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#TheSmoreYouKnow and #emergencycute: A conceptual model on the use of humor by science agencies during crisis to create connection, empathy, and compassion

Sara K. McBride [a,*], Jessica Ball [b]

[a] U.S. Geological Survey, Earthquake Science Center, 350 N. Akron Road, Moffett Field, CA, 94035, USA
[b] U.S. Geological Survey, California Volcanic Observatory, 350 N. Akron Road, Moffett Field, CA, 94035, USA

A B S T R A C T

Studies from a variety of disciplines reveal that humor can be a useful method to reduce stress and increase compassion, connection, and empathy between agencies and people they serve during times of crisis. Despite this growing evidence base, humor's use during a geohazard (earthquake, volcanoes, landslides, and tsunami) to aid scientific agencies' crisis communication response has been rarely studied. A broad literature review of humor in crisis and an exploratory examination of several case studies reveal that scientific organizations, specifically those that respond to geohazards, can harness the power of humor to help create connection and empathy with the publics they seek to serve. We find evidence that supports our argument that the use of humor acknowledges a shared human experience, reducing the barriers between public officials, scientists, and the people most impacted by crisis. Public statements made by scientists and public officials during the U.S. Geological Survey (USGS) response to the Kīlauea eruption in 2018 in Hawai'i, United States, and GNS Science/GeoNet (GeoNet) response to the M7.8 Kaikōura/North Hurunui earthquake in 2016 in Aotearoa New Zealand, are used to inform the development of this conceptual model. We then posit a conceptual model which unifies concepts from the literature with our case studies to provide potential guidelines for those crisis communicators working for science agencies on how best to use humor to help people cope during times of crisis. This model can be further tested for future research to determine its effectiveness and utility for scientific agencies responding to geological crises.

1. Introduction

There is a dearth of literature about how humor is utilized by public officials, specifically physical scientists during geohazard crisis such as volcanic eruptions and earthquakes. Humor studies enjoy a rich philosophical and theoretical discourse in many disciplines, and, critically, tend to have an interdisciplinary reach. Humor research has been published under the aegis of philosophy [1], linguistics [2,3], public health, nursing, psychology, sociology [4,94], anthropology [2,5], communication and media studies [6], neurology [7], marketing [8], journalism [95,96] education [9], and biology [10], among other disciplines.

Each discipline has a different purpose to their work when approaching humor [4]. Here, we focus our exploration of humor on modes and topics that may have the best chance of being funny across broad publics, as well as the roles of timing, appropriateness, and locality to develop a conceptual model of effective humor during times of crisis. For the purposes of our research, we exclude forms of performance or comedy such as standup comedy, satires, farce, slapstick, as communicating about a crisis is not for entertainment.

Finally, it is important to note that humor is contextual - there is very little evidence to suggest that humor is universal across cultures [11]. Murthy and Gross [12] found that, by comparing disasters by locations, there was little connection between humor themes on social media for disasters in the Global South compared to the Global North. Jiang, Li, and Hou [13] notes that shifts in globalization, however, are creating more universal topics of humor that are acceptable across cultures and countries. In this article,

* Corresponding author.
E-mail addresses: skmcbride@usgs.gov (S.K. McBride), jlball@usgs.gov (J. Ball).

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we explore literature and case studies to develop a conceptual model, with the goal to improve communication for geoscience agencies communicating during crisis.

2. Humor theories

First – what is humor? Humor has numerous definitions, however for the purposes of our research, we prefer an operational definition: humor can be defined as a message, image, or visual that induces heightened arousal, smiling, or a laughter from an intended audience [100]. Theories such as relief theory, superiority theory, and incongruity theory are used to explain the main sources, mechanisms, or benefits [4]. Relief theory describes humor's role in releasing stress and tension, as explored by Wanzer, Booth-Butterfield, & Booth-Butterfield [14]. According to Kuipers [4]; humor is a social occurrence and creates social connections. Several themes have emerged around what makes something funny: incongruity, context, social interactions, culture, and power [11]. The connection between humor and crisis is largely relevant in terms of stress management and coping, particularly in the frame of providing "relief". The relief argument was first explored by Herbert Spencer in an article entitled "On the Physiology of Laughter" [15], which argued that the act of laughing relieves nervousness, anxiety, and stress. Wanzer et al. [14] found evidence of relief theory in action during their investigations of high stress environments for health care workers and how these workers used humor for coping. Pollio [16] noted that families used humor in times of crisis to process the experience together.

Superiority theory explores the need for us to laugh at other people's follies and mistakes, so we can feel greater than them [17]. However, this mocking kind of humor is inappropriate for use by public officials and should be avoided, not least because the audience will feel "othered" or isolated [9]. In a crisis the need for emotional release and safety is much higher; Ulmer, Seeger, and Sellnow [18] argue that people are already feeling fragile during crises and scientists should not exacerbate that feeling. We therefore will not explore superiority theory's utility further, given its risks and lack of benefit from both the source and their publics.

Incongruity theory (IT) was first developed in Aristotle's discourse on humor, particularly in his book *On Rhetoric* (Aristotle, 350 B. C.). Aristotle argued that to create laughter, expectation must be created in the audience and be violated by the speaker. IT further matured in the 18th century, with philosophers Schopenhauer, Kant, and Beattie, who focused on how incongruity can be generated [19]; they posited that something is funny when it is contrasted by a norm, pointing out the ridiculousness of a particular situation. We consider incongruity a particularly useful theory to explore for humor during crisis, as norms are challenged situationally during times of upheaval.

