they solve problems.

The science fiction films released between 2010 and 2019 that I analyzed represented science with the most accuracy and cast scientists in a more positive, ethical manner. Therefore, once these films age to 10 years and, therefore, are capable of contributing to American cultural memory (The National Film Preservation Board as cited in Specht & Rutherford, 2014), public perceptions toward science will likely increase, assuming more accurate depictions of science uphold in the film industry. For example, to develop *The Martian* (2015), producers consulted with NASA to accurately represent aspects of space and space travel, specifically in relation to Mars. Given what is already known about Martian soil, there is no reason events in the film could not take place in real life. *Gravity* (2013) also represented science accurately. The film focused less on scientific processes and space travel and more on dangers of operating in space. The depiction of science in *Prometheus* (2012) was a bit improbable given its futuristic setting; however, it

incorporated realistic aspects of authentic scientific fields, including archeology and astrobiology. Mad scientists were not depicted in the films under study that were released between 2010 and 2019. Therefore, unrealistic and inaccurate depictions of science in fiction films were more frequent in earlier decades, and the quality of scientific portrayals in science fiction films was accurate with time.

Recommendations for Future Research

The study serves as a gateway to further investigation into the influence of entertainment media on public perceptions of science. By compiling a list of culturally significant media texts that integrate science as an integral component of production, the study described herein provides future researchers with resources to delve deeper into the semiotics used to illustrate science and the potential effects such depictions can have on past, present, and future audiences.

I recommend that researchers conduct a qualitative and quantitative social semiotic discourse analysis of the culturally significant scientific documentaries and television series that I chose to exclude from my study but still identified in Table 1. Nisbet et al. (2002) explained that the National Science Board's Science and Engineering Indicators Survey suggested that different media—television, science television, and science films—affect people's perceptions differently. Therefore, it would be interesting to examine how scientific portrayals in the documentaries and television shows differ from the scientific portrayals I identified in science fiction films. Considering both fictional and nonfictional narratives are capable of transporting viewers similarly (Batat & Wohlfeil, 2009; Green & Brock, 2000), understanding how an audience might gain meaning from denoted images of science in the documentaries and comparing them to the connotative analysis conducted in

the present study would assist scholars in gaining a holistic interpretation of the impact of cinematic portrayals on public understanding. This approach would further highlight the differences between how viewers might learn from fictional versus nonfictional narratives.

Similar to the current study, most of the literature investigating the influence of scientific portrayals in films on public perceptions of science make inferences about how people might learn from them based on data collected from the media text themselves (Barriga et al., 2010; Kirby, 2003; Plait, 2007). Few studies use people as data collection sources to understand the effect. Therefore, I further recommend researchers conduct a follow-up study involving semi-structured one-on-one interviews with members of the general public who watch films regularly to gain their interpretation of the results found in the study.

From a quantitative perspective, another way to interpret the accuracy of the current study and to further understand the impact of cinematic portrayals of science on public perceptions would be to design a survey instrument using results from the denotative and connotative analyses with Likert-type response options. The survey could be implemented among lay publics who watch science fiction films. Results would help researchers understand the extent of which the results from the current study impact public perceptions of science.

It would also be beneficial for future researchers to design experimental studies using members of the non-scientific community. A pre- and post-test design could incorporate findings from the denotative and connotative analyses presented herein. The culturally significant films shown to participants could either be the science fiction films analyzed in the current study or others identified in Table 1. In addition, Nisbet et al.

(2002) found that, when compared to men, women have less knowledge of science, are less likely to use media that promote the informal learning of science, and are more likely to be skeptical about science. Therefore, empirically testing how differences in gender and differences in other demographic and psychographic characteristics, impact one's digestion of science information.

Comparing results from the current study with results from the proposed qualitative and quantitative studies described above would provide researchers with a holistic interpretation of how cinematic depictions of science influence public learning, attitudes, and behaviors. Researchers could triangulate the data from a combination of these studies—qualitative and quantitative—and interpret the influence of science fiction portrayals from an all-inclusive lens. This analysis would provide researchers with an in-depth understanding of how filmic depictions of science impact public learning and understanding. The conclusions and recommendations that result from the analysis could have the potential to assist in the development of effective science communication efforts capable of achieving societal impact.

I further recommend that future research incorporate the use of Dialsmith's perception analyzer equipment and software which allows for real-time collection of closed-ended feedback and moment-to-moment analysis of live and recorded content. Presenting excerpt clips that depict signs supporting the emergent themes of the films I analyzed would enable lay people to record their perceptions of the scientific depictions in the moment. Through this, researchers could identify the specific instances involving science and scientists that people react positively and negatively toward. Results would

further assist science communication scholars to understand public perceptions of science in an effort to design impactful communication strategies.

Researchers should also conduct a similar study to the one described herein using news media instead of entertainment media. An analysis of semiotics within news media would reveal ways in which icons, indices, and symbols communicate science information to the intended audience and, therefore, shape public perceptions of science and scientists. A semiotic analysis of news media would also identify intended or unintended journalistic practices and help researchers, news consumers, and journalists understand the influence news media depictions and portrayals of science might have on the public's understanding of science. If researchers pursue this study, they should consider narrowing their inquiry to analyzing semiotics within news media covering a specific scientific topic (e.g., climate change, genetic engineering, infectious diseases). This would provide researchers with an in-depth understanding of how public perceptions are shaped regarding particular facets of science, which would enable science communicators to develop context-specific communication approaches that could increase public support and understanding.

