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Audience Reactions to Climate Change and Science in Disaster Cli-fi Films: A Qualitative Analysis

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Abstract

Little scholarly attention has been paid to how audiences interpret pop culture messages about climate. This paper addresses this issue by taking up the case of disaster cli-fi films and exploring how audiences react to film representations of climate change. It draws on data from focus groups to evaluate audience responses to disaster cli-fi films. Analysis reveals that by only briefly discussing climate change in their plotlines, the films weaken their environmental message. The paper concludes with a discussion of the effects of disaster cli-fi films on environmental attitudes and suggestions for further research.

Introduction

The mass media are a crucial source of information regarding the causes and predicted effects of anthropogenic climate change for many people (J. M. Boykoff & Boykoff, 2007; M. T. Boykoff & Rajan, 2007; Brulle, Carmichael, & Jenkins, 2012; Corbett & Durfee, 2004). As a result, researchers have begun to analyze the discourse surrounding climate change in the media, particularly the news media. Although these studies have produced valuable information, they do not address the effects of non-news media—namely, fictional narratives—on climate change attitudes and beliefs.

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Climate fiction, or "cli-fi," (Bloom, 2017) is an emerging area of exploration for climate change communications. Cli-fi is a growing presence in literature, cinema, and gaming and consists of narratives that examine the causes, effects, and implications of anthropogenic climate change (Merchant, 2013). Braddock and Horgan describe narratives as "any cohesive and coherent account of events with an identifiable beginning, middle, and end about characters engaged in actions that result in questions or conflicts for which answers or resolutions are provided" (2016, pp. 382–383).

Researchers have begun to address cli-fi's impact on public attitudes and beliefs about climate change (Leiserowitz, 2004; Lowe, Brown, Dessai, de Franca, Doria, Haynes, & Vincent, 2006; Svoboda, 2014, 2016). However, so far these approaches have mainly used quantitative measures to examine audience responses to cli-fi. A numerical approach leaves the possibility open that significant aspects of the interpretive process are missing from the current literature. This paper addresses this gap by undertaking a qualitative examination of how audiences interpret climate fiction using the subject of disaster cli-fi films.

I provide background by briefly describing cli-fi and how it relates to disaster films. I then discuss narrative persuasion and how narratives have been used to communicate facts. I then provide an overview of the challenge of communicating science to the public, followed by a review of the connection between realism and emotion in driving narrative transportation. I then review the methods and data for the study and discuss the significant impacts of film on audience emotions, weighing this against the question of realism in film. I suggest that this question of balance is important for understanding audience responses to climate disaster films as they inform audience views on climate change.

I use data from focus groups of disaster cli-fi film audiences to qualitatively evaluate their responses to climate change and climate science in three films: *NYC Tornado Terror* (2008), *Lightning: Bolts of Destruction* (2003), and *F6 Twister* (also released under the title *Christmas Twister*) (2012). Discussions centered on audiences' emotional responses to the films and their evaluation of the films' factual accuracy and were analyzed using grounded theory. My analysis suggests that films weaken any environmental message present by only discussing climate change in a cursory way. My analysis also revealed audience skepticism about the speed and severity of climate disasters depicted in the films and the problem of the lone scientist. I conclude with a discussion of the potential effects of disaster cli-fi films on environmental attitudes and suggestions for further research.

Background

What is cli-fi?

Cli-fi is a portmanteau of the words climate and fiction coined by Dan Bloom (Bloom, 2017). Climate change and other environmental problems are increasingly featured in fictional films (Murray & Heumann, 2009) such as the blockbusters *The Day After Tomorrow* (2006) and *Snowpiercer* (2013) and lower-budget productions such as *Category 6* (2004). The cli-fi film genre is broad and contains films that touch on climate change only briefly (Svoboda, 2016).

Most research on cli-fi films examines better-known productions such as *The Day After Tomorrow* (Leiserowitz, 2004; Lowe et al., 2006; Svoboda, 2014) or *The Age of Stupid* (Howell, 2011). Kaplan explores the broader genre and concludes cli-fi is evidence of environmental pre-trauma, or anxiety about things that will happen in the future (2015). Svoboda examines the history of cli-fi films and begins the process of classifying these films by the type of disaster they feature (Svoboda, 2016).

