Portrayals of Technoscience in Video Games: A Potential Avenue for Informal Science Learning

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Abstract
Given the proliferation of video games and their potential to contribute to informal science learning and perception formation, we provide an assessment of how commercial video games portray technoscience. Our examination was guided by theories commonly applied in studies of entertainment media’s contributions to public understanding of science. Results indicate that technoscience and its practitioners are common fixtures within video games and that their presence is often conspicuous and enthusiastic. Our findings challenge common assumptions about the treatment of science in media and compel research examining the role of informal gaming in cultivating future generations of scientists.

Keywords
video games, interdisciplinary science communication, media portrayal of science, public perception of science, public understanding of science, youth perception of science, technoscience

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Introduction

Video games represent an increasingly large portion of the modern media diet, now played in nearly 70% of American households (Feiler, 2012). They are also qualitatively different from other popular forms of entertainment media in their degree of user autonomy, immersion, and interaction (Vorderer, Bryant, Pieper, & Weber, 2006). This ubiquity and novelty have sparked research examining the potential contributions video games make to education in science, technology, engineering, and math (STEM; e.g., Barab et al., 2009; Mayo, 2009), cognitive enhancement (e.g., Annetta, Minogue, Holmes, & Cheng, 2009; Appelbaum, Cain, Darling, & Mitroff, 2013; Gerber & Scott, 2010), and socioeconomic research (Bainbridge, 2007). While these avenues continue to be fruitful, focusing on formal learning environments inherently overlooks the potential for commercial video games to meaningfully engage people about science and technology within informal contexts.

Understanding portrayals of technoscience within commercial video games is essential to current multidisciplinary efforts to understand how digital gaming contributes to citizens’ understanding, perceptions, and behaviors relative to contemporary STEM issues. Our contention rests on well-established social scientific theory and recent research demonstrating that entertainment media (e.g., television) include increasingly favorable depictions of science and scientists and that these portrayals are associated with favorable perceptions of science for groups of people who share certain sociodemographic traits (Dudo et al., 2011). Our contention is further buoyed by the growing reality that digital entertainment media represent salient informal learning environments that establish the foundation for classroom learning (Greenfield, 2009).

This study’s primary aim is to provide an overview of the prominence and portrayals of technoscience and its practitioners in contemporary video games. We conduct an extensive analysis using a new online survey methodology to examine participants’ responses to their gaming experiences. This exploratory method enabled us to access a group of individuals—experienced video game players—normally difficult to recruit through conventional procedures. Our results challenge common assumptions about the treatment of technoscience in popular media, and we hope they will compel communication researchers to problematize informal gaming’s role in cultivating future generations of scientists.

Literature Review

The Ubiquity of Video Games

The media ecosystem is constantly changing. New platforms routinely emerge, altering the way we create and consume media. Electronic gaming
represents an increasingly important example of this phenomenon. The video game industry generated $67 billion by 2010 (Bilton, 2011) and is projected to generate $112 billion by the year 2015 (Gartner, 2011). This growth can be attributed to gaming’s popularity, with three out of four American households playing electronic games (Feiler, 2012). This popularity crosses demographic boundaries. For example, 60% of adults aged 18 to 34 years own or play video games. This volume of playership is likely to increase as households with children represent one of the groups most interested in next-generation consoles, including the Nintendo WiiU, Playstation 4, and Xbox One (Mintel, 2012). Large portions of young and middle-aged Americans derive gratifications from electronic gaming and are likely to continue to devote time inhabiting these digital environments.

Moreover, rapid technological advancements in electronic gaming options present novel ways of interacting with media. In fewer than three decades, video games have evolved from simple two-bit renderings of moving blocks (think, Pong) to games that boast blockbuster film–level production qualities, scripts, and marketing budgets, as well as novel opportunities for interaction that allow players to cocreate narratives based on decisions they make during gameplay. In short, video games are not only an increasingly substantial part of the American media diet but also qualitatively unique. For these reasons, we argue that it is—and will continue to become—important for science communication scholars to consider the potential of modern video games to engage players about science in novel, memorable ways that contribute to their understanding, perceptions, and behaviors relative to STEM issues.

Video Games and Science

Researchers agree that video games influence cognitions, emotions, and behaviors in positive and negative ways (Buckley & Anderson, 2006). Overall, it is widely noted that video game play can have both short and long-term effects through priming and observational learning processes (Weber, Ritterfeld, & Kostygina, 2006). Although numerous studies have examined the effects of video game play, they tend to focus on deleterious effects, such as aggressive thoughts, emotions, and behaviors (Möller, Krahé, Busching, & Krause, 2012). However, not all video game content is negative and violent (see Bushman, Rothstein, & Anderson, 2010; Ferguson & Kilburn, 2010). Researchers have noted that video games can positively affect cooperative behaviors and problem-solving skills (Adachi & Willoughby, 2012). Furthermore, numerous studies have shown that video game play can have positive effects on various learning outcomes (Mellecker, Witherspoon, Watterson, 2013; Stansbury & Munro, 2013; Tanes & Cho, 2013). Lee and
Peng (2006) noted that video game play positively affects educational outcomes, spatial skills, cognitive abilities, and even therapeutic treatments.