2.1. Humor and scientists

Scientists, as posited in Kilbourne [20]; have a public perception problem: "scientists are different, alien, and foreign, and therefore automatic targets for ridicule (pg. 340)." Morreal noted that some in the science commnity rejected humor, both as a serious topic for study as well as in their communication style [98]. We note that during times of crisis, given the stressors that peoplecan face, using humor for communication may be a similar coping mechanism to "gallows" humor, which can be used in crisis situations as a way to defuse difficult moments for professionals working in challenging environments [21,96]. "Gallows" humor during a shared experience may be useful to 'insiders' of a profession but can also have risks when viewed from outside the affected group [21]. This perception of physical scientists as being humorless is in contrast with adjacent disciplines, like medical practice, where gallows humor is understood to be part of the profession [21,22]. Physical scientists, in particular, may be reluctant to use humor during crisis, perhaps viewing it as inappropriate to their roles or their perceived objectivity. Also, communicating during times of crises is not without risks for physical scientists. One notable case is the M6.3 L'Aquila earthquake, when an emergency management official, who was representing the scientists, stated that an earthquake swarm was normal, and that people should not worry but it was better to drink a glass of wine [23]. A damaging earthquake occurred shortly thereafter, killing more than 300 people, which led to the prosecution, conviction and later acquittal of those scientists [24,25]. Further, we argue that there are certain types of humor that may not be appropriate for use in times of crisis, because the risk of causing offense is high. For the purposes of this article, we focus on physical scientists who act as spokespeople for geological science agencies involved with geohazards (volcanoes, earthquakes, tsunami, and landslides); however, other scientists who have a role to communicate in a crisis may find this work beneficial.

Emotions can be difficult for physical scientists to express during an earthquake or eruption, even though they may feel excitement or that these events are "fun", as explored by Lamontagne & Goulet [26] in the case of seismologists expressing excitement after earthquakes. The risk of offending people or not appearing empathetic is high [27]. But humor, coming from physical scientists, can have benefits during crisis as well. The perception of scientists being humorless is shifting, in part due to the advent of social media, as explored in Simis-Wilkinson et al. [28]. In that study, the authors analyzed the Twitter hashtag #overlyhonestmethods, in which scientists shared their humorous methods and research failures. The results indicated that the use of #overlyhonestmethods allowed for scientists to be more transparent as to the process and limitations of science, allowing non-scientists a perspective into a community that can often seem aloof and opaque. This may be particularly salient given that, like medical practitioners, some physical scientists have public emergency response functions, for example, producing information products such as aftershock forecasts or tsunami information during natural hazard events [29]. Yeo et al. [30] explored source relationships with scientists and various publics, finding that humor did indeed increase likability and relatability of the scientist. McBride [97] argued for earthquake scientists to consider likability and relatability in their communication with various publics. Further, Yeo et al. [31] studied how people engaged with science messages that were encased in humor, finding that engagement was increased when humor was utilized as a framing device. This research indicates that humor is, indeed, a powerful framing device to increase connection between scientists and the publics they seek to engage. However, we found no formal studies of how and in what situations humor is used by geoscientists in geological crisis, making this a timely and relevant study given the variety of crises that have occurred during the rise of social media as a rapid

communication mechanism.

2.2. Humor and crisis

Crisis is defined as when a group of people, be it an organization, town, state, nation, or other, perceives a threat to their values, life-sustaining functions, or infrastructure, which much be responded to swiftly to mitigate harm [32]. Coombs [33] defines crisis communication as the collection, processing, and dissemination of information to address a crisis. As stress is linked with crisis, communication can both increase and reduce this stress. As Nezu, Nezu, and Blissett [34] assert, a sense of humor can moderate the impacts of stressful events to diminish long term psychological distress. We argue this is why the examination of humor and whether it can be useful to reduce stress and trauma during crisis is useful.

Contemporary research also indicates that increased stress, such as that caused by crises like volcanic eruptions and earthquakes, requires a release, like humor and its by-product: laughter [34–37]. Regular releases can benefit personal wellbeing and can assist in helping people cope with crisis [35]. Socially, there are a few common ways to have a shared emotional release, with crying and laughter being the two most frequently used outlets [38]. The emotional response of crying can be extremely effective, particularly to express grief [39]. However, evidence suggests that not all cultures feel comfortable with open expressions of emotional release like crying [40]. Hendriks and Vingerhoets [41] found that, when participants were shown crying faces, they interpreted the people crying to be less emotionally stable but more empathetic or likable. Humor appears to be more universally palatable; additionally, Nezu et al. [34] argue that humor can assist people's resiliency and ability to recover from stressful events, like crisis.

Perko et al. [42] found that, when studying a community situated close to a nuclear facility where there is a constant risk of harm caused by a criticality at the facility as well as toxicity from the waste materials, humor strengthened community ties and was critical for community resilience [43]. The same applies in times of war; Frankl [44] recounted that he and other concentration camp survivors in World War 2 would use humor to collectively cope with horrific daily conditions associated with the Holocaust.

Humor has been used to help people process dramatic events, like crises. McGraw et al. [27] argued that for an event to be humorous, the community has to engage in some sort of processing of the experience. An early example of this is how communities processed the sinking of the Titanic in 1912; this case study is one of the first cases of mass media humor during a crisis [6]. Smyth [36] argued that part of communal coping with the 1986 Challenger space shuttle disaster was the use of inappropriate humor by spectators of the event, as a way to emotionally distance and allow them to cope with the crisis. The terrorist attacks on September 11, 2001 were also the subject of humor; Ellis [45] explored this to develop a model which posited that humor is suppressed early on and then emerges after a period of time as stages of coping. More recently, COVID-19 and its connections to humor has been studied, with one study finding that humor can alleviate adverse psychological consequences from the pandemic [46]. However, COVID-19 and the use of humor raised questions of ethical uses of humor arose early during the COVID-19 pandemic, with concerns over racist and sexist jokes causing harm in the media [47]. Finally, a critical part of successful crisis communication includes creating empathy and connection with impacted publics [48]. [102] notes that humor can create empathy and relationships, depending on the humor style. This makes humor a potentially valuable device to create empathy and connection during crisis.

2.3. Applying humor in a crisis context

While these theories can provide some context as to why humor is useful in a crisis situation, they do not provide guidelines for its practical application in official crisis response communication. In this section, we address what topics are suitable for humor in crisis, timing, and why the timing and the source of humor is critical to its success. We reflect on literature from the field of crisis communication that can assist in building our conceptual model. Further, we briefly profile communication channels, focusing our work on social media, which has become popular with science agencies and their publics during crises [31].

