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Harnessing the awe of eclipses to enhance science engagement

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This study examines the impact of the 2024 Total Solar Eclipse on participants' feelings of awe, science identity, and interest in science-related activities through structured science engagement events. Drawing on a mixed-methods approach, the research collected data from over 1,300 attendees at NASA-hosted eclipse events across the United States, with follow-up surveys conducted 6 months later. Findings reveal that the eclipse evoked high levels of awe, which remained relatively stable over time. Participants also reported elevated science identity and intentions to engage in future science activities; however, a gap was observed between intention and action. Correlational analyses suggest that awe, science identity, and science engagement are interrelated and mutually reinforcing. These results underscore the potential of awe-inspiring natural phenomena to serve as powerful catalysts for informal science learning and long-term public engagement with science.

KEYWORDS

science identity, science engagement, solar eclipse, public outreach, awe

1 Introduction

Few natural phenomena evoke as profound an emotional and communal experience as a total solar eclipse. The awe-inspiring nature of total eclipses comes from their stunning visual display and their presumed ability to instill a deep sense of wonder, humility, and connection to something greater than oneself (Goldy et al., 2022), based on the experience of an unusual visual display right before, during and after totality, with the associated brief darkness, the drop in temperature, changes in the auditory landscape (bird sounds), or unusual visual lines on the ground as totality approaches, and what ability to see the sun's corona during totality. A total solar eclipse is also a rare celestial event for most people (even as they are visible regularly at any one time somewhere on Earth). The combination of relative rarity and unusualness with unique perceptual experiences renders total solar eclipses potentially awe-inspiring natural events. The 2024 Total Solar Eclipse on April 8 was one of the most widely anticipated astronomical events in recent history, offering a unique opportunity to engage the public in science through a shared, emotionally resonant experience (NASA, 2024a). To support the public's interest in the eclipses, federal agencies such as the National Aeronautics and Space Administration (NASA) or the National Oceanic and Atmospheric Administration (NOAA); major astronomy-related organizations like the American Astronomical Union (AAU) and the Astronomical Society of the Pacific (ASP) and hundreds of amateur astronomy clubs; science centers, science museums and many other types of informal science education settings; and thousands of community-based institutions like public libraries participated in and organized public engagement events to help people witness the eclipse and deepen their understanding of the science behind it. The convergence of public enthusiasm and the widespread organization of science engagement events presented a unique opportunity to explore how the emotional impact of witnessing

a total solar eclipse--particularly the experience of awe--can influence public engagement with science, but also how an unusual natural phenomenon can inspire or create a sense of awe and wonder. We can also determine whether unusual science experiences may engage audiences who do not strongly identify with science or have limited access to formal science education (Carver et al., 2021).

Research has shown that informal learning environments can foster curiosity, increase interest in science, and influence long-term attitudes toward science (Falk and Dierking, 2010; National Research Council, 2009). Emotional engagement—such as through awe-inspiring experiences—has been hypothesized as a key factor in deepening these impacts (Storksdieck and Staus, 2023). When a scientific phenomenon emotionally resonates with people, they are more likely to extend their engagement, remember it, talk about it, and seek further learning opportunities (Falk and Storksdieck, 2005; Storksdieck, 2006). In this context, public total eclipse events represent a powerful form of informal science engagement, combining spectacle, community, and scientific interpretation in a way that can create emotional connections to science.

This study aims to explore how eclipses--particularly when experienced through structured science engagement events--can evoke and sustain feelings of awe, how a sense of awe might be influenced by a person's existing science identity, and whether and to what degree the experience of an awe-inspiring natural phenomenon might inspire continued interest in science-related activities. We used the opportunity of the 2024 total solar eclipse and the fact that there were many public viewing events designed to create a communal and "interpreted" experience of the total eclipse to investigate a series of research questions:

