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ARTICLE

Can media inspire public engagement with astronomy? Assessing information modalities and potential mechanisms for inspiration in a basic science context

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Abstract

Although many science communicators strive to inspire audiences, scant research has sought to understand how media may evoke inspiration. The present study was a three-condition (modality: text-only, audio-only, and audiovisual) between-subjects experiment examining how media content about the James Webb Space Telescope (JWST) motivated participants' feeling moved, awe, curiosity, rumination, and their inspiration state. The findings revealed no statistical difference between using text or audio content, but that audiovisual content can hinder rumination if self-transcendent emotions are not induced. Findings revealed that content leading participants to feeling moved and experiencing awe should lead to reflective thought, and ultimately, feelings of inspiration.

Keywords

Public engagement with science and technology; Science and media; Science communication: theory and models

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Although the literature in the science of science communication has grown substantially in the past two decades, and the importance of “setting your goal(s)” and “knowing your audience(s)” is well-established in practice and in scholarship [Besley & Dudo, 2022; Smith, 2021], more work is needed to understand and test tactics that science communicators might implement in service of strategic communication, particularly in the domain of basic science, also known as fundamental or discovery science. Similarly, advances in communication and information technologies and their potential to engage publics with science are outpacing scholarly efforts to systematically understand, and thus inform, the processes, effects, and consequences of implementing specific science communication strategies and tactics. For example, recent technological advances enable publics to see images of space in vivid detail. Many news reports and public discourse surrounding these advances suggest that such depictions of space are beautiful and inspiring, which may yield new opportunities for public engagement with astronomy, and discovery science more broadly.

Many basic scientists and communicators who engage the public with research hope to inspire individuals in some way. Inspiration is an emotional state in which a stimulus evokes an extraordinary understanding or perception from an individual, who is moved to act upon the information that is newly understood or perceived [Chang, 2023]. Media psychology literature suggests inspiration can be induced by media content, which may prompt emotions such as curiosity, wonder, and awe, and may initiate further processes including rumination [Chang, 2023; Valdesolo, Shtulman & Baron, 2017]. The potential inspirational effects of science media content might also differ based on the format by which information is delivered [Green et al., 2008]. Yet, to date, no research has examined how content delivered in different formats might effectively induce feelings of inspiration in the context of basic science. The goal of this study was to observe the communication engagement process when individuals encounter science media content to explain and predict how such media might lead to inspiration. In this way, the public engagement outcomes we examined were individuals' cognitive and affective involvement related to a mediated stimulus.

Despite the myriad opportunities and anecdotal evidence, the question of how media can be leveraged effectively and strategically to elicit feelings of inspiration remains an open one. In this study, we seek to address this question with a precise focus on how science media content about astronomy might induce feelings of inspiration in individuals. Our focus on strategic public engagement in a basic science context is intentional: our purpose is to advance our understanding of how science media might be used to induce feelings of inspiration, a public engagement outcome and individual state conceivably desired by many basic science communicators, and practically, to inform how science communicators might allocate limited resources (e.g., time, money, media) toward inspiring those with whom they intend to communicate about basic science. Moreover, we focus on astronomy because it is a key basic research discipline (i.e., it is an area of focus for The Kavli Foundation and often funded by the U.S. Department of Energy), it is relatively salient on the public agenda (images from space are frequently shared via news), and existing communication research on astronomy has focused on cultivating positive emotions as a public engagement objective [for a review, see Besley, Peterman, Black-Maier & Evia, 2021; Newman et al., 2021].

To address these needs, we conducted a three-condition experiment (information format: text-only vs. audio-only vs. audiovisual) embedded in an online survey. This between-subjects experiment assessed the extent to which the presentation of media in different modalities about the James Webb Space Telescope (JWST) development and launch affect participants' engagement with science media, including their feelings of curiosity, awe, and feeling moved. We also observed participants' self-reported experience of thought provocation (i.e., the extent to which they engaged in reflective thought) to see how these variables might be associated with participants' inspiration state.

1 ▪ Media and inspiration

Although much of the media psychology literature has focused on hedonic motivations (e.g., pleasure, enjoyment) for consuming media content in the past three decades, more research has begun to explore and understand eudaimonia as a distinct media effect. Eudaimonic motivations for media consumption include the search for meaning and insight [Raney, Oliver & Bartsch, 2019]. This acknowledges the parallel reality that while consumers often seek media content for pleasure and enjoyment, "media users [often] intentionally consume content to encounter meaningful and poignant portrayals of the human condition, providing fodder for grappling with questions of life purpose and meaning" [Raney et al., 2019, p. 259]. As a form of eudaimonic media, inspirational media can be defined as "media that elicits a self-transcendent state or self-transcendent emotions (e.g., elevation, awe, admiration, etc.)" [Dale, Fisher, Liao & Grinberg, 2023, p. 768], and "that draw[s] attention away from the self and egoistic concerns, and instead encourage[s] a heightened awareness and concern for people or issues that are broader than the self" [Oliver et al., 2021, p. 191]. Inspiration as an emotion can be conceptualized as an outcome (e.g., "an appreciation for and accommodation of a stimulus" [Dale et al., 2023, p. 768]) or as a motivational state that may lead to future action [Dale et al., 2023; Hart, 1998; Thrash & Elliot, 2004]. That is, one can experience the feeling of inspiration without actually being motivated to act on it. In this way, inspirational media may trigger an inspiration state among exposed media users, and the process of being inspired may be induced by a variety of self-transcendent emotional experiences.