2.3.1. Humor and proximity to crisis

Proximity, whether physical or emotional, is a critical factor in how people perceive or accept humor. Community bonding is also enhanced by physical and emotional proximity to impactful events [103]. In the Boston Marathon Bombings, individuals who were either in attendance, or knew someone who was either injured or impacted from the event, were more highly engaged searching out media sources covering the emerging story [104]. More recently during the COVID-19 pandemic, people have used humor to cope with the pandemic [49–51]. Social media in particular has created global platforms that allow for emotional proximity to events even if physical proximity is lacking [104]. Therefore, we argue that proximity, whether physical or emotional, is an important component to whether humor is acceptable or not during times of crisis.

2.3.2. Timing and humor

Sometimes referred to as poor comedic timing, jokes made with the wrong pacing or at the incorrect time in the crisis can fall flat. Tennant [37] studied nurses, humor, and older adult patients, concluding that if the timing was inappropriate, such as a joke made during a sensitive or emotion-laden moment, the intervention could be destructive to the patient. McGraw et al. [52] found that, in the case of Hurricane Sandy (2012) and social media responses, social media users' expressions of humor changed over time, creating a humor "sweet spot." This "sweet spot" was defined as occurring when people online had some psychological distance from the tragedy and were no longer under extreme direct threat, but when the threat was still within the collective memory [52]. Further, in the McGraw et al. [52] study, it is suggested that this "sweet spot" is about 8 days after the threatening event, plus or minus a day, although this can be variable depending on the duration of the event. Hence, if one was going to err on the side of caution, it would be better to try to be funny later in the crisis, even if the joke fell flat due to being too late, than being too early and risk offending people who still felt threatened. In summary, the old comedic adage holds true: timing (in crisis) is everything.

2.3.3. Appropriate humor

So, what types of humor are appropriate? There are multiple theories on humor and what constitutes appropriateness [4]. Gruner [11] and Chapman [92] both argue that humor is contextual - there is very little evidence to suggest that what is funny to one group, cultural or otherwise, is funny to another. Medical personnel and emergency responders, as explored in Obrdlik [22] and Thorson [21]; frequently reported that issues of good taste and appropriateness arose outside of a clinical setting. These findings are reflected in Tham [53]'s article detailing the experiences of staff members at an emergency room department in the Philippines during a 2003 SARS outbreak, which concluded that humor was critical to the emotional and social coping of this group. Further, police and forensic staff are prone to use humor at crime scenes, specifically in murder investigations [54]. Police officers handling body parts post-disaster have noted that some of their humor would not have been appropriate outside the location and the group of responders [55]. Given this, contextual reflection is critical before communicating using humor.

Finding "safe" topics to use for humor is a complex endeavor. Self-deprecating humor could be useful; a safe person to make fun of is always oneself. Hoption et al. [56] established that when leaders used self-deprecating humor, they were considered better leaders than those who were not humorous at all or used more "aggressive" forms of humor. In 2013, the company Alibaba faced a crisis after it had been accused of false advertising by users of Weibo, China's most popular social media platform; the CEO Jack Ma utilized self-deprecating humor to help restore the reputation of his organization [57]. He mocked his own intelligence and appearance; the tactic appeared to be successful [57]. But not all cultures feel comfortable with self-depreciation; in a study of comparing humor between Australians, Americans, and British, Americans were the least comfortable with self-deprecation [58]. Therefore, cultural and occupational context is critical in considering the appropriateness of using self-deprecating humor.

Humor that includes animals may be safe to employ during a crisis and is present in many cultures and publics, particularly when the animal is found to be 'cute'. The strategy of using cute animals to promote COVID-19 crisis public health information by Taiwanese public health agencies was successful in that these posts were shared and liked more widely than the "non-cute posts" during the COVID-19 pandemic [59]. There is evidence of people finding "cute things" as soothing, safe and attractive; the power of "cute" has been used to sell items to consumers particularly across different age groups [60]. In Kogan et al. [61]; stressed veterinary students were shown videos of cute animals and had a notable decrease in stress after viewing these videos. Further, the value of animals as "therapeutic caregivers" has long been established in the medical community as explored by Katcher & Beck [62]; making them a potentially safe humor topic for most people. [101] determined that people online often sought out pictures of "cute" cats to dissipate negative emotional states. However, we note that cruelty towards animals or mocking the distress of animals is problematic and should be avoided.

2.3.4. Humor and the source

Relationships between the source and receiver are a critical component to consider when developing a crisis communication approach [63,64]. The source is defined as the originator of the message [65]. The source and their characteristics (race, gender, age, ethnicity) of the humor are important when the receiver is determining whether something is funny or not [66]. For example, a recent study suggested that men who use humor in the workplace are perceived positively while women who use the same jokes can be perceived as not being serious about their work by their peers and colleagues [67]. The authors of this study suggest that it is not meant to discourage women, or any demographic, from continuing to be authentic representations of themselves if that includes humor, as authenticity is a central component of whether a person finds the source trustworthy [68]. Trusted scientists, regardless of gender, typically are perceived as authentic by their publics either because they live locally (e.g., where the crisis is occurring) or are familiar enough to be regarded as reliable sources of scientific information [69,70]. This suggests the importance of "pre-established" relationships; agencies or individual scientists are known to community members before a crisis occurs [69]. These trusted sources may be able to utilize humor more effectively because of this trust and relationship with their publics rather than someone who has no relationship with those publics.

2.3.5. Humor and communication channels

The choice of communication channel (e.g., social media, broadcast media, print media), as defined by Berlo [65]; may be as important as the message itself, and messages may be modified to fit the style and tone of the channel [71]. Uses and Gratification Theory suggests that people access channels, particularly news sources, which most frequently mirror their own values and beliefs [72]. As a result, some platforms are better suited than others to communicating with humor, and social media is frequently used by those seeking both information about a crisis as well as humor related to it [73]. Additionally, humor has a shorter transit time and longer 'shelf life' on platforms like Twitter [74]. Further, we focus our work on social media, as it can be highly effective for agencies in terms of crisis communication, as examined in the case study regarding the Fukushima nuclear disaster following the M9.1 Tohuku Earthquake in Japan [105].