Despite prolific research attention directed toward the effects of playing video games, to our knowledge no empirical studies have yet examined how technoscience is portrayed in modern video games or how these portrayals contribute to science-related outcomes among their players. Instead, the extant research addressing connections between video games has emerged largely from educational psychology and focused on how instructional video games (i.e., virtual learning technologies) can be used to aid formal classroom science learning (Barab & Dede, 2007; Barab et al., 2009; Dede & Barab, 2009; Nilsson & Jakobsson, 2010). Most of these studies indicate positive outcomes in terms of engagement, discussion, and critical thinking (Annetta et al., 2009; Gerber & Scott, 2010).

While important, this research focuses on parts of a much larger picture. They do not help us understand the interplay between informal video game play and the development of individual-level outcomes related to technoscience, from basic effects (e.g., becoming aware of controversial scientific innovations, like nanotechnology) to midrange psychological effects (e.g., forming mental schema about the nature of scientific work) to more complex behavioral effects (e.g., encountering science in ways that pique interest in science and engineering as academic and professional goals). We contend that informal gaming is a potentially salient dimension of how the public learns and thinks about technoscience today and, as such, requires theoretically driven, empirical research. Before any claims can be made about effects, however, we first need to map the terrain and gauge the ways in which scientists are depicted in video games. In the next section, we review scholarship examining portrayals of science and scientists in entertainment media. This research and the theoretical orientations on which it rests inform the design of our current study.

**Entertainment Media Portrayals of Science and Scientists**

Although communication science has long problematized the contributions of media to public understanding of science, most efforts have focused on informational media, namely, journalism. In the 1980s, a handful of researchers turned their attention toward depictions of science and scientists in entertainment content on television and in films, identifying predominately negative portrayals of science and scientists. For example, LaFollette’s (1982) brief history of televised science revealed that commercial television disseminates dubious images of science. Subsequent studies echoed these findings (Collins, 1987; Gerbner, 1987; Gerbner, Gross, Morgan, & Signorielli, 1981), concluding that scientists are depicted as superhuman
(Hornig, 1990), as being powerless to nefarious external forces (Goldman, 1989), or as exhibiting physical and psychological stereotypes (e.g., white lab coats, unkempt hair, antisocial tendencies; for an overview, see Perkowitz, 2007).

More recent analyses, however, have demonstrated that entertainment media depictions of science have become increasingly sophisticated and, in some ways, less inimical (Gerbner & Linson, 1999; Ley, Jankowski, & Brewer, 2012). For example, one recent quantitative analysis of prime time TV found that scientists are considerably more likely to be categorized as good (81% of the sample) than as bad (3% of the sample; Dudo et al., 2011). These entertainment media portrayals of science—both positive and negative—contribute to individual-level outcomes, such as science learning and attitude formation (Barriga, Shapiro, & Fernandez, 2010; Bates, 2005; Lowe et al., 2006). Yet these patterns are complicated. Research from the 1980s found that frequent TV viewers were more likely to hold negative perceptions about science (Gerbner, 1987; Gerbner et al., 1981), while more recent research has failed to find this negative relationship (Dudo et al., 2011).

Other recent research has focused on TV’s role in the formation of science perceptions but in more granular ways that examine exposure and use of specific TV genres and shows. This empirical research has unearthed both positive and negative associations between entertainment TV use and science perceptions. For example, Nisbet and Goidel (2007) and Brossard and Dudo (2012) found that frequent viewing of religious TV programming contributes to unfavorable attitudes toward scientific issues, while positive links have been discovered between viewing dramatic and comedic programming and support for agricultural biotechnology (Besley & Shanahan, 2005) and viewing science fiction programming and support for therapeutic cloning (Nisbet & Goidel, 2007). Additionally, the popular TV show CSI has been linked not only to increases in viewers’ awareness of and interest in forensics (Podlas, 2006) but also toward producing more positive, readily available mental images of female scientists for middle school girls (Jones & Bangert, 2006).

These studies demonstrate that entertainment media, specifically TV programming, contribute to viewers’ interest, identification, and perceptions relative to science and that this contribution can be especially salient for youth and people without formal science education. This point has also been reached in several commissioned reports that have been produced within the past 5 years attempting to synthesize the state of research related to informal science learning. For example, Bell, Lewenstein, Shouse, and Feder (2009) note that science-related media will continue to play a major role in the ways that people learn about science informally and will help learners develop initial interests in science as well as their perceptions of science and scientists.
Theoretical Approaches

Cultivation theory has commonly guided examinations of entertainment media relative to portrayals of science and their effects. Based on the assumption that television is society’s dominant storyteller, the main task of cultivation research is to examine the relationship between exposure to TV messages and people’s perceptions (Shanahan & Jones, 1999). This is accomplished via empirical assessment of TV content (referred to as “message system analysis”) and subsequent survey research designed to measure perceptions about social realities among individuals with varying amounts of exposure to television (referred to as “cultivation analysis”; Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002). Specifically, cultivation theory hypothesizes that heavy viewers (i.e., frequent viewers) of television will be more likely to hold conceptions of the world consistent with what is seen on television (Shanahan & Morgan, 1999). Decades of research have unearthed cultivation effects for different topics, including violence (Gerbner, Gross, Morgan, & Signorielli, 1980), gender (Signorielli, 1989), and politics (Gerbner, Gross, Morgan, & Signorielli, 1984).