Chang [2023] proposed a model, including three processes of evocation (e.g., exposure to media content), emotional transcendence (e.g., experiences of awe, curiosity, and feeling moved), and motivation (e.g., provoking reflective thoughts), to describe how media content might lead individuals to a state of inspiration. In accordance with this model, the current study observed how science media may induce feelings of curiosity, awe, and feeling moved as self-transcendent emotions that may contribute to an individual's inspiration state. Common predictions in the media psychology literature are that inspirational media may lead consumers to feeling moved or touched, encourage consumers to be contemplative, and induce awe through the process of self-transcendence [Chang, 2023; Dai & Jiang, 2024]. In this study, curiosity is defined as a desire for new experiences and acquiring new knowledge [Bjerknes, Wilhelmsen & Foyn-Bruun, 2024], awe is defined as perceived vastness and need for accommodation, and feeling moved is defined as a touching feeling that is often evoked by some stimulus such as media content [Chang, 2023]. Undoubtedly, self-transcendent emotions may be evoked through stories that individuals encounter. The power of storytelling as a fundamental method of human communication and persuasion is well documented [W. R. Fisher, 1984; Green & Brock, 2000], and stories about science have been shown to induce interest and feelings of awe and inspiration [Dahlstrom, 2014; Riedlinger et al., 2019].

Although the extent to which individuals can or want to be engaged by science media varies, we presumed that general stories about astronomy, a basic science, should elicit feelings of inspiration. The JWST, successor to the Hubble Space Telescope, is a large infrared telescope that serves thousands of astronomers across the globe. Media content describing the JWST project were selected for this study given the JWST's salience and recency as a tool for basic science, and its potential for inducing eudaimonic experiences and self-transcendent emotions among individuals.

2 ▪ The impact of information modality

Although digital media afford the ability to present scientific information in multiple modalities, information modality can influence how individuals consume information and affect subsequent outcomes. Media richness theory [Daft & Lengel, 1986] provides a conceptual framework from which to examine the impact of information modality on information processing and other outcomes. The framework conceives of information richness as having a timely ability to change an individual's understanding. Daft and Lengel [1986] describe rich media as information "that can overcome different frames of reference or clarify ambiguous issues to change understanding in a timely manner" [1986, p. 560]. Lower media richness is more characteristic in information that requires a longer time to enable individuals' understanding. Moreover, differences in media richness relate to a "medium's capacity for immediate feedback, the number of cues and channels utilized, personalization, and language variety" [Daft & Lengel, 1986, p. 560]. In this regard, science media designed to be rich (e.g., audiovisual content versus audio or textual content) should be more easily processed and perhaps more inspiring than less rich mediated information. For example, enriching the format of information (e.g., text to audio to audiovisual) likely yields more realistic portrayals of the information being consumed, which can make that information more persuasive in terms of perceived credibility, believability, and the likelihood that individuals will share the information [Sundar, 2008; Sundar, Molina & Cho, 2021]; however, individuals' mental capacities become more burdened in information contexts where they have to process multimodal information streams. In other words, individuals require greater mental capacity to process audio and/or visual information relative to the likely less burdensome process of interpreting one modality, such as only processing written words [e.g., J. T. Fisher, Hopp & Weber, 2019]. In these ways, information format may have consequences for not only real-time processing of information, but also committing that information to memory and recalling it in the future.

Modality can also influence the emotions that are elicited by media content. For example, in the context of the SARS-CoV-2 (COVID-19) pandemic, negative emotions such as distress have been linked to consuming news via television and the internet but not to information acquisition via newspapers [Hwang, Borah, Shah & Brauer, 2021]. It is reasonable to predict, then, that communication modality may also be associated with self-transcendent emotions elicited by the content of the communication. Especially in the context of a basic science topic, such as astronomy, that deals with issues that are physically and/or conceptually vast and, therefore, likely awe-inspiring [Gottlieb, Keltner & Lombrozo, 2018], modality may be a critical factor in the extent to which awe and similar emotions are elicited and experienced.

