

“That’s some positive energy”: how social media users respond to #funny science content

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Abstract

Many scientists make use of social media and take various approaches to humor in their posts to encourage online public engagement, yet little is known about how publics respond to particular types of online science humor. This study investigates the behavioral effects of the presence of different types of science humor, specifically anthropomorphism, wordplay, and the two combined, shared by a scientist on Twitter. Individuals who experienced higher levels of mirth after exposure to humorous science content were more likely to leave a comment on the social media post. Additionally, individuals’ need for cognition moderated the relationship between humor exposure and mirth, as well as the relationship between mirth and leaving a comment. These results and future research are discussed.

Keywords

Public engagement with science and technology; Science and media

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Introduction

Many scientists have embraced social media platforms to generate engagement with publics. Forty-seven percent of members of the American Association for the Advancement of Science (AAAS) reported using social media “to discuss or follow science” [Pew Research Center, 2015, p. 4] and this trend has also been observed among celebrity scientists, university researchers, and institutions such as NASA and National Geographic [van Eperen & Marincola, 2011; You, 2014]. Objectives for these connected scientists include improving people’s relationships with science, defending science, and informing and exciting audiences [Dudo & Besley, 2016; Savage, 2015; van Eperen & Marincola, 2011; You, 2014].

The use of humor is among the suggested strategies for achieving these objectives and engaging publics with science [Baram-Tsabari & Lewenstein, 2013; Goodwin & Dahlstrom, 2014]. Yet, while science humor is encouraged and is currently used by scientists on social media, there is a paucity of research about the forms of humor

that are effective for engaging audiences. Indeed, there are intuitive reasons to believe that some forms of humor might be more appropriate for different audiences. For example, witty wordplays or clever satirical remarks might better appease an audience with an intellectual curiosity for science, while doing little to engage those who lack such an affinity toward science. Conversely, simple anthropomorphic drawings or crude caricatures might make science both more interesting and more accessible to a general audience, while pushing away those who find this kind of humor to be childish.

Nevertheless, several studies suggest humor may improve public engagement with science on social media [Anderson & Becker, 2018; Brewer & McKnight, 2015; Cacciato, Becker, Anderson & Yeo, 2020; Yeo, Su, Cacciato, McKasy & Qian, 2020]. Existing research has primarily focused on attitudinal outcomes and behavioral intentions — despite the notoriously weak documented relationship between self-reported behavioral intentions and actual behaviors [Webb & Sheeran, 2006] — and further investigation is needed to ascertain how science humor affects *actual* engagement behaviors. Research is also needed to understand the effect of individual attributes, like differences in need for cognition (NFC) [one's preference to engage in the effortful processing of information, see Cacioppo & Petty, 1982], on response to funny science content. For instance, NFC might impact how audiences process a joke, such as whether they think about or otherwise search for the punchline. Similarly, individual traits might influence what audiences do if and when they “get” the joke, which might include adding criticism or endorsement of the joke or even their own funny comment [Zhang, 1996]. In other words, individual attributes such as NFC might moderate the relationship between humor exposure and the experience of mirth, or the experience of mirth and what people do in response to that feeling.

Here, we seek to address such gaps by examining the effects of different types of science humor — featured in a social media context — on audiences. As part of an experiment, we test the mediated effect of different humor types — specifically, anthropomorphism (attributing human-like qualities, including appearance and behavior, to non-human beings or objects), wordplay (the playful use of words or phrases that have multiple meanings), and a combination of the two — on experienced humor (i.e., enjoyment of the joke or mirth) and leaving a comment on a Twitter post. We also examine how an individual trait, NFC, might moderate the processing of the joke, as well as the experience of mirth. In doing so, we contribute practical knowledge to science communication and add to a growing body of theoretical literature on the effects of science humor.

Literature review

Humor and science communication

Interest in exploring the effects of using humor in communication has increased over the past several decades. Advertising research has found that humor can influence attitudes toward advertising content and sources, increase attention and positive affect, and reduce negative cognitions related to the advertisement [Duncan & Nelson, 1985; Eisend, 2011; Weinberger & Gulas, 1992]. There has also been evidence of a positive relationship between exposure to humor and behavioral intentions, like intentions to purchase [Bryant, Alan, Silberberg &

Elliott, 1981; Eisend, 2009; Phua & Kim, 2018] or to engage in preventative health behaviors [Nabi, 2016].

Researchers have acknowledged for decades that science can be particularly suitable for humor [Kilbourne, 1996]. Several more recent studies found that humorous content is playing a growing role in activism around climate change, including Hee et al.'s [2022] examination of placard signs at Australia's *School Strike 4 Climate*. Their qualitative content analysis revealed that both wordplay and anthropomorphism were quite common in the protest materials of the Australian youth. The authors argued that humor might serve a variety of functions amongst the group of activists, including making their message more memorable, acting as a unifying device across the group, and even helping the activists themselves by serving as a means of coping with their personal anxiety about the topic of global climate change. While not focused specifically on humor, similar outcomes were noted in a study of creators of science comics. The comic authors specifically described their art as making science more visible, memorable, and approachable, among other things [Collver & Weitkamp, 2018].

Skurka, Niederdeppe, Romero-Canyas and Acup [2018] pushed the issue of humor as activist device further, focusing on how videos and television shows can influence broader attitudes toward climate change and behavioral intentions concerning the topic. They found that humorous videos produced greater activism intentions related to climate change than non-humorous videos, yet did not influence risk perceptions. Meanwhile, Anderson and Becker [2018] found that satirical videos about climate change from *The Onion*, a satirical news magazine, increased beliefs in a changing climate as well as perceptions of risks among those who did not originally believe climate change to be a paramount issue. Similar patterns were replicated for belief in global warming among viewers of *The Daily Show* and *The Colbert Report* [Brewer & McKnight, 2015]. A pair of studies on science standup comedy videos found that experienced humor predicted interest in sharing, "liking", and commenting on the content and higher intentions to engage with more science on social media [Cacciato et al., 2020], while also enhancing one's view that comedy is a valid source of scientific information [Yeo, Anderson, Becker & Cacciato, 2020]. The present study builds on this body of work while expanding the context to examine actual behavioral responses to humorous science content.