Given that social media channels contain humorous topics combined with the benefit of a faster feedback loop between source and publics, we will use case studies from those channels. One of our case studies focuses on the agency response of the U.S. Geological Survey (USGS) and we note there is important interplay between broadcast (print, radio, and television) and social media in previous responses, with 'traditional' media producers mining social media information for their stories, as explained in McBride, Llenos, Page, and van der Elst [70]. Further, while in the past USGS employees prioritized broadcast media over social media channels as explored in McBride et al. [70]; this 'traditional' media focus may be shifting over time as social media is found to be an effective crisis communication tool.

3. Methods

Our main method is the use of exploratory case studies combined with a review of best practices as described in the literature, to determine how well suggested best practices hold up when applied in case studies. Our research builds on multiple communication and humor theories, combining these, as suggested by Whetten [75]. Our purpose is to consider how physical science agencies can use humor to manage their communication to create empathy, trust, and compassion. We consider multiple fields outside of geohazards, including medical, public health, linguistics, communication, and philosophy, among other disciplines, in our exploration of theory.

We choose not to pursue a specific hypothesis about the use of humor in crisis, but rather to develop a conceptual model which can be used to build broader theory, enhance conjectures, and be tested with specific hypotheses [76]. Case studies, as an interpretivist method, are appealing for applied disciplines because they provide a better understanding of processes, problems, and programs which can improve practice [77]. This aligns with the purpose of our study and conceptual model: to improve communication for geoscience agencies communicating during crisis.

Our case studies examine two specific events: the 2018 Kīlauea eruption in Hawai'i, United States [78] and the 2016 M7.8 Kaikōura/North Hurunui earthquake in Aotearoa New Zealand [79]. Published literature, social and other media communication, and personal experience are all used to inform these case studies (the authors were both science responders in these events). We utilize

Fig. 1. A compilation of 'Rusty the Lava Rooster' screenshots, including a) the original Rusty, his fan page and a USGS tweet promoting 'his' live video stream on Hawai'i Civil Beat, b) a selection of Rusty fanart, and c) the t-shirts created to memorialize his appearances, including several whose proceeds were donated to relief efforts. Reprinted with permission.

interpretivism, as a methodological approach which can provide rich insights into "the complex world of lived experience from the point of view of those who live it" [80]; p. 118). By considering experiences, we focus on meaning rather than measurement, as suggested by Daymon and Holloway (2002), who maintain that experience can be a resource in formulating and interpreting research. Phillips (2014) argues that "insider" researchers can provide key insights into research via their own experiences. Hence, the positionality of this work is interpretations from responders who have personal knowledge of these events. An insider perspective to pre, during, and post crisis can be valuable in recalling events through rich personal experiences that may not be known to outsider researchers [71]. However, with this perspective, bias must be acknowledged. To reduce bias and the perception that this study is an attempt to re-write accounts to reflect better response tactics than occurred, we also draw from official communications and social media posts that are still available online, unedited or which were archived and unedited. We did not rely on comparative analytics nor a formal qualitative analysis, as social media can deteriorate over time [70]. In both of our case studies, we used textual searches using internal platform and external universal search engines. To refine our media searches, we used the search terms specific to our examples of humor; for instance, searching "USGS Volcanoes" and "marshmallow" yielded 197 unique or slightly modified articles for one of the Kīlauea incidents. The other portions of the case studies concerned phenomena which did not receive much coverage in 'traditional' media but were largely discussed on social media.

4. Case studies

4.1. Rusty the Lava Rooster, #TheSmoreYouKnow, and an Ex-GPS: the Kīlauea eruption case study

The 2018 eruption of Kīlauea Volcano in Hawai'i was a complicated crisis which lasted more than 4 months and impacted multiple locations and communities [78]. In terms of impacts, the eruption injured dozens of people, destroyed more than 700 homes and community structures, displaced 2500 people and cost hundreds of millions of dollars in lost tourism revenue for the Island of Hawai'i [81].

Social media became a crucial aspect of the crisis response for both scientists and those impacted by the eruption; it was used not only as a way to distribute timely information between scientists and communities and within communities, but also as an outlet for questions, conversations, and even humor regarding the eruption [81]. While the majority of the social media communication with scientists during the early, quickly evolving stages of the eruption was focused on situational awareness and safety, we noted in our review of social media archives on Facebook and Twitter that humor was introduced into the conversation by the impacted community around the 2-week mark. We defined this point as the first time humor was used in a sustained manner, by multiple members of the community and by the USGS Volcanoes twitter administrators (the social media team staffed by USGS volcanologists and communication staff), who were invited into the conversation by being tagged on social media.

Around the middle of May 2018, several citizens in the Leilani Estates subdivision (lower Puna, Hawai'i) began livestreaming the opening of eruptive fissures and the advance of lava flows in their neighborhood. While the original intention of the livestreams may have been to capture the activity and inform residents about the state of their homes, one livestream in particular, which was shared by the USGS for situational awareness purposes, began to be recognized for the crowing of a rooster near the camera. Social media commentators were quick to latch on to "Rusty the Lava Rooster" as a humorous topic. Rusty's owner provided updates about his rooster, a fan page and fanart sprung up, and several "Rusty the Lava Rooster" t-shirts appeared (Fig. 1). The saga of Rusty the Lava Rooster is an example of both relatable and animal-centric humor; though residents were losing their homes, they could recognize and share the amusement over a vocal rooster incongruously superimposed over a background of destruction. In addition, this signaled a receptiveness on the part of the local audience to humor when discussing the eruption. It further heralded that the community members following the USGS Volcanoes social media accounts were ready for the use of humor. While the humorous comments originated with the community, the USGS was able to step into the conversation and add their own comments about Rusty.