While the original applications of cultivation theory regarding the topic of science explored the potential for TV use to directly contribute toward unfavorable public science perceptions (Gerbner, 1987; Gerbner et al., 1981), recent studies have been increasingly nuanced, yielding more detailed insights about TV’s contributions to public understanding of science (Besley & Shanahan, 2005; Brossard & Dudo, 2012; Dudo et al., 2011; Nisbet et al., 2002). Most notably, these studies have uncovered the potential of entertainment TV to pose positive outcomes relative to science learning and opinion formation. Collectively, these results suggest that cultivation theory be integrated into studies of entertainment media and science in ways that shift the focus from the traditional cultivation effect toward explications of how entertainment media can have varied effects for different people (Morgan, Shanahan, & Signorielli, 2009).

Along with cultivation theory, social cognitive theory (SCT; Bandura, 1986) has commonly guided studies concerned with media effects. Stemming from social learning theory (Bandura, 1977), SCT demonstrates that behaviors may be learned either through observation or direct enactment. Observation (i.e., modeling) requires that individuals extract relevant exemplars of an action, integrate that action with already existing standards, and produce new rules of behavior (Bandura, 2002). The modeling aspect implies that individuals can vicariously observe others, frequently via media representations, and learn appropriate behaviors or ways of thinking based on the outcomes of those thoughts or actions. This process, often referred to as identification learning (Bandura, Ross, & Ross, 1963), varies depending on numerous factors. Research on television, for example, has shown that the
amount of media influence on identification learning changes based on viewers’ cognitive attributes (Comstock & Scharrer, 2001), personal experience (Faber, Brown, & McLeod, 1979), and amount of direct contact with individuals from a media model’s social group (Fujioka 1999). Reinforcement and justification also play important roles in identification learning, with individuals being more likely to enact behaviors that they see rewarded rather than punished (Bandura, 2002; Ley et al., 2012).

Within video game research, SCT has been used to explain and predict how violent video games affect knowledge structures and influence ways of thinking (Anderson & Bushman, 2002). Video game players are required to appraise situations and take suitable actions in order to achieve success (e.g., advancing a level, beating a boss). These decision processes influence cognitive knowledge structures that influence behavioral reactions, which may generalize to real-world situations (Eastin, 2006). Although scientific depictions in video games have not been examined, SCT in the context of other media—particularly, television and film—suggests individuals’ science-related attitudes, beliefs, and behaviors might be influenced (Long & Steinke, 1996; Long et al., 2010; Steinke, 2005). These patterns should extend to video games.

Research Questions

Given that this is the first study of its kind, we propose a series of research questions based on the aforementioned extant research and theoretical frameworks. These research questions are designed to provide a benchmark understanding of digital gaming’s treatment of technoscience.

**Research Question 1:** How pervasive is technoscience in modern, commercial video games?

**Research Question 2:** How is technoscience portrayed in modern, commercial video games?

**Research Question 3:** How pervasive are scientist characters in modern, commercial video games?

**Research Question 4:** How are scientist characters portrayed in modern, commercial video games?

Method

**Procedure and Participants**

The logistical challenges of using traditional human coding methods to analyze modern video games have been well documented (Schmierbach, 2009). Modern games are often technologically sophisticated, exhibiting cinematic, nonlinear,
immersiveto analyze these games in comprehensive ways. This challenge becomes especially acute when researchers are attempting to examine game characteristics that are highly specific and latent. Making this point, Ivory (2006) noted, the precise content experienced by a video game player . . . depends on the experience, skill, and time commitment of the player, among other factors. It is therefore difficult to apply systematic and reliable content analysis to such an inconsistent narrative, and application of traditional content analysis strategies appropriate for older media may often be inappropriate for video games. (p. 104)

Rather than studying the content via traditional methods, therefore, it may be better to examine how the individuals who are “experts” on the source view the content. Thus, using players as an authoritative source on particular video game content might be the best approach to understanding that content (Ivory, 2006).

With that in mind, we designed an online survey using Qualtrics software that was posted as a job (referred to as a “Human Intelligence Task” or “HIT”) on Amazon’s Mechanical Turk (MTurk), an online crowd-sourcing contract labor website. MTurk is a popular research tool in the social sciences (Bohannon, 2011) and has been validated as a reliable data source. Analyses of MTurk highlight its immense promise as a research tool, often finding that it meets or outperforms traditional data-gathering techniques on many criteria (e.g., providing representative samples, yielding reliable data, facilitating quick and inexpensive data acquisition; Behrend, Sharek, Meade, & Wiebe, 2011; Buhrmester, Kwang, & Gosling, 2011; Crump, McDonnell, & Gureckis, 2013; Holden, Dennie, & Hicks, 2013; Mason & Suri, 2012; Simons & Chabris, 2012). We opted for MTurk to conduct an analysis of technoscience in video games because of its potential to help circumvent the numerous methodological challenges that we anticipated with using traditional content analysis. Most important, using MTurk enabled us to enlist gamers as analysts. Doing so was essential because it allowed us to measure accurately the pervasiveness of technoscience in video games (i.e., using gamers as analysts meant we did not have to limit our sample to a predetermined, narrow list of game titles). Further, active gamers—as opposed to convenience coders from a student population, for example—possessed the skill to play the games and therefore the experience, motivation, and knowledge necessary to yield more detailed data from the analysis process.