While eclipses are widely assumed to be awe-inspiring, this study seeks to empirically measure the intensity and longevity of that awe, both immediately after the event and in the months that follow. In addition, we examined whether the experience of the eclipse shaped or reinforced science identity, and if changes to science identity occurred, whether they persisted over time. This study also assessed whether attending a science-focused eclipse event and experiencing eclipse totality led to increased expressed interest in science-related activities and whether participants followed through on those intentions by participating in subsequent reinforcing experiences (Falk and Dierking, 2010) or follow-up activities (Storksdieck, 2006). Finally, we investigated the interrelationships among awe, science identity, interest, and follow-up participation to understand how these factors interact and potentially reinforce one another. By addressing these questions, this study contributes to a growing body of research on the emotional and cognitive impacts of informal science learning. It highlights the potential of awe-inspiring natural phenomena to foster deeper public engagement with science.

2 Literature review

The concepts of awe and science identity are important for understanding how people connect with scientific phenomena outside of formal educational settings. This study draws on the psychological foundations of awe, the development and impact of science identity, and how emotionally resonant experiences—such as total solar eclipses—can promote engagement with science through informal science activities. By anchoring our investigation in these theoretical frameworks, we aim to gain a better understanding of how awe-inspiring natural events can spark sustained interest in science and contribute to identity development.

Awe is a complex and potentially powerful emotion that, at its core, represents a state of feeling stunned or amazed, but is distinguished from expressions of surprise, pleasure, or amazement by being triggering a sense of perceptual vastness and a need for cognitive accommodation (Keltner and Haidt, 2003). In other words, "awe is a self-transcend emotion that encourages individuals to focus attention outside of themselves and to extend beyond their momentary needs and desires" (Price et al., 2021). In recent years, awe has garnered increasing attention in psychological and educational research for its potential to influence cognition, behavior, and social connection. People who experience awe tend to become more curious, more open to new experiences, and feel a stronger sense of connection to others and the natural world (Piff et al., 2015; Rudd et al., 2012).

Informal science researchers have shown that awe motivates people to engage more deeply and reflect more thoughtfully. Recent research by Price et al. (2021) underscores the importance of awe in informal learning environments, particularly in museums and cultural institutions. Price et al. (2021) surveyed nearly 900 visitors at various science and art museums. They found that people consistently reported awe-related perceptions across institutions, which modestly but meaningfully influenced their memory of learning experiences. Moreover, Price et al. (2021) demonstrated that awe is not a monolithic emotion but rather comprises multiple dimensions—including feelings of connection, physical sensations, and a diminished sense of self—which can each influence learning differently. This emotional resonance can reinforce or even reshape an individual's science identity, especially in informal settings where learning is self-directed and socially contextualized (Avraamidou, 2020). Thus, awe may function as both a trigger for immediate engagement and a mechanism for long-term identity formation and engagement, linking emotional experience with cognitive and social dimensions of science learning (Storksdieck et al., 2005).

Science identity refers to the extent to which individuals perceive themselves—and are recognized by others—as "science people" (Carlone and Johnson, 2007). Science identity is not static; it evolves over time and across contexts, influenced by personal experiences, social interactions, and cultural narratives (Avraamidou, 2020; Brickhouse et al., 2000; Sandrone, 2022; Vincent-Ruz and Schunn, 2008). Informal science experiences--such as attending public science events or visiting a science museum provide unique social and structural affordances--such as collaborative learning and hands-on activities–that allow people to freely explore their roles and identities as science learners away from formal assessments and structure present in formal learning settings (Riedinger, 2015).

Recent models of informal science learning emphasize the interplay between emotion, engagement, and the development of science identity. Storksdieck and Staus (2023) propose the Virtuous Cycle of Affect, Engagement, and Learning, a conceptual framework in which emotionally resonant experiences—such as awe—can trigger situational interest. This interest, in turn, fosters deeper engagement and learning, which may ultimately contribute to the development or reinforcement of a science identity. In this model,

awe-inspiring events like a total solar eclipse are powerful "on-ramps" to sustained science interest. When people engage in hands-on learning, reflect on their experiences, and interact socially, they can spark a cycle of curiosity, exploration, and identity formation. This supports the findings of Staus and Falk (2017), who showed that emotional arousal significantly predicts short-term learning in informal science settings. Like the nature documentaries they studied, eclipses offer emotionally charged, immersive experiences that boost memory retention and deepen conceptual understanding.