Finally, I recommend researchers conduct a social semiotic discourse analysis of documentaries related to agriculture (e.g., *Food, Inc.* (2008), *Forks Over Knives* (2011), *GMO OMG* (2013)). By understanding the icons, indices, and symbols used to represent agriculture and the food system within these films, science communicators and agricultural communicators can develop context-specific messages and communication approaches that aim to educate consumers on agricultural values and practices that counteract the misleading depictions of how food is produced and sold in the United States.

Recommendations for Science Communicators

Results from the study described herein have clear implications for the continued efforts of science communicators. A standard practice in many science communication training programs, finding a relational element to connect with an audience is critical. To negate the stereotypical behavioral characteristic associated with scientists that the films analyzed herein reinforce (e.g., scientists being antisocial, scientists being egotistical, scientists having an unhealthy obsession with work), scientists should continuously attempt to reference the people close to them as relational elements when discussing their research with public groups. Perhaps scientists could describe how support from their family, friends, and/or colleagues helped them be successful and stay motivated. Another frequently recommended practice for scientists to adhere to is to lessen or eliminate the use of technical jargon when explaining their work. Results from the current study support this communication approach, as it would likely reduce the perception that scientists have an unattainable level of intelligence that makes them difficult to interact with and unapproachable.

Additionally, although referencing the success (e.g., awards, publications, etc.) associated with the research being communicated might add credibility, scientists should approach discussing achievements with caution because they should not indicate that extrinsic rewards are their primary care and goal. People want to know that scientists conduct research for the betterment of mankind and that they care about the social implications of their work. Therefore, scientists should make a concerted effort to explain to their audience the purpose of their research and describe how it could specifically impact their listeners and the broader society.

Furthermore, scientists should be familiar with their own values and norms of scientific practice. Learning to concisely articulate their efforts to perform and maintain ethical scientific practice would likely increase trust among audience members and contradict a potential pre-existing belief that scientists are often unethical in their research. To further build trust among audience members and increase the speaker's perceived credibility, scientists should be fully transparent when presenting their work and when answering questions. Especially if they work in a controversial scientific field (e.g., vaccinations, GMOs, climate change) scientists should explicitly state their effort to provide full transparency to their audience. This action could offer reassurance to those in the audience who might be skeptical of a scientist's intentions and could mitigate the perception of secrecy surrounding controversial issues. When scientists communicate specifically about genetic engineering, they should strive to alleviate the perceived dangers associated with the topic. Avoiding the term "unnatural" and the phrase "against the natural order of things" is important given these words were often used in films to negatively describe genetic engineering. Avoiding the terms could prevent triggering individuals to feel reluctant to listen or unsupportive.

Last, it is important for science communicators to disseminate research among channels in which the general public is engaged. For example, The Conversation is a network of media sources that publishes news stories written by academics and members of the scientific community directly for those within the public arena. South by Southwest, a film festival that hosts a variety of conferences with interactive sessions relating to film and the TV industry, would also be an innovative place for science communicators to disseminate related research. In addition, science communicators should disseminate

research and engage with the public about science by attending science fairs, science festivals, and science cafés, and by participating in citizen dialogues and public lectures. They should also publish on social media platforms (e.g., Facebook, Twitter, Instagram, LinkedIn, YouTube, Reddit, Snapchat, Pinterest, blogs) and share personal science-related stories on Story Collider. Science communicators should also contact their university's Office of Research Communications, or a related entity, to identify the ways in which research can be disseminated broadly.

Recommendations for Film Producers

Furthermore, it would benefit the American public if more movie producers used science consultants to inform the development of their narrative. Although this practice is steadily increasing (Kirby, 2003), it needs to become standard industry practice. Using scientists to help develop the portrayal of science in films would not only improve the implications of viewers watching the production, but also allow scientists to use the film as a promotional device for their research field (Kirby, 2003). Frank (2003) explained that the large majority of science fiction films and television shows produced within the last 90 years were clearly unconcerned with scientific accuracy. In 2020, the effects of this lack of concern are particularly evident given the widespread mistrust and skepticism harbored by much of the general public toward science. Fortunately, science consultants are considered increasingly critical to a production involving science (Frank, 2003). The figurative cost of maintaining or further widening the gap between the science and non-science communities, which entertainment media contribute to, largely outweighs the monetary cost of hiring science consultants, a service that costs between $100 and $200 per hour.

Limitations

The study described herein is not without limitations. As noted earlier, research within the qualitative paradigm rely on situated praxis. Specht (2013) explained that in social semiotic analyses "the researcher becomes the research mechanism; calibrating the thoughts, feelings, and beliefs of the human instrument is an often-difficult, self-reflective undertaking" (p. 56). Therefore, the denotative analysis, connotative analysis, conclusions, and recommendations contained in chapters four and five are discerned based on my interpretation alone. The work of others in an attempt to replicate the study could likely yield different results as humans interpret stimuli based on pre-conceived ideas and experiences. The selection process involved to identify the population of culturally significant films and television shows (see Table 1) that informed the study's progression also relied solely on my understanding of the centrality of science to the production based on IMDb's synopsis.

