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Scientific entertainment: how audiences interpret science on The Big Bang Theory

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Scientific entertainment: How audiences interpret science on *The Big Bang Theory*

by

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A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Journalism and Mass Communication

Program of Study Committee:
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ABSTRACT

Proponents of science literacy claim that the public needs more knowledge about science, and the field of entertainment education demonstrates that this learning can come through entertainment programming in addition to more informative media products. While studies have examined the effects of entertainment upon science learning in a short-term experimental context, what remains unexplored is why audiences choose to consume entertaining scientific content and how they interpret the embedded science information across long-term relationships with entertainment programming. This study fills this gap by using a uses and gratifications framework to explore why and how audiences select and interpret embedded science information within popular entertainment media.

This study interviewed 45 audience members who have chosen to view at least one full season of *The Big Bang Theory* to explore their reasons for doing so and how they interpret the science within the program. *The Big Bang Theory* is a good context in which to examine these questions because it is a popular television program about science and one in which the producers have publicly stated how they want the program to effect the audience. Results suggest that all participants watch the program for purposes of diversion, although other gratifications are present. Likewise, most participants do not consider that they have learned much science from the program; yet other statements suggest that they are learning science, but conceptualize it differently than how proponents of science literacy do. Other differences are discussed based on the participant's pre-existing knowledge and interest in science.

CHAPTER I

INTRODUCTION

Proponents of science literacy claim that the general public requires some level of accurate scientific knowledge to be able to make informed decisions about themselves and about society (Miller, 1983). In the case of a democracy where public opinion drives politics, this level of accurate scientific knowledge is necessary for society to function at all. However, most proponents of science literacy also note that the current scientific knowledge of the public is far below what is needed (Retzbach et al., 2013). A 2009 national survey found that the general public has trouble answering questions regarding basic science knowledge (Pew Research Center, 2009). For instance, the latest survey finds fewer than 50% of the public knows that atoms are larger than electrons or that lasers do not work by focusing sound waves. The National Science Foundation (NSF) collects biannual scientific literacy data from which Dudo et al. (2011) concluded that science knowledge has not improved over the seven years examined. When scientists themselves were polled in the same Pew Research survey mentioned above, 85% of scientists think it is a major problem that the public does not know much about science; 76% believe the news do not distinguish well-founded science from not and 48% believe and consider it problematic that news media oversimplify scientific findings (Pew Research Center, 2009). Things did not change well. In 2015 Pew Research Center's survey, researchers found out that most Americans can answer basic questions, such as 86% of Americans can describe the Earth's inner layer, 82% of participants can answer uranium is the source to make nuclear weapon. However, only 29% of Americans and 16% of American Association for the Advancement of Science members think the country's K-12 STEM education can be ranged among top of the world (Pew Research Center, 2015).

While the public may not meet the benchmarks of science literacy as conceptualized above, the public does generally seem to find science interesting and trustworthy. The National Science Foundation (2014) reported that 50% of the public considered that the benefits of science “strongly” (p. 29) outweigh the negatives and the Pew Research Center (2009) finds that most Americans think science has a positive impact on our society and makes their lives easier. Regarding where and how often the public gets their science information, 35% of Americans say they read science news “very often” with an additional 41% noting they do try to read “some” science news. And 67% of Americans say they regularly watch scientific information on television (Pew Research Center, 2009, p. 49).

However, research into entertainment education emphasizes that individuals do not only learn from news or serious media products -- content designed to be entertaining can also inform audiences.

Singhal and Rogers (1999) defined:

Entertainment education [as] the process of purposely designing and implementing a media message to both entertain and educate in order to increase audience members’ knowledge about an educational issue, create favorable attitudes, shift social norms, and change the overt behavior of individuals and communities (p. 9).

Singhal, Cody, Rogers and Sabido (2004) concluded that entertainment education is a “communication strategy” (p. 32) used toward positive change among audiences. For example, McKee, Aghi, Carnegie and Shahzadi (2004) examined the effectiveness of entertainment-education using a cartoon entitled *Meena*. *Meena* is aimed at changing children’s perceptions and behaviors “that hamper the survival, protection and development of girls in South Asia” (Pantha & Rezwan, 2014, para. 3). *Meena* is a young South Asian girl who wants equal treatment in her

society (McKee, Aghi, Carnegie & Shahzadi, 2004). When Meena finds she has received less food than her brother, she asks why and the answers she receives and her subsequent actions both entertain and persuade toward the program's desired ends. Entertainment education can be an effective persuasive message for viewers because it can get them involved into the narrative structure (Moyer-Gusé, 2008) or so mentally engaged into the story world that their attitudes or behavioral intentions may align with those presented in the narrative (Green, & Brock, 2000).

This effect of entertainment education extends to the realm of science communication as well. Looking at how science is portrayed in entertainment media, Gerbner (1987) concluded that compared with other occupations on television, such as lawyers and doctors, scientists are more likely to be portrayed as bad or evil, or as the odd character in TV shows. More recently, Dudo et al. (2011) replicated the analysis in a more recent media environment and found that the portrayals of scientists are now more positive, often being seen as geeky or honest.

Moving beyond portrayal, other studies have explored the effects of science-related entertainment messages. Collins, Elliott, Berry, Kanouse, & Hunter (2003) examined an episode of the comedy *Friends* that conveyed a condom-efficacy message teaching teens about safe sex, and found it resulted in effective attitude change toward the narrative message. Cody, Fernandes and Wilkin (2004) explored an episode from the BBC soap opera *EastEnder* that educated the public "how to cope with [HIV], the importance of social support structures and medical assistance at lives' end" (p. 243). Similar studies have explored the effects of science-related entertainment education in health communication (Le, 2006), risk communication (Retzbach et al., 2013) and agricultural communication (Hornik, 1988).