Beyond its motivational effects, awe may also influence how individuals think about science. Gottlieb et al. (2018) found that individuals who frequently experience awe tend to have a more accurate understanding of the nature of science. Unlike other positive emotions such as joy or pride, awe was uniquely predictive of scientific thinking, suggesting that it may foster greater appreciation for the complexity and uncertainty inherent in science. The relationship between awe and science identity is dynamic. While awe can inspire interest in science, a person's existing science identity may also shape how they experience awe. Those identifying with science, or more so, those who "do" science, may be more attuned to the scientific significance of awe-inspiring events (Cuzzolino et al., 2019) In contrast, those with less developed science identities may experience awe as a gateway to new ways of thinking and learning.

While informal science learning environments are known to foster awe, positive attitudes toward science, and increased interest in further science engagement (Falk and Dierking, 2010; National Research Council, 2009), there is likely a persistent intention–action gap, in what people intend to do after their experience in an informal learning space and what they actually do, this gap is a well-documented phenomenon in behavioral science, but not yet widely studied in education spaces (Sheeran and Webb, 2016) Participants may express strong intentions to engage further with science following an inspiring event, but without continued support or reinforcement, these intentions may not translate into sustained behavior. A recent meta-analysis by Xia et al. (2025) found that the long-term influence of informal science education programs on science interest and intent to engage further in science-related activities varies significantly, being strongly shaped by contextual factors, including program structure and follow-up opportunities.

The April 8, 2024, Total Solar Eclipse presented a rare and emotionally intense opportunity to examine the intersection of awe, science identity, and informal science engagement in a large-scale, real-world context. While prior studies (e.g., Goldy et al., 2022) have documented the emotional impact of eclipses, the breadth of science engagement events for the 2024 eclipse presented an opportunity to examine how such experiences influence not only feelings of awe but also participants' evolving relationships with science. This study leveraged the embedded science engagement activities within multiple public eclipse events to measure participants' emotional responses, science identity, and follow-up engagement. We aim to gain a deeper understanding of how awe functions as both an entry point and a sustaining force in science learning, as well as the bidirectional nature of science identity. This work will have important implications for the design of future science outreach efforts by shedding light on how emotionally resonant and awe-inspiring experiences can be leveraged to broaden participation in science and foster lasting connections to scientific inquiry.

3 Methods

This study employed a mixed-methods design to investigate four core research questions.

1. To what degree does an eclipse inspire awe in people who chose to attend a public viewing event? And how is awe sustained after an eclipse?
2. What does science identity look like after viewing an eclipse at a science engagement event? And how is science identity sustained after an eclipse?
3. To what degree does attending a science engagement-focused eclipse event evoke interest in doing science-related activities afterwards? And do attendees act on these science-related activity intentions?
4. How are feelings of awe, science identity, interest, and follow-up participation in science-related activities connected?

We collected data through brief, structured intercept interviews and self-administered online surveys conducted at multiple NASA-hosted 2024 Total Solar Eclipse viewing events across the United States, as well as in a follow-up survey emailed to respondents 6 months after the eclipse. The survey instruments included quantitative items, such as Likert-type ratings of awe and science identity, and qualitative prompts designed to capture participants' most memorable aspects of the eclipse experience. This study, protocols, and instruments used were reviewed and approved by the Oregon State University Internal Review Board (HE-2024-871).

3.1 Measures

To assess participants' experiences of awe and engagement with science during large-scale public eclipse events, we developed a custom survey protocol tailored to the unique constraints and opportunities of the setting. One of our challenges in developing the interview and survey protocol was determining how to conduct meaningful but short interviews at large-scale public engagement events. We did not want to detract from the experience, but hopefully add to it or be only a minor inconvenience. Existing validated instruments, such as the Awe Experience Scale (AWE-S) (Yaden et al., 2018) and the Situational Awe Scale (SAS) (Krenzer, 2018), although comprehensive, were not well-suited for rapid deployment after the eclipse in a dynamic, outdoor environment with thousands of attendees. These tools require extended reflection and multiple-item subscales, which could disrupt the immersive nature of the eclipse experience and reduce response rates. Although we did not directly use these measures, their constructs and structure influenced our approach. For instance, we included items related to connectedness with other people and the natural world. We also drew inspiration from Carver et al. (2021), who studied attendee motivations for a 2017 total solar eclipse event using a brief paper-based survey with four open-ended prompts.