Our HIT was posted to the MTurk website and was made available to MTurk’s pool of workers, commonly referred to as “Turkers.” Registered Turkers could voluntarily complete our HIT, as long as they could identify a
video game that includes science and technology, were familiar enough with
the game to answer our questions accurately, and could replay the game if
necessary. The study adhered to the standards of academic research involving
human subjects, and Turkers were told that the HIT was designed to help a
team of researchers examine how video games portray science and technol-
ogy. Turkers were compensated 30 cents, a rate of pay based on recent
research examining best practices for conducting MTurk research (Horton,
2011; Mason & Suri, 2012; Sun, Wang, & Peng, 2011). Data collection began
in October 2012 and continued until mid-December, 2012. Turkers took an
average of 10 minutes to complete the survey; 302 surveys were completed.

Instrument and Measures

Survey instrument development was guided by the extant literature and theo-
retical frameworks discussed previously. Specifically, we chose to focus on
message attributes (e.g., physical stereotypes, gender) commonly examined
in media research based on cultivation and SCT. We refined the instrument
over a period of approximately 6 months based on pre-tests conducted with
colleagues and initial responses from a small group of Turkers. The most
notable adjustment made was to shorten the instrument by using more closed-
ended questions to help minimize the risk of response fatigue. Our pre-tests
did not reveal any problems related to instrument validity.

Respondent Descriptives. Six respondent demographics were measured: age,
education, gender, household income, ethnicity, and state of residence.
Respondents’ age was measured as a continuous variable in years ($M = 26.34$,
$SD = 7.56$, minimum = 17, maximum = 64). Education level was assessed
using a 7-point measure ranging from 1 = some high school to 7 = received
doctorate ($M = 3.93$ [some college], $SD = 1.22$, minimum = 1, maximum =
7). Respondents’ gender was a categorical variable with female and male
(68.2%). Respondents’ annual household income was assessed using an
11-point ordinal measure ranging from 0 (US$0 to US$9,999) to 25
(≥US$100,000; $M = 4.49$ [US$40,000 to US$49,999], $SD = 2.91$, minimum
= 1, maximum = 11). Respondent ethnicity was measured via a categorical
variable, including Caucasian (77%), Asian (10%), African American (7%),
Hispanic (5%), and other (1%). Respondents indicated their U.S. state of resi-
dence (California, 11%, Texas, 7%, New York, 6%). Respondents’ video
game use was coded. Amount of time spent playing video games was mea-
sured by combining two separate measures asking respondents to indicate the
average amount of time they spend playing video games on weekdays and
weekends. These items were combined into one measure indicating the
average amount of time spent playing video games (in hours) in 1 week \((M = 9.79, SD = 7.24, \text{minimum} = 0, \text{maximum} = 40)\).

**Game Descriptives.** Respondents were asked to list the name of the game, the name of the platform(s) on which they played the game (the most frequent responses were console [65%] and computer [35%]), and the genre of the game (the most frequent responses were first-person shooter [38%], adventure/fantasy [30%], and massively multiplayer online game/role-playing game [11%]).

**Portrayals of Technoscience: Presence.** The overarching presence of technoscience in video games was measured from reactions (on a 5-point scale from 1 = *strongly disagree* to 5 = *strongly agree*) to this stem: “In the game, science and/or technology . . .” Respondents were asked to rate their agreement for four possible portrayals: “plays a major role in the narrative,” “plays a major role in succeeding,” “is a significant obstacle,” and “is shown actually happening (e.g., someone working in a laboratory, testing a new technology).”

**Portrayals of Technoscience: Characteristics.** More granular portrayals of science in video games were measured from reactions (on a 5-point scale from 1 = *strongly disagree* to 5 = *strongly agree*) to this stem: “The game shows scientific innovation and/or technology as . . .” Respondents were asked to rate their agreement for 15 possible portrayals: “a force for good (i.e., as a solution to problems),” “a force for bad,” “a way to find the truth (or truths),” “way to secure a better future,” “posing risks and benefits,” “connected to religion,” “connected to politics,” “connected to warfare,” “powerless to external forces,” “uncertain,” “mystical/mysterious,” “reliable,” “logical,” “accessible to most people,” and “done by highly intelligent people.”

**Portrayals of Scientist Characters.** Respondents were asked if the game includes a “scientist” character (i.e., a character who portrays a scientist, inventor, medical doctor). If they answered “yes,” they were then asked to list the character’s name. Respondents were also asked to rate the character’s presence in the game (on a 7-point scale from 1 = *minor* to 7 = *central*) and to identify the character’s specialization(s) from a list including “physicist,” “medical doctor,” “biologist,” “inventor,” “chemist,” “engineer,” “geneticist,” “researcher,” “technologist,” and “other.” The categories engineer, geneticist, researcher, and technologist were added post hoc because they represented the most common specializations entered by respondents into the open-ended “other” category.

Characters’ demographics also were measured. Characters’ age was measured by asking respondents to identify if the character was “young,” “adult,” “middle-aged adult,” “senior,” or “other.” Respondents were asked to
indicate the character’s gender (including the possible responses “male,” “female,” and “unclear”) and ethnicity. Characters’ species also were identified by asking respondents to indicate if the character was “human,” “robot/cyborg,” “anthropomorphic (resembling human form),” “alien,” “mutant,” “fantasy creature (e.g., goblin),” or “other.”