While these studies have examined the effects of entertainment upon science learning in a short-term experimental context, what so far remains unexplored is why audiences choose to consume entertaining scientific content and how they interpret the embedded science information across long term relationships with entertainment programming. This study will fill this gap by using a uses and gratifications framework to explore why and how audiences select and interpret embedded science information within popular entertainment media.

The results of this research can be important for multiple reasons. From the media side, the results can be used to better allow media producers to create science content that will align with how audiences seek out and interpret the messages. From the individual side, the results can be used to better understand the role that science information play in individual's lives and the needs that it fulfills. From the society side, improved alignment of media production and audience needs may eventually improve scientific literacy and ultimately the application of scientific knowledge within our democratic society.

Specifically, this study will interview audiences that have chosen to view at least one full season of *The Big Bang Theory* to explore their reasons for doing so and how they interpret the science within the program. *The Big Bang Theory* is a good context in which to examine these questions because it is a popular television program about science among college students, the story setting is scientists work in university as well and one in which the producers have publicly stated how they want the program to affect the audience.

CHAPTER 2

LITERATURE REVIEW

Science Communication

“Science and technology are an integral part of our culture and heavily influence our everyday lives” (Bowater & Yeoman, 2013, p.1). Science communication, therefore, is the process by which information about this science and technology is disseminated to various audiences. While in a broad sense science communication can involve any communication of science-related information, it is often used to describe the public communication can present scientific topics to people who are not good at science. This process is also referred to as the popularization of science (Davis, 2010), which involves the “appropriate simplification” of complex science to lay publics (Hilgartner, 1990, p. 529). While the actual practice of science communication can follow a range of models, U.S. maintains a solid scientific literacy and educational and teaching method (Bowater & Yeoman, 2013).

Scientific literacy is the knowledge and understanding of scientific facts and processes (Bowater & Yeoman, 2013). Scientific literacy has four elements, (1) a knowledge of basic textbook facts of science; (2) an understanding of scientific methods, e.g. experimental design; (3) an appreciation of the positive outcomes of science and technology; (4) a rejection of superstitious beliefs. Science for All Americans (AAAS, 1989) defined a scientifically literate person as “one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes” (p. 4).

Science literacy is claimed to be beneficial in many ways. Thomas and Durant (1987) said to benefit society through the “promoting the public understanding of science, including benefits to science, benefits to individuals and benefits to society ” (as cited in Hodson, 2008, p. 9). On the other hand, Thomas and Durant (1987) pointed out there is another benefit as it “may be thought to promote more democratic decision making by encourage people to exercise their democratic rights... to promote more effective decision-making” (as cited in Hodson, 2008, p. 14). Science literacy is also said to support science itself. A scientific literate public is believed to support science in general because the public values science and understand what scientists do (Hodson, 2008). Finally, scientific literacy is also said to benefit individuals within society. There is one purposes of science communication is to convey knowledge so that it can be assimilated in a form, then offer it to intended audience (Gregory & Miller, 1998). It can give people more opportunities to get better jobs and be better prepared to adopt new technology. Also it can help them make better and important decisions, related to “health, security and economic well-being” (Hodson, 2008, p. 10).

Therefore, Bowater and Yeoman (2013) claimed that many scientists and science communication scholars suggest that the public ought to “have a stock of scientific knowledge akin to literacy and numeracy” (p. 11) if they are to be useful citizens, adapt for functioning as workers, consumers, and voters in our modern society (as cited in Bauer *et al.*, 2007).

Furthermore, this stock of knowledge can be tested (Hodson, 2008). However, most proponents of science literacy also note that when science literacy is measured, the public is far below what is needed. The Pew Research Center (2009) found that even though the public was familiar with basic science knowledge that affected their health and daily lives, they couldn’t handle “textbook” science questions as well. For example, just over 50% of people know that

antibiotics cannot kill viruses and bacteria and more than a third of the public does not realize that some radioactivity is naturally occurring (Pew Research Center, 2009, p. 52).

In response, the government has invested in trying to improve the public's science knowledge. In 2013, NSF collaborated with other organizations, such as the UK-based Wellcome Trust and the Noyce Foundation to spend \$14.4 million on science learning, supporting research into "how learning happens outside the classroom and exploring the most effective practices and building the evidence base in science area" (NSF, 2014, para. 5). Likewise, the Informal Science Education program (ISE) tries to increase the public's appreciation and understanding of science, technology, engineering and mathematics (STEM) through numerous grant opportunities.

One supposed cause for this lack of scientific literacy is the "distortion" of science information by the mass media. The traditional view of the popularization of science describes a two-stage model where (1) scientists develop genuine scientific knowledge and (2) popularizers disseminate simplified accounts to the public (Hilgartner, 1990, p. 533). However, either due to media bias or simply a lack of understanding, these simplified accounts are seen, at best, as inferior to the science or worse, as a harmful distortion of it. Hilgartner (1990) refutes this idea, claiming that the task of differentiating genuine knowledge from popularized knowledge is not straightforward, and claims of distortion are often used by scientists to retain power over the societal interpretation of their data.

Nevertheless, popularization raises the issue of how much the public is interested in science and from what sources they receive their information. The Science and Engineering Indicators reported (2012) that "Americans have consistently expressed interest in science and technology, with 41% reporting they were 'very interested' and 50% reporting they were

‘moderately interested’ in new scientific discoveries” (p. 4). Additionally, mass media turns out to be the most important source used to obtain science information. “Americans are now about equally likely to rely on the Internet as on television as their primary source of general science and technology information” (p. 4).

In the new media era, the mass media provides many opportunities to influence the public’s knowledge and view of science. This influence works at two levels: first is that the media is the main source from which people receive science information and the second is that the media’s particular portrayals of science influence what can be understood. Therefore, understanding how science is disseminated through the mass media and how individuals seek out and make sense of that information can help understand how science literacy is developed from an audience side.

But in what forms are science disseminated through the mass media? While the most common format surveyed are informative news reports, Bowater and Yeoman (2013) emphasize that science information within the media are present in many formats, including entertainment programming.