Our survey protocol included two versions of our survey instrument. The first, called the Day-of-Eclipse Survey, was administered on the day of the Total Solar Eclipse either in person through interviews with data collectors or self-administered online via a QR code on a commemorative sticker. We designed the survey to be completed in just a few minutes. The second instrument,

the Follow-Up Survey, was sent 6 months later to participants who completed the Day-of Survey and opted in for follow-up contact. The survey instruments are nearly identical and included closed- and open-ended items to assess: 1) Motivation for attendance (e.g., interest in the eclipse, NASA's presence), 2) Engagement with NASA exhibits, as indicated by satisfaction ratings and descriptive impressions, 3) Self-perception as a "science person", rated on a 1–10 scale (influenced by Aghekyan (2019) 4). Awe-related responses, including agreement with statements such as "The total solar eclipse was the most awe-inspiring event I have ever experienced" and "I felt a greater sense of connection to nature/people" (influenced by Yaden et al., 2018; Price et al., 2021; Krenzer, 2018). 5) Follow-up on intended science activities, such as plans to learn more about the Sun, eclipses, or NASA, and to attend future science-related events, 6) Open-ended responses capturing the most interesting thing learned during the event and memories of viewing the eclipse, and 7) Demographic and follow-up information, including location of origin and optional email for a longitudinal follow-up (see Supplementary Material). This study analyzes responses to questions about awe, science identity, intended follow-up science activity, and memories of viewing the eclipse. We are analyzing other questions for a separate study (Sellers, in preparation).

We followed the MEASURE approach, as described by Kalkbrenner (2021), to develop and validate the interview and survey protocols. The validation process included conducting a pilot study at the 2023 Annular Solar Eclipse event, hosted by NASA, coinciding with the Albuquerque International Balloon Fiesta (i.e., "Fiesta"). An annular solar eclipse differs from a total solar eclipse in that the shadow of Earth does not fully cover the visible sun disk, and therefore a very slim (annular) rim of light is still visible, with implications for the experience itself: For instance, even with the most minimal remaining light, the corona is not visible, and the experience of sudden darkness is not as pronounced as with the total solar eclipse. The pilot was critical to refining and validating our final survey instruments for the 2024 eclipse. It was imperative to test the instrument for its suitability in conducting short interviews during a busy and exciting event.

Over 100,000 people watched the eclipse at the balloon fiesta. During the event, the research team and three other Data Collectors distributed a survey via bookmarks with a QR code to the survey and conducted short interviews with attendees. The pilot survey included items about: 1) why people decided to attend the Fiesta, 2) if they knew NASA was involved at Fiesta and how they felt about the NASA tent if they visited it, 3) their impressions before and/or after the eclipse, 4) how individuals compared their experiences viewing the annular eclipse to other awe-inspiring experiences, and 5) how likely the attendees were to engage with other science events.

We collected surveys (n = 30) and conducted interviews (n = 211) from October 12 to 14 at Fiesta. We asked respondents to rate the awe-inspiring eclipse on a 1–10 scale, with 10 being the most awe-inspiring event they have ever experienced. Fiesta attendees (n = 56) placed the Annular Solar Eclipse in a middling spot compared to other awe-inspiring events (mean = 6.95, SD = 1.76); their self-reported most awe-inspiring events included giving birth, visiting Hawaii, events at the Fiesta, and the 2017 Total Solar Eclipse. The research team also asked interviewees about the types of science-related events they were most likely to engage with because of their experience with the eclipse. They are most likely to travel to view the April 2024 Total Solar Eclipse (n = 51) and share their eclipse experiences with family and friends (n = 54). We asked attendees if they considered themselves to be a science person, and the overall response (mean = 6.85, SD = 2.51) indicated that attendees did not generally describe themselves as science people.