The intersection between disaster films and cli-fi

I focus here on disaster cli-fi films, a type of cli-fi that intersects with the disaster film genre. By definition, cli-fi narratives discuss climate change, but they do not always depict natural disasters. *Mad Max: Fury Road* (2015) implies climate change contributed to the collapse of ecosystems but does not show this happening in the film itself. Disaster films focus on disasters as they happen but do not always mention climate change. *Twister* (1996) is driven by storm chasers following destructive tornadoes but does not feature climate change. Disaster cli-fi films, on the other hand, *show climate change-driven disasters as they unfold*. These films frequently depict climate change inaccurately—compressing long-term environmental changes into a few hours, for instance (Murphy, 2014)—but they relate natural disasters to climate change to a greater or lesser degree.

The persuasiveness of narratives

Communication scholarship suggests narratives can influence attitudes and beliefs of audiences (Braddock & Dillard, 2016; Mulligan & Habel, 2011, 2013). Facts—including science facts—presented in narratives may appear more real to audiences than facts not seen in narratives (Marsh, Butler, & Umanath, 2012). One study showed audiences judged science facts embedded within a narrative to be more truthful than facts not included in the narrative (Dahlstrom, 2010). Indeed, inaccurate facts presented in narratives are often remembered by audiences and then misattributed to reputable sources (Barriga, Shapiro, & Fernandez, 2010; Butler, Zaromb, Lyle, & Roediger, 2009; Marsh, Meade, & Roediger III, 2003).

Barriga et al. (2010) suggest that the tendency for people to believe facts they have read in narratives occurs because the narrative reminds people of things they believe they heard previously from credible sources. They write:

> It is cognitively taxing for fiction readers to retrieve from memory the original source of factual information, particularly when it is not central to the understanding of the plot. Thus, people may remember facts introduced in a story, but do not connect them with the original source, believing instead that they have "always known" the fact to be true. (Barriga et al., 2010, p. 6)

These findings are significant for cli-fi scholars because they suggest cli-fi audiences and readers may absorb inaccurate information about climate change through exposure to these narratives. This is not to discount a multitude of other factors (such as education and scientific literacy) that contribute to attitudes, beliefs, and knowledge about climate change, but it does raise the possibility of cli-fi influencing audiences in ways that we are, as of yet, unaware.

The persuasive power of narrative is related to several interconnected factors, including transportation. Green and Brock (2000, p. 701) define transportation as being "absorbed in a story or lost in a narrative world." When audiences feel transported, they become more open to incorporating new facts, attitudes, and beliefs presented in the narrative into their own worldviews (Moyer-Guse, 2008; Shen, Ahern, & Baker, 2014).

In turn, a narrative's *realism* can influence how easily audiences are transported into the world of the story (R. Busselle & Bilandzic, 2008; R. W. Busselle & Bilandzic, 2009; Caputo & Rouner, 2011; Hall, 2003). Busselle and Bilandzic (2008) suggest most audiences approach fictional narratives with an understanding that they are consuming something that is not real and willingly suspend disbelief in order to engage, allowing for transportation. However, when audiences encounter aspects of the narrative that seem unrealistic, their capacity for disbelief is challenged and transportation is interrupted (R. W. Busselle & Bilandzic, 2009; Rooney, Benson, & Hennessy, 2012). Busselle and Bilandzic suggest violations of external realism (by depicting events that cannot or would not happen in the real world) or internal realism (by depicting events that go against the internal logic of the narrative world or create plot holes) are especially disruptive to transportation (2009), thus reducing the narrative's ability to influence attitudes and beliefs.

Realism and emotion

Research on realism suggests perceived realism and emotional involvement in films are positively correlated (Konijn, van der Molen, & van Nes, 2009; Tan, 2008). Audiences emotionally engage more with narratives that seem real. In turn, this engagement sustains feelings of realism by encouraging viewers to set aside reservations about aspects of the story that seem unrealistic.

Emotional engagement can be broken when the narrative violates internal or external realism (R. Busselle & Bilandzic, 2008; Rooney et al., 2012). Such violations take audiences out of the world of the narrative by reminding them that the story is "just a film" (Rooney et al., 2012, p.

407). In turn, the decreased emotional involvement in the film can then erode perceptions of realism.