Because this study was focused on the real-time process of how information modality might impact self-transcendent emotions and the state of being inspired, the study is primarily informed by scholarship focused on the immediate processing of science media content. For example, research comparing the impacts of using traditional texts and interactive media to communicate about the JWST found that interactive media yielded greater levels of support for JWST construction, but there were no observed differences between other measures of support [Weber, Dinc & Williams, 2016]. Given these findings, we propose:

H1: The video stimulus will induce highest levels of (a) curiosity, (b) awe, and (c) feeling moved while the text-only stimulus will induce the lowest levels of these emotions. The audio-only stimulus will induce levels of (a) curiosity, (b) awe, and (c) feeling moved between those elicited by the video and text-only stimuli.

3 ▪ The link between eudaimonic emotions and cognition

Thought-provoking experiences are defined by a state of contemplation and deep thought [Chang, 2023]. Eudaimonic media has been shown to yield cognitively engaging experiences resembling thoughtful reflection and elaborative thinking [Raney et al., 2019]. More specifically, eudaimonic emotions have yielded reflective thinking, increased topical interest, and information seeking behavior among research participants [Bartsch & Schneider, 2014]; additionally, feelings of being moved have been shown to elicit reflective thinking [Bartsch, Kalch & Beth Oliver, 2014]. Similarly, awe has been proposed to have evolved in part to motivate reflective processing that may encourage individual exploration [Lucht & van Schie, 2024]. Other research demonstrated that feelings of awe were positively related to scientific thinking [Gottlieb et al., 2018] and awareness of one's knowledge gap [McPhetres, 2019], which may stimulate subsequent information seeking. Taken together, previous research suggests that self-transcendent emotions should provoke cognition, and such cognition should lead to a greater state of inspiration. Given the previous literature, the following two hypotheses were proposed:

H2: Respondents with higher levels of (a) curiosity, (b) awe, and (c) feeling moved will find the media content they viewed to be more thought-provoking.

H3: Finding the media content to be more thought-provoking will be associated with a greater feeling of inspiration.

4 ▪ Method

We obtained a sample of U.S. adults (*N* = 754) through the online survey vendor, Prolific, which attempted to match our sample to quotas for age, gender, race, and political affiliation from the U.S. Census Bureau's American Community Survey (ACS). Data were collected between May 28 and June 3, 2024. The experimental procedures were approved by the Institutional Review Board of the authors' institutions. Participants were paid at a rate of $16.12 per hour to complete the study. The median time to complete the survey experiment was approximately 11 minutes. The mean age of respondents was 45.7 years (*SD* = 15.5), 50% were female, and 75.6% were White. The median household income was "$60,000–$69,999" and the median level of education was between "2 year degree (e.g., associate degree)" and "4 year college degree (e.g., bachelor's degree)" (see Table 1 for a comparison of this study's demographics with those in the 2022 U.S. Census Bureau data). We did not include a comparison of household income in Table 1 as the categories measured were too discrepant. Our sample demographics match that of U.S. American Community Survey data when it comes to gender and race. However, the median age in our sample is older than that of American Community Survey data (these data also include individuals under 18 years old) and is more educated.

Table 1. Age, gender, race, and education of respondents in the sample compared to data from the 2022 American Community Survey conducted by the U.S. Census Bureau.

	Sample (*N* = 754)	**U.S. Census Bureau data**
Age (median)	46	39
Gender (%)		
female	50.7	50.4
male	49.3	49.6
Race (%)		
White	75.6	74.9
Non-White	24.4	25.1
Education (%)		
Less than high school	0.9	10.5
High school graduate	11.7	27.7
Some college or associate's degree	37.4	29.3
Bachelor's degree or higher	50.0	33.0

5 ▪ Experimental design

After consenting to participate and responding to some introductory pretest questions (e.g., media attention),[1] respondents were randomly assigned to one of three experimental conditions (text-only vs. audio-only vs. audiovisual [i.e., video]). There were 251 respondents in the text-only condition, 252 in the audio-only condition, and 251 in the audiovisual condition. Each condition was drawn from a NASA video on YouTube[2] that provides an overview of the James Webb Space Telescope [James Webb Space Telescope (JWST), 2023]. In the text-only condition, participants read the transcript of the video. In the audio-only condition, they listened to the sound in the video without the visuals. Participants assigned to the third condition watched the entire video. The audio and video conditions were about 3 minutes and 30 seconds long. Stimuli can be found on OSF.