The physical traits of the characters were measured from reactions (on a 7-point semantic differential scale) to this statement: “For each pair of physical traits choose the point between them that reflects the extent to which you believe the traits describe the character’s physical appearance.” Respondents were presented with four pairs of physical traits, including “frail-muscular,” “short-tall,” “unattractive-attractive,” and “thin-fat.” Respondents also were asked to identify any of the following specific features exhibited by the character: “glasses/goggles,” “lab coat/scientific attire,” “big nose,” “big head,” “unkempt hair,” “facial hair,” “scars,” and “other.” Personality traits of the character were measured from reactions (on a 7-point semantic differential scale) to this statement: “For each pair of adjectives choose the point between them that reflects the extent to which you believe the adjectives describe the character.” Respondents were asked about 20 personality traits: “foolish-wise,” “nerdy-cool,” “deranged-mentally stable,” “villaneous-heroic,” “unreliable-reliable,” “absentminded-observant,” “eccentric-conventional,” “introverted-extroverted,” “lazy-energetic,” “impassionate-passionate,” “disrespected-respected,” “evil-good,” “dangerous-harmless,” “cruel-kind,” “disagreeable-agreeable,” “dishonest-honest,” “selfish-altruistic,” “unjustified-justified,” “weak-strong,” and “disadvantaged-advantaged.”

Scientist characters’ depictions also were measured from reactions (on a 5-point scale from 1 = mostly negative to 5 = mostly positive) to this statement: “The character contributes to the outcomes in the game’s storyline that are . . .” Respondents also indicated how often scientists characters were verbally and physically aggressive (on a 5-point scale from 1 = very rarely to 5 = very often), as well as the motives for characters’ aggression based on seven response options, including “protection of life,” protection of someone else’s life,” “personal gain,” “retaliation,” “anger,” “mental instability,” and “other.”

**Results**

The impetus for this exploratory study was to see how often technoscience and its practitioners are woven into the narratives of modern, commercial video games. Our analysis indicates that technoscience is abundant in video games, with the respondents identifying 141 unique video games including technoscience (Research Question 1). Figure 1 shows the video game series identified most frequently as depicting technoscience. The Call of Duty series

Downloaded from scx.sagepub.com at University of Texas Libraries on February 22, 2014
Science Communication was identified most often (24 times), followed by Halo (22 times), Portal (21 times), Half-Life (17 times), Assassin’s Creed (16 times), Mass Effect (15 times), Bioshock (13 times), and Borderlands (12 times).

Technoscience also appears to be featured quite prominently within these 141 different games (Research Question 2). Respondents indicate that technoscience plays a major role in nearly three quarters (73.5%) of the games’ narratives and that it plays a major role in experiencing success in nearly four fifths (78.4%) of the games. Technoscience also is shown “actually happening” (e.g., a scientist character working in a research lab) in 60% of the games.

We next examined common portrayals of technoscience in video games. Figure 2 displays the overall presence of 15 different types of portrayals via respondents’ levels of agreement about whether each type of portrayal was shown in the game. To help interpretation, we grouped these 15 portrayal characteristics into five distinct conceptual themes: the accessibility of technoscience, the methodology of technoscience, technoscience’s associations to external forces, outcomes of technoscience, and epistemic value of technoscience (i.e., the overarching valence associated with technoscience relative to its role in society).

In terms of its overall tone, technoscience is portrayed quite positively in video games. It is more likely to be shown as a force for good \( (M = 3.68, \)
than a force for bad ($M = 3.21, SD = 1.17$). Furthermore, three
outcomes of technoscience—posing risks and benefits ($M = 3.96, SD = 0.95$),
providing a way to find truth(s) ($M = 3.56, SD = 1.03$), and helping secure a
better future ($M = 3.61, SD = 1.09$)—are all characteristics commonly per-
ceived in games by the respondents. Technoscience, however, is more likely
to be shown as posing risks and benefits than as a way to find truth(s) or
secure a better future.

We also assessed how technoscience itself—its methodology—is depicted
in games. It seems that the rigor and reason of the scientific method shines
through in games. Respondents report that technoscience is more likely to be
shown as logical ($M = 3.73, SD = 0.91$) and reliable ($M = 3.48, SD = 0.99$)
than to be shown as either being mysterious, mystical, and superstitious ($M = 
3.02, SD = 1.27$) or being uncertain ($M = 2.88, SD = 1.09$).

Video games infrequently associate technoscience with external social
forces, such as politics ($M = 2.94, SD = 1.35$) or religion ($M = 2.29, SD = 
1.25$). Technoscience, however, often is associated with warfare and weap-
ony ($M = 3.85, SD = 1.28$) and is more likely to be shown with this particular

**Figure 2.** Characteristics of technoscience as portrayed in video games.
Note: Response scale only partially displayed. The original neutral value on the
scale (3) is presented as 0 to enhance interpretability.
association than it is with politics or religion. Despite this association with war, respondents indicate that technoscience is infrequently depicted as being powerless to external forces in a broader sense (including war; $M = 2.94$, $SD = 1.35$), with its association with warfare more likely to be depicted than an association as powerless.

We also examined how games portray the accessibility of technoscience—that is, what types of people are shown as its practitioners. While a slight majority of respondents indicate that technoscience is shown as being accessible to “most people” ($M = 3.07$, $SD = 1.18$), it is more likely to be shown as something that is done by people who seem “highly intelligent” ($M = 3.88$, $SD = 0.97$).