This pilot test was key to refining the interview and survey instruments and protocols for the 2024 Total Solar Eclipse, where we aimed to interview and survey a larger number of people across multiple events. From our pilot at the annular eclipse, Fiesta attendees varied in their comfort with sustained conversation–some attendees only wanted to answer a few questions. In contrast, others were willing to chat for a considerable amount of time. We found that about 5 min was a suitable amount of time needed to engage most attendees during interviews. We performed a Cronbach's alpha test with the pilot data to assess the validity of the custom awe construct ($\alpha = 0.884$). Based on the results of the Cronbach's test, we decided to simplify the awe measure by asking four items on a Likert scale to measure this construct (see Supplementary Material). During interviews, we asked people to anchor the awe scale to their most awe-inspiring experience. Attendees seriously considered the question, as they commonly described seeing the birth of their children as their most awe-inspiring experience. Analyzing these responses helped us understand how people were interpreting our awe measure. We felt the items were ready to be deployed in surveys and interviews at subsequent events around the 2024 Total Solar Eclipse.

3.2 Study sites and participants

During the 2024 Total Solar Eclipse, NASA organized 14 locations (referred to as SunSpots) in seven states: Texas, Arkansas, Ohio, Indiana, Pennsylvania, New York, and Maine, across the path of totality (NASA, 2024a; NASA, 2024b). These events were designed to engage the public and provide educational opportunities about the eclipse, as well as current NASA missions and research. At each event, NASA missions and programs had an activity space with hands-on activities and demonstrations (see Sellers, in preparation, for additional details now in review) (Figure 1). These included decorating eclipse glasses, making UV bead bracelets, and demonstrating current mission technologies. Each event also included special presentations and panels with NASA astronauts and scientists. For example, at the Dallas Arboretum event, NASA's Maurice Henderson presented the Eclipse OmniGlobe, a fascinating display that helped explain the scientific phenomena occurring during the eclipse (Figure 2).

To recruit participants for this study, our research team conducted spot interviews at events in three SunSpots: Dallas Arboretum in Dallas, TX, the Indianapolis Motor Speedway in Indianapolis, IN, and an event in Houlton, ME. We connected with event hosts at several other NASA-supported events to distribute stickers featuring the survey QR code; these locations included the Kerrville, Texas River Festival in Kerrville, TX, and the Austin Central Library's Eclipse Watch Party in Austin, TX, as well as other locations. At the interview locations, we hired data collectors, many of whom are undergraduate students with an interest in astronomy. In total, we had 35 data collectors, 30 of whom we hired explicitly for the event, and 5 were members of our research team. We conducted

FIGURE 1
Attendees at the Indianapolis Motor Speedway view NASA exhibits ahead of the total solar eclipse, Monday, April 8, 2024, in Indianapolis, Indiana. Photo Credit: (NASA/Joel Kowsky).

FIGURE 2
Maurice Henderson speaks to guests about the upcoming total solar eclipse at the Dallas Arboretum, Sunday, April 7, 2024, in Dallas, Texas. On Monday, April 8, a total solar eclipse will sweep across a narrow portion of the North American continent from Mexico's Pacific coast to the Atlantic coast of Newfoundland, Canada, while a partial solar eclipse will be visible across the entire North American continent along with parts of Central America and Europe. Photo Credit: (NASA/Keegan Barber).

multiple online training sessions to introduce the data collectors to the event plan and our data collection procedures. Data collectors practiced the interview protocols with each other, as well as with friends and family, in the lead-up to the eclipse. Due to the large crowd size and the aforementioned concerns of not detracting from attendees' experience, the data collectors employed opportunistic sampling to interview event attendees (Farrugia, 2019).