To assess random assignment of participants to the experimental conditions, we used analysis of variance (ANOVA) and chi-squared tests, where appropriate, to test whether there were differences in age, gender, race, education, income, and political ideology between conditions. For gender ($\chi^2(2, 754) = .28$, $p = .87$), race ($\chi^2(2, 754) = .38$, $p = .83$), education ($F\ (2, 751) = .46$, $p = .63$), income ($F\ (2, 751) = .07$, $p = .93$), and political ideology ($F\ (2, 751) =$ $.14$, $p = .87$), we found no significant differences between experimental conditions. However, for age ($F\ (2, 751) = 3.04$, $p = .05$), we did find a significant difference between respondents assigned to the audio-only and audiovisual conditions. The means and standard deviations of age in the conditions were as follows: text-only ($M = 46.0$, $SD = 15.5$), audio-only ($M = 47.3$,

1. Questions that were asked of respondents prior to exposure to the stimulus were not used in this study nor were they used to determine inclusion criteria for the experiment. These questions were designed to ease respondents into the survey-experiment.
2. The video can be found here.

SD = 15.1), and audiovisual (*M* = 43.9, *SD* = 15.8). As a result, we included *age* as a covariate in our regression models. *Age* is a self-reported continuous variable.

After exposure to the stimulus, we conducted manipulation checks asking respondents whether the media they engaged with consisted of text- or audio-only, or audio and video. A chi-squared test showed that respondents accurately recalled the format of the manipulation to which they were exposed ($\chi^2(4, 754) = 1405$, $p < .001$).

Following the manipulation checks, we measured the extent to which participants felt curiosity, awe, and moved by the content. We also measured the extent to which they found the content to be thought-provoking and their state of inspiration, which served as the dependent variable in our analysis.

6 ▪ Measures

Curiosity. (Cronbach's α = .97; overall: *M* = 5.38, *SD* = 1.52; text-only: *M* = 5.38, *SD* = 1.41; audio-only: *M* = 5.16, *SD* = 1.60; video: *M* = 5.60, *SD* = 1.51) was measured with a mean index of five items measured on a seven-point Likert scale (1 = "Not at all," "7 = Very much"). The items asked respondents to rate the extent to which the stimulus they saw "made them curious," "made them interested," "was amazing," "filled them with a sense of wonder," and "was fascinating."

Awe. (Cronbach's α = .93; overall: *M* = 4.19, *SD* = 1.50; text-only: *M* = 4.05, *SD* = 1.41; audio-only: 4.01, 1.55; video: *M* = 4.51, *SD* = 1.50) was an averaged index of eight items adapted from previous work [van Elk, Karinen, Specker, Stamkou & Baas, 2016]. Participants were asked to rate the extent to which they felt the following on a seven-point Likert scale (1 = "Not at all," "7 = Very much"): "I felt the experience of something beautiful," "I felt that ultimately all life is one," " I felt self-transcendent," "I experienced a loss of sense of space and time," "I felt that our life is part of a bigger whole," "I was impressed," "I felt awe," and "I had an aesthetic experience."

Feeling moved. (Cronbach's α = .93; overall: *M* = 4.19, *SD* = 1.73; text-only: *M* = 4.01, *SD* = 1.68; audio-only: *M* = 4.13, *SD* = 1.75; video: *M* = 4.42, *SD* = 1.73) is an averaged index of three items from Chang [2023] measured on a seven-point Likert scale (1 = "Not at all," "7 = Very much"). Respondents were asked to rate the extent to which they felt "touched," 'moved," and "warm-hearted" while viewing the stimulus.

The extent to which respondents found the media content to be *thought-provoking* was measured using three items (Cronbach's α = .88). The items were averaged to create an index (overall: *M* = 5.11, *SD* = 1.43; text-only: *M* = 5.16, *SD* = 1.32; audio-only: *M* = 5.04, *SD* = 1.45; video: *M* = 5.12, *SD* = 1.51). Participants were asked to rate the extent to which they agreed or disagreed with the following three statements: "The media content was thought-provoking," "I found the media content to be very meaningful," and "The media content made me think about meaningful issues."

Inspiration state. (Cronbach's α = .97; overall: *M* = 5.11, *SD* = 1.43; text-only: *M* = 4.00, *SD* = 1.79; audio-only: *M* = 3.99, *SD* = 1.82; video: *M* = 4.31, *SD* = 1.90) was measured using items adapted from Chang [2023]. This measure is a mean index of three items measured on a seven-point Likert scale (1 = "Not at all," "7 = Very much"). We asked participants to report the extent to which they felt the following while viewing the media content: “something inspired me,” “I experienced inspiration,” and “I was inspired to do something.”

Zero-order correlations of the key conceptual variables can be found in Table 2.

Table 2. Zero-order correlations (Pearson’s r) between conceptual variables of interest in the model. All correlations (two-tailed) in the table are significant, i.e., p < .001.

	Curiosity	**Awe**	**Feeling moved**	**Thought-provoking**
Awe	0.78			
Feeling moved	0.71	0.85		
Thought-provoking	0.80	0.73	0.70	
Inspiration state	0.67	0.76	0.75	0.66

7 ▪ Data analysis

Data analyses were conducted using *R* version 4.4.0 (2024-04-24 ucrt). To address H1, we conducted analysis of variance (ANOVA) to compare the means of curiosity, awe, and feeling moved between experimental conditions. When the ANOVAs produced significant results, we conducted Bonferroni-adjusted pairwise comparisons.