REFERENCES

Ahteensuu, M. (2012). Assumptions of the deficit model type thinking: Ignorance, attitudes and science communication in the debate on genetic engineering in agriculture. *Journal of Agricultural and Environmental Ethics, 25*(3), 295–313. https://doi.org/10.1007/s10806-011-9311-9

Aiello, G. (2016). Theoretical advances in critical visual analysis: Perception, ideology, mythologies, and social semiotics. *Journal of Visual Literacy, 26*(2), 89–102. https://doi.org/10.1080/23796529.2006.11674635

Anderman, E. M., Sinatra, G. M., & Gray, D. L. (2012). The challenges of teaching and learning about science in the twenty-first century: Exploring the abilities and constraints of adolescent learners. *Studies in Science Education, 48*(1), 89–117. https://doi.org/10.1080/03057267.2012.655038

Anderson, E. S., Winett, R. A., &n Wojcik, J. R. (2000). Social-cognitive determinants of nutrition behavior among supermarket food shoppers: A structural equation analysis. *Health Psychology, 19*(5), 479–486. https://doi.org/10.1037/0278-6133.19.5.479

Appel, M., & Richter, T. (2007). Persuasive effects of fictional narratives increase over time. *Media Psychology, 10*(1), 113–134. https://doi.org/10.1080/15213260701301194

Aronofsky, D. (Director). (2006). *The fountain* [Film]. Warner Bros; Regency Enterprises; 20th Century Fox.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice Hall.

Barnett, M., & Kafka, A. (2007). Using science fiction movies scenes to support critical analysis of science. *Journal of College Science Teaching, 36*(4), 31–35.

Barnett, M., Wagner, H., Gatling, A., Anderson, J., Houle, M., & Kafka, A. (2006). The impact of science fiction film on student understanding of science. *Journal of Science Education and Technology, 15*(2), 179–191. https://doi.org/10.1007/s10956-006-9001-y

Barriga, C. A., Shapiro, M. A., & Fernandez, M. L. (2010). Science information in fictional movies: Effects of context and gender. *Science Communication, 32*(1) 3–24. https://doi.org/10.1177/1075547009340338

Batat, W., & Wohlfeil, M. (2009). Getting lost "Into the Wild": Understanding consumers' movie enjoyment through a narrative transportation approach. *Advances in Consumer Research, 36,* 372–377.

Becker, J., Paton, D., Johnston, D. M., & Ronan, K. R. (2012). A model of household preparedness for earthquakes: How individuals make meaning from earthquake information and how this influences preparedness. *Natural Hazards, 64*(1), 107–137. https://doi.org/10.1007/s11069-012-0238-x

Berger, A. A. (2006). *Media and communication research methods* (4th ed.). SAGE Publications.

Besley, J. C., & Tanner, A. H. (2011). What science communication scholars think about training scientists to communicate. *Science Communication, 33*(2), 239–263. https://doi.org/10.1177/1075547010386972

Bloom, P., & Weisberg, D. S. (2007, May). Childhood origins of adult resistance to science. *Science, 316*(5827), 996–997. https://doi.org/10.1126/science.1133398

Brake, M., & R. Thornton. (2003). Science fiction in the classroom. *Physics Education, 38*(1), 31–34.

Branagh, K. (Director). (1994). *Mary Shelley's Frankenstein* [Film]. TriStar Pictures; Japan Satellite Broadcasting; IndieProd Company Productions; American Zoetrope.

Braun, V., & Clarke, V. (2011). *Thematic analysis.* [PowerPoint slides]. Google Scholar. http://fnm.tums.ac.ir/userfiles/iao/workshop/5-thematicanalysisslides-prof.braun.pdf

Bryman, A. (2016). *Social research methods*. Oxford University Press.

Bubela, T., Nisbet, M. C., Orchelt, R., Brunger, F., Critchley, C., Einsiedel, E., Geller, G., Gupta, A., Hampel, J., Hyde-Lay, R., Jandciu, E. W., Jones, S. A., Kolopack, P., Lane, S., Lougheed, T., Nerlich, B., Ogbogu, U., O'Riordan, K., Ouellette, C., Spear, M., Strauss, S., Thavaratum, T., Willemse, L., & Caulfield, T., (2009). Science communication reconsidered. *Nature Biotechnology 27*(6), 514–515. https://doi.org/10.1038/nbt0609-514

Burakgazi, S. G., & Yildirim, A. (2013). Accessing science through media: Uses and gratifications among fourth and fifth graders for science learning. *Science Communication, 36*(2), 168–193. https://doi.org/10.1177/1075547013505847

Burton, T. (Director). (2012). *Frankenweenie* [Film]. Walt Disney Pictures; Tim Burton Productions.

Butler, J. G. (2002). *Television: Critical methods and applications* (2nd ed.). Lawrence Erlbaum Associates.

California Academic of Sciences. (2009, March 13). *American Adults Flunk Basic Science.* Science Daily. https://www.sciencedaily.com/releases/2009/03/090312115133.htm

Carpenter, J. (Director). (1980). *The Thing* [Film]. Universal Pictures.