Information processing and humor

Much of the available knowledge to explain why and how individuals find types of humor to be funny comes from studies in advertising and theories grounded in social psychology. While the existing scholarship generally agrees that humor is an effective way to garner audience attention [Madden & Weinberger, 1982; Weinberger & Gulas, 1992], there is considerable disagreement about the processes by which humor operates to influence audience engagement and attitudes. Cognitive theories of humor draw from theoretical predecessors in social psychology and information processing such as the Elaboration Likelihood Model [Cacioppo, Petty, Kao & Rodriguez, 1986] and the Heuristic-Systematic Model [Chaiken, 1980]. According to these models, when individuals evaluate a message, they either allocate substantial cognitive resources to deeply process the material or opt for shallower processing and reference available cues to make decisions.

Cognitive theories of humor suggest that to understand a joke individuals engage in cognitive elaboration, allocating attention and cognitive resources to comprehend the humorous message before connecting it to knowledge, attitudes, and motivations [Eisend, 2011; Krishnan & Chakravarti, 2003; Heiss & Matthes, 2021; Slater & Rouner, 2002; Weinberger & Gulas, 1992]. Becker and Anderson [2019], for instance, found that people who viewed a satirical video reported more message elaboration compared to those in a control group. Cognitive elaboration has also been found to increase intentions to engage; for example, Heiss and Matthes [2021] found that cognitive elaboration after viewing a newsfeed with funny content spurred intentions to engage directly with political posts.

Affective theories of humor are also grounded in social psychology but offer a different path for explaining humor's impacts on attitudes. Such models argue for a more immediate impact of humor based on the emotional response — either positive or negative — that it evokes within an individual. Affective responses can result in "affective transfer" — namely, the process by which an emotional response to a stimulus is carried over to closely linked or proximal objects [De Houwer, Thomas & Baeyens, 2001]. This might be considered a more peripheral route to attitude formation, one that requires little to no message elaboration. Scholars have speculated that the (positive) affect produced by humor might serve as either a distraction that draws attention away from other attributes of a message or even an obstacle that prevents an individual from the act of careful processing; however, the link between humor and distraction can best be described as mixed [Nabi, Moyer-Gusé & Byrne, 2007].

There are reasons to believe that distinct humor types might be differently processed. Roth et al. [2018] found that levels of "hedonic content" — a measure of how funny and joyful content is — influenced how audiences processed the content of video clips. Specifically, they compared audience reliance on different processing styles based on whether respondents received a low, medium, or high hedonic entertainment experience. They found that, while the low and high hedonic conditions resulted in the highest levels of heuristic processing and the lowest levels of systematic processing, the medium hedonic entertainment experience drove audiences toward systematic processing and away from heuristic processing. Their results suggest a blending of entertaining and thought-provoking information can encourage careful elaboration, while purely entertaining and purely thought-provoking content pushes audiences away from such elaboration.

Nabi and colleagues [2007] uncovered different patterns in the processing of humor messages. First, they found that the funnier respondents found a message, the more deeply they processed that message. Second, they found that messages perceived as funny were associated with less counterarguing, but a greater likelihood of discounting the message as "just a joke". Overall, they describe humor as resulting in closer, but less critical, message processing.

A key feature of many of these studies is the lack of testing different humor types to better understand if specific forms of humor are more or less likely to engage audiences. And, when different humor types are tested, it is usually with vastly different jokes that vary in several ways, making isolating the humor type as responsible for any change in findings quite difficult. For example, Polk, Young and Holbert [2009] acknowledged that their experiment analyzing audience

exposure to either a satirical or an ironic clip of *The Daily Show with John Stewart* was limited due to the numerous factors that differed between the clips. So, the present study addresses these gaps in the literature.

Humor types and mirth

While there are dozens of humor types [Bryant et al., 1981; Buijzen & Valkenburg, 2004], wordplay, satire, and anthropomorphism are among the common types of science humor shared on social media [Su et al., 2022]. Here, we focus on wordplay and anthropomorphism as these two humor types can be inserted and removed into our stimulus materials without compromising the overall consistency of the joke, a point to which we will return in our explanation of the stimulus materials. Wordplay is conceptualized as the playful use of words or phrases that have dual meaning, such that they fit in with one context while evoking another [Taylor & Mazlack, 2004]. An example of wordplay in action would be the sentence, "I was struggling to figure out how lightning works, but then it struck me". This sentence plays on the double meaning of the phrase "struck me", which can refer to both being hit by the lightning, as well as suddenly acquiring new knowledge about the topic. This type of humor would appear to benefit from, if not require, at least some form of elaboration from audiences as it requires an understanding of the double-meaning of the phrase "struck me" to get the joke. Thus, it might fit better under the umbrella of the cognitive theories of humor. Indeed, wordplay, as a humor type, has been described as a more "complicated", "abstract", "sophisticated", and "complex" form of humor [Buijzen & Valkenburg, 2004, p. 151] — at least when compared to the other humor type we explore in this research, anthropomorphism.

Anthropomorphism is defined as attributing human-like qualities, including appearance and behavior, to non-human beings or objects. It is often depicted visually, for example, by drawing a smiling face on a sun or a scowl on a raincloud in a cartoon about the weather. It can also be portrayed by altering the text of a joke, such as giving a wise-cracking personality to an inanimate object or allowing a non-human character to speak and deliver a punchline. Anthropomorphism is a simpler form of humor than wordplay and is one of the first forms of humor that people are able to recognize and understand [Buijzen & Valkenburg, 2004]. There are reasons to believe that this humor type may not require much, if any, elaboration from audiences as giving human characteristics to inanimate objects should be immediately recognizable to all. Thus, anthropomorphism appears more consistent with the literature on affective theories of humor.

Of course, different humor types can be layered on each other, producing jokes that include elements of multiple humor types. In this study, we examine not just the impacts of anthropomorphism and wordplay in isolation, but the impact of the two humor types when included in the same joke. We argue that including both a more elaborative humor type (wordplay) alongside a more affective humor type (anthropomorphism) should expand the audience for the humor, partly because it has the potential to be seen as funny in two different ways. We anticipate this should result in overall higher feelings of experienced humor, or *mirth*. Overall, we propose the following pair of hypotheses:

H1: Respondents in the anthropomorphism and wordplay conditions will report higher levels of experienced mirth than those in the no humor condition.