After the Rusty the Rooster commentary in May 2018, the USGS Volcanoes media team began to perceive that humor might be appropriate in select situations about the eruption. The next interaction involving humor occurred on the May 28, 2018. The account received a question on Twitter asking whether marshmallows could be roasted over lava flows. While a question like this was not necessarily important to answer for situational awareness, the USGS Volcanoes team members feared that leaving the question unaddressed or answering in the positive could encourage thrill-seekers to enter restricted areas in the Puna area (as had already happened several times). Adopting a conversational tone and joking about visually striking chemical reactions that could result between volcanic gas and marshmallows @USGSVolcanoes answered in the negative, as illustrated in Fig. 2.

By 29 May, the tweet had garnered intense media scrutiny, from outlets who were already reporting on the eruption as well as some who were not. At least 197 unique written media stories were published about the tweet, from major media outlets and wire services, like the Associated Press (2018), CNN (Park, 2018), and Time (Calfas, 2018). Dozens of television media outlets ran stories about the USGS warning people not to roast marshmallows over lava flows; Chuck Todd, MSNBC anchor, ran a story featuring a hand-drawn explanatory diagram, a reference to *Ghostbusters,* and a graphical pun on NBC's public service announcements ("The S'more You Know") (Fig. 2). Responses from social media were varied; several people were upset at the perceived disrespect to affected communities; others castigated the author as idiotic; and still others recognized the joke and commented in kind.

In this case, an attempt at humor fell flat with some observers despite occurring nearly a month into the crisis, while others recognized the absurdity of the suggestion and played on it to provide more amusement in the face of a grim situation. This is an illustration of how even the 2-week-guideline for the timing of crisis humor may not apply universally across publics.

A third incident shows how the USGS Volcanoes social media team turned the loss of a sensor into a lighthearted moment. When a follower inquired on the well-being of a non-broadcasting GPS sensor on the floor of the rapidly subsiding caldera, @USGSVolcanoes tweeted a response quoting the famous Monty Python "Dead Parrot" sketch, to the great delight of some Twitter users, as illustrated in

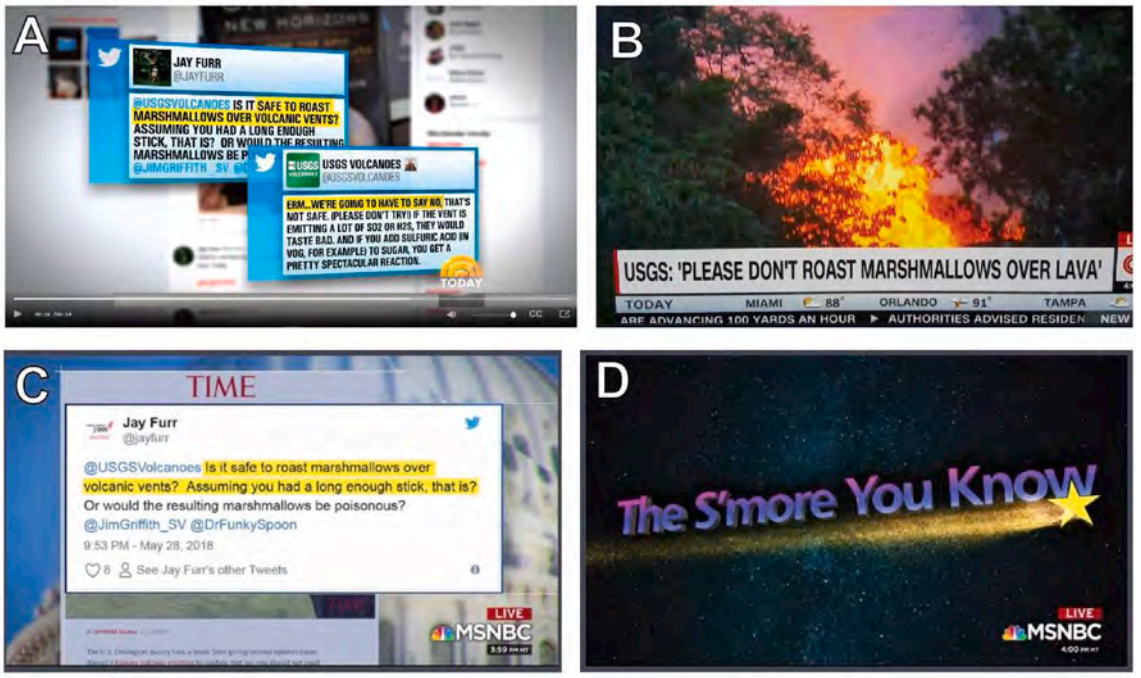

Fig. 2. Selections from May 30, 2018, media coverage of the @USGSVolcanoes answer to the question of roasting marshmallows over lava flows. A) The Today Show, B) CNN, C) Meet the Press Live (MSNBC). D) shows a parody of the NBC public service announcement graphic 'The S'More You Know', created for the MSNBC segment in C).