Carter, C. (1997). *The X-Files* meets the skeptics. *Skeptical Inquirer*, *21*(1), 24–28.

Caulfield, T. (2004). Biotechnology and the popular press: Hype and the selling of science. *Trends in Biotechnology, 22*(7), 337–339. https://doi.org/10.1016/j.tibtech.2004.03.014

Chandler, D. (2017). *Semiotics for beginners*. Retrieved from http://visual-memory.co.uk/daniel/Documents/S4B/

Chandler, D. (2007). *Semiotics: The basics* (2nd ed.). Routledge.

Chazelle, D. (Director). (2018). *First man* [Film]. Universal Pictures; Amblin Entertainment; DreamWorks Pictures; Temple Hill Productions.

Chiu, C-M., Hsu, M-H., & Wang, E. T. G. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision Support Systems, 42,* 1872–1888. https://doi.org/10.1016/j.dss.2006.04.001

Christidou, V. (2011). Interest, attitudes and images related to science: Combining students' voices with the voices of school science, teachers, and popular science. *International Journal of Environmental & Science Education, 6*(2), 141–159.

Collin, R. (2015, May 8). Will there every be another John Hughes? [The Telegraph]. Retrieved from https://www.telegraph.co/uk/film/what-to-watch/john-hughes-best-movies/

Condon, B. (Director). (2004). *Kinsey* [Film]. Fox Searchlight Pictures; Myriad Pictures; American Zoetrope.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research.* SAGE Publications.

Crawford, S. A. G. M. (1988). The sport film—Its cultural significance. *Journal of Physical Education, Recreation & Dance, 59*(6), 45–49. https://doi.org/10.1080/07303084.1988.10609782

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice, 39*(3), 124–130. https://doi.org/10.1207/s15430421tip3903_2

Creswell, J. W., & Poth, C. N. (2018). *Qualitive inquiry and research design* (4th ed.). SAGE Publications.

Crichton, M. (1999, February). *Ritual abuse, hot air, and missed opportunities: Science views media*. Paper presented at the meeting of the American Association for the Advancement of Science, Anaheim, CA.

Cronenberg, D. (Director). (1986). *The fly* [Film]. SLM Production Group.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* Sage Publications.

Cuarón, A. (Director). (2013). *Gravity* [Film]. Warner Bros Pictures; Esperanto Filmoj; Heyday Films.

Dahlstrom, M. F. (2014). Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences of the United States of America, 111*(4), 13614–13620. https://doi.org/10.1073/pnas.1320645111

Dark, M. L. (2005). Using science fiction movies in introductory physics. *The Physics Teacher, 43,* 463–465. https://doi.org/10.1119/1.2060648

Davies, S. R., & Horst, M. (2016). *Science communication: Culture, identity, and citizenship*. Palgrave Macmillan. https://doi.org/10.1057/978-1-137-50366-4

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6), 582–601. https://doi.org/10.1002/1098-2736(200008)37:6<582::AID-TEA5>3.0.CO;2-L

Dierking, L. D. (2005). Lessons without limit: How free-choice learning is transforming science and technology education. *História, Ciências, Saúde–Manguinhos*, *12*, 145–160. https://doi.org/10.1590/S0104-59702005000400008

Donaldson, R. (Director). (1995). *Species* [Film]. Metro-Goldwyn-Mayer.

Druyan, A., MacFarlane, S., Braga, B., Cannold, M., Hanich, L., Holtzman, S., & Clark, J. (Executive Producers). (2014). *Cosmos: A spacetime Odyssey* [TV series]. Fox Broadcasting Company; National Geographic Society.

Dubeck, L. W., Bruce, M. H., Schmuckler J. S., Moshier, S. E., & Boss, J. E. (1990). Science fiction aids science teaching. *The Physics Teacher, 28,* 316–318. https://doi.org/10.1119/1.2343039

Dubeck, L. W., Moshier, S. E., & Boss, J. E. (2004). *Fantastic voyages: Learning science through science fiction films* (2nd ed.). Springer.

Edgar, L., & Rutherford, T. (2017). A semiotic analysis of a Texas cooperative extension marketing packet. *Journal of Applied Communications, 96*(1), 15–28. https://doi.org/10.4148/1051-0834.1140

Efthimiou, C., & Llewellyn, R. A. (2004). Cinema as a tool for science literacy. *Physics Education, 16*(1), 1–13.

Eggert, B. (2007). *The fly*. Deep Focus Review. https://deepfocusreview.com/definitives/the-fly/

Else, J. H. (Director). (1981). *The day after trinity* [Film]. KQEH.

Falk, J. H., Storksdieck, M., & Dierking, L. D. (2007). Investigating public science interest and understanding: Evidence for the importance of free-choice learning. *Public Understanding of Science, 16*(4), 455–469. https://doi.org.10.1177.0963662506064240

Feldman, M. P., Morris, M. L., & Hoisington, D. (2000). Genetically modified organisms: Why all the controversy? *Choices*, *15*, 8–12. https://WhyAllTheControversy.pdf

Finley, S. (2008). Arts based research. In J. G. Knowles, and A. L. Cole (Eds.), *Handbook of the arts in qualitative research: Perspectives, methodologies, examples, and issues* (pp. 71–81). Sage.