Narrative Transportation and Entertainment Education

Entertainment media is content consumed for mostly enjoyable reasons, often resulting in a positive mood and the desire to seek out similar experiences in the future (Green, Brock & Kaufman, 2004). Yet, entertainment media can have more of an effect than mood manipulation. “Certain entertainment content has the potential to influence how traditional forms of public affairs material are perceived and subsequently consumed by an audience” (Holbert, Lambe, Dudo & Carlton, 2007, p. 22). One process by which entertainment media can influence audiences is through narrative persuasion.

One key of entertainment media is that it can take people away from reality into a fictional, narrative world (Green, Brock & Kaufman, 2004). This process of mentally engaging with a narrative world is called transportation (Green & Brock, 2000). Green and Brock (2000) state, “to the extent that individuals are absorbed into a story or transported into a narrative world, they may show effects of the story on their real-world beliefs” (p. 702). Highly transported people are more likely to accept the information provided in narratives and to modify their attitudes to agree with the narrative conclusions (Green & Brock, 2000). Additionally, transportation can create openness to new information, allowing audiences to use the knowledge from what they have seen on TV in their everyday reality (Green, Brock & Kaufman, 2004). For instance, Moyer-Gusé (2008) explored how the television program *Soul City* used dramatic plots to influence knowledge and attitudes toward HIV prevention, condom use, rape and other social issues.

Transportation also provides opportunities for “identity play” (Green, Brock & Kaufman, 2004, p. 318), because transportation can “open the doors to exploring and experimenting with other possible selves” (p. 318), media viewers don’t need to change their lives in order to experience different perspectives. Beyond individual perspectives, people who are highly transported also tend to identify with the characters in narrative stories– often considering the characters if “they were real people” (Green, Brock & Kaufman, 2004, p. 318). Green and Brock (2000) said that sympathetic characters may come to seem like friends and in some cases this bond may help satisfy viewers’ need for belonging and identifying (Green, Brock & Kaufman, 2004). When individuals become highly involved in a narrative world, they will “develop a strong sense of connection of familiarity with characters encountered repeatedly or continuously

over time” (Green, Broke & Kaufman, 2004, p. 319). The characters’ situations and experiences can then be integrated into the audiences’ own lives (Giles, 2002).

While transportation can occur with a narrative created for any purpose, entertainment-education (E-E) is defined as “the process of purposely designing and implementing a media message to both entertain and educate, in order to increase audience members’ knowledge about an educational issue, create favorable attitudes, shift social norms, and change overt behavior” (Singhal & Rogers, 1999, p. 9). Entertainment-education is a strategy for containing “educational messages into popular entertainment media with the goal of positively influencing awareness, knowledge, attitudes, and/or behaviors” (Moyer-Gusé, 2008, p. 407). Combining the effects of transportation with a purposefully designed narrative toward particular aims can result in strong persuasion. In fact, Moyer-Gusé (2008) states “entertainment-education may offer a more effective way to influence attitudes and behavior than traditional persuasive messages by arousing less resistance to the persuasive messages contained within a narrative” (p. 408). For instance, *Meet the Montoyas* was a comic book series produced by New Mexico Department of Health’s Diabetes Control Program to portray positive ways that Hispanic families can deal with the diabetes (Singhal et al., 2004).

While informative news is often considered to be the main purveyor of science information to the public, science communicators are starting to turn to entertainment media as a way to influence more people about science. Humor, storytelling and metaphors can be used for entertainment and persuasion in science communication (Center for Inquiry, 2009; Miller, 2008). Many of the federal science funding agencies now have groups designed to work with Hollywood and television producers to improve the portrayal of science in entertainment programming, including the NSF (Whiteman, 2009), NAS (Jackson, 2014) and CDC’s

entertainment education (CDC, 2015). Entertainment media with a focus on science is not just growing, but also popular. *The Big Bang Theory* is a sitcom focused on science, which was number two in the ratings for the 2013-14 TV season with over 20 million viewers (TV by the Numbers, 2014; Mitovich, 2014).

The Big Bang Theory

The Big Bang Theory is a comedy currently airing on CBS. The program presents four young scientists who are “neurotic, competitive and socially inept, who resemble the well-known stereotype of the mad scientist, albeit without the grey hair” (Bowater & Yeoman, 2013. p. 25). For example, the main character is Sheldon, who has an IQ of 187, went to college at 11 and earned his Ph.D. at 16. In this show, he lacks any understanding of irony and sarcasm, doesn’t understand romantic situations, and displays strict and unique habits that often serve as a comedic foundation. Additionally, *The Big Bang Theory* routinely includes scientific information within the setting, plot or jokes, demanding at least some level of scientific understanding to “get” the joke. For example, in one episode Sheldon uses Dutch researcher Mirjam Tuk’s theory that people with a full bladder can make better decisions to helping him to decide which new video game console to purchase.

While *The Big Bang Theory* may appear merely created for entertainment, the program does tend toward entertainment education as the producers have discussed their goals for creating the program in a series of media interviews. First, the producers want their audiences to be more interested in science. When asked if he thinks *The Big Bang Theory* helps the public understand science, Erik Kaplan, the co-producer of *The Big Bang Theory*, stated that some audiences have become more interested in science because of the program (Ulaby, 2013).

Second, the producers claim they want to change stereotypes and humanize scientists. Erik Kaplan said, “What we try to do is to make people feel that scientists are real people and that science is something that real people, like themselves, could do” (Vance, 2013, para. 2).

Third, the producers claim they hope *The Big Bang Theory* persuades more people to become scientists. David Saltzberg, the science advisor *The Big Bang Theory*, said that one of the reasons he decided to become a scientist was from a television show named *Space: 1999*. He believes that the “rigor and passion for science” presented in *The Big Bang Theory* might inspired children in the audience to “one day become scientists, too” (Ulaby, 2013, para. 21).