We conducted spot interviews (also known as intercept interviews (Flint et al., 2016)) with event attendees before and after the totality of the eclipse on the day of the event. These interviews, which lasted 2–5 min, focused on emotional responses to the eclipse, engagement with the science activities, perceptions of NASA, and intentions for further science engagement. We recorded interviews either on paper or on a tablet device. Interviews recorded on paper were later input into Qualtrics. If the interview had occurred before the eclipse that day, we would not have asked questions about their emotional responses to the eclipse. We asked interview and survey respondents if they agreed to be contacted 6 months later for a brief follow-up survey, focusing on their memories of the eclipse and their continued engagement in science-related activities. The interview questions were also available via a self-administered survey, accessible via a QR code on free commemorative stickers distributed at the events (Figure 3). Note that we purposely did not collect demographic data of respondents because we did not have research questions associated with demographic factors, and because we did not need demographic information to characterize the sample.

3.3 Data analysis

Since the interview instruments included both closed-ended items (e.g., Likert-scale ratings) and open-ended questions, we employed a convergent mixed-methods approach, combining quantitative and qualitative analyses (Creswell and Clark, 2017). We used descriptive statistics (i.e., mean, mode, and standard deviation) to summarize participant responses across key variables, including self-reported awe, science identity, and intended science engagement activities. We used the Wilcoxon signed-rank test to assess changes in science identity and awe-related perceptions before and after the eclipse. This test evaluated whether participants' self-perceptions as "science people" or their sense of awe in viewing the eclipse shifted significantly following the event.

Using the Spearman rank-order correlation coefficient, we also examined the relationship between awe, science identity, and engagement in science-related activities. This analysis helped determine whether higher levels of awe were associated with stronger science identity or greater intentions to engage in science-related activities after the event. Open-ended responses to the prompt "What is one memory that has stuck with you from viewing the eclipse?" were analyzed using content analysis (Bernard et al., 2016). Responses were reviewed for completeness and clarity, then coded inductively to identify recurring themes.

4 Results

Across the eclipse events, 1,328 people completed a survey or interview. Seven hundred respondents agreed to a follow-up survey, and 188 completed it (27% response rate). Most of our responses came from interviews at the Indianapolis Motor Speedway event (n = 700) or the Dallas Arboretum events (n = 484) (Table 1).

Most respondents traveled to view the eclipse, but 855 came from another state or country to attend one of the events. Respondents came from across the United States, including Hawaii, Delaware, and Washington, D.C., as well as from around the world, including Russia, China, and Spain. Here, we examine the extent to which eclipse events influenced attendees' sense of awe, their connection to their science identity, and their commitment to participating in future science events.

4.1 The 2024 total solar eclipse created a sense of awe

On the day of the eclipse, the mean of the awe measure for all respondents was 8.7 out of 10 (n = 501; SD = 1.27; note that