We next assessed the presence and portrayals of technoscientists (i.e., scientist characters) in video games (Research Questions 3 and 4). Overall, there are ample scientist characters in these games, the majority of them are primary characters (i.e., protagonists or antagonists), and they are almost exclusively associated with positive character attributes. Of the 141 unique video games identified, 77 of these games (55%) include one scientist character or more. Respondents provided data for a total of 260 scientists (the same character could be identified and assessed multiple times by different respondents) and identified 123 unique scientist characters.

Gordon Freeman from the Half-Life series was identified most often (15 times), followed by Mordin Solus from the Mass Effect series (14 times), Glados from the Portal series (7 times), Isaac Kleiner and Eli Vance from the Half-Life series (6 times and 5 times, respectively), Zed from Borderlands (5 times), and Catherine Halsey from Halo (5 times). Additionally, many games contain more than one scientist character. As shown in Figure 3, Bioshock contains at least five unique scientist characters, while four other games contain at least four unique scientist characters, and three other games contain at least three unique scientist characters.

Fifty-six percent of the scientist characters are portrayed as “highly visible, central characters,” and the scientist characters exhibit a relatively diverse range of occupational specializations, including most frequently as inventors (66 times), medical doctors (48 times), or physicists (39 times) and least often as geneticists (8 times) and engineers (10 times). Figure 4 shows the complete breakdown of specializations by frequency.

Scientist characters are far more likely to be portrayed as human (77%) than they are any other species, including aliens (9%), robots/cyborgs (7%), anthropomorphic characters (5%), or other creatures (2%). In terms of age, scientist characters are more often portrayed as adults (46%) than they are as youth (3%), middle-aged adult (33%), senior (14%), or some indeterminate age (4%). Scientist characters are also predominantly portrayed as male
Figure 3. Video game series containing the most scientist characters.

Figure 4. Video game characters’ scientific specializations.
Science Communication

Figure 5. Scientist characters’ (A) physical and (B) personality traits in video games.
Note: Response scale only partially displayed. The original neutral value on the scale (4) is presented as 0 to enhance interpretability.

(73%) and White (86%). Asian scientist characters are the second most present ethnicity but are rarely portrayed (6%). African American (4%), Hispanic (1%), Native American (0%), and Middle Eastern (0%) scientists are essentially nonexistent.

We also evaluated the physical and personality traits associated with these scientist characters. In terms of basic physical characteristics (see Figure 5A), scientist characters are more likely to be thin than fat ($M = 3.02, SD = 1.25$), tall than short ($M = 4.38, SD = 1.37$), attractive than unattractive ($M = 4.27, SD = 1.56$), and frail than muscular ($M = 3.69, SD = 1.51$). Respondents also were asked to report if the scientist characters possess physical features commonly associated with media stereotypes. While a slight majority of the
scientist characters wear lab coats (55%) and a slight minority wear glasses (42%), most of the scientist characters in video games exist without other stereotypical features including unkempt hair (24%), facial hair (23%), big noses (13%), big heads (12%), and scars (12%).

Figure 5B displays the prevalence of specific personality traits associated with the scientist characters. Although some of the trait pairs do not have a clear valence (e.g., introverted, extroverted), the majority of the trait pairs exhibit clear differences in terms of valence. As such, in Figure 5B the more negatively valenced traits appear on the left and the more positively valenced traits appear on the right. Seventeen of the 20 personality-trait pairs indicate positive depictions. When considered together, these findings illuminate interesting patterns. For example, scientist characters tend to be depicted as beneficent. They are more likely to be good than evil ($M = 4.89, SD = 1.85$), heroic than villainous ($M = 4.59, SD = 1.79$), kind than cruel ($M = 4.57, SD = 1.81$), altruistic than selfish ($M = 4.33, SD = 1.81$), and likable than disagreeable ($M = 5.01, SD = 1.74$). One exception is that they are more likely to be shown as dangerous than harmless ($M = 3.57, SD = 1.91$). Scientist characters are also overwhelmingly portrayed as sound of mind. They are more likely to be wise than foolish ($M = 5.13, SD = 1.56$), reliable than unreliable ($M = 5.15, SD = 1.55$), observant than absentminded ($M = 5.27, SD = 1.51$), mentally stable than deranged ($M = 4.57, SD = 2.00$), and respected than disrespected ($M = 5.41, SD = 1.57$). They also are more often shown as driven, as more energetic than lazy ($M = 5.37, SD = 1.34$), and passionate than impassionate ($M = 5.67, SD = 1.33$). Scientist characters, however, are more likely to be portrayed as eccentric than conventional ($M = 3.44, SD = 1.71$) and nerdy than cool ($M = 3.61, SD = 1.72$).

Last, we examined the valence of the scientist characters’ contributions to their game’s overall story line and their use of verbal and physical aggression. Respondents indicate that scientist characters’ contributions to game story lines were somewhat or mostly positive (57%), with 26% of their contributions being neutral and only a handful (17%) being somewhat or mostly negative. Additionally, scientist characters tend to shy away from hostility: 62% rarely or very rarely exhibit verbal aggression, and 64% rarely or very rarely display physical aggression. Moreover, of the scientists who do exhibit verbal or physical aggression, respondents indicate that they most frequently do so (49%) to protect life (Figure 6).