Whether films can evoke emotions in audiences is important because climate change communications scholarship suggests that the emotional content of media messages can influence audience reactions (Beattie, Sale, & McGuire, 2011; Smith & Leiserowitz, 2012, 2014). Smith and Leiserowitz (2014), for instance, found that media that evoke hope, interest, and worry are positively correlated with support for climate change mitigation policies.

Studies also have looked at the effect of cli-fi films on audiences' level of emotion (Beattie et al., 2011) and environmental concern (Howell, 2011; Leiserowitz, 2004; Lowe et al., 2006). In general, these studies find that fictional cli-fi films can elevate emotion levels in audiences. In turn, this may cause audiences to feel more concern about climate change, which is then linked with a desire to take action (Beattie et al., 2011). A key question then becomes how audiences perceive climate change and climate science in disaster cli-fi films. Although such films portray climate change via emotionally dramatic visual images, they are nonetheless fictional and may lose audience involvement via unrealistic dramatizations.

Methods

This study uses qualitative methods and focus groups to understand audience perceptions of realism and fiction in disaster cli-fi films. I draw on established focus group methodology (Krueger & Casey, 2009; Morgan, 1993, 1996) to center analysis on the question of which aspects of disaster cli-fi films impact audience perceptions. I used the grounded theory guidelines laid out by Charmaz for analysis (Charmaz, 2006). These guidelines allow me to explore how respondents create meaning from the narratives and "minimize[e] preconceived ideas about the research project and the data" (Charmaz, 2008, p. 155).

Groups ranged from two to five respondents drawn from the student body of a university in the southeastern United States. I recruited students through a social sciences participant pool run by the university and participants received research course credit for their participation in the study. My research assistant and I determined that we had reached saturation after six focus group sessions. Specifically, we reviewed the notes and transcripts collected during each focus group session and compared them to the notes and transcripts from previous sessions to establish whether any new themes had arisen. We halted the focus groups after we concluded that they were no longer producing new themes.

During each session, participants watched one of three disaster cli-fi films: *NYC: Tornado Terror* (2008), *F6 Twister (Christmas Twister)* (2012), or *Lightning: Bolts of Destruction* (2003). Four groups viewed *NYC: Tornado Terror* to standardize responses between groups, and I continued using this film until I reached saturation. Because disaster cli-fi films vary considerably in terms of their realism, I held two additional focus groups in which students were shown either *F6 Twister (Christmas Twister)* or *Lightning: Bolts of Destruction* to ensure that

responses were not limited to *NYC: Tornado Terror.* Although the groups viewed a total of three films, the themes that emerged from the *F6 Twister (Christmas Twister)* and *Lightning: Bolts of Destruction* sessions were overwhelmingly similar to those from the *NYC: Tornado Terror* groups, suggesting that audiences viewing different low-budget disaster cli-fi films generally respond to them similarly.

I asked participants a series of open-ended questions to elicit their reactions to the films. Questions progressed from general to specific. I first asked participants to note specific scenes or moments within the film that impacted them and how they reacted to the films' various characters. I then asked participants whether the film had a message. Some groups immediately brought up environmental themes, but I took care not to lead them to environmental messages. I followed this with questions about the film's realism and its depiction of science. Finally, I asked participants whether they believed the film had impacted their own environmental attitudes and beliefs and whether it could affect other people's environmental attitudes and beliefs.

I analyzed the focus group results using grounded theory, beginning with transcribing the audio files and coding the transcripts as per Charmaz (2006). I coded the transcripts for mentions of climate change or global warming. The films tended to use "global warming" over "climate change" and most participants echoed this. I also coded for content related to science and the scientists in the films, as well as for statements about specific natural disasters featured in the films. I paid particular attention to statements that conveyed skepticism, uncertainty, as well as outright disbelief. Through analyzing the combinations of particular themes within the films as well as attitudes expressed by the participants towards these themes, I drew several conclusions as to how elements of disaster cli-fi films impact participants.

Results

Themes of climate change and the environment

Almost all participants cited action scenes featuring natural disasters in response to questions about what images or moments stood out to them. In particular, they cited outlandish and scientifically inaccurate scenes. The *NYC Tornado Terror* groups, for instance, frequently cited a scene in which a ball of lightning electrocutes an office worker as she is sheltering from the storm.