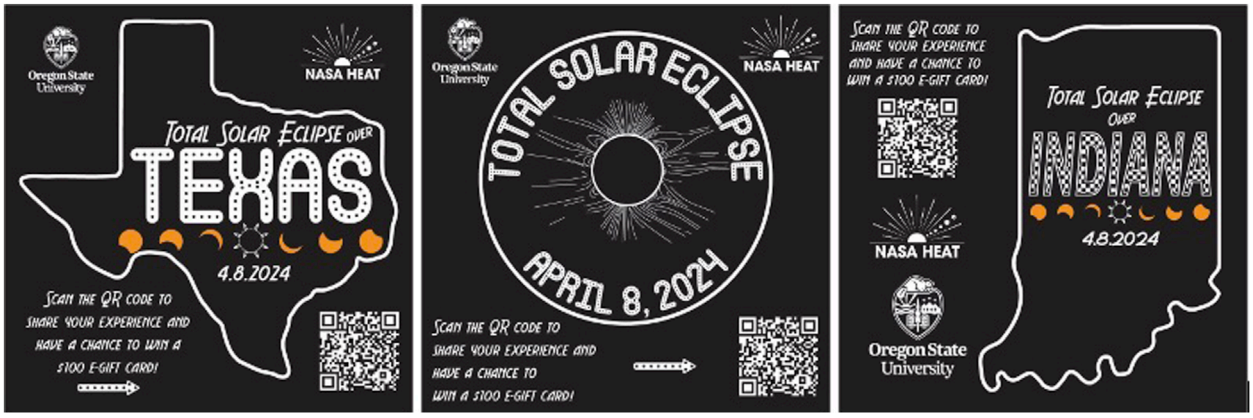

FIGURE 3
Commemorative Eclipse Stickers, designed by research team member, Victoria Sellers. These stickers were handed out to attendees at multiple eclipse events along the path of totality, either as an invitation to complete the survey on their own (the QR code on the sticker linked to the online self-administered version of the survey) or as a thank you item for attendees who completed an interview with one of our data collectors.

TABLE 1 Number and percent of respondents from each study site.

Location	Participants	%
All locations	1,310	100
Texas	522	40
Dallas, Texas	484	37
Other Texas locations	38	3
Indianapolis, IN	700	53
Houlton, ME	65	5
Other/Not Provided	23	2

we asked this question only of respondents we interviewed after the eclipse occurred that day). For the subset of total respondents who took both the day-of and follow-up surveys, the mean of the awe measure on the day of the eclipse was 9.1 (n = 87; SD = 1.27), and their mean in the follow-up survey was 8.50 (n = 116; SD = 1.47). The relatively low standard deviation indicates that most participants' awe ratings clustered closely around the mean, suggesting a consistent and strongly positive emotional response across respondents. Figure 4 shows the distribution of awe amongst respondents.

We performed a Wilcoxon Signed-Rank Test to compare the means on the day of the eclipse and in the follow-up survey ($p = < 0.001$; n = 79, we compared the means of the respondents who took both surveys). The results of this test show a significant difference in respondents' feelings of awe between the day they viewed the eclipse and 6 months after they viewed it.

The Spearman rank-order correlation coefficient test shows a strong correlation ($r = 0.68$; $p = < 0.01$) between respondents' feelings of awe on the day they viewed the eclipse and 6 months after they viewed the eclipse, indicating that respondents who reported high measure of awe on the day of the eclipse tended to feel high measures of awe later.

To further explore the emotional impact of the 2024 total solar eclipse, we conducted a thematic analysis of responses to the follow-up survey question: "What is one memory that has stuck with you from viewing the eclipse?" One hundred twenty respondents provided answers to this question. We performed content analysis of these responses, and five major themes emerged: Awe and Wonder, Social Connection, Scientific Interest, Visual and Emotional Impact, and Unique Experience. Figure 5 shows these major themes and examples of the responses.

The most prominent theme was a high sense of awe. Respondents frequently used words like "amazing," "incredible," and "awe-inspiring" to describe their reactions. Many respondents emphasized the event's communal nature. They mentioned that watching the eclipse with family, friends, or even strangers created a shared emotional experience, fostering a sense of community and connectedness. Some responses reflected an appreciation for science and the natural world. Respondents were curious and admired how an eclipse occurs and how scientists can predict and forecast eclipses. Other respondents noted the eclipse's visual impact, including the sudden darkness, the corona, and the atmospheric changes that occurred. Several respondents described being moved to tears or stunned into silence during totality. Finally, many respondents emphasized the rarity and singularity of the event, noting that it was a once-in-a-lifetime experience or their first time witnessing a total solar eclipse.

4.2 Event attendees see themselves as science people

We asked event attendees to self-report their science identity by asking them to rate whether they are a science person. On