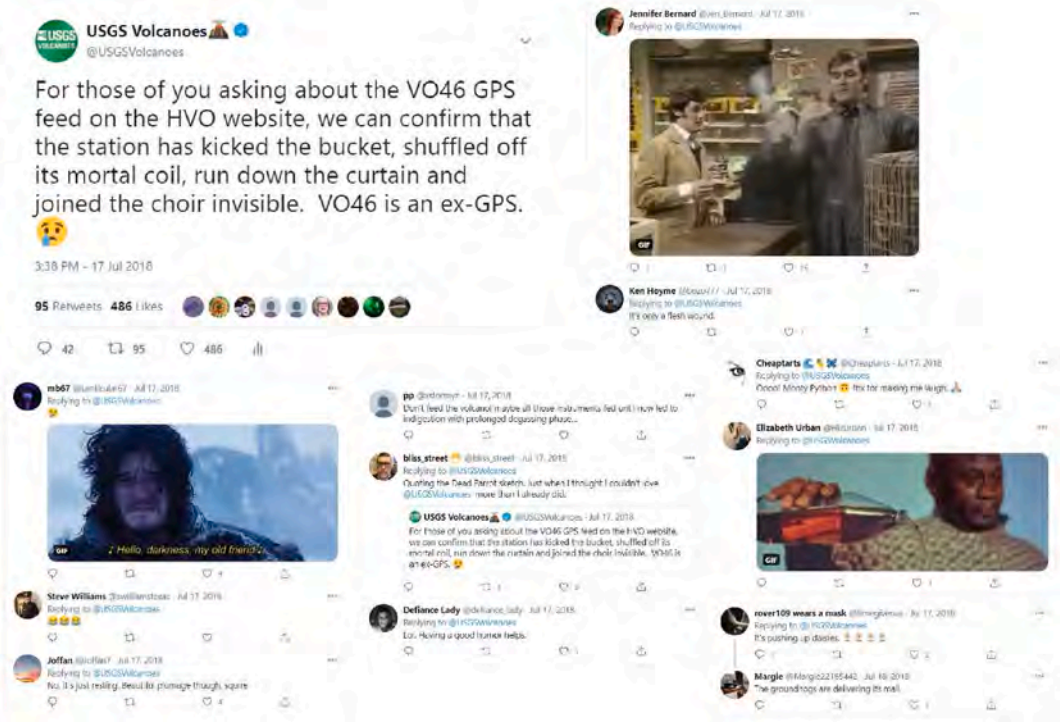

Fig. 3. *A compilation of @USGSVolcanoes' original tweet regarding the loss of a GPS sensor (the ex-GPS), referencing the Monty Python 'Dead Parrot' sketch* described in Chapman et al. [93]*, and public responses. The sensor had been located on the floor of the Kilauea Caldera and its signal disappeared when it was dropped several hundred meters and presumably buried in rubble.*

Fig. 3. The "Dead Parrot" skit is one of the more famous skits from the 1960s–1970s British comedy group from the United Kingdom; the full script is in Chapman et al. [93]. Numerous replies praised the good humor of the scientists behind the account and offered condolences on the 'death' of the sensor, interspersed with more Monty Python quotes. This moment may have served both to humanize the USGS Volcanoes social media team, and to allow the team themselves an outlet for releasing stress accumulated during the eruption response.

4.2. M7.8 Kaikōura/North Hurunui earthquake: #emergencycute

On the November 14, 2016, a M7.8 earthquake ruptured across 20 plus different faults to generate one of the largest earthquakes in Aotearoa New Zealand's history [79,82]. The earthquake, which began near Waiau and ruptured along 150 km of faults, lasted for almost 2 min, generated a tsunami, and caused widespread disruption across both the southern North Island and the Upper South Island [29]. The cities of Wellington and Christchurch experienced shaking, as well as numerous smaller, more rural communities. The agency responsible for reporting on earthquakes, GNS Science, did so through its GeoNet hazard monitoring project, which was co-founded and supported by the Earthquake Commission (EQC) [29].

Earthquakes are common in Aotearoa New Zealand, but the size and scale of the Kaikōura/North Hurunui earthquake were upsetting to people throughout the country [83]. GeoNet's twitter account was automatically reporting the main earthquake and aftershocks, and staff who managed the account provided context and scientific information. On the evening of the 16 November, the GeoNet project began tweeting the hashtag[1] #emergencycute to announce the "night shift" was taking over, as noted in Fig. 4.

A subtle shift occurred when the 24/7 operations wound down to regular operations and #emergencycutes were only utilized after a strong aftershock (M4.5+). The #emergencycute hashtag was met with support from Twitter users and continues to be used after strong shakes by the GeoNet account, as illustrated in Fig. 5; each tweet garnered hundreds of likes, as many as 100 retweets, and largely positive written responses, making these posts a well distributed type of this tweet from this account.

This approach was lauded in an article in the Spinoff by science communicator Richard Easter, which stated:

Fast, informative and robust, GeoNet did a stellar job tracking the Christchurch earthquakes. As a "science communicator" (that is, a scientist who sometimes talks about science to people who are neither students or fellow scientists) I take my hat off to them – they quickly convey complex, ambiguous information to everyone in New Zealand with an understated panache. Their Twitter feed alone should be on every Comms student's reading list [85].

The article highlights a tweet that included the #emergencycute hashtag and includes impacts from the Canterbury earthquake sequence [99].

In 2021, the Australia Broadcasting Corporation (ABC) used #emergencycutes during the Covid-19 lockdowns, as illustrated in Fig. 5. They credited GeoNet as the source of #emergencycutes.

These tweets may have been successful due to their content (animals), timing (post event), and their origins at GeoNet; the extent to which followers shared and 'liked' them can be seen as an indicator of approval of the use of humor during this crisis situation. The benefits to an agency is increased trust, empathy, and connection between the scientists and the people they serve. We argue that the humor of #emergencycute lies in incongruity from the unexpected source, e.g. scientists who are not necessarily known to be a source of humor providing pictures of baby animals.

We note with both our case studies, with the 2018 Kīlauea eruption and the 2016 Kaikōura earthquake, that neither were severe enough to be termed a "disaster" but, based on the definition we use from Boin and Hart (2007), there was threat and concern from various impacted publics. This is critical to note as large scale disasters, with significant loss of life, may never be funny; we accept this is a limitation of our study. However, the use of humor appeared to be popular in separate geohazard responses in two separate nations, thousands of miles apart. We now explore how these case studies and the literature are combined to posit a conceptual model for future use of humor during crisis.

5. A conceptual model for science communication in crisis using humor

The development of conceptual models for communication research is a foundational practice beginning with Westley and MacLean Jr [86]. Westley and MacLean Jr [86] developed their conceptual model - defining it as a preliminary paradigm for a theoretical system - by reviewing, synthesizing, and combining research. We combine this process with our case study examination to develop our own model of humor in crisis communication. Since the focus of our discussion and case studies has been confined to geohazards and federal agencies, we target scientists or other key spokespeople in public government roles, but it may still have applications for communicators in other crisis response settings. This representation is still an unvalidated overview which would benefit from further study and refinement; as stated previously, there is a dearth of literature on serious aspects of the use of humor during crises by physical scientists to provide relief or release to a stressed community. Hence, this model is informed by literature from other disciplines; if a concept was noted in more than two articles or the evidence from one article was particularly strong on its own, we deemed it appropriate for our geohazard-centric communication model. Fig. 6 summarizes key findings, and emphasizes via an architectural metaphor that any model including humor requires a relationship with many if not all of the various components explored in our review of the literature.