PARTICIPANT 16: [T]hat really big one [ball of lightning] that went inside the building.

PARTICIPANT 2: Probably remember the scene with the electrical ball coming into the building.

Another commonly mentioned moment involved New York City skyscrapers illuminated by St. Elmo's fire. St. Elmo's fire is a real phenomenon but was inaccurately depicted as a luminous

green substance coating the outside of buildings. The office workers use rubberized mats to make their way down the stairwell, escaping the electrified structure.

INTERVIEWER: So, are there particular scenes…that stood out to you?

PARTICIPANT 11: Probably the stairwell with the electricity going up.

PARTICIPANT 17: The electricity throughout the film, in the stairwell and on the buildings. You could just see the electricity [on the side of the building].

Participants were divided on the central theme of the films. Some participants saw themes of persistence and being appreciative of what you have in life. They spoke about the persistence of Cassie, the scientist protagonist of *NYC Tornado Terror* and her husband, Jim, the deputy mayor of New York City.

PARTICIPANT 6: I guess, I mean generally, at least Cassie demonstrated persistence in the matter. Sticking to her ultimate plan, and being persistent and so devoted to some form of goal. And don't give up.

PARTICIPANT 12: The one guy at the end…he made it sound like the message was appreciate what you have.

PARTICIPANT 24: Believe in yourself.

Other participants saw climate change as a predominant theme.

PARTICIPANT 1: I think a lot of it is a message about global warming. I generally agree with that.

PARTICIPANT 12: They're saying that global warming is changing the environment in ways that we can't understand yet.

PARTICIPANT 22: It was pretty politically charged, with the whole idea of global warming and its causing all these rapid movements is a big, I don't know when this movie was made, but still a pretty big politically charged film.

Several participants had reservations about climate change as the narrative's main theme, noting that it was only loosely tied into the overall plot.

INTERVIEWER: You mentioned global warming. Is that a major theme in this, would you say?

PARTICIPANT 12: Yeah, they did mention it, but I feel like they would have talked more about it if that was the main cause.

Participants who also expressed skepticism about anthropogenic climate change had a strong reaction to the narrative's climate elements. Participant 22, for instance, called *F6 Twister (Christmas Twister)* "politically charged" and argued that the film was highly inaccurate. He cited Logan, a climate-skeptic meteorologist and one of the film's main antagonists, as having the most appropriate view of climate change.

PARTICIPANT 22: I think Logan was the only one who was right in saying that things happen and [there is] a constant stage of change.

Likewise, Participant 20 eagerly identified climate change as a theme of the film *NYC Tornado Terror* and described it as "propaganda." He compared it to the episode "ManBearPig" (Parker, 2006) from the television show *South Park.*

PARTICIPANT 20: I just saw it as a giant environmentalist propaganda type. Way out of the scope. There's laser lightning beams falling from the apartment...They're [the climate scientists] always right and the government never listens to us and they don't care about anything. I just thought it was so out of the scope that I couldn't really get into the characters. I just kind of was upset with the writers and the way they, it was so overboard. I honestly thought [of] *South Park*, "ManBearPig."

Here, the participant argues that *NYC Tornado Terror* is similar to Gore's film *An Inconvenient Truth* (2006), which attempted to warn people about global warming but was decried by climate change deniers as alarmist. The "ManBearPig" episode of *South Park* shows Gore causing destruction in his wild attempts to warn people about the fictional ManBearPig, before announcing that he is producing a new film starring himself.

Participants who were concerned about climate change also identified environmental themes but tended to be less emphatic that climate change was a central message, suggesting that climate skeptics are more likely to pick up on climate change themes in pop culture than people who support the consensus. Climate skeptics may see such media representations of climate change as threatening their worldview (Kahan, 2012; Kahan, Jenkins-Smith, & Braman, 2011), shaping their opinions about the narrative in question.

Relationship between climate change and disasters in film

Participants overwhelmingly questioned the connection between climate change and natural disasters as depicted by the films. Many accepted the link between climate change and extreme weather, but (justifiably) felt that the films did not accurately portray the link. Participants noted that the films contained only a cursory discussion of climate change and failed to connect it with disasters in a meaningful way. This lack of a connection with climate change was a major factor in participants' reluctance to identify climate change as a major theme.