To address H2 and H3, we conducted mediation analyses using the PROCESS macro for *R* [PROCESS version 4.3; Hayes, 2022]. We used a model built-in to the PROCESS macro (Model 80) with 10,000 bootstrap samples to estimate our hypothesized model and we specified that the independent variable was nominal with multiple categories corresponding to the experimental conditions (i.e., dummy coding). The reference category for the experimental condition was the text version of the stimulus. In our results and discussion, we use the terms *relative total, relative direct,* and *relative indirect effects* as recommended by Hayes [2017], though we recognize and acknowledge that the cross-sectional nature of our sample limits evidence of causal relationships.

8 ▪ Results

The ANOVAs comparing mean levels of curiosity, awe, and feeling moved between the experimental groups were significant (curiosity: F (2, 751) = 5.54, p = .004; awe: F (2, 751) = 8.56, p < .001; feeling moved: F (2, 751) = 3.77, p = .02; Figure 1). We found partial support for H1. The hypothesized pattern of means between experimental groups was supported when it came to respondents feeling awe (H1b) and moved (H1c) by the stimulus. In these cases, levels of awe and feeling moved were highest among those who watched the video stimulus and lowest among those who read the text stimulus. However, our hypothesis about curiosity (H1a) was not supported. Although respondents who saw the video stimulus had the highest mean score of curiosity, the text version of the stimulus elicited a higher mean of curiosity compared to the audio stimulus.

Relative to the text condition, the audio stimulus did not significantly affect curiosity, awe, or feeling moved. However, compared to the text stimulus, the reception of the video stimulus resulted in higher feelings of awe and feeling moved, but not curiosity (Table 3, Figure 2).