H2: Respondents in the combined condition will report higher levels of experienced mirth than those in no humor condition, the anthropomorphism condition, and the wordplay condition.

Predicting commenting behaviors

People engage with social media content through a combination of liking, commenting, or sharing, depending on the platform. Uses and gratifications theory maintains that such engagement is goal-oriented; we use media to satisfy needs [Katz, Blumler & Gurevitch, 1973]. Early research suggested that media use was driven by motivations such as staying informed or seeking entertainment [Katz et al., 1973]. More recent research, specific to social media, indicates that need for entertainment, appearing fashionable to others, information sharing, and socialization are strong motivators of engagement [Alhabash & McAlister, 2015; Chen, 2011; Khan, 2017; Quan-Haase & Young, 2010]. Perhaps it is for this reason that humor is ubiquitous on social media. Not only does it entertain, but, in online settings, humor can invite socialization through shared experiences. Further, humor can be a form of social currency that is created and maintained by individuals to belong to, and bond with, groups [Neuendorf, Skalski, Jeffres & Atkin, 2014; Neuendorf & Fennell, 1988]. Humorous public acts on social media are often met with attention and approval from one's digital peers in the form of engagement. As a result, a humorous post is more likely to be favored by platform newsfeed algorithms, increasing social reach and visibility [Highfield, 2015].

Research on commenting — responding to social media content by typing commentary or reactions in a designated text field — is limited. However, two studies on Facebook and YouTube engagement have found that self-status seeking, socialization, and relaxing entertainment are the top motivating predictors for leaving a comment [Khan, 2017; Smock, Ellison, Lampe & Wohn, 2011]. Here, we are interested in commenting behaviors, particularly the likelihood of leaving a comment following exposure to a joke. It is important to note that *comments* here refer to those that are coherent and meaningful, and thus entail some cognition and active engagement [Khan, 2017].

Based on the premise that experiencing mirth after viewing a joke is indicative of "getting the joke", we suggest that participants will be more likely to recognize the needs that interaction with funny content can fulfill and have greater motivation to respond coherently. Because they can be understood by others, meaningful comments can invite engagement with the commenter, potentially fulfilling needs for social status (through visibility), entertainment, and socialization. For this reason, we expect a positive relationship between experienced mirth and leaving a comment.

H3: Higher levels of experienced mirth will be positively associated with leaving a comment.

Identifying the moderating effect of need for cognition (NFC)

Not all individuals have the same desire to engage in the effortful processing of information. Rather, they differ in their need for cognition [Cacioppo & Petty, 1982]. People who are low in NFC are more likely to engage in shallow information processing, and as a result, have a greater tendency to rely on peripheral cues when evaluating materials and forming opinions. Those who score high on NFC enjoy effortful processing. They are more likely to derive pleasure from solving challenging puzzles and exercising their mental faculties. Thus, they rely more heavily on the elaborative processing of information, rather than on snap judgments or peripheral cues [Cacioppo & Petty, 1982].

Applied to our central focus in this work — which are the impacts of different types of science humor on audience mirth and the subsequent impacts of mirth on an audience member's likelihood of leaving a comment — it is reasonable to expect that NFC might also play a moderating role in the hypotheses already discussed. That is, someone low in NFC, as compared to someone high in NFC, might be less inclined to spend the necessary time and cognitive resources to discover the punchline in a subtle play on words, thereby impacting the enjoyment, or mirth, they derive from the joke. Conversely, someone who has a high NFC, compared to someone scoring low in the characteristic, may have less appreciation for the more obvious humor that characterizes much anthropomorphic comedy. Similarly, NFC might also impact the effort one puts into thinking about a comment to add to a joke, with those scoring high on the trait being more likely to devote cognitive resources toward thinking about a comment to add to the thread. This leads us to investigate the locus of moderation of NFC — that is, whether the moderation in this conditional process model (Figure 1) occurs in the first stage, the second stage, or at both paths simultaneously.

RQ1: Does NFC moderate the relationship between humor types and mirth, mirth and leaving a comment, or both?

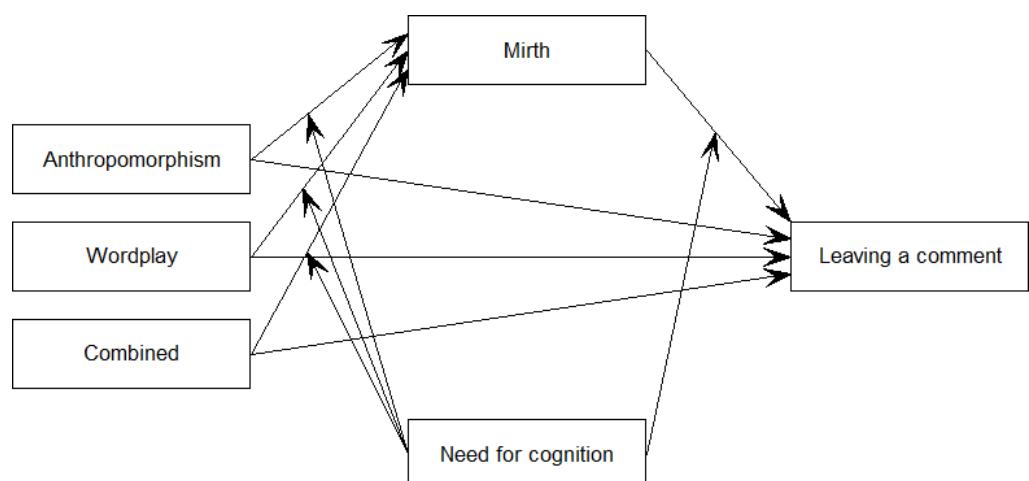


Figure 1. Conceptual models showing the hypothesized mediation and potential conditional process models. Sex, age, race, and education are controlled in the models.