This model, illustrated in Fig. 6 intimates that considerations of timing, appropriate humor topics, the nature of the crisis and a

[1] Hashtags are a searchable word or phrase that allows users to follow a particular discourse on Twitter, Instagram, and Facebook [84]; however, they can also be used to add literal subtext and/or subtle, humorous commentary to a message.

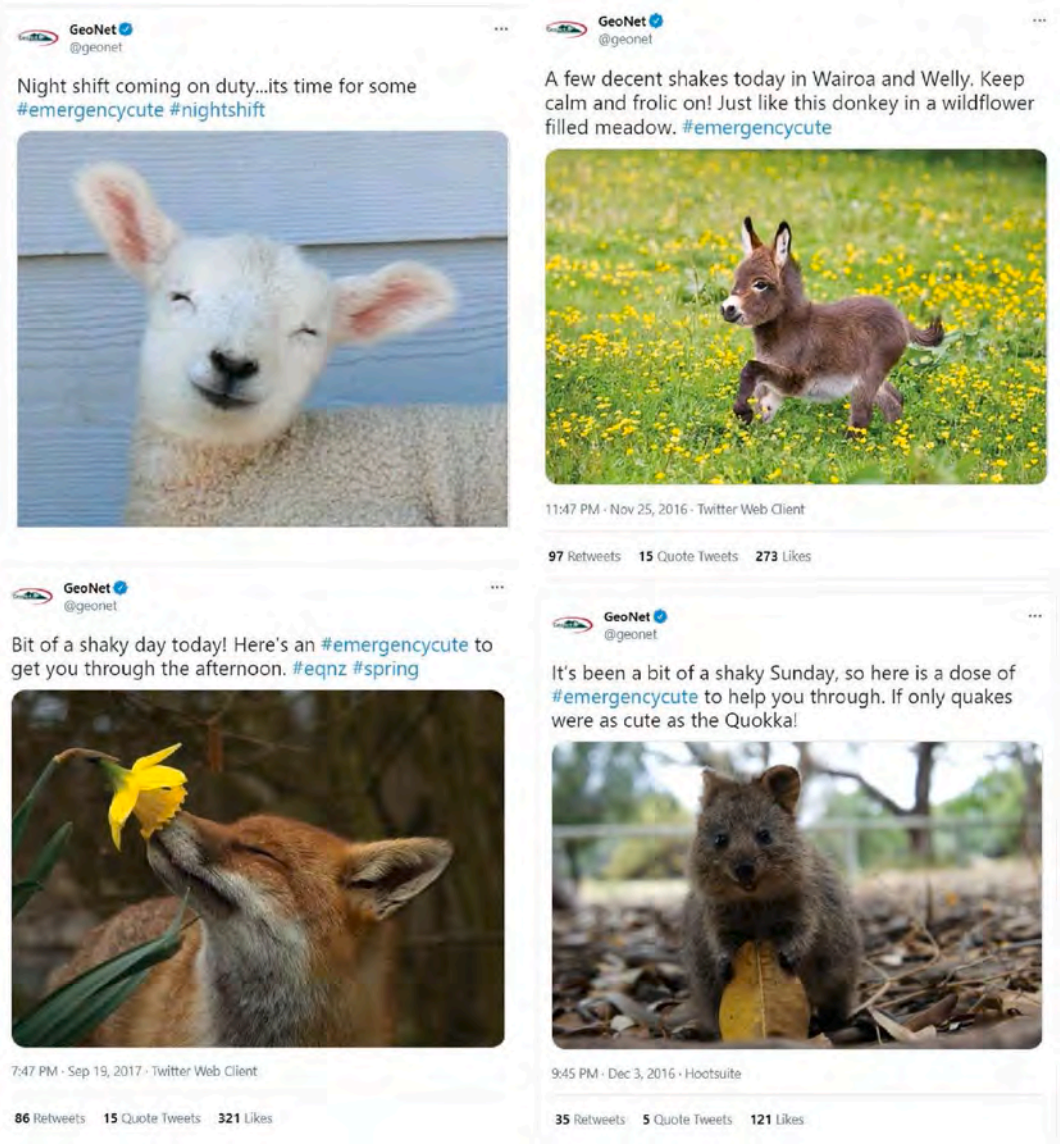

Fig. 4. Examples of #emergencycute tweets, produced by the GeoNet project.

communal need for release, appropriate channels, and the relationship between the source of the information and its publics, are critical for success. As the case studies explored above illustrate, humor was largely welcomed by stressed publics and the media after a certain amount of time had passed, which in turn elevated the visibility of the respective social media accounts in the 2018 Kīlauea eruption and 2016 Kaikōura earthquake sequence. In addition, by using humor during the Kīlauea crisis, the USGS Volcanoes accounts developed dedicated groups of followers who promoted the accounts, corrected misinformation, and even answered questions based on the knowledge disseminated by the USGS. These followers represent a basis of trust which will increase the likelihood that the USGS will be accepted as an arbiter of scientific and situational information in the future.

In this conceptual model, timing is presented as the keystone to successful humor. No matter how appropriate the topic, channel, type of humor, or relative safety of audiences during the crisis, an ill-timed joke will still fail. A collective need for emotional release and a relationship of trust between the source and audience of the humor are foundational to successful crisis humor but can be scaled depending on the audience; even if only a small subset of an audience has a need for a humorous emotional release, they can still contribute to the success of the humor strategy overall. This was especially the case in the 2018 Kīlauea eruption, where the most crucial subset of the audience to reach was the locals being directly affected by volcanic hazards; their acceptance mattered the most to the communications team in that situation, but later helped build trust within the broader audience who were observing their reactions.