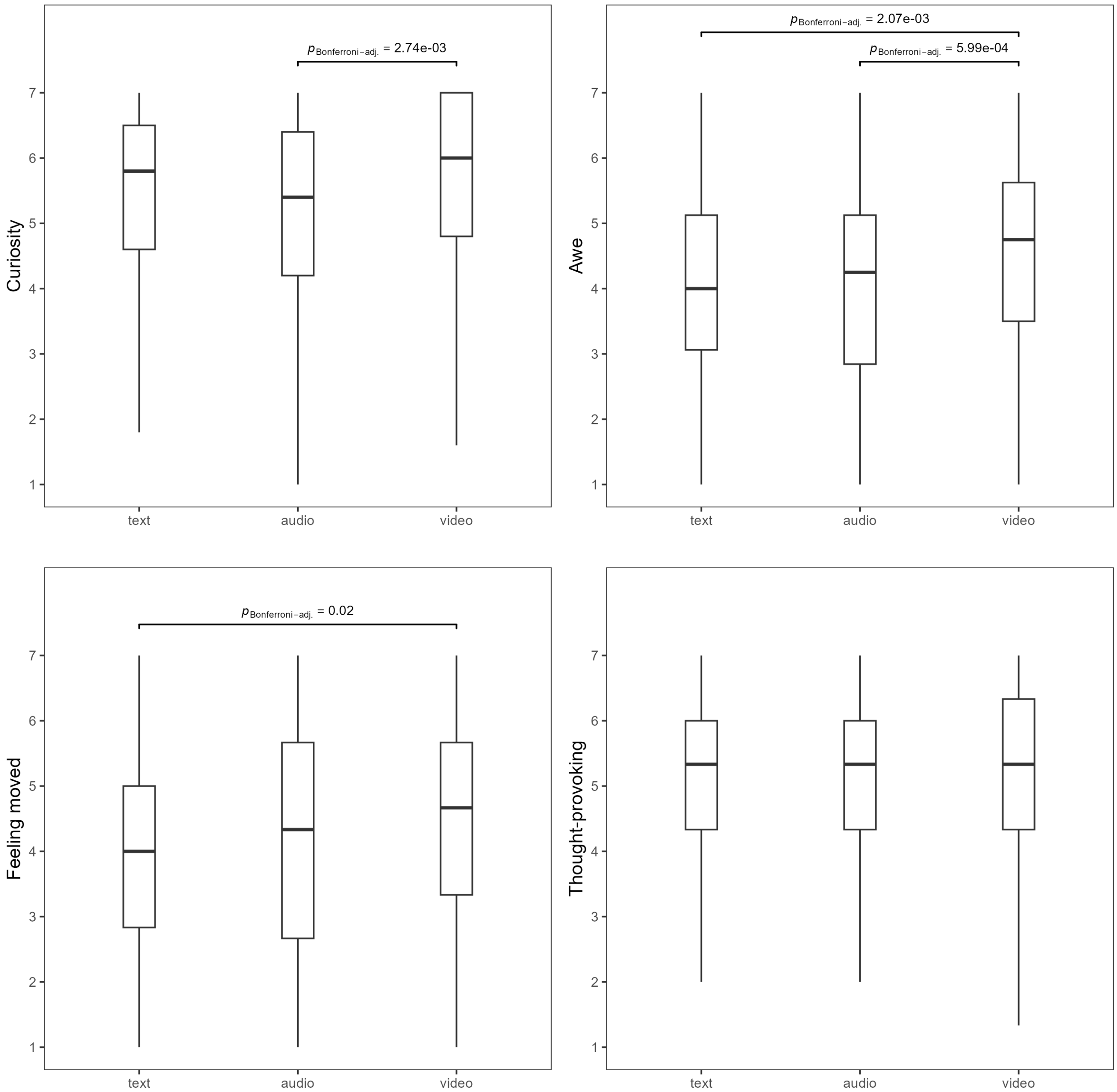

Figure 1. Boxplots showing mean values of curiosity, awe, feeling moved, and thought-provoking between experimental conditions. Significant differences are shown with Bonferroni-adjusted p-values.

We found support for H2a, H2b, and H2c. Finding the content to be thought-provoking was positively associated with curiosity (H2a; $B = .54$, $SE = .03$, $p < .001$), awe (H2b; $B = .12$, $SE = .04$, $p = .003$), and feeling moved by the content (H2c; $B = .16$, $SE = .03$, $p < .001$). We also found support for H3, which posited that finding the content to be thought-provoking would be positively associated with feelings of inspiration ($B = .18$, $SE = .05$, $p < .001$). To ease interpretation, we added significant coefficients from our model to a conceptual figure of our hypothesized relationships (Figure 2).

Relative total, direct, and indirect effects in the tested model were estimated using 10,000 bootstrapped samples (Table 4). These bootstrapped effects are significant if the bootstrapped 95% confidence interval does not encompass zero. We found that the audiovisual condition had a total effect on the outcome variable (effect size = .32, $SE = .16$, p

Table 3. Results from PROCESS model (N = 754).

	Curiosity		Awe		Feeling moved		Thought-provoking		Inspiration state	
	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p
Constant	4.60 (.19)	< .001	3.40 (.18)	< .001	3.06 (.21)	< .001	1.14 (.13)	< .001	.05 (.20)	.782
Age	.02 (.00)	< .001	.01 (.00)	< .001	.02 (.00)	< .001	-.00 (.00)	.802	-.01 (.00)	< .001
Experimental conditions										
Audio	-.25 (.13)	.063	-.06 (.13)	.635	.09 (.15)	.533	-.01 (.07)	.897	.03 (.10)	.795
Video	.26 (.13)	.052	.48 (.13)	< .001	.45 (.15)	.002	-.28 (.07)	< .001	-.06 (.10)	.580
Mediators										
Curiosity	—	—	—	—	—	—	.54 (.03)	< .001	.10 (.05)	.053
Awe	—	—	—	—	—	—	.12 (.04)	.004	.39 (.06)	< .001
Feeling moved	—	—	—	—	—	—	.16 (.03)	< .001	.37 (.05)	< .001
Thought-provoking	—	—	—	—	—	—	—	—	.18 (.05)	< .001
	F(3, 750) = 11.7 p < .001		F(3, 750) = 11.5 p < .001		F(3, 750) = 11.7 p < .001		F(6, 747) = 274.6 p < .001		F(7, 746) = 189.6 p < .001	
Model R2	.045		.043		.045		.688		.640	