PARTICIPANT 2: One of the things that stood out to me was…they never gave much of an explanation as to what was going on. The news kept saying that it was a side effect of global warming.

PARTICIPANT 11: I mean, they mention it [climate change], but to me it doesn't seem related because when I think of global warming, I think "Holy crap, everyone's going to die."

Some participants speculated that climate change was simply a way to advance the plot.

PARTICIPANT 14: It's just something to blame for this. We don't really understand it, but let's say it's global warming…They had a good story, but they needed something in the background [that was] scientific. Sort of reminded me of "The Day After Tomorrow."

One participant remarked that the film's treatment of climate change was so irrelevant to the rest of the plot that she had forgotten it by the film's ending.

PARTICIPANT 23: Well, it's something she mentioned, but it's not throughout the movie and it's being reintroduced to you and it's being explained to you. It's just briefly mentioned…and [I] totally even forgot by the end of it that they mentioned global warming because it was just in passing.

Environmental messages that may be present in disaster cli-fi films such as this are thus diluted by the ambiguous relationship between disasters and climate change and the lack of a concrete mechanism linking the two.

Speed and severity of disasters

Participants expressed skepticism as to whether the natural disasters depicted could unfold with the speed and severity depicted in the films. Several participants noted the extreme nature of the disasters made the film seem less realistic and credible.

PARTICIPANT 21: [I]t loses all credibility with just the magnitude of how frequent these tornadoes are…The chance of this happening is extremely low, so it loses all its credibility when you're pushing it to that extent.

One participant suggested the extreme and unusual disasters may lead to audiences' dismissing not only the film itself, but climate science as sensationalized.

PARTICIPANT 1: Well, global warming causes more extreme weather and…hurricanes or tornadoes and things like that. I don't think you got anything this extreme where a tornado shoots lightning. So, people who watch would be, "Oh, that's not real global warming, that's exaggerated."

Others felt that the disasters' rapid speed damaged the films' realism.

PARTICIPANT 5: I feel like it happened too fast.

PARTICIPANT 12: [W]ith the science…let's not forget that this all happened in the span of a day.

PARTICIPANT 17: It was really drastic. "Oh, nice day," and then the tornadoes show up and then the storm would go about it and then it turned into completely gray sky. It really cannot happen that fast, I'm pretty sure that it doesn't happen in 3 minutes.

The disasters' rapid speed added to the lack of scientific context to make the film less impactful for one participant:

PARTICIPANT 18: I just didn't like the fact that they were…I think they [the main characters] were at a party or something like that, and these things [the tornadoes] just come up out of nowhere. So, can you at least tell us what led to it over the years? To me they should have done something to lead up to that…It scares me for a second and then it's just, "Can this possibly happen?"

Exaggerating the speed and severity of natural disasters associated with climate change appears to damage external realism for audiences, potentially making the films less likely to impact their attitudes and beliefs.

Representation of science in disaster cli-fi films

The depiction of science was a significant source of skepticism and uncertainty for participants. Many participants found the science and underlying concepts unrealistic. When asked how accurate the film's science was, some participants outright rejected it:

PARTICIPANT 21: Literally zero. There's nothing behind it.

PARTICIPANT 19: I think the majority of the stuff we saw in the film was really unrealistic.

Similar to Lowe et al.'s results (Lowe et al., 2006), some participants expressed uncertainty as to the boundary between factual science and film science. Despite criticizing the films for lack of scientific realism, comments made by several participants reveal a degree of uncertainty regarding science fact vs. fiction. Many participants admitted they were unsure whether the phenomena depicted—such as St. Elmo's fire and cloud seeding—were possible. They expressed surprise when other participants pointed out that these were not entirely fictionalized concepts, expressing tentative acceptance of the fictionalized science.

PARTICIPANT 11: I thought it was pretty cool, the idea that, with the mini tornadoes, it's kind of cool. I didn't know that they get cold on the inside, though.

PARTICIPANT 14: I don't know too much about extreme weather, so, I mean to me just the idea that something like that could potentially happen is really crazy.

PARTICIPANT 1: [I]t's something that could happen, hypothetically.