Multiple factors contribute to the success of humor used in crises. The timing of humor is the keystone of the model because it is more important than the content of the joke; humor expressed too early can be perceived as insensitive or cruel, while a joke told too

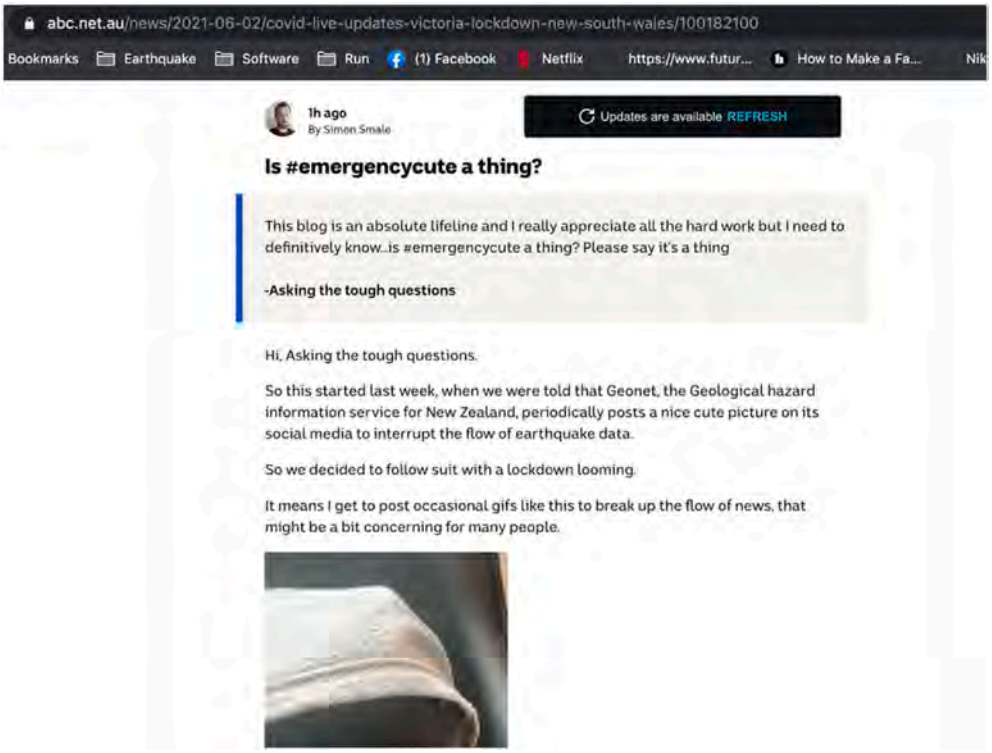

Fig. 5. Screenshot from the ABC website citing GeoNet as the source of #emergencycutes. Retrieved from https://abc.net.au/news/2021-06-02/covid-live-updates-victoria-lockdown-new-south-wales/100182100 (April 28, 2022).

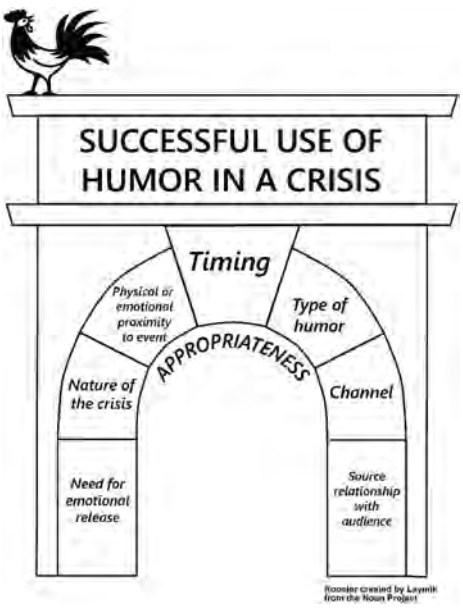

Fig. 6. Conceptual model for successful use of humor by scientists and/or agencies in a crisis response. Note that 'Timing' is purposefully placed within the keystone of the arch. Rooster for scale.

late may come off as "out of touch". Ultimately, effective humor needs to be appropriate, inoffensive, kind, and compassionate to all people facing a crisis. Safe topics for humor include self-deprecation, animals, and some situational commentary.

6. Future research

Given the many complexities associated with humor and scientists using it, this model should be considered a starting point, rather than a conclusion, for exploring these concepts further. More crises case studies could be explored, particularly COVID-19's impact on the use of humor, for which there are already several studies [50,87,88]. The U.S. Center for Disease Control (CDC) has also used humor in the past for pandemic preparedness (*Zombie Apocalypse* preparedness campaign, [89]. Given the evolving landscape of authority/source trust and how and when humor is used, exploring this topic would be a fruitful and rich vein of future research. Another opportunity for testing the model (and contrasting two case studies) could be the 2020 lava lake formation at Kīlauea (December 2020 – present; social media campaign largely complete) during which the same social media team at the USGS communicated with the same local and global audiences.

While this article provides a model for how humor can be used to benefit scientists and the communities they serve, it is important to note that there may be some situations which are so communally upsetting, that the use of humor is never appropriate, for example, the Boxing Day Tsunami in 2004 [90], or even smaller but still tragic events like Whaakari/White Island eruption in 2019 [91]. If scientists, whether at an agency or as individuals, are unsure about integrating humor into their crisis communication strategy, we recommend consulting with communication specialists or peers, to discuss appropriateness.

7. Conclusion

Humor is a beneficial tool to connect scientists, and the publics they seek to serve, during times of crisis. Although humor has received inconsistent attention and support across research disciplines, several consistent aspects remain. Humor provides a much-needed social release during times of crisis; laughter is also a socially connecting activity and can create warmth and empathy between people who share in it. Good humor also has physical and social benefits during times of intense stress. Finally, shared humor also serves a role in humanizing scientists (a group traditionally viewed as aloof and unreachable), creating likability, relatability, and potentially trust in scientists, which is crucial to effective communication.

While the conceptual model we have developed is based on a limited set of case studies and requires further research to determine whether it bears out in a broader range of situations, we assert that it is a promising avenue of both investigation and practice. Ultimately, humor can provide a release but also illustrates our collective humanity during times of crisis, when we most need reassurance. Those responsible for communicating difficult scientific information about an impactful crisis could consider humor as an important tool in their communications toolkit.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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