**Discussion**

Given the rapid proliferation of video games and their potential to contribute to informal science learning and perception formation, the goal of this article
was to provide a benchmark assessment of how contemporary video games portray technoscience and its practitioners. Our exploratory study was guided by theories commonly applied in studies of entertainment media’s contributions to public understanding of science and was conducted via Amazon’s MTurk, a popular online crowd-sourcing tool. Overall, our results suggest that technoscience and its practitioners are common fixtures within the storylines of modern video games, and their presence in these games is often conspicuous and enthusiastic.

The motivation for this study was to see how often technoscience and its practitioners are woven into the narratives of modern video games. Results suggest that their presence is relatively commonplace, with respondents identifying 141 unique games containing technoscience and 123 different scientist characters within these games. Whereas scientist characters appear quite rarely in contemporary primetime TV (Dudo et al., 2011), scientist characters abound in video games. This apparent pervasiveness of technoscience and scientists in video games, we argue, legitimizes future research attention.

Moreover, our analyses indicate that technoscience has a prominent presence and overwhelmingly favorable portrayals within these games. Technoscience, for example, is far more often shown as an overall force for

Figure 6. Motives behind scientist characters’ displays of aggression in video games.
good than bad and is often presented as a means toward achieving a more prosperous future and to unearthing truths. Furthermore, the scientific method shines through insofar as games frequently portray science as logical and reliable and not as mysterious or mystical. And although games minimize the uncertainty associated with science in ways similar to television programming (Collins, 1987; Ley et al., 2012), games often portray science realistically as posing both beneficial and risky outcomes. Together, these results suggest potential effects that are more likely to fall in line with research finding positive links between entertainment media and public understanding of science (e.g., Besley & Shanahan, 2005; Nisbet & Goidel, 2007) than research finding cultivation effects (e.g., Gerbner et al., 1981).

Although technoscience is not associated with external social forces like politics, it is often linked with warfare. This is hardly surprising given the prolific role war and weaponry play in many video games, but this connection remains noteworthy. Our data do not allow us to understand the nature of this association (e.g., was the science-war relationship portrayed as being adaptive or maladaptive), but the fact the games do not show science as being powerless to external forces—as is the case in Hollywood films (Goldman, 1989)—suggests that the science-war relationship is rarely depicted as being one-sided. Nevertheless, given the frequency of the war-science association in video games, future research would do well to tease out its nuances. Technoscience as an effective way to aid destruction and technoscience as an effective way to cure biological epidemics transmit fundamentally different messages about its social role.

Similarly, video game portrayals of scientist characters are mostly positive. Scientist characters tend to be highly visible, beneficent, driven, sound of mind, and peaceful. They also tend to defy the negative psychological attributes (e.g., antisocial, amoral, villainous) historically associated with scientist characters in movies (Perkowitz, 2007) and television (Gerbner et al., 1981). Scientists in games also are associated with a relatively diverse array of specializations (e.g., inventor, medical doctor, biologist) and are most commonly cast as humans. Conversely, the scientist characters also exhibit some less desirable attributes. They are significantly more often shown as nerdy and eccentric, they sometimes display common media stereotypes (e.g., donning white lab coats), and they are mostly White males. The latter finding is consistent with recent research finding a predominance of White and male scientists in TV programming (Dudo et al., 2011, Long, Boiarsky, & Thayer, 2001). Additionally, technoscience is primarily shown as the domain of intellectually gifted individuals, not something that is accessible to the “rest of us”—a depiction that is also consistent with other media accounts of scientists (Hornig, 1990; Long & Steinke, 1996).
SCT implies that these various trends in character depictions could provide gamers with models for how to feel, think, and behave like a scientist (Bandura, 1986). Furthermore, SCT holds that individuals are more likely to portray attitudes and behaviors that are positively reinforced rather than punished (Bandura, 2002). If the scientists or technoscience depicted in video games are used as a force for good and the players are rewarded for their application in progressing in the game, then they are likely to positively affect players’ views of technoscience overall. On one hand, our findings show that video games provide platforms for positive observational science learning among players. The scientist characters overwhelmingly display positive attributes, exhibit highly desirable physical and psychological traits, contribute to game narratives in positive ways, and rarely exhibit aggression born from cruel motives. It is possible these favorable characteristics provide encouraging, relatable models of scientists that inspire positive identification among players.

However, it also is possible that the demographically homogenous nature of scientist characters we find in video games contributes to an aura of exclusivity about science that inhibits positive identification, especially among women and non-Whites. However, these possibilities are empirical questions that require attention. Scholars should look to the robust body of research examining TV’s role in informal science learning for inspiration and theoretical and methodological guidance (e.g., Long et al., 2001; Long & Steinke, 1996; Steinke, 1999, 2005; Steinke et al., 2007). One initial study could use the “draw-a-scientist” test to examine the extent to which portrayals of scientists in video games alter how youth conceptualize what it means to be a scientist, specifically to see if these conceptualizations move beyond the unflattering stereotypes traditionally expressed by this age-group (Losh, 2010). Using SCT, future research should also examine depictions of technoscience and scientists in video games that communicate positive and negative rewards and consider the differential effects of these different reward portrayals on avid and casual gamers. It could be that avid gamers—through repeated exposure—have different cognitive schemas for playing video games that influence the type and magnitude of gameplay effects.