PARTICIPANT 3: I'm not an expert but I think anything's possible.

Other participants were more ambivalent:

PARTICIPANT 2: Could be possible. One of the things that stood out to me was that…they never gave much of an explanation as to what was going on. The news kept saying that it was a side effect of global warming.

PARTICIPANT 8: I was thinking about the high-low atmosphere splitting and things like that. I don't know if that's a thing, but that just sounds more believable.…So there were certain aspects of it, you know, that I feel were possible.

PARTICIPANT 23: I feel like lightning can definitely kill people and if it's powerful enough, can cause a fire or whatever, but I don't know. Maybe small parts of it were realistic, but most of it wasn't.

PARTICIPANT 25: It's just the concept in general that was interesting, that one massive storm could overtake…I wasn't sure. It didn't seem really real. I don't know in terms of the scientific part of it, to determine if it's actually feasible.

Several participants explained they were unqualified to judge the films' accuracy without further research.

PARTICIPANT 11: I don't have anything to compare it to yet [in terms of accuracy]. I haven't researched it.

PARTICIPANT 18: I don't know if something like this could be a possibility. I would have to do research on it to speak on it, but it's definitely scary if it can happen. So [it] definitely scares people.

Many participants said the film disasters were too outlandish and vague to look up on their own, but others expressed curiosity. In line with Hart and Leiserowitz's findings on information-seeking among *The Day After Tomorrow* audiences (Hart & Leiserowitz, 2009), participants expressed interest in learning more about the disasters in the film. I asked participants what, if anything, they would look up after the discussion.

PARTICIPANT 12: How much of that [the tornadoes in the film] is actually true.

PARTICIPANT 15: Are there any tornados [such as those shown] that actually happened?

Participants also critiqued the films' representation of science, particularly the lone scientist trope. The mysterious disasters in all three films are eventually understood and/or destroyed by a single scientist character who races the clock with his/her research. Participants correctly argue that science is frequently a collaborative enterprise, making it unlikely that a lone scientist could successfully solve such a complex problem on his/her own.

PARTICIPANT 4: I think there would be a lot more people involved, a lot more.

PARTICIPANT 16: She was the only one who came up with something. I guess she was the head and she was the smartest one…But I mean, I was wondering, "What were those people [the rest of the scientific staff] doing?"

Likewise, participants criticized the speed with which the lead scientist identified the problem and developed a solution. These critiques were often related to participants' perceptions that the disaster evolved too quickly:

PARTICIPANT 11: Science does not take a day.

PARTICIPANT 12: [T]here would be a lot more testing and stuff going on, especially if it is some kind of disaster…But they were so sure – at least she was – so sure that this is exactly the perfect solution, and you don't get that sort of certainty in that short of time.

PARTICIPANT 11: And remember two hours before [revealing the solution to the tornado outbreak] she [the lead scientist] was like, "This will take years." Two seconds later – done. No.

Efficacy and disaster cli-fi films

One important criticism participants had of the film was that it did not contain any suggestions as to how to combat anthropogenic climate change in the real world. Participants felt the environmental message of the film was weakened by telling them a story about the dangers of climate change but failing to provide any suggestions for concrete actions audience members could take in their own lives to mitigate the threat.

PARTICIPANT 5: I think this film in particular didn't really address that [taking action to minimize the threat] because they didn't give an explanation for why it was out there. They just jumped right in there. There wasn't, "Oh there's so much greenhouse gas," or "Oh you're using too much fossil fuels."

PARTICIPANT 14: [T]hey didn't really go deeper in terms of this is why it's global warming specifically…And [there was] no message about, "We need to fix what we're doing or something." They're just, "Oh let's stop this, what's going on now."

PARTICIPANT 8: I feel like it doesn't say any of the techniques [to stop climate change] – if someone was to, you know, think it was their fault.

This criticism is in line with other studies in the social sciences that argue the lack of concrete suggestions for how to combat climate change weakens environmental messages (Hart & Feldman, 2014; Li, 2014).

Impacts on environmental attitudes

The consensus was that these films are not particularly effective at changing environmental attitudes, particularly in light of the criticisms regarding lack of efficacy. Although some participants suggested that less educated, less informed members of the public would be more likely to take the films at face value, participants generally felt that the films were too inaccurate to impact attitudes. Some participants even went as far as to say films such as the ones used in the study made people less likely to accept anthropogenic climate change as a real threat for which action is required.