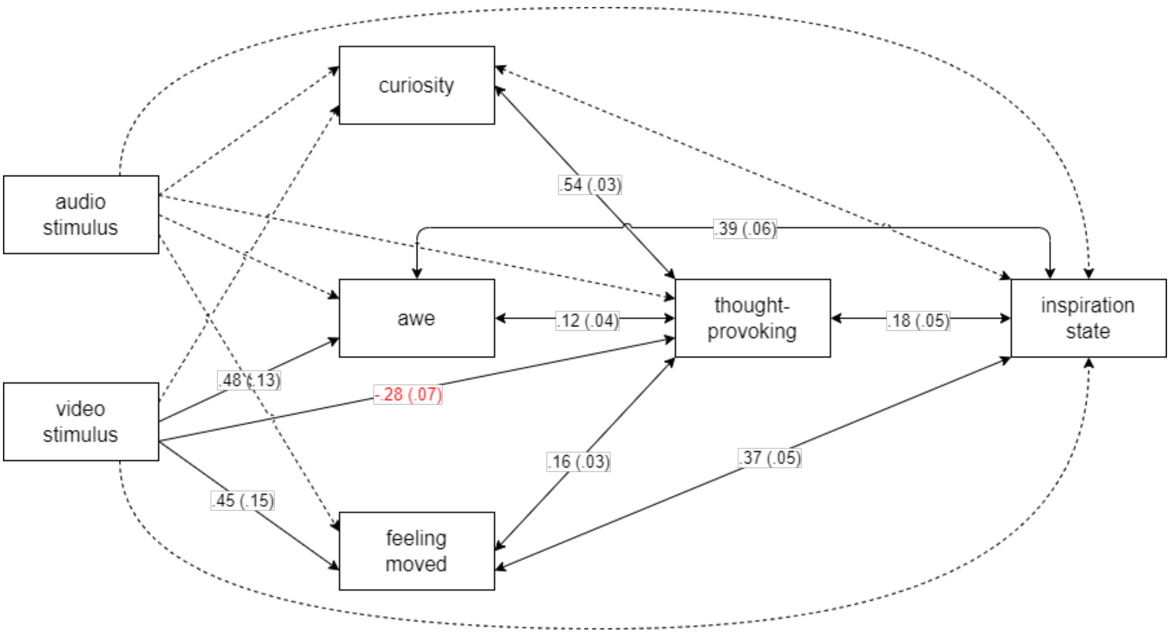

Figure 2. Model showing the associations between variables of interest. Dotted lines indicate non-significant relationships. Unstandardized coefficients with standard errors in parentheses are shown for significant relationships (p < .05).

= .05, 95% bootstrapped confidence interval [.001, .646]). However, there was no significant relative direct effect of the experimental stimuli on the dependent variable. Regarding indirect effects, we found five significant indirect effects in the model between the experimental stimuli (specifically the video stimulus) and the outcome variable, inspiration state (Table 4, Figure 2).

The first significant relative indirect effect is that of the video stimulus on inspiration state through awe (Table 4). The path coefficients in the model can be used to calculate the relative indirect effect, which is (.48)(.39) = .18. This indicates that respondents who saw the

Table 4. Relative indirect effects in the model (N = 754). Bootstrapped confidence intervals are constructed using 10,000 bootstrapped samples.

	Effect	SE	95% CI
Stimulus — Curiosity — Inspiration state			
Audio	-0.024	0.019	[-.070, .004]
Video	0.026	0.020	[-.003, .074]
Stimulus — Awe — Inspiration state			
Audio	-0.024	0.051	[-.126, .079]
Video	0.187	0.060	[.082, .317]
Stimulus — Feeling moved — Inspiration state			
Audio	0.035	0.056	[-.076, .150]
Video	0.168	0.065	[.054, .308]
Stimulus — Thought-provoking — Inspiration state			
Audio	-0.002	0.013	[-.028, .026]
Video	-0.049	0.019	[-.090, -.016]
Stimulus — Curiosity — Thought-provoking — Inspiration state			
Audio	-0.023	0.015	[-.059, .001]
Video	0.025	0.015	[.000, .059]
Stimulus — Awe — Thought-provoking — Inspiration state			
Audio	-0.001	0.003	[-.009, .005]
Video	0.011	0.006	[.002, .025]
Stimulus — Feeling moved — Thought-provoking — Inspiration state			
Audio	0.003	0.005	[-.006, .013]
Video	0.013	0.006	[.003, .028]

video stimulus scored, on average, .18 units higher on the inspiration scale as a result of the effect of the stimulus on awe, which, in turn, was positively associated with the dependent variable. Similarly, the relative indirect effects of the video stimulus through feeling moved and finding the content to be thought-provoking on inspiration state were also significantly different from zero–(.45)(.37) = .17 and (−.28)(.18) = −.05, respectively. The indirect effect of the video stimulus on inspiration state via the thought-provoking variable is negative because respondents who were exposed to the video stimulus, relative to the text one, reported lower levels of finding the content to be thought-provoking. Therefore, as a result of the video stimulus' effect on the thought-provoking variable, participants who watched the video scored, on average, .05 units lower on inspiration state.

However, if respondents had an emotional reaction to the video stimulus (e.g., awe, feeling moved) that was then associated with finding the content to be thought-provoking, the relative indirect effects are positive (awe: (.48)(.12)(.18) = .01; feeling moved: (.45)(.16)(.18) = .01).

9 ▪ Discussion

In the present work, we set out to examine how media content about a basic science topic, astronomy, might elicit feelings of inspiration among those who engage with it. Specifically, we investigated how media content modality (text vs. audio vs. audiovisual) might evoke awe, curiosity, feeling moved, and thought provocation that motivate a state of inspiration.

Although the findings revealed mixed support for the proposed hypotheses, the results yielded important insights and avenues for future research.