Even if *The Big Bang Theory* is produced mainly for entertainment purposes, these statements suggest that some aspect of its creation was toward specific persuasive aims related to science and its perceptions. However, these goals come from the creators themselves – what remains unknown is how audiences react to these aims and how they either guide or conflict with the audiences’ goals for their own viewing experiences.

Uses and Gratifications Theory

While entertainment education studies often measure attitude change after exposing participants to a message or measure general changes in attitudes across a selected population, a uses and gratifications framework focuses on why individual audience members select certain messages and what they gain from doing so. Specifically, uses and gratifications explore media use and its effect in a realistic media environment to provide a better understanding of how individuals interact with media. There are three tenets of the theory: “(1) consumers actively seek out the media to satisfy individual needs; (2) consumers’ communication choices are purposeful and goal-directed; and (3) consumers are conscious of their own motives in using the media” (Chua, Goh & Lee, 2011, p. 14). Based on these tenants, audiences are not passive but

instead actively seek out “the type of media to use for satiating a specific need” (Hicks, Comp, Horovitz, Hovarter, Miki & Bevan, 2012, p. 2275).

While the needs satisfied by media can be diverse, the theory often categorizes needs into the following four types of gratifications. (1) Diversion refers to a way to escape everyday problems through emotional release; (2) personal relationships refers to a way to build or foster relationships with others; (3) personal identity refers to a way to better define the self through self-reference, reality exploration, or value reinforcement and (4) surveillance refers to a desire to learn new information about a particular topic (McQuail, 2010). Uses and gratifications studies often use these gratifications to categorize why individuals seek certain media. For instance, a uses and gratifications study into why individuals use Yelp.com found it was mostly used for surveillance/information-seeking purposes, with less purposes of entertainment, convenience, interpersonal utility, or diversion (Hicks, Comp, Horovitz, Hovarter, Miki & Bevan, 2012).

Beyond just gratifications sought, uses and gratifications can also be used to explore how audiences interpret the content they consume and how they evaluate it afterwards to determine if it fulfilled their expected gratifications. For example, Grellhesl & Punyanunt-Carter (2012) used the uses and gratifications theory to compare the relationship between gratifications and text messaging practices for undergraduate students. They found text messages were used by students who found the experience easier and more convenient than competing forms of messaging.

While uses and gratifications provide an important perspective to understand media use and effect, it has largely been overlooked in a science communication context related to entertainment media.

Study Objectives

Discussions of science literacy often focus on what science information can bring to the public, how science information should influence the public or how to do a better job of educating the public. Similarly, entertainment media can represent an important source of science-related information and attitudes, but existing research has mostly focused on controlled effect studies or general surveys that do not permit a good understanding of why audiences choose to consume science-related entertainment media or how they interpret or evaluate their experience. This study aims to fill this gap by providing a uses and gratifications perspective on how audiences engage with science-related entertainment media and how such interaction may lead to science literacy. Specifically, this study will use *The Big Bang Theory* as the entertainment context to explore why fans of the program choose to watch and how they interpret and use the science portrayed within the program.

Research Questions

- RQ1. What gratifications are being met when audiences watch *The Big Bang Theory*?
- RQ2. What elements of transportation are present when audiences watch *The Big Bang Theory*?
- RQ3. What categories of science-related content do audiences take away from *The Big Bang Theory*?
- RQ4. How has the consumption of this science-related content influenced the audience relative to science literacy goal of using science to improve decision-making in real life?
- RQ5. How well does this actual audience influence align with the influence intended by the series producers?
- RQ6. How do individuals in a science-related field or area of study differ on the above questions compared to individuals in a non science-related field?

CHAPTER 3

METHODS

Sample

Because this research intends to explore audience's ongoing interactions with *The Big Bang Theory*, interviewees needed to have a pre-existing relationship with the program.

Therefore, participants were only included if they have watched at least one season of the program. Participants continued to be interviewed until saturation was found in the responses. This study received IRB approval.

A total of 45 interviewee participated in this study. Several methods were used to recruit participants. Snowball sampling resulted in 26 participants, postings on social media resulted in an additional 18 participants and a mass email and flyer campaign at a large Midwest university resulted in an additional two participants. In all, the final sample consisted of 53% females with an average age of 26 ($SD = 2.67$); 89% were graduate students and 11% were undergraduate; 60% were in STEM fields while 40% were not; and 27% were U.S. citizens, 57% were Chinese and 16% were students from other foreign countries. See table 1 for a breakdown of the sample characteristics.

Table 1: Information for STEM and non-STEM field participants

	Graduate Students		Undergraduate Students	
STEM field	Male: 17	US: 4	Male: 0	US: 0
	Female: 11	International: 24	Female: 0	International: 0
Non-STEM field	Male: 4	US: 7	Male: 1	US: 4
	Female: 13	International: 10	Female: 4	International: 1

Procedure

Data was collected through in-depth interviews as this methodology can provide a depth of information not possible from survey based questionnaires and allow the interviewer to pose follow-up questions based on the unique responses of each respondents (Wimmer & Dominick, 2013). Interviews were conducted either in person or over Skype or Whatsapp and lasted between 13-50 minutes with an average of 26 minutes (SD = 8.66) All interviews were recorded and transcribed.

The interview questions began broad to allow audiences to offer and articulate concepts in their own words first. More specific questions followed to cue specific concepts of interest for this study.

Specifically, this study links four areas of literature and the interview questions were designed to elicit discussion on how the interviewee experienced factors from these conceptual areas.

Questions exploring Uses and Gratifications asked why participants choose to watch the program and what they got out of the experience and if science played a role in the needs sought. Questions exploring transportation asked about the level of engagement when watching the program and the degree of identification or liking audiences have with the characters. Questions focused on science literacy asked if any the reported goals of science literacy do individuals remember taking away from *The Big Bang Theory* as well as their thoughts on the relationship of the program to larger benefits of science literacy. Finally, questions exploring entertainment education asked if the experienced outcomes of engaging with the program align with the intended outcomes stated by the series producers. See the appendix for the full question list that guided the interviews.