Method

The data were collected in October 2018 using a Qualtrics opt-in panel, which randomly selects participants from Qualtrics' available pool of participants and invites them to participate in the survey for incentives using real-time software, email, or text. Participants invited to participate satisfied a quota sample requirement that matched the 2013 U.S. Census American Community Survey with approximate ratios of age, gender, and geographic region. While 1,543 individuals started the survey, 1,530 panelists completed it, yielding a completion rate of 99.2 percent. A response rate cannot be calculated as we do not know how many individuals were invited to participate. Six respondents were excluded from analysis due to missing data, resulting in a final sample size of 1,524. The average study participant was 46.7 years old, 51.6% of respondents identified as female, and 71.4% as white.

Experimental design

A four (humor types) \times two (social media metrics) between-subjects experiment was embedded in the online survey. The social media metrics were manipulated by changing the number of retweets and likes associated with the original tweet. In the low social media metrics condition, the original post had three retweets and five likes; those numbers were 288 and 480 in the high social media metrics condition. The numbers for both the low and high social media metrics conditions were based on a simple look at humorous science posts on the platform and the approximate number of retweets and likes that seemingly unpopular and popular posts were found to garner. In the present study, we are interested in the mechanism of humor on the dependent variables. As such, we controlled for the social media metrics by including a binary variable that represented the metrics conditions to which participants were assigned (high metrics coded high).

Following exposure to pre-test questions, including validated NFC measures, participants were randomly exposed to one of eight experimental conditions depicting a Twitter conversation about science (see Figure 2 for examples of the stimuli). Across all conditions, the Twitter conversation started with a post of a cartoon by a fictional scientist, Dr. Jamie Devon. The original post was adapted from a science joke on the internet about atoms losing electrons and subsequently becoming positively charged. Each post included both text and an illustration. Additionally, each condition included one Twitter response. This response was posted by a fabricated user, Kasey Chase. This comment was designed to strengthen the experimental manipulation and was consistent with the humor type condition (e.g., it provided a second dose of anthropomorphism in the anthropomorphism condition, a second dose of wordplay in the wordplay condition, etc.). Gender-neutral names were used to avoid any confounding effects of source gender on the outcome variables of interest.

The four humor type conditions were *no humor*, *anthropomorphism*, *wordplay*, and *combined* (anthropomorphism and wordplay). In the no humor condition, the text of the post was altered to a science fact that was consistent with the joke. We also changed the hashtag in the no humor condition to "#science #fact" instead of "#science #funny". In the anthropomorphism condition, the humor was produced by giving human characteristics to the atoms. This was done both by altering the image of the atoms (giving them arms, legs, and facial expressions) and by altering

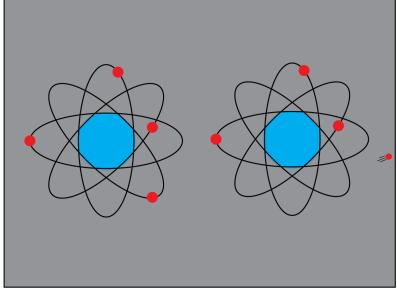
Figure 2. The (high social media metrics) experimental stimuli.

No humor
Anthropomorphism

Wordplay
Combined

Dr. Jamie Devon [Follow](#)

Atoms are composed of electrons, protons, and neutrons. When an atom loses an electron, it becomes more positive. #science #fact



11:30 AM - 25 Feb 2018

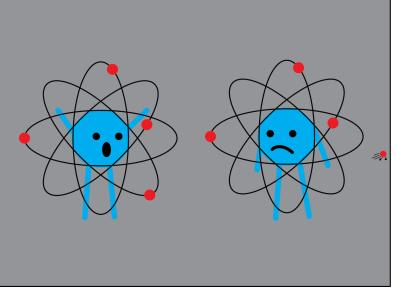
288 Retweets 480 Likes

[Tweet your reply](#)

Kasey Chase @kchase · 5m
Replying to @drjamiedevon
It becomes an ion! 😊

Dr. Jamie Devon [Follow](#)

Two atoms are talking. One says "I think I've lost an electron." "Are you sure?" "Yeah, I'm sure." #science #funny



11:30 AM - 25 Feb 2018

288 Retweets 480 Likes

[Tweet your reply](#)

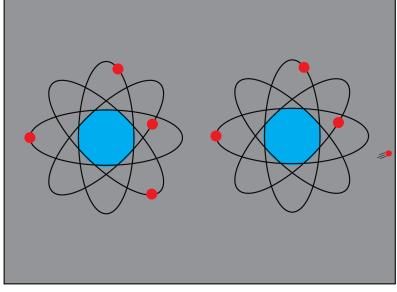
Kasey Chase @kchase · 5m
Replying to @drjamiedevon
Another atom says "You gotta keep an eye on it!" 😊

No humor
Anthropomorphism

Wordplay
Combined

Dr. Jamie Devon [Follow](#)

Two scientists are talking. One says "Researchers think some atoms are losing electrons." "Are they sure?" "Yeah, they're positive." #science #funny



11:30 AM - 25 Feb 2018

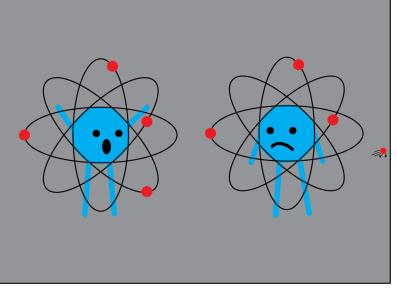
288 Retweets 480 Likes

[Tweet your reply](#)

Kasey Chase @kchase · 5m
Replying to @drjamiedevon
Another scientist says "You gotta keep an ion it!" 😊

Dr. Jamie Devon [Follow](#)

Two atoms are talking. One says "I think I've lost an electron." "Are you sure?" "Yeah, I'm positive." #science #funny



11:30 AM - 25 Feb 2018

288 Retweets 480 Likes

[Tweet your reply](#)

Kasey Chase @kchase · 5m
Replying to @drjamiedevon
Another atom says "You gotta keep an ion it!" 😊

the voice in the text (having the atoms be the speakers of the text in the cartoon). In the wordplay condition, the humor was produced with a pun in the text of the cartoon. The pun played off the double-meaning of the word “positive”, which can refer to both the atoms becoming positively charged and the certainty of the statement. The combined condition included both the anthropomorphism and wordplay alterations in a single cartoon. The stimuli were designed to be functionally equivalent, reducing the chance of additional elements having unexpected and unmeasured effects on our measured outcomes [see Cacciatore, Scheufele & Iyengar, 2016]. In all conditions, we kept the number of words in the post consistent (between 18 and 20 words, plus the pair of hashtags noted above).