Flicker, E. (2003). Between brains and breasts – women scientists in fiction film: On the marginalization and sexualization of scientific competence. *Public Understanding of Science, 12*(3), 307–318. https://doi.org/10.1177/0963662503123009

Flicker, E. (2008). Women scientists in mainstream film. In B. Hüppauf, and P. Weingart (Eds.), *Science images and popular images of the sciences* (pp. 241–256). Routledge.

Flores, G. (2002). Mad scientists, compassionate healers, and greedy egotists: The portrayal of physicians in the movies. *Journal of the National Medical Association, 94*(7), 635–658.

Fraenkel, J. R., Wallen, N. E., & Hyun H. H. (2019). *How to design and evaluate research in education* (10th ed.). McGraw Hill Education.

Frank, S. (2003). Reel Reality: Science consultants in Hollywood. *Science as Culture, 12*(4), 427–469. https://doi.org/10.1080/0950543032000150319

Freeman, M., McCreary, L., & Younger, J. (Executive Producers). (2010–2017). *Through the wormhole* [TV series]. Discovery Science Channel; Revelations Entertainment; The Incubator; Discovery Science.

Frost, P., Ingraham, M., & Wilson, B. (2002). Why misinformation is more likely to be recognised over time: A source monitoring account. *Memory, 10*(3)*,* 179–185. https://doi.org/10.1080/09658210143000317

Garland, A. (Director). (2014). *Ex machina* [Film]. Film4 Productions; DNA Films.

Gauchat, G. (2010). The cultural authority of science: Public trust and acceptance of organized science. *Public Understanding of Science, 20*(6), 751–770. https://doi.org/10.11770963662510365246

Geiger, J., & Rutsky, R. L. (2005). Introduction. In J. Geiger & R. L. Rutsky (Eds.), *Film analysis: A Norton reader* (pp. 17–41). W. W. Norton & Company.

Gerbner, G., Gross, L., Morgan, M., & Signorelli, N. (1981). Scientists on the TV screen. *Culture and Society*, *42*, 51–54.

Gilliam, T. (Director). (1995). *12 monkeys* [Film]. Universal Pictures; Atlas Entertainment.

Goldschein, G., Pizzi, J., Naidus, M., Nye B., Springarn-Koff, J., Wood, T., & Nishimura, L. (Executive Producers). (2017–present). *Bill Nye saves the world* [TV series]. Bunim-Murray Productions; Mentality; Netflix.

Gottlieb, E., McKenna, J., & Brock, E. (Executive Producers). (1993–1998). *Bill Nye the science guy* [TV Series]. Public Broadcasting Service; PBS.

Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of Personality and Social Psychology, 79*(5), 701–721. https://doi.org/10.1037/0022-3514.79.5.701

Green, M. C., Brock, T. C., & Kaufman, G. F. (2004). Understanding media enjoyment: The role of transportation into narrative worlds. *Communication Theory, 14*(4), 311–327. https://doi.org/10.1111/j.1468-2885.2004.tb00317.x

Green, M. C., & Clark, J. L. (2012). Transportation into narrative worlds: Implications for entertainment media influences on tobacco use. *Addiction, 108,* 477–484. https://doi.org/10.1111j.1360-0443.2012.04088.x

Green, M. C., & Fitzgerald, K. (2017). *Transportation theory applied to health and risk messaging*. Health and Risk Communication. https://doi.org/10.1093/acrefore/9780190228613.013.261

Green, M. C., Kass, S., Carrey, J., Herzig, B., Feeney, R., & Sabini, J. (2008). Transportation across media: Repeated exposure to print and film. *Media Psychology, 11*(4), 512–539. https://doi.org/10.1080/15213260802492000

Greenwood, J. (2016). The limits of language: A case study of an arts-based research exploration. *New Zealand Journal of Research in Performing Arts: Nga mahi a Rehia no Aotearoa, 6,* 88–100.

Guggenheim, D. (Director). (2006). *An inconvenient truth* [Film]. Participant.

Haynes, R. (2003). From alchemy to artificial intelligence: Stereotypes of the scientist in Western literature. *Public Understanding of Science, 12*(3), 243–253. https://doi.org/10.1177096366250312300 3

Haynes, R. D. (1994). *From Faust to Strangelove: Representations of the scientist in Western literature.* John Hopkins Press.

Hirtle, J. S. P. (1996). Coming to terms: Social constructivism. *The English Journal, 85*(1). 91–92.

Hodge, R., & Kress, G. (1988). *Social semiotics.* Polity Press.

Hughes, J. (Director). (1985). *Weird Science* [Film]. Universal Pictures.

Iedema, R. (2001). Analyzing film and television: A social semiotic account of *Hospital: An Unhealthy Business.* In T. Van Leeuwen & C. Jewitt (Eds.), *Handbook of visual analysis* (pp. 183–206). SAGE Publications.

Igartua, J. J., & Barrios, I. (2012). Changing real-world beliefs with controversial movies: Processes and mechanisms of narrative persuasion. *Journal of Communication, 62*(3)*,* 514–531. https://doi.org/ 10.1111/j.1460-2466.2012.01640.x

Jackson, J. K. (2008). Gender, mad scientists and nanotechnology. *Spontaneous Generations, 2*(1), 45–55. https://doi.org/10.4245/sponge.v2i1.3516

Jane, B., Fleer, M., & Gipps, J. (2007). Changing children's views of science and scientists through school-based teaching. *Asia-Pacific Forum on Science Learning and Teaching, 8*(1), 1–21.