Transcripts were analyzed using a three-step coding process to ensure that the themes identified were representative of the full data collected. In the first step, all responses were read and initial themes identified. In the second step, the responses were divided into two groups based on if the participant was from a STEM field or not. All responses were read again within this grouping and additional themes were found and some of the initial themes modified. In the third and final step, all responses were again combined and read again to confirm that the previous themes were representative of the data. During this process, themes continued to be refined and affirmed until the final results were summarized.

CHAPTER 4

RESULTS

The results from each of the first five research questions will be reported in turn. The final research question (RQ6) is crosscutting as it asks if participants from a science-related field differ relative to the other research questions compared to participants in non science-related fields. Therefore, the results of RQ6 will be discussed alongside the results of each of the other research questions.

Uses and Gratifications

The first research question asked what gratifications are being met when audiences watch *The Big Bang Theory*. Every participant described diversion as a primary gratification, often noting that they watch the show because it is funny. For instance, participant R noted, “It is fun. I mean it is easy. I used to watch a lot of TV that heavy, now I just like watching show that is easy, and *The Big Bang Theory* is easy, it is fun, it does not require a lot of you.” Similarly, participant C said that he wants comedy to relax him when he feels bored and participant V noted that he watched the show when he just wants to kill time.

Personal identity was also noted by 60% of the sample as a primary gratification. The form of this gratification varied, from identifying with the “nerdiness” of the characters, such as when Participant D noted that “the show talks about nerds; I feel they are close to us,” or seeing similarities with their own lives, such as when Participant E said, “I like the program and the characters, sometimes they remind me of my friends.” This gratification even extended to identifying with the perceived intended audience the producers were trying to reach. Participant K felt that he was part of a small group that was able to understand the humor. “I think the show is very unique, its humor is unique. Only STEM students can get them, and I am the lucky guy.”

Fostering personal relationships as a gratification was also prevalent. Liking characters from the program was noted by 36% of the sample. This category focuses more on liking relationships with fictional characters rather than the real life relationships often implied by this gratification. However, these relationships were mentioned with enough frequency that they are included in this category, such as when Participant B noted, “I like the show because I enjoy the interactions between characters,” and when participant U said she liked the program because, “Sheldon made me laugh. Then I enjoyed how smart he was, how funny.” If the conceptualization of this relationship gratification is limited to fostering real life relationships, the frequency drops significantly, with only 7% of the sample mentioning anything related to real relationships. The ones that did describing using the program to as a social topic for discussion or to show off, as Participant F described, “I am not from STEM field, so I want to know more scientific knowledge to show off in front of my friends, I think that is cool.”

The final gratification, surveillance or the desire to learn new information about a particular topic, was also present but also at lower frequencies at 22% of the sample. The knowledge sought ranged from learning about science, such as when Participant A noted there is some physics you can learn from the show, to leaning more about American culture, as when Participant C said that the reason he watches the show is because he studies abroad in America and he wants to “figure out what Americans usually do in university.”

Contrasting participants in STEM fields from those who are not, the largest difference regards personal identity. Most of the participants from STEM fields mentioned the similarity they feel from the context and that they can identify with characters and situations from the program. For instance, they like physics, so they watch the show, or that they think the show talks about nerds, and since they are also a nerd, they like to watch it.

People from non-STEM field, on the other hand, were less likely to identify with the characters and instead focus on the interactions between characters as a liking relationship or as mere diversion. For example, both STEM and non-STEM participants described the characters in *The Big Bang Theory* as being “nerds,” but this label was interpreted differently. Participants from STEM fields used “nerd” to self-identify and feel similar to the characters while non-STEM field participants referred to a “nerd” as being funny because it was outside the norm.

Finally, as described within the theory, gratifications are dynamic and may change throughout the process of consuming media. Some participants noted how their gratifications changed as they continued to watch the program. Scientific jokes that before were uninterpretable became a source of humor or even learning as more time was spent with the program. Likewise, even non-STEM participants began to identify more with characters after spending more time with the program, thinking, “if I had a friend like Leonard...” or “if I were Leonard...”

For example, Participant F, a non-STEM graduate student, described that she began watching the show for diversion as she just thought it was funny. As she continued watching, she started thinking she could learn something from the program and that science itself was “very cool.” She was able to recite some specific science-related lines from the program about string theory and Schrödinger’s cat, and notes she thinks it impresses others when she uses that information when talking with her friends.

Transportation

The second research question asked what elements of transportation are present when audiences watch *The Big Bang Theory*. Based on the responses from the participants, the concept of transportation will be extended in this section to include broader concepts of engagement,

including interaction, identification and liking. The experiences of watching the program turned out to depend more on if the participant primarily watched the program on television or on their laptop rather than if their field was STEM or not. Television was the primary medium used for 31% of the sample with the remaining 69% opted more often to watch on their laptop.

Participants who primarily used television to watch the show exhibited varying degrees of engagement. Some participants noted that they explicitly set aside time to watch the program or record multiple programs on DVR to watch when they have time. However, other participants would only watch when they happened upon the program. Participant Z noted: “I don't set aside a time, if I happened to flip the channel, and catch it, and then I will watch it.” Even so, all participants who primarily used television noted that they focused on the program when watching and did not do other tasks at the same time.

Participants who primarily used television to watch the show also tended to watch with others. The program was therefore not solely for diversion, but also for relationship building, a gratification that the participants seemed not to acknowledge or be aware of in the previously asked gratification questions. This social consumption also allowed for increased discussion and engagement with the content. Participant AA said, “I will watch the show in the living room, usually with my family. We usually talk about [it] when we watching it, like oh no, this is going too terrible. Oh no, here it is comes, things like that. And we pretty much just laugh.” Participant BB said about who watches, “Usually family, my daughter and my daughter’s mother. We usually watch it whenever it is on. Or my friends and I watch it together. And we talk about it during the show or on the commercial.”