After exposure to the stimulus, respondents were asked to add comments, if they had any, into a text box. These responses constituted the sample used for the dependent variable described in the next section. Respondents then answered post-test questions, which included self-reported mirth.

Measures

Humor condition is a nominal variable that identifies the four different experimental groups: “no humor” ($n = 365$), “anthropomorphism” ($n = 391$), “wordplay” ($n = 390$), and “combined” ($n = 383$). Humor conditions were dummy-coded with the no-humor condition serving as the reference group.

Mirth is a five-item measure in which respondents described the Twitter conversation using five, 7-point semantic differential scales that assessed the extent to which the conversation was humorous, funny, playful, amusing, and entertaining. The items were averaged to create a composite variable ($M = 4.49$, $SD = 1.89$; Cronbach’s $\alpha = .94$).

The dependent variable, *leaving a comment*, was a binary variable coded by a team of four graduate research assistants based on whether the comments are viewed as meaningful (Krippendorff’s $\alpha = .84$). Comments that contained meaningless keystrokes or variations of “no”, “none”, “n/a”, or “no comment” were coded as not meaningful. Of the 1,524 participants, 445 left a relevant, meaningful comment (29.2%).

The moderator, *need for cognition* [NFC; Cacioppo & Petty, 1982], is an averaged index measured by asking participants the extent to which each of the following statements described them (1 = “Not at all like me”, 7 = “A lot like me”): “I prefer complex to simple problems”, “I like having the responsibility of handling a situation that requires a lot of thinking”, “I find satisfaction in deliberating hard and for long hours”, “I enjoy a task that involves coming up with new solutions to problems”, and “I prefer my life to be filled with puzzles that I must solve” ($M = 4.57$, $SD = 1.51$; Cronbach’s $\alpha = .90$).

We controlled for the *social media metrics manipulation* (high metrics coded high), *sex*, *age*, *race*, and *education*. *Sex* was a binary variable (female coded high); 51.6% of respondents were females. The average study participant was 46.7 years old ($SD = 16.8$). *Race* was a dichotomous variable (68.7% white) based on respondents’ self-identification. *Education* measured how many years of education (K-12 and higher education) each respondent had completed at the time of the survey ($M = 13.90$, $SD = 4.57$).

Data analysis

Data were analyzed using *R*. The hypothesized model (Figure 1) was tested using ordinary least squares regression with the computational add-on, PROCESS 4.0 [<http://www.processmacro.org>; Hayes & Matthes, 2009]. Model 58 was used to test our hypotheses and research questions; 95% confidence intervals were generated using 5,000 bootstrapped samples. We also used analysis of covariance (ANCOVA), controlling for the *social media metrics manipulation, sex, age, race, and education*, to conduct pairwise comparisons between humor conditions and examine the mean levels of mirth among respondents in each condition. It should be noted that PROCESS cannot use floodlight analysis [Johnson & Neyman, 1936] to probe interactions with multicategorical independent variables [Hayes, 2017; Hayes & Montoya, 2017]. Therefore, we used the method suggested by Hayes and Montoya [2017] for pairwise inference using indicator coding.

Results

Respondents in the humor conditions experienced greater mirth than those assigned to the no-humor condition ($F(3, 1515) = 61.5, p < .001$, partial $\eta^2 = .109$; see also Table 1); those exposed to the non-humorous stimulus experienced the least amount of humor, supporting H1. Respondents in the group that viewed the combined humor stimulus experienced the highest levels of mirth, followed by those in the single humor type conditions, supporting H2. Pairwise comparisons revealed differences in mirth for all conditions, except between those assigned to the anthropomorphism- and wordplay-only conditions (Figure 3). Exposure to the anthropomorphism, wordplay, and combined humor conditions significantly predicted leaving comments (Table 1).

To address H3, we examined the likelihood of leaving a comment. Mirth predicted the likelihood of leaving a comment (Table 1; $B = .237, SE = .039, p < .001$), thus supporting H3.

Our research question asked about the locus of moderation in the conditional process model. We found that NFC moderated both paths, i.e., between the humor conditions and experienced mirth (but only among respondents exposed to the wordplay and combined humor conditions) (Table 1), and the path between mirth and the dependent variable. The first interaction — between the humor conditions and NFC on experienced mirth — is depicted in Figure 4. Those assigned to the humor conditions experienced higher levels of mirth than those in the no-humor group, regardless of their NFC. However, the humor conditions had the strongest impacts on those low in NFC and the weakest impacts among those high in NFC.

The second interaction — between mirth and NFC on leaving a comment — is shown in Figure 5. This figure shows that at low levels of NFC, the effect of mirth on one's willingness to contribute a comment to the Twitter thread is not moderated by this individual trait. However, as mirth increases, so does the moderating effect of NFC on one's willingness to add a comment, and these effects are most pronounced among respondents with relatively higher NFC.