Kabil, A. (2016). Meet the psychedelics-obsessed scientist who wanted to learn dolphins' language. https://timeline.com/neuroscience-doctor-drugs-lsd-c17d5e84c653

Jackson, M. (Director). (2010). *Temple Grandin* [Film]. HBO Films; Ruby Films.

Kirby, D. A. (2013). Forensic fictions: Science, television production, and modern storytelling. *Studies in History and Philosophy of Science Part C: Studies in*

History and Philosophy of Biological and Biomedical Sciences, 44(1), 92–102. https://doi.org/10.1016/j.shpsc.2012.09.007

Kirby, D. A. (2011). *Lab coats in Hollywood: Science, scientists, and cinema.* MIT Press.

Kirby, D. A. (2014). Science and technology in film: Themes and representations. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology* (pp. 97–112). Routledge.

Kirby, D. A. (2003). Science consultants, fictional films, and scientific practice. *Social Studies of Science, 33*(2), 231–268. https://doi.org/10.1177/03063127030332015

Kirby, D. (2008). Cinematic science. In B. Trench & M. Bucchi (Eds.), *Handbook of public communication of science and technology* (pp. 67–94). Routledge.

Kirby, D. (2003). Scientists on the set: Science consultants and the communication of science in visual fiction. *Public Understanding of Science*, *12*, 261–278. https://doi.org/10.1177/0963662503123005

Kitzinger, J. (2005). Focus group research: Using group dynamics to explore perceptions, experiences and understandings. In I. Holloway (Ed.), *Qualitative research in healthcare* (pp. 56–69). Open University Press.

Langlois, M. A., Petosa, R., & Hallam, J. S. (1999). Why do effective smoking prevention programs work? Student changes in social cognitive theory constructs. *Journal of School Health, 69*(8), 326–331.

Lester, P. M. (2006). The sensual and perceptual theories of visual communication. In P. M. Lester (4th Eds.), *Visual communication: Images with messages* (pp. 50–64). Thomson Wadsworth.

Lester, P. M. (1995). *Visual communications: Images with messages*. Wadsworth Publishing.

Limaye, R. J., Rimal, R. N., & Brown, J., & Mkandawire, G. (2013). Using entertainment education to promote self-efficacy and aspirations among young Malawians: The Tisankhenji Radio Program. *Cases in Public Health Communication & Marketing, 7,* 16–34.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* SAGE Publications.

Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content analysis in mass communication: Assessment and reporting intercoder reliability. *Human Communication Research, 28*(4), 587–604. https://doi.org/10.1111/j.1468-2958.2002.tb00826.x

Losh, S. C. (2006, August 10). *American stereotypes about scientists: Gender and time effects*. Paper presented at the American Sociological Association, Montreal Convention Center, Montreal, Quebec, Canada.

Malone, A. (Executive Producer). (1980). *Cosmos* [TV Series]. Public Service Broadcasting; PBS.

Madden, J. (Director). (2005). *Proof* [Film]. Miramax; Endgame Entertainment.

Michigan State University. (2007, February). Scientific literacy: How do Americans stack up? https://www.sciencedaily.com/releases/2007/02/070218134322.htm

Motta, R. (2014). Social disputes over GMOs: An overview. *Sociology Compass, 8*(12), 1360–1376. https://doi.org/10.1111/soc4.12229

National Academies of Sciences, Engineering, and Medicine. (2017). *Communicating Science Effectively: A Research Agenda.* The National Academies Press. https://doi.org/10.17226/23674

National Research Council. (1996). *National science education standards*. The National Academies Press.

National Science Board. (2004). Science and technology: Public attitudes and understanding. In *Science and Engineering Indicators 2004* (chapter 7). Washington, DC: U.S. Government Printing Office. http://nsf .gov/statistics/seind04/c7/c7i.htm

National Science Foundation. (2000). *Indicators: Science and engineering 2000.* National Science Foundation.

Nisbet, C. M., Scheufele, D. A., Shanahan, J., Moy, P., Brossard, D., & Lewenstein, B. V. (2002). Knowledge, Reservations, or Promise? A media effects model for public perceptions of science and technology. *Communication Research, 29*(5), 584–608. http://doi.org/10.1177/009365002236196

Nolan, C. (Director). (2014). *Interstellar* [Film]. Warner Bros; Legendary Entertainment; Paramount Pictures; Syncopy, Inc.; Lynda Obst Productions.

Nowotny, H. (2005). High- and low-cost realities for science and technology. *Science, 308*(5725), 1117–1118. https://doi.org/10.1126/science.1113825

Maienschein, J. (1998). Scientific literacy. *Science, 281*(5379), 917. https://doi.org/10.1126/science.281.5379.917

Malić, B. (2016). Cold war, cold fear: Analysis of John Carpenter's "The Thing." Accessed December 30 from https://21stcenturywire.com/2016/08/15/cold-war-cold-fear-analysis-of-john-carpenters-the-thing/

Mann, M. (Director). (1999). *The insider* [Film]. Touchstone Pictures; Forward Pass; Spyglass Entertainment.