However, participants who primarily used television to watch the show say that they do not often go back to think about an episode afterwards. When asked if he does go back,

Participant R said “not much. I have such limited TV time that I watch. Usually I watch the show once and then I deleted it.”

In contrast, participants who primarily used their laptop to watch the show appear more goal driven to watch the program as they must actively visit a streaming site to do so. Similar to the other group, this group also notes that they focus on the program when watching rather than turn it on in the background while doing other things. Participant H said, “When I watch the show, I would like to focus on it. Because my major is not physics, some topics they talk about I am not familiar with. So if I [do] not focus on it, I may [not] understand what they were talking about.”

However, participants who primarily used their laptop to watch the show usually do so by themselves. They often note a strong purpose to receive science information or scientific jokes from the show, but they don't have much willingness or chance to discuss this with others. Participant F said, “I watch the show by myself and no, not very often. Some of my friends don't like nerdy shows, so I won't discuss with them.” Similarly, participant K said, “I watch the show alone. And I used to like to talk with my friends sometimes, like [about] the 3D printer, but I found out they didn't pay much attention on that. So now, I just watch the show by myself.”

Participants who primarily used their laptop to watch the show also tend to acknowledge going back to think about the show more often after watching. Participant DD said: “I sometimes will go back and think about [an] episode. Like there is an episode about [when] Howard and Bernadette had their anniversary, Howard made a song for her, I really like that song. It combined with science, romance and literature in it.” Participant F said, “If they talk about funny theories or jokes, then I will go back and take a look.”

In sum, the platform in which the participants chose to view the program was related to different types of engagement and transportation. All participants noted that they focus their attention on the program when they watch *The Big Bang Theory*, suggesting a transporting experience. However, participants who watch on television are less focused on seeking out the program and elaborate less on the content after watching. However, they also are more likely to watch the program with others and engage in discussion during the program. In contrast, participants who watch on their laptop are more focused on seeking out the program and do elaborate on the content after watching, yet watch alone and seem to lack the engagement of social discussion while viewing.

Finally, regarding liking relationships, there seem to be little difference between participants in a STEM versus non-STEM field when they talk about their favorite characters. All participants had their own favorite characters, which was not related to their academic background, but instead to their personality and experiences. For instance, Participant B described how she thought about the characters when she said, “What if they were real people in my life or what if they were my friend? Could I accept what they did?” Participants from both STEM and non-STEM fields said there are times when they don't understand the science within the program, but thought it wouldn't hinder their understanding of the plots and characters.

Science Content

The third research question asked what categories of science-related content do audiences take away from *The Big Bang Theory*. When asked to think about the types of science present in the program, interviewees almost exclusively thought about the hard sciences, specifically physics, chemistry, engineering and biology. Participant Q articulated this focus most clearly. When asked to talk about science, she qualified, “I am talking about hard science.” For this

section, there was little difference between participants in STEM and non-STEM fields; both groups seemed to identify and take away the same types of science-related content.

Science is an intrinsic part of the program, as noted when participant N said, “I think science is everywhere in this show. Like their conversation, when they eat lunch together, they talked a lot about science. And everything [that] happened, like Howard went to space.”

However, the category of science that was most referenced and resulted in the most engagement was science presented as part of a joke. Many participants noted that they would go online to seek more information about the science within a joke, either to better “get” the joke or because the joke made them more curious about the science itself. Participant M described that “There [are] jokes and fun facts... And sometimes only scientists can know the jokes. If you are not scientist, it is not easy for you to get those jokes.” Participant G, who was in a STEM-field, said that she felt she already knew most of the science mentioned on the program and “...so most of the time, I focused on [searching about] jokes from the show.” The power of the humor to focus the participants attention around the science was best articulated by participant C. “We do not talk about science related content, we talk about jokes.”

Beyond jokes, the second most mentioned category of science taken away from the program was short, cause-and-effect relationships that were sometimes referred to as science “tips.” These were often scientific descriptions of effects that played some role in the plot line of the program and could be implemented in real life. For instance, participant L remembered one episode where it was said singing songs while doing an activity would increase the efficiency of that activity. Likewise, participant Y noted, “there is one episode, [where] Sheldon eats brussel sprouts and then keeps farting. I noticed that, [and] then I never eat brussel sprouts again.”

Additionally, while jokes and “tips” were most often mentioned, a few participants did acknowledge noticing and looking up information related to general science topics discussed. Participant H said, “I do not have strong physics background, [so] I would Google some of them. Usually I will read some related articles. For example, some website may recommended articles related to *The Big Bang Theory*, then I would read them all.” Similarly, participant K noted that he likes to Google some scientific items or results from the show, such as “Schrödinger’s cat.” However, “I can only understand the superficial level. I could not tell what exactly that is. But I know what they talk about on the show.”

The fourth research question asked how has the consumption of this science-related content influenced the audience relative to science literacy goals, specifically, the increased ability to use science in everyday decision-making. In general, participants did not think the science content present in *The Big Bang Theory* was useful in a practical sense. This is partially because the “science” often thought of relative to *The Big Bang Theory* falls into topics of theoretical physics, such as string theory or black holes, which the participants noted were not applicable in their daily life. For participants not from a STEM field, they think this science is complicated and difficult to understand and so it is not significant to them. For participants who are from a STEM field, they think this science content is not new information, so there is no benefit.

Above all, interviewees did not think the science content from the program had much influence on them because, “this is just a TV show.” Even though some participants acknowledged learning something from the show, they thought what they learned was superficial and not important to their daily or academic life.

Entertainment Education

The fifth research question asked how well does the actual audience influence align with the influence intended by the series producers. The producers of *The Big Bang Theory* have stated three goals to their audiences: 1) to increase interest in science, 2) to change stereotypes and humanize scientists and 3) to persuade more people to become scientists.