An index of moderated mediation is often used to test moderated mediation, like that described in Figure 1. However, this cannot be done when an indirect path is moderated at two points because the conditional indirect effect becomes a

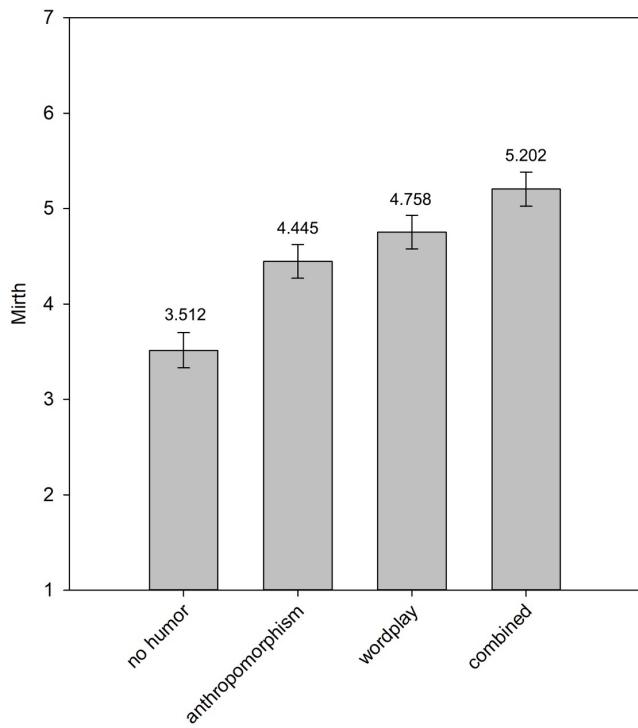


Figure 3. Mean of experienced mirth among respondents assigned to the humor conditions ($N = 1,524$). Error bars represent standard errors. Differences in mean levels of mirth between experimental conditions are significant except that between anthropomorphism and wordplay.

Table 1. Unstandardized coefficients, standard errors, and p -values in the PROCESS model (Model 58) predicting leaving a comment ($N = 1,524$).

	Mirth			Leaving a comment		
	B	SE	p	B	SE	P
Constant	-2.389	.304	< .001	-1.917	.450	< .001
Sex (female)	.061	.096	.528	-.718	.139	< .001
Age	.001	.003	.800	-.001	.005	.932
Race (white)	.271	.099	.006	.105	.147	.474
Education	.017	.010	.080	.003	.013	.814
Social media manipulation	.130	.086	.127	-.072	.123	.560
Anthropomorphism	.982	.121	< .001	.737	.192	< .001
Wordplay	1.260	.122	< .001	.800	.192	< .001
Combined	1.723	.122	< .001	.576	.199	.004
Mirth	—	—	—	.237	.039	< .001
Need for Cognition (NFC)	.435	.062	< .001	.092	.050	.065
Anthropomorphism \times NFC	-.199	.080	.013	—	—	—
Wordplay \times NFC	-.284	.083	< .001	—	—	—
Combined \times NFC	-.349	.083	< .001	—	—	—
NFC \times Mirth	—	—	—	.067	.023	.004
Model R^2	$R^2 = .227, p < .001$			$-2LL = 1609.0, p < .001$		
	<i>Nagelkerke R</i> ² = .201					

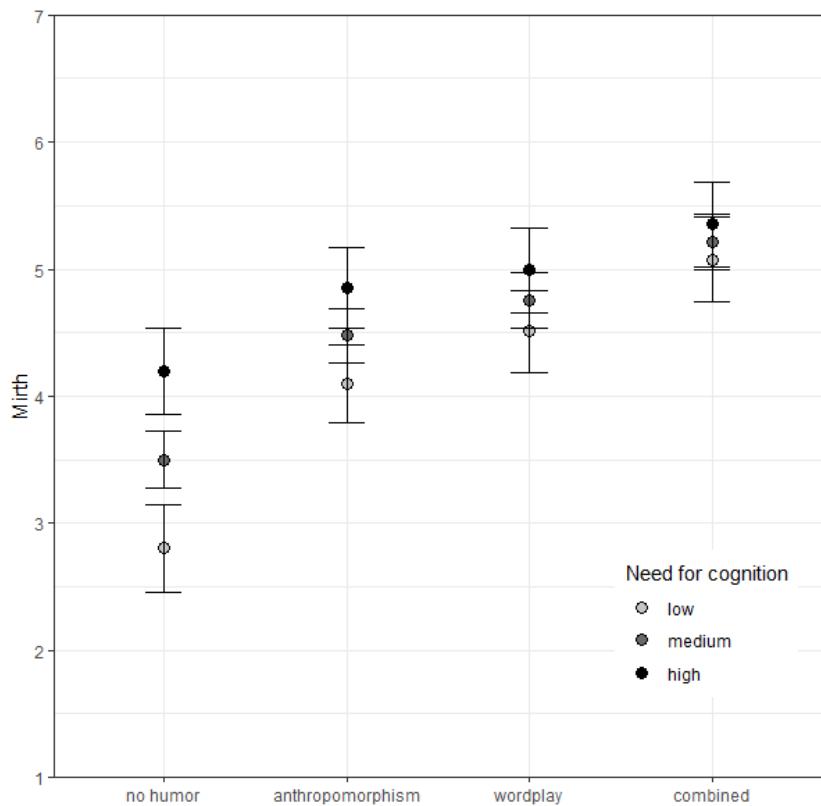


Figure 4. Moderating effect of need for cognition (NFC) on the relationship between humor conditions and mirth in the model predicting leaving a comment ($N = 1,524$). Low, medium, and high NFC correspond to 16th, 50th, and 84th percentiles.

Table 2. Relative conditional indirect effects of humor conditions on leaving a comment based on need for cognition ($N = 1,524$).

	Need for Cognition					
	Low		Medium		High	
	Effect	CI	Effect	CI	Effect	CI
<i>Experimental condition</i>						
Anthropomorphism-only	.171 (.077)	[-.003, .401]	.233 (.049)	[.123, .378]	.227 (.072)	[.067, .447]
Wordplay-only	.225 (.099)	[-.004, .509]	.299 (.059)	[.167, .468]	.276 (.076)	[.112, .516]
Combined	.299 (.128)	[-.005, .649]	.409 (.076)	[.232, .621]	.400 (.092)	[.204, .679]

Note. Low, medium, and high need for cognition represent the 16th, 50th, and 84th percentiles, respectively. Ninety-five percent confidence intervals were generated with 5,000 bootstrapped samples using the PROCESS 4.0 add-on for R.

nonlinear function of the moderating variable [Hayes, 2017]. In lieu of this, Hayes [2017] suggests that the conditional indirect effects at different points of distribution of the moderator are satisfactory to infer moderated mediation. The relative conditional indirect effects and bootstrapped confidence intervals of humor conditions on the dependent variables for low (16th percentile), medium (50th percentile), and high (84th percentile) levels of NFC can be found in Table 2. We found evidence of moderated mediation for the indirect relationship between the humor conditions and leaving a comment, moderated by NFC, but only among those with medium and high levels of NFC.