Manning, P. K., & Cullum-Swan, B. (1994). Narrative, content, and semiotic analysis. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 463–477).

Marsh, E., Meade, M., & Roediger, H. (2003). Learning facts from fiction. *Journal of Memory and Language, 49,* 519–536. https://doi.org/10.1016/S0749-596X(03)00092-5

Marsh, J. (Director). (2014). *The theory of everything* [Film]. Working Title Films.

Mathijs, E. (2003). AIDS references in the critical reception of David Cronenberg: "It may not be such a bad disease after all." *Cinema Journal, 42*(4), 29–45.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

O'Donnell, V. (1983). *How films function as persuasion for the mass audience*. Paper presented at the International Communication Association, Dallas, TX.

Pajares, F., Prestin, A., Chen, J. A., & Nabi, R. L. (2009). Social cognitive theory and mass media effects. In R. L. Nabi and M. B. Oliver (Eds.), *Media processes and effect.* Sage.

Pansegrau, P. (2008). Stereotypes and images of scientists in fiction films. In B. Hüppauf, & P. Weingart (Eds.), *Science images and popular images of the sciences* (pp. 257–266). Routledge.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). SAGE Publications.

Parsa, A. F. (2004). *Visual semiotics: How still images mean? Interpreting still images by using semiotic approaches.* Paper presented at the 2nd International Symposium Communication in The Millennium: A Dialogue Between Turkish and American Scholars, In Cooperation with University of Texas, Anadolu University and Istanbul University.

Pew Research Center. (2015). Beyond distrust: How Americans view their government. https://www.people-press.org/2015/11/23/beyond-distrust-how-americans-view-their-government/

Pew Research Center. (2015). Perception of conflict between science and religion. https://www.pewresearch.org/science/2015/10/22/perception-of-conflict-between-science-and-religion/

Pew Research Center. (2009). Religion and science in the United States. https://www.pewforum.org/2009/11/05/an-overview-of-religion-and-science-in-the-united-states/

Pew Research Center. (2017). Science news and information today. https://www.journalism.org/2017/09/20/science-news-and-information-today/

Pew Research Center. (2019). Trust and distrust in America. https://www.people-press.org/2019/07/22/trust-and-distrust-in-america/

Pew Research Center. (2019). What Americans know about science. https://www.pewresearch.org/science/2019/03/28/what-americans-know-about-science/

Peyton, B. (Director). (2017). *Rampage* [Film]. Warner Bros Entertainment.

Pieri, D. (2006, November). Mad, bad, and dangerous? The scientist and the cinema. *Psychology Today, 59*(11), 60. https://doi.org/10.1063/1.2435650

Plait, P. (2007). *Bad astronomy*. http://www.badas-tronomy.com/bad/movies/

Raimi, S. (Director). (2004). *Spider man 2* [Film]. Marvel Studios; Sony Pictures; Marvel Entertainment; Columbia Pictures.

Reitman, I. (Director). (1994). *Junior* [Film]. Universal Pictures; Northern Lights Entertainment.

Riddett-Moore, K., & Siegesmund, R. (2012). Arts-based research: Data are constructed, not found. In S. R. Klein (Ed.), *Action Research Methods* (pp. 105–132). Palgrave Macmillan.

Rogers, E. R., & King, S. R. (2013). Intervention based on social cognitive theory: Evaluating adolescents' knowledge of OTC pain medication. *Journal of the American Pharmacists Association, 53*(1), 30–38. https://doi.org/10.1331/JAPhA.2013.11231

Rogers Public Library. (n.d.). *Mad scientists.* http://rogerspubliclibrary.org/2016/06/mad-scientists/

Rose, C. (2003). How to teach biology using the movie science of cloning people, resurrecting the dead, and combining flies and humans. *Public Understanding of Science, 12*(3), 289–296. https://doi.org/10.1177/0963662503123007

Russell, K. (Director). (1980). *Altered states* [Film]. Warner Bros.

Schacter, D. L., Gilbert, D. T., & Wegner, D. M. (2011). *Psychology* (2nd ed.). Worth Publishers.

Schiavo, M. L., Prinari, B., Saito, I., Shoji, K., & Benight, C. C. (2019). A dynamic systems approach to triadic reciprocal determinism of social cognitive theory. *Mathematics and Computers in Simulation, 159,* 18–38. https://doi.org/10.1016/j.matcom.2018.10.006

Schumacher, J. (Director). *Flatliners* [Film]. Columbia Pictures.

Scott, R. (Director). (2012). *Prometheus* [Film]. 20th Century Fox; Brandywine Productions; Scott Free Productions; RatPac-Dune Entertainment.

Scott, R. (Director). (2015). *The martian* [Film]. Scott Free Productions; TSG Entertainment; Genre Films.

Scott, R., & Scott, T. (Executive Producers). (2005–2010). *Numb3rs* [TV series]. Scott Brothers' Scott Free Productions; CBS Television Studios; CBS.

Segal, P. (Director). (2000). *Nutty professor II: The Klumps* [Film]. Universal Pictures; RLJE Films; Imagine Entertainment.