In regard to increasing interest in science, the participants were somewhat split. Many of the participants from a STEM-field thought that the program had no influence on their interest in science because they already had an interest to begin with. Participant G described it this way: “I am kind of a scientist. I like science. I think it is because I like science, [that] I want to watch the show. Not because the show makes me get more interested in science”.

In contrast, just over half of the participants who were not from STEM-fields did note that the program had made them more interested in science. These participants said they would be more likely to read science news or to search online for science topics, results or scientists mentioned in the show. Participant F even claimed that, “because of this program, I want to study physics.” However, the remaining non STEM-field participants disagreed that the program made them more interested in science because they didn’t think they understood the science from the show. Participant N said, “I do not understand the science part, so I do not think it changes my thought about science.” Even though understanding the science is not a requirement for increased interest in science, these participants linked the two, possibly implying that they don’t understand the science because they are not interested enough to try to do so.

In regard to the second goal of to changing stereotypes and humanizing scientists, all of the participants agreed that the show humanizes scientists. Participant R said, “I think they humanize scientists and make scientists look like real people,” she then added, “I do think they

humanize scientists, but I don't know if they change stereotypes.” This question of whether this humanizing changed stereotypes was contentious among the participants.

Within the participants from a STEM field, some thought the program was breaking stereotypes by showing a more a positive side of scientists, such that they are humorous, charming, professional and passionate. Other participants from a STEM field worried that it was playing off of old, negative stereotypes to make fun of scientists, such that they are not flexible, not good at being social, nerdy or too focused on research. Participants who were not from STEM fields thought more positive, they think the show portrayed scientists are smart; they feel close to scientists through the show; they know scientists are real people, they have their troubles and happiness.

In regard to the final goal of persuading more people to become scientists, none of the participants reported an increased interest in becoming a scientist. Much of this has to do with the sample, which represents students who have already decided on their intended area of study. However, the answers did show a strong third person effect as all the participants noted that they thought the program could persuade people who are in high school or middle school. Participant T said, “I think people who have not decided what they want to do..., they may think oh, I can do [a] major in science. They watch something for entertainment, [but] it will probably ... help them to make decision, considering science as an option.”

CHAPTER 5

DISCUSSION

News and textbooks are not the only sources for people to learn about science -- people can also learn about science from entertainment television series as well. Striating with an entertainment education foundation, this study focused extending our understanding from an effects paradigm to a uses and gratifications perspective on how audiences engage with science-related entertainment media and how such interaction may relate to aspects of science literacy. Specifically, this study used *The Big Bang Theory* as an entertainment context to explore why audiences of the program choose to watch and how they interpret and use the science portrayed within the program.

There were two primary groups within the sample, differentiated by whether or not an individual is currently in a STEM field of study. Because both the program of interest and the proposed research questions focus on science, an individual's pre-existing knowledge and experience relative to science would likely influence interpretations. This difference did manifest in some of the science-related content, such as participants in a STEM field of study were more likely to self-identify with the "nerdy" characters and less likely to feel more interested in science because of the program. However, this difference had little impact on the more entertainment-related variables, such as how participants engaged with the program or how they thought the program would influence others.

Gratifications and Transportation

The ways that media can influence audiences depends on the reasons that audiences choose to consume that media in the first place. All the participants noted that they chose to watch *The Big Bang Theory* for reasons of diversion, specifically because it was funny. This sets

a foundation for further discussion of entertainment education because the participants did indeed see the program as entertainment and sought it out primarily for escape and enjoyment. Even when participants felt they did not understand the science within the program, they continued watching because they were able to understand the character motivations and events enough to enjoy the program – and since that was the primary purpose, their needs were satisfied.

Other gratifications were present, however, which shows the complexity in understanding what audiences get out of consuming certain media products. Participants from STEM fields also used the program for purposes of personal identity, seeing similarities in the settings and events and identifying with the “nerdiness” of the characters in ways that the non-STEM participants did not. To a smaller degree, participants also used *The Big Bang Theory* to actively try to learn content or to build relationship, either by showing off what knowledge they gained or by merely watching with others.

The degree of engagement with the program will also determine the degree of influence a media product can have on audiences. The participants all reported active engagement with the program, focusing on the content while watching and not trying to multitask or using the program as background content. However, the platform used seemed to alter the type of engagement. Participants who primarily watched the program on television usually watched with others and engaged in social discussion of the program, but were less engaged before or after the program. In contrast, participants who primarily watched the program on their laptop were more likely to actively seek out the program and think about it afterwards but lacked this social discussion during the program.

Future research should explore if these groupings of engagement result in different persuasive outcomes, possibly comparing social engagement during a program with individual elaboration afterwards. Regardless of these nuances, the participants reported activities and rituals surrounding the program to suggest that they were likely sufficiently transported to expect influence predicted from entertainment education theory.

Likewise, a possible grouping factor beyond STEM versus non-STEM would be the length of time a viewer has spent watching the program. In this study, the range of viewing length ranged from two to nine seasons, yet this difference showed no impact on any of the questions of interest. Future research should explore this lack of a relationship and test what factors, if any, are impacted by length of relationship with an entertainment program.

Science Literacy and Entertainment Education

This study explored how audiences interpret the embedded science information within the program. Neither the STEM and non-STEM participants thought they learned much science from the program, either because they already thought they knew the content or because the main topic of hard science and theories were not seen as useful to their daily lives. Yet, both groups were able to clearly recall specific science-related content present in the program and many reported that they search online to better understand the science presented as jokes within the plot of the program. This discrepancy between a lack of perceived learning and behavior that suggests learning is taking place may be due to how the participants conceptualized “science knowledge.” Many of the participants assumed that the science needed to be relevant to their lives to count as learning, however the tenants of science literacy would consider the behaviors described to be indicate of an increase in science literacy, specifically the first two elements: (1) a knowledge of basic textbook facts of science and (2) an understanding of scientific methods.