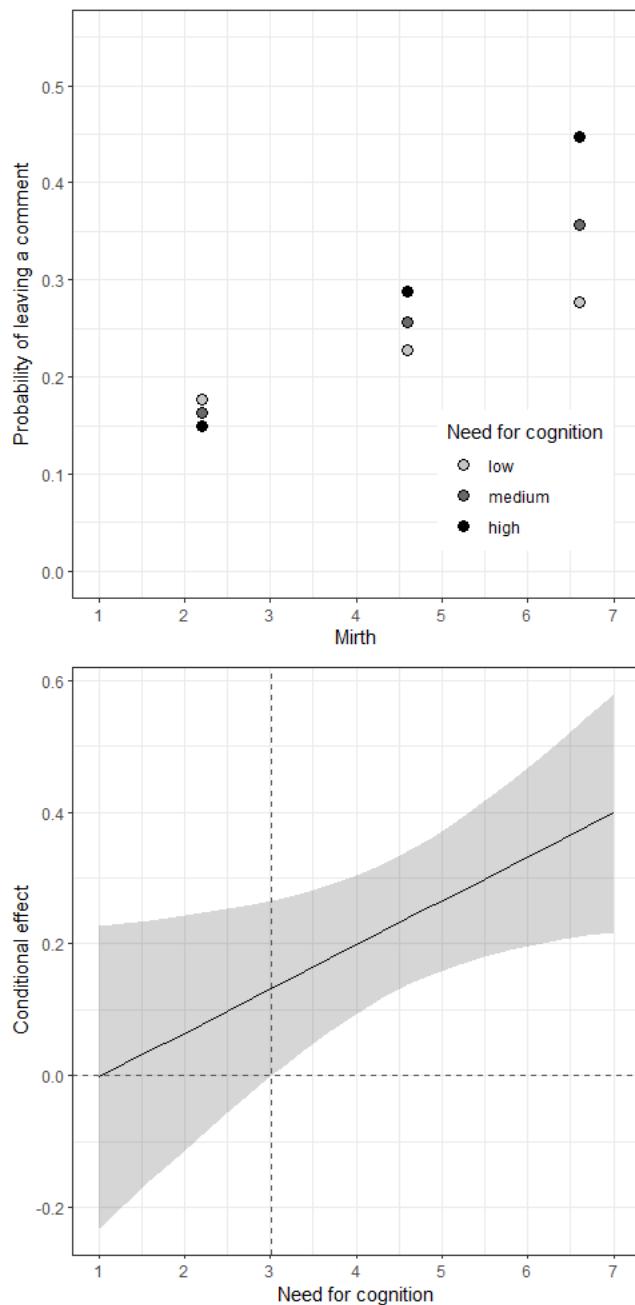


Figure 5. Moderating effect of need for cognition (NFC) on the relationship between mirth and probability of leaving a comment ($N = 1,524$). Low, medium, and high NFC correspond to 16th, 50th, and 84th percentiles.

The PROCESS model revealed significant relative direct pathways between the humor conditions and the dependent variable. To determine the relative total effect, we regressed the outcome variable on the humor conditions while controlling for the social media metrics manipulation, demographics, and need for cognition [Hayes, 2017]. The relative total effects of the anthropomorphism, wordplay, and combined humor conditions on the likelihood of leaving a comment were .669 (SE = .189, $p < .001$), .722 (SE = .189, $p < .001$), and .470 (SE = .195, $p = .016$), respectively.

Table 3. Overview of hypotheses and research questions.

#	Wording	Statistical test	Result
H1	Respondents in the anthropomorphism and wordplay conditions will report higher levels of experienced mirth than those in the no humor condition.	ANOVA	Hypothesis Supported
H2	Respondents in the combined condition will report higher levels of experienced mirth than those in no humor condition, the anthropomorphism condition, and the wordplay condition.	ANOVA (with pairwise comparisons)	Hypothesis Supported
H3	Higher levels of experienced mirth will be positively associated with leaving a comment.	OLS Regression via PROCESS	Hypothesis Supported
RQ1	Does NFC moderate the relationship between humor types and mirth, mirth and leaving a comment, or both?	OLS Regression via PROCESS	Significant moderation along both paths

Discussion

The present study responds to previous calls to incorporate humor into science communication [Baram-Tsabari & Lewenstein, 2013; Goodwin & Dahlstrom, 2014] by offering empirical evidence of its effects on viewers. We do so by investigating the effect of social media science humor on individuals' likelihood of leaving comments in response to the humorous Twitter thread. A summary of all hypotheses and research questions, including the results, can be found in Table 3. Our results suggest that the type of humor is an important factor in using science humor. Not only did anthropomorphism, wordplay, and a combined humor condition cause more mirth among participants than a no-humor condition (thus supporting H1), but the combination of anthropomorphism and wordplay in a single joke was found to produce higher levels of mirth than single doses of those two humor types (thereby supporting H2). This suggests that our respondents recognized and responded to our humor manipulation, and also that humor can have compounding effects when multiple attempts are made in a single communication. Importantly, and in support of H3, mirth played an important role in participants' commenting behaviors on the humorous Twitter thread, with those who experienced higher levels of mirth more likely to respond with a comment. This is consistent with previous research that found that people perceived different types of humor to be amusing to different degrees [Yeo, Su et al., 2020]. In turn, greater amusement was associated with higher intentions to engage with science content. At least for commenting behaviors, it appears that funnier is better.

Further, we proposed a research question examining the effect of audience differences in NFC on response to science humor on social media. Regardless of the humor condition, those with higher NFC experienced higher levels of mirth. Additionally, NFC moderated the path between both the wordplay and combined humor conditions and mirth, but not the path between the anthropomorphism-only condition and mirth (Figure 4). NFC plays a bigger role in influencing mirth for posts lacking in humor as well as those in which humor is simplistic — possibly even childish — as appeared to be the case with our anthropomorphism condition. A possible explanation for this pattern of results is discussed below.