It may also be fruitful for scholars to explore the extent to which gamers’ perceptions of technoscience and scientists may be influenced differently across game genres. Specifically, researchers may focus on massively multiplayer online games (e.g., Starcraft, EVE) and how their unique, community-based structure could contribute to informal learning outcomes than more conventionally structured solo-player games. These efforts could be guided, in part, by theoretical orientations stemming from interpersonal and computer-mediated communication scholarship.
Testing these potentialities in future research is especially salient given the escalating amount of time youth spend playing video games, their lack of direct contact with flesh-and-bone scientist role models, the continued atrophy of traditional sources of science media (Mooney & Kirshenbaum, 2009; Romm, 2013), setbacks to large-scale STEM education programs (Boone & Marsteller, 2011), and the continually low proportion of women and minorities pursuing graduate educations in science and engineering (National Science Board, 2010, 2012). Our mapping of technoscience’s presence in video games is necessary to help inform and direct examinations of the effects of these portrayals. We contend that future research should be conducted to examine what specific attributes of technoscience depictions in video games most effectively resonate with and inspire budding scientists and engineers.

Limitations

The primary limitations in this study are connected to our methodology. The data of interest in this study are highly specific and challenging to examine using conventional methods (Schmierbach, 2009). With this in mind—and given our desire to provide as comprehensive a preliminary assessment as possible—we chose to crowd source our examination of technoscience in video games to active gamers via MTurk because they possess the skill, experience, and motivation to play modern video games and, therefore, the potential to provide the most exhaustive data relative to our research questions. Indeed, our respondents reported playing an average of nearly 10 hours of games per week. This approach, of course, came with risks, the most significant being that this approach afforded us less quality control over the data. While we excluded responses that contained obvious errors (e.g., incomplete surveys), we did not have the same level of control that comes with traditional content analysis. Ultimately, however, we were comfortable with this trade-off, as using a traditional content analysis procedure would not have allowed us to answer our research questions with the depth provided by using MTurk.

We also realize that the natural inclination of any content analyst is to conduct an intercoder reliability analysis. We are keenly aware of this procedure but believe that it is incommensurate with our unique data collection procedure. Specifically, the data collection in this study was not done by a handful of trained coders but rather by gamers who self-selected into the survey because they have experience playing a video game containing portrayals of technoscience. As such, the data’s veracity does not rely on a few select individuals’ seeing the content in the same way, which is the fundamental reason for conducting intercoder reliability in traditional content analyses (Riffe, Lacy, & Fico, 2005). Like asking potential voters to identify and
share their perspectives about the characteristics of a TV advertisement for a political candidate, our survey asked gamers to share their perspectives about characteristics in video games. The hypothetical survey of political ads on TV would not expect reliability among the data provided by the respondents’ and neither did our study. In fact, in both cases the research is being conducted in order to see how individuals perceive the presence of certain message attributes. As such, any trends identified relative to the message attributes include the possible natural variance that may exist among the respondents, which makes the identified trends more meaningful. While we feel confident in our methodological choices, we recognize the need for additional research designed to vet MTurk as a tool for crowd-sourced content analysis. Our research team is currently performing such an examination.

One other possible limitation stems from our chosen method: the potential that our findings may be slightly skewed because our respondents self-selected into the survey. It is possible, for example, that the predominately favorable science and scientist portrayals identified by our respondents are artifacts of a widespread positive predisposition they harbor toward technoscience. On one hand, this possibility was unavoidable given the specialized type of media content we sought to assess. But more important, it is essential to note that the respondents also identified numerous unfavorable characteristics of technoscience and scientists, which should minimize concerns about any extreme biases present in the data. It is also important to note that other populations (e.g., nongamers, parents) may perceive technoscience and scientists in these video games differently than our respondents. This is an empirical question that should be considered in future research, but if what we—the academic community—care about most are the potential effects of this content, then we should direct the majority of our research attention to the group most likely to experience these effects: the gaming community.

**Conclusion**

Overall, this study demonstrates that modern video games represent fertile ground for science communication research. Our analysis suggests that technoscience and its practitioners are common fixtures within the narratives of popular video games. Although some outmoded stereotypes exist akin to those found in earlier assessments of science on television and in films, science and scientists are conspicuous in modern video games and are portrayed in ways that are primarily enthusiastic. These results fall in line with recent research finding a trend toward more positive portrayals of science in entertainment media and pose implications for those of us seeking to understand, connect with, and inspire nascent generations of STEM researchers. It may
be tempting to undervalue the contributions commercial video games make to individuals’ relationships with science because they are fictional and informal. Video games, however, now represent one of the primary platforms through which youth observe and interact with scientists. Said differently, video games are fast becoming a key science touch point for average citizens. The continued challenges besetting STEM education programs and our new media ecosystem require that the expert community pay attention to these digital representations and investigate their contributions to learning, perception building, and career choices relative to STEM.

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Note
1. We use the term technoscience in the article when referring to the conceptual target of our study. Technoscience is a concept from science and technology studies that reflects the fact that science and technology are inextricably linked and coproduced (Latour, 1987). Technological tools and methods, for example, enable the generation of new scientific knowledge, which consequently helps forge new technological innovations and processes. This phenomenon is readily evident in fields like nanotechnology and epigenetics. Given our strategic effort to capture video game depictions of science and technology, it was most appropriate—and more accurate—for us to frame our study as focusing on “technoscience” instead of “science.” For more information about this concept, see Sismondo (2004).

References


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