Whether the participants are placing too little value on basic facts or proponents of science literacy are giving facts too much value remains to be decided. There are other aspects of science literacy that may have more of an impact on science literacy goals than facts themselves. For instance, some participants from non-STEM fields noted that even though they did not understand the science within the show, they did note that they began to think that science is cool and wanted to pay more attention to science.

It is important to note that the science content that was most often remembered and engaged with that included as part of the jokes and plotline. This aligns with the gratifications discovered from the earlier research question – since diversion was the primary gratification, the science content most aligned with what led to more enjoyment, namely the jokes, was most elaborated upon. Again, this emphasizes the need to align the desired content with the gratifications that audiences bring to the media experience.

Regarding the actual entertainment education goals of the program, the participants noted mixed results. The producers of *The Big Bang Theory* reported three goals of creating the program: (1) for audiences to be more interested in science (2) to change the stereotypes and humanize scientists and (3) to persuade more people to become scientists.

Participants from STEM fields did not feel they had become more interested in science because they already were interested. In contrast, some said it was their pre-existing interest in science that caused them to start watching the program in the first place. For the participants who were not in STEM field, about half did feel the program increased their interest in science. The half that did not reported that this was because they felt they had trouble understanding the science. This suggests that there is an audience for whom the program may indeed achieve this first stated goal, namely individuals who do not already have an interest in science but for whom

the incorporation of science into the entertainment program aligns with their ability to understand it. This is likely the audience that the producers had in mind and is also one that proponents of science literacy would argue need targeting. As for what proportion of the actual viewing audience is made of this target audience and what proportion is more like the STEM participants who came to the program because of a pre-existing interest in science remains to be explored.

All the participants agreed that the program achieved its second goal, to humanize scientists. However whether doing so was beneficial or detrimental to perceptions of scientists overall was contentious. Most of the participants who were not in STEM fields felt that the program made scientists feel like real people and just like themselves. While some STEM participants agreed, others worried that the program relied too much on socially awkward and nerdy stereotypes and therefore was not portraying scientists in a positive light. However, pairing these findings with the non-STEM “target audience” from the previous paragraph suggests that this humanizing may overall have a positive influence on perceptions of science and scientists.

Regarding the final goal of persuading more people to become scientists, all of the participants also agreed that this goal had not influenced them. While this is likely because of the sample interviewed, most did assume that the program would be likely to persuade individuals who were at a point in their lives where they were trying to decide what profession to study. A different sample would be necessary to better evaluate the influence of this stated goal.

Limitations and Future Research

While this study has added a uses and gratifications perspective to science-related entertainment education studies, there are limitations to these results. All participants were students, most at the graduate level, and many were international students. While this represents

a valid audience for the selected program, it hardly represents the entire diversity present in the programs actual viewing audience. Future research should extend these questions to other audiences, specifically individuals who might be choosing professions or other gradations of people who have limited pre-existing experience or interest in science. Additionally, exploring a sample that aligns with the actual viewing audience would also improve generalizability, if such demographic exist or are made public.

While the interview method chosen to explore these questions provides an in-depth understanding of why individuals behave in the ways that they do, the results are particular to the individuals interviewed are not generalizable to larger populations. Similarly, these results are based on self-reports of viewing. Future studies could supplement this data through viewer diaries, knowledge tests or other quantitative measures of consumption and influence. Likewise, these data support the idea that gratifications are not static, but change over time. A longitudinal study could examine how and why these gratifications change over a long-term viewing relationship and how those changing gratifications alter the intended (or unintended) influences of such entertainment education content.

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APPENDIX A INTERVIEW QUESTIONS

Uses and Gratifications:

- Why do you watch *The Big Bang Theory*?
- How long have you been a fan of *The Big Bang Theory*?
- What did you think the first time you watched *The Big Bang Theory*? Why did you decide to keep watching the program?

Transportation:

- Tell me about your ritual for watching the program. Do you set aside time to watch or turn it on in the background while doing other things?
- Do you watch it alone or have a group of friends you either watch it with or discuss it later?
- Do you ever go back and think about an episode after you are finished watching it?
- Tell me what you think of the characters. Who do you like and why?

Science Literacy:

- Science is an important part of *The Big Bang Theory*. In what ways do you notice science being incorporated into the program?
- Have you learned anything about science from watching *The Big Bang Theory*?
- What aspects about science do you think are accurate within *The Big Bang Theory*?
- What aspects about science do you think are inaccurate?
- Do you think everyone notices this science? What types of people do you think do notice this science?
- Do you think science is portrayed in good light?

Entertainment –Education:

- How do you think you are affected by the program's use of science-related content?
- How do you think others may be affected by the program's use of science-related content?
- What did you think about science before you seen this show?
- Has this program changed anything you thought about science?
- Are you more interested in science because of this program?
- Have you ever used the science knowledge from the show in your daily life?
- The producers of this show said they want the program to cause people to be more interested in science, to change stereotypes and humanize scientists and to persuade more people to become scientists. Has the program led to any of these effects in you?

APPENDIX B IRB APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4500
FAX 515 294-4267

Date: 12/18/2014
To: Xi Yang
224 S Kellogg Ave Unit 7, Ames, IA 50010
CC: Dr. Michael Dahstrom
215 Hamilton Hall
From: Office for Responsible Research
Title: Scientific Entertainment: How Audiences Interpret Science on The Big Bang Theory
IRB ID: 14-609
Study Review Date: 12/17/2014

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

- (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures with adults or observation of public behavior where
 - Information obtained is recorded in such a manner that human subjects cannot be identified directly or through identifiers linked to the subjects; or
 - Any disclosure of the human subjects' responses outside the research could not reasonably place the subject at risk of criminal or civil liability or be damaging to their financial standing, employability, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**
- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. **Only the IRB or designees may make the determination of exemption**, even if you conduct a study in the future that is exactly like this study.

Please be aware that **approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **An IRB determination of exemption in no way implies or guarantees that permission from these other entities will be granted.**

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.