PARTICIPANT 2: I think if people would see this movie they would kind of think that global warming is not real because of the movie.

PARTICIPANT 13: I mean from this [film], they probably think of it as a joke.

That being said, participants did not outright reject the idea that fictional films could have indirect impacts on attitudes. Even though viewers might dismiss the films as unrealistic, a lingering uncertainty could remain, as some participants noted:

PARTICIPANT 4: I think that people might not believe it, but then still have the doubt that it could happen.

PARTICIPANT 2: I think in the back of their mind.

Because participants had difficulty distinguishing where fact and fiction diverged, the possibility of extreme disasters seemed to remain for some participants.

PARTICIPANT 18: [O]f course you're going to have people that say, "Oh Syfy, just another one of those movies." Then you have some people that at first hand, will get kind of scared, because they're like, "Well, I don't know much about science," like myself, and they'll think, "Well, maybe this possibly can

happen, even though it's a movie." But for a while people might think, "Maybe this can happen."

Discussion

Several conclusions can be drawn from these results. Participants generally noticed recurring mentions of climate change but were divided on whether these constituted a major theme. Much of this hesitancy came from the lack of a detailed, specific discussion of climate change within the films. Interestingly, the few participants with a skeptical attitude toward anthropogenic climate change tended to be most adamant that climate change was a theme. It may be that such participants were not sufficiently transported into the world of the narrative to preclude back arguing against the films' premises. It may also be that participants who have strong feelings of climate skepticism may have picked up on climate change references early on because they perceived such references as an effort to challenge their deeply-held beliefs.

The predominant emotional responses to the films were incredulity and confusion. Underneath this umbrella of skepticism were three specific areas of disbelief: the causal relationship between climate change and disasters (violation of internal realism), the swiftness and severity of the portrayed disasters (violation of external realism), and the representation of science (violation of external realism).

Despite their generally skeptical attitude toward the depiction of science and climate change in the films, participants remained uncertain about the barrier between science fact and science fiction. Even though participants openly expressed disbelief that the events in the film could happen, many seemed unsure as to the *degree* to which the films exaggerated and invented phenomena. This uncertainty suggests participants struggled to pinpoint the specific point at which the films departed from established science, similar to the results found by Lowe et al. (2006).

It appears the violations of internal and external realism documented impacted audience involvement in the films, as predicted by the literature. The combination of extreme, scientifically-questionable events and weak causation in disaster cli-fi films caused audiences to lose track of the climate change theme. In addition, participants questioned the sped-up timelines and exaggerated intensity of the disasters in the films. Unrealistic timelines and impossible impacts from climate change are common criticisms of disaster cli-fi films levied by both filmgoers and scientists alike (Leiserowitz, 2004; Lowe et al., 2006). Participants felt the use of a lone scientist trope, where a single individual diagnoses and solves the disaster on his/her own, was inaccurate. They suggested these features made the film less realistic and weakened their engagement with the storyline. This is in line with other research which suggests that films must maintain a certain level of *believability* to ensure that audiences remain engaged (Lowe et al., 2006).

Overall, participants doubted the films' ability to affect environmental attitudes and beliefs. They argued the films were too inaccurate and lacking in credibility to influence how the public thinks about climate change. These findings contradict other research on environmental attitudes and fictional films. Although the participants dismissed the influence of these particular films on environmental attitudes, studies have shown that *The Day After Tomorrow* (2004) did affect audiences' attitudes toward climate change (Howell, 2011; Leiserowitz, 2004; Lowe et al., 2006).

There are a few possible explanations for the disconnect between what participants *say* about the impacts of film on environmental attitudes and what researchers have *measured*. The third-person effect is a well-documented phenomenon within communications studies (Davison, 1983) which "predicts that individuals will perceive media messages to have greater effects on other people than on themselves" (Salwen & Dupagne, 1999, p. 523). The third-person effect is thought to arise because people generally believe they are smarter than others; thus, they are less likely to be persuaded by the media than others who are less intelligent (Paul, Salwen, & Dupagne, 2000). Given the participants' observation that the natural disasters depicted in disaster cli-fi films are highly unscientific and exaggerated, it could be that participants assumed that no one was gullible enough to be influenced by them. Theoretically, this would suggest a sort of floor to the third-person effect whereby some forms of media are seen as so obviously absurd that no one could be influenced by them—even the assumed less-intelligent third-person.