When a post is objectively not funny (as in the no-humor condition) or possibly childish or obvious in terms of its humor (as is likely the case in the anthropomorphism-only condition), those with low NFC quickly recognize it as such. This translates into a low rating of mirth. In contrast, it may be that the high NFC respondents are more likely to scrutinize the cartoon, given their preference to engage in the effortful processing of information. In other words, they examine the post more closely, and in a cartoon like the one provided in the anthropomorphism-only condition, perhaps they catch some of the more subtle funny details, such as the fleeing electrons. Similarly, high NFC respondents might also be more likely to notice and attend to the comment that follows the original post — a comment that is designed to provide a second dose of the same type(s) of humor in our experimental design. This type of scrutiny by those high in NFC would explain their tendency to provide higher mirth ratings when assigned to the anthropomorphism condition.

A similar logic might explain why those high in NFC were more likely to report higher mirth scores when exposed to the no-humor condition. They may be more likely to notice the follow-up comment that describes the situation in the image as one that produces an ion, and perhaps appreciate the knowledge being shared by a fellow user. Unfortunately, we did not include any items in our survey that might help us determine whether they were more likely to notice either the follow-up comment or the smaller details within the post that we noted earlier. Regardless, it is worth noting that it is not so much that those high in NFC find the no-humor condition funny. Instead, their ratings suggest that they are rather neutral in how they view that condition. Their higher mirth scores are probably more accurately described as being the product of those who scored in the low and medium NFC range being so negative in their evaluation of the no-humor condition. Nevertheless, future research is needed to unpack why we observe such differences in mirth ratings for a condition that was designed to be completely lacking in humor.

NFC also moderated the path between experienced mirth and leaving a comment. Overall, NFC was positively associated with leaving a comment, but its effects were most pronounced among those who experienced higher levels of mirth from the experimental stimulus materials. This finding suggests that those with a high NFC are especially motivated to add to the discussion when they found the original content particularly humorous. One explanation for this pattern is that those with a high NFC are more likely to take on the challenge of coming up with a witty or clever comment to add to a funny thread. To investigate this possibility, we conducted a *t*-test with NFC as the outcome variable and whether a participant left a comment with an attempt at humor ($M = 4.99$, $SD = 1.43$, $n = 64$) or one without an attempt at humor ($M = 5.10$, $SD = 1.49$, $n = 381$) as the grouping variable. The *t*-test revealed no significant differences ($t(88.7) = -0.54$, $p = 0.59$). It is also possible that the motivation to leave a comment is driven by a simple appreciation for the difficulties of coming up with a clever joke and/or a witty comment that follows a joke. Indeed, it was not uncommon to see appreciative remarks like “funny!” or “well done” among the submitted comments. A subsequent analysis of variance (ANOVA) determined significant differences between those who left a positive comment ($n = 243$) and those who left a neutral ($n = 176$) or negative one ($n = 26$) ($F(2, 442) = 7.62$, $p < .01$). Those who left a positive comment had an average NFC score of 5.32 ($SD = 1.43$), which was

significantly higher than those who left either a neutral comment ($M = 4.82$, $SD = 1.46$, $p < .01$) or a negative comment ($M = 4.56$, $SD = 1.68$, $p = .036$).

Our results support prior conclusions that science humor can influence mirth and behavioral response [Becker & Anderson, 2019; Skurka et al., 2018]. Further, it supports more recent work that suggests humor may have a positive association with engagement between publics and scientists on social media [Cacciatore et al., 2020]. We observed a direct relationship between the humor conditions and leaving a comment. This leads us to suggest that mirth may not be entirely necessary to process humor and comment on a post. Audiences may sometimes use shallow information processing to assess humor shared on social media. These findings support and expand on prior assertions in cognitive theories of humor [e.g., Eisend, 2011; Slater & Rouner, 2002]. Future research should examine what different levels of cognitive involvement might mean for attitude development about science issues, particularly those where public opinion is relatively unformed or nonpartisan. Audience motivations for engaging with social media may also be an important factor to account for when predicting the depth of elaboration with science material, humorous or otherwise. However, user intentions and anticipated gratifications were not explicitly measured in the present study. This may be an ample area of exploration for future research.

Some limitations of this study should be noted. First, this study used a non-probability quota sample that matched U.S. Census Bureau data. This sampling method results in the inclusion of minority groups that may not necessarily be represented in probabilistic sampling methods [Wrench, Thomas-Maddox, Richmond & McCroskey, 2019]; nonetheless, we recognize that lack of a random sample limits our ability to generalize our findings to the American adult population. Additionally, due to the experimental design, there was a degree of artificiality. Twitter and social media users encounter dozens of competing textual and visual messages on their newsfeeds. These visible posts have been curated based on interests and networks of followers/friends. Further, in a real digital media environment, social media users can directly click and engage with the content of choice. In our experiment participants were presented with a single Twitter discussion and not provided the means of browsing or clicking. This ability to leave a comment on a singular post may have made them more likely to leave a comment. We acknowledge that this design limits the ecological validity of our findings and our ability to generalize them to casual scrolling in a native newsfeed. Yet, humor's demonstrated ability to draw attention [Eisend, 2011, 2009; Weinberger & Gulas, 1992] suggests such posts may nonetheless stand out among a sea of status updates.

While information gaps between American publics and experts continue to define attitudes, behaviors, and policy support, growing evidence points to the potential of social media to bridge divides by enabling greater scientist engagement. This study finds that science humor used in digital environments has the potential to initiate such conversations, thus improving the accessibility and approachability of science and scientists. Humor's ability to foster commenting may make it a powerful tool to communicate about difficult science issues. However, it is also worth noting that the blanket use of humor is not a panacea for communication problems. Communicators who attempt to leverage humor to better connect with audiences face several challenges, including possible concerns about appearing as

less serious communicators or even ill-informed. Moreover, given growing concerns about mis- and dis-information, there are reasonable questions to ask about whether increasing the likelihood of all audiences sharing their opinions about science on social media platforms in humorous ways is a good thing, if that shared opinion is motivated by a goal of being funny rather than accurately informing a more serious debate. Overall, humor's ability to foster commenting may make it a powerful tool to communicate about difficult science issues but a careful choice needs to be made regarding the type of communicative objective to be achieved and the mechanism that might be driving it.

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