Our findings inform how inspirational media may be used to effectively communicate about basic science if the goal of basic science communication is to inspire. Practically, these findings suggest that communicators may prefer to use audiovisual content, although with important potential consequences for thought provocation and feelings of inspiration if awe and feeling moved are not induced; though there is no statistically observed difference between using text or audio content. Our findings also suggest that JWST may induce awe from viewing, which may lead to reflective thought, and ultimately, feelings of inspiration. Although there were no significant differences between how information modality impacted self-reported curiosity, curiosity was relatively high among all participants across all experimental conditions. Although this finding did not generate support for the proposed hypothesis (H1a), this finding should be encouraging in that regardless of information modality, participants were curious about the content, and the impact of curiosity on participants' inspiration state was fully mediated by thought provocation. Therefore, these findings suggest science communication practitioners would do well to pique the curiosity of media users, which should evoke reflective thought and ultimately inspire them.

Another interesting finding, was that audiovisual content was negatively related to reflective thought and, in turn, feelings of inspiration, which may seem to be counterintuitive to the goals or objectives many science communicators might aspire to. Media richness theory may help explain this finding in that rich media are assumed to ease individuals' information processing burden in a quicker amount of time (e.g., which may manifest in less of a need for media users to engage in reflective thought). Another possible explanation for this finding is research suggesting that multi-sensory stimuli (e.g., audiovisual inputs versus audio-only inputs or visual-only inputs) increase the cognitive burden of processing information in real time, which presumably could diminish viewers' ability to think about newly encountered information and/or integrate such information into their existing mental schemas [J. T. Fisher et al., 2019]. Unfortunately, the current study design limits our ability to parse this out; however, future research should explore this more fully. For example, perhaps the motivated processing of basic science media content happens in an arc-type experience where, upon exposure to the media content, media consumers experience self-transcendent emotions (e.g., awe and feeling moved) after which point the emotional experience peaks, and reflective thought (which may include sense-making and integrating the self-transcendent experience(s) with existing mental schemas) then occurs. Future research should further interrogate the emotional and cognitive processes and effects of engaging basic science media content, and the durability of such experiences for consumers' consequent emotions, cognitions, and behaviors.

These findings advance science communication by testing media psychology theory in an astronomy context, which is a form of basic science. Practically, the findings offer empirical evidence for how science communicators may use media to inspire the public regarding a discovery science context and the impacts of using such media. Future research should further look at the content and structure of inspirational science media and the process of inspirational science media consumption to understand and inform the strategies, processes, outcomes, and ethics associated with science media design and media consumption choices [Chang, 2023; Dale et al., 2023; Oliver et al., 2021]. Similarly, the field would benefit from more nuanced study of the variety of self-transcendent emotional and eudaimonic experiences that may be evoked by science media, as well as their potential consequences [Raney et al., 2019]. For example, Luna and Bering [2021] proposed that although feelings of awe in science communication may increase interest in science, there are likely many different "awe types in science communication, each with different forms and functions in relation to the mandates within the multiplicity of contexts in this cultural space" [2021, p. 2]. Future research should continue to interrogate these areas to arrive at a more informed understanding of how science media, communication, and information strategies might be developed and implemented to satisfy public eudaimonic, or truth-seeking, mediated experiences that positively impact science engagement outcomes, such as attitudes, learning, and support [Sinai, Caffery & Cosby, 2022]. Additionally, future research should continue to explore how and why specific audiences are engaged by basic science media content, and uncover potential individual differences in how basic science communication content strategies and tactics may uniquely affect specific audiences.

Beyond the limitations endemic to most, if not all, survey-experimental work, this study consisted of a single-message experiment; therefore, the results afford little ability to generalize beyond the specific message context examined in this study. Similarly, participants may not have been interested in or inspired by this one message or context; future research should explore a variety of basic science contexts and messages to understand unique and distinct processes, effects, and consequences. Our second limitation is that many of the variables are correlated (Table 2). We are not overly surprised that this is the case as most of these variables measure positive affect in some way. Although the correlations are positive and significant, we believe these to be concepts to be distinct when it comes to content validity. Moreover, this study was a cross-sectional design and we are careful not to comment on the durability of the effects related to one message exposure over time. Our quota sample also presents a limitation to our findings. Our sample, though it matched population estimates when it came to gender and race, was older and more educated than the general adult population of the U.S. When it comes to science, an older and more educated sample are likely to be more engaged [Saks & Tyson, 2022]. This factor is likely to be more important when it comes to a niche scientific topic, such as microbiomes, compared to one that is widely covered by news media. The launch of the JWST is an example of the latter; it was a global effort that represented large-scale collaboration. That said, future efforts should examine how our findings hold up in other scientific contexts. Additionally, to what extent will participants remember the information and will their feelings motivate them to do anything else related to science now or in the future? Future research should continue to interrogate the consequences of using various information modalities to reach audiences, and how such choices might influence outcomes associated with specific science communication goals and objectives.

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Data availability statement. Data are available upon reasonable request. We do not have participant consent to share the data openly but are committed to sharing de-identified data with individual researchers who reasonably request them.

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