I suggest that what is more likely is that participants were more influenced by the films than they openly acknowledged. Indeed, given the uncertainty expressed by many participants as to where scientific fact stopped and science fiction began, the films may have impacted participant environmental attitudes without their explicit awareness. This impact would support the findings of Lowe et al. (2006) and Leiserowitz (2004), as well as the concerns that audiences will mistake fictional science for science facts (Kirby, 2003b, 2003a). Studies that suggest people struggle to separate fact from fiction when watching science fiction films (Barriga et al., 2010) and historical fiction films (Butler et al., 2009; Marsh et al., 2012, 2003) add to this fear.

Thus, it is worth considering the possibility that, although fictional films are unlikely to sway climate deniers and unlikely to shake supporters of the consensus, subtler environmental beliefs and scientific understandings of issues like climate change could be affected. These misunderstandings have implications for climate change communicators and advocates, who may find themselves spending more time debunking misperceptions. Although more research is needed, it is possible that the inaccurate science in these films can contribute to a general lack of understanding of what causes climate change, how humans are contributing, and why climate change is a threat.

Equally concerning is the possibility that film audiences, having been exposed to inaccurate ideas about climate change and storms in disaster cli-fi, may be more susceptible to misinformation in the event of actual storms. During the preparations for Hurricane Irma in September 2017, for example, an image of a fake news ticker with the caption "Irma Now Contains Sharks" went viral on social media (Porter, 2017). Irma was the subject of a variety of

hoaxes, including the rumor that it would make landfall in Florida as a Category 6 storm (hurricanes are measured on the Saffir-Simpson scale, which goes up to 5) (Ohlheiser, 2017). It may be that people who saw these films misremembered the inaccurate, fictional storm information later, making them more receptive to misleading claims during an actual extreme weather event. More research is needed to determine to what extent, if any, inaccurate information in cli-fi influences perceptions of real disasters. However, as was evident during Irma, debunking such misinformation falls on the shoulders of meteorologists and other public safety officials whose time would be better spent warning of actual dangers.

Limitations and directions for future research

Using undergraduate students for focus groups poses certain limitations, as these students are not representative of movie audiences in the United States or elsewhere. It is also possible younger media consumers have different levels of scientific education and understanding than older media consumers, impacting what they see as realistic or unrealistic. Further studies should explore how a wider audience interacts with disaster cli-fi films to see whether these results hold true for other demographics.

Audiences exposed to historical fiction films often incorrectly interpret historical fabrications as fact (Butler et al., 2009; Marsh et al., 2012, 2003). Whether such misinterpretations occur with disaster cli-fi films as well is an area of study that would be quite fruitful and important. Specifically, if audiences are absorbing misleading or false information about climate change from popular culture, science communicators may be forced to devote increasing amounts of time and energy to debunking false notions propagated in fiction.

Other studies exploring the influence of film on environmental attitudes have suggested films can affect attitudes and beliefs about climate change (Howell, 2011; Leiserowitz, 2004; Lowe et al., 2006). These studies also suggest fictional representations of climate change in film can influence audiences' intended *actions* on climate change. Because of the limited scope of this study, it is not possible to say whether the low-budget disaster cli-fi films such as the ones examined here have similar effects on audience actions. Given the proliferation of these films in the media marketplace, it would be useful for science communicators to understand how these films impact their audiences' willingness to act on climate change.

Although it has been over a decade since the theatrical release of *The Day After Tomorrow* (2004), new examples of climate change in popular culture are multiplying rapidly. The *Sharknado* series—which specifically invokes climate change—has become a cult classic, with five films total in the series as well as books, documentaries, and a plethora of merchandise. Cli-fi is rapidly becoming an important genre in film and other media. Social scientists who wish to study public attitudes on climate change will increasingly need to engage with pop culture. My findings suggest the relationship between pop culture and attitudes is complex but specific

components of film and fiction may be more important than others in determining audience reactions.

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