Sharp, J. H. (2011). Semiotics as a theoretical foundation of information design. *Conference for Information Systems Applied Research, 4,* 1–6. https://www.researchgate.net/profile/Jason_Sharp4/publication/297706201_Semiotics_as_a_Theoretical_Foundation_of_Information_Design/links/56e08aac08aee77a15fe9ac4/Semiotics-as-a-Theoretical-Foundation-of-Information-Design.pdf

Sjöberg, L., & Engleberg, E. (2009). Risk perception sand movies: A study of availability as a factor in risk perception. *Society for Risk Analysis 30*(1), 95–106. https://doi.org/10.1111/j.1539-6924.2009.01335.x

Smith, H. W. (1975). *Strategies of social science research: The methodological imagination.* Prentice Hall.

Sparks & Honey Cultural Strategists. (2013). *How 100 million Americans are becoming more conscious*. https://bigthink.com/amped/how-100-million-americans-are-becoming-more-conscious

Specht, A. (2013). *A social semiotic discourse analysis of film and television portrayals of agriculture: Implications for American cultural memory* [Doctoral dissertation, Texas A&M University]. BuckeyeBox.

Specht, A. R., & Rutherford, T. (2014). The pastoral fantasy on the silver screen: The influence of film on American cultural memory of the agrarian landscape. *Journal of Applied Communications 99*(1), 21–37.

Spielberg, S. (Director). (1993). *Jurassic park* [Film]. Universal Pictures.

Spottiswoode, R. (Director). *And the band played on* [Film]. HBO Films.

Steinke, J. (2005). Cultural representations of gender and science: Portrayals of female scientists and engineers in popular films. *Science Communication, 27*(1), 27–63. https://doi.org/10.1177/1075547005278610

Stillion, B. D., Pratte, J. M., & Romero, A. (2010). Engagement at the theater: Science in the cinema. *Science Education and Civic Engagement, 2*(2), 41–44.

Szu, E., Osborne, J., & Patterson, A. D. (2017). Factual accuracy and the cultural context of science in popular media: Perspectives of media makers, middle school students, and university students on an entertainment television program. *Public Understanding of Science, 25*(5), 596–611. https://doi.org/10.1177/0963662516655685

Thibault, P. (1991). *Social semiotics as praxis: Text, social meaning making, and nabokov's ada*. University of Minnesota Press.

Thorson, K., & Wells, C. (2015). How gatekeeping still matters: Understanding media effects in an era of curated flows. In T. P. Vos and F. Heinderycks (Eds.), *Gatekeeping in Transition* (pp. 25–44). Routledge.

Tisdell, E. J., & Thompson, P. M. (2007). 'Seeing from a different angle': The role of pop culture in teaching for diversity and critical media literacy in adult education. *International Journal of Lifelong Education, 26*(6), 651–673. https://doi.org/10.1080/02601370701711349

Tukachinsky, R., & Stokunaga, R. (2013). 10 the effects of engagement with entertainment. *Annals of the International Communication Association, 37*(1), 287–322. https://doi.org/10.1080/23808985.2013.11679153

Van Laer, T., de Ruyter, K., Visconti, L. M., & Wetzels, M. (2014). The extended transportation-imagery model: A meta-analysis of antecedents and consequences of consumers' narrative transportation. *Journal of Consumer Research, 40*(5), 797–817. https://doi.org/10.1086673383

Van Leeuwen, T. (2005). *Introducing social semiotics.* Routledge.

Vega, B. G. (2018). *Science and the scientist in Frankenstein: From literature to film adaption* [Master's thesis, Universidad de Valladolid]. Universidad de Valladolid Repositorio Documental.

Verhoeven, P. (Director). (2000). *Hollow man* [Film]. Columbia Pictures.

Wardlow, C. (2017). *A scientist walks into a movie*. Film School Rejects. https://filmschoolrejects.com/a-scientist-walks-into-a-movie-48b98b9e1af2/

Weingart, P., Muhl, C., & Pansegrau, P. (2003). Of power maniacs and unethical geniuses: Science and scientists in fiction film. *Public Understanding of Science, 12*(3), 279–287. https://doi.org/10.1177/0963662503123006

Weingart, P. & Pansegrau, P. (2003). Introduction: Perception and representation of science in literature and fiction film. *Public Understanding of Science, 12*(3), 227–228. https://doi.org/10.1177/0963662503123001

Weir, K. (2013). More than job satisfaction. *American Psychological Association, 44*(11), 39–46. https://www.apa.org/monitor/2013/12/job-satisfaction

Weitekamp, M. A. (2017, January). The images of scientists in *The Big Bang Theory*. *Physics Today, 70*(1), 40–48. https://doi.org/ 10.1063/PT.3.3427

Williams, J. (2011). How do scientists work? In R. Toplis (Ed.), *How science works: Exploring effective pedagogy and practice* (pp. 31–45). Routledge.

Wilson, K. Jr. (Director). (1989). *Day One* [Film]. CBS.

Winkler, H., Mantley, J., & Rich, J. (Executive Producers). (1985–1992). *MacGyver* [Tv Series]. Henry Winkler-John Rich Productions; ABC.

Zemeckis, R. (Director). (1997). *Contact* [Film]. South Side Amusement.