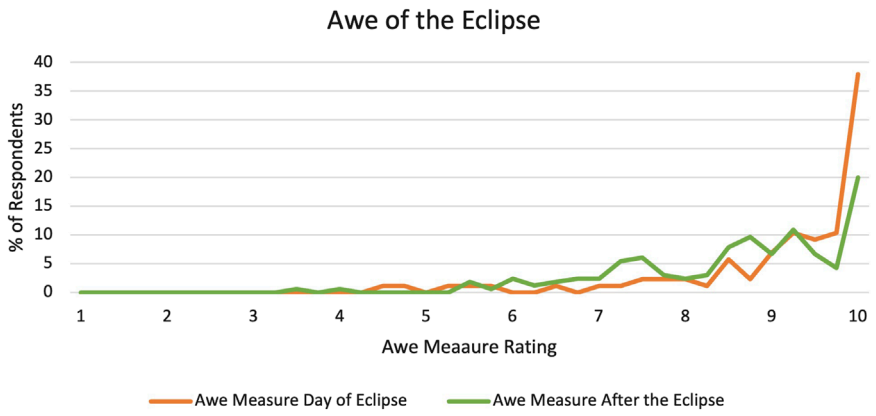

FIGURE 4
Distribution of respondents' reported rating of awe on a scale of 1–10 on the day of the eclipse (red) and after the eclipse (orange). A notable increase in the percentage of respondents rating their awe at the highest level (10) occurred on the day of the eclipse, and awe understandably wanes 6 months later.

Awe & Wonder	Social Connection
"Feeling a real sense of awe."	*"The sense of community seeing it together, the sense of calm during totality."*
Scientific Interest	**Visual and Emotional Impact**
"The visual of the actual eclipse and the event and how it was widely celebrated and how it felt like a greater science family at the event."	*"There was complete silence as we watched this amazing event right above us."*
Unique Experience	
"What a unique opportunity it was to see something that we take as a normal thing in the sky from a completely different perspective."	

FIGURE 5
Respondents' memories of the eclipse. Five major themes emerged: Awe and Wonder, Social Connection, Scientific Interest, Visual and Emotional Impact, and Unique Experience.

a scale of 1–10, with 1 being not at all a science person to 10 being very much a science person, the day-of average was a 7.4 (n = 1,239; SD = 2.306. For respondents who took both the day-of and follow-up surveys, their day-of average was 8.3 (n = 73; SD = 1.93). In the follow-up survey, the average was 7.95 (n = 62; SD = 2.1) (Figure 6). We performed a Wilcoxon signed-rank test to compare the means of the respondents who took both surveys ($p = <0.001$; n = 180). The results show a significant difference in their science identity on the day of the eclipse and 6 months later. The eclipse events possibly boosted science identity, and this waned after the eclipse.

There is also a strong correlation ($r = 0.57$; $p < 0.01$) between science identity on the day of the eclipse and science identity in the follow-up survey, indicating that 1) science identity is relatively stable in the follow-up respondents (respondents with a high science identity on the day of the eclipse reported a high science identity in the follow up survey), and 2) respondents who have stronger (or more stable) science identities are more likely to respond to a follow-up survey. This could mean that we did not capture the attendees who did not have as strong science identities.

4.3 Respondents are excited to engage in additional science activities, but experienced an intent-action gap

We asked respondents about the science-related activities they intended to do after their experience at the eclipse events, and the follow-up survey asked them about the activities they actually engaged in over the previous 6 months. On eclipse day, respondents (46%; n = 607) most commonly indicated they wanted to learn more about NASA's current research and missions. In the follow-up survey, respondents indicated that they most commonly learned more about how eclipses occur (47%; n = 87). The second most common response was "learned more about NASA's current research and missions" (45%; n = 82).

We further examined responses to this question by breaking out responses by the awe and science identity measures; however, this did not change the top selections. It is clear that NASA's presence was significant at these events and that they were eager to learn more about NASA and eclipses.

Most respondents chose more than one option for how they planned to follow up (1.8 activities, n = 1,310, respondents (n = 126) who filled out both surveys planned to do an average of 2.7 activities), and those who responded to the follow-up survey reported doing 1.7 activities (n = 174).

4.4 A correlation exists between feelings of awe, science identity, and intent and further engagement in science-related activities

We performed a Spearman rank-order correlation coefficient to examine the relationship between awe, science identity, interest, and further engagement in science-related activities. The test shows a positive correlation between awe on the day of the eclipse with both science identity on the day of the eclipse ($r = 0.275$, $p < 0.05$) and science identity 6 months later ($r = 0.248$, $p < 0.05$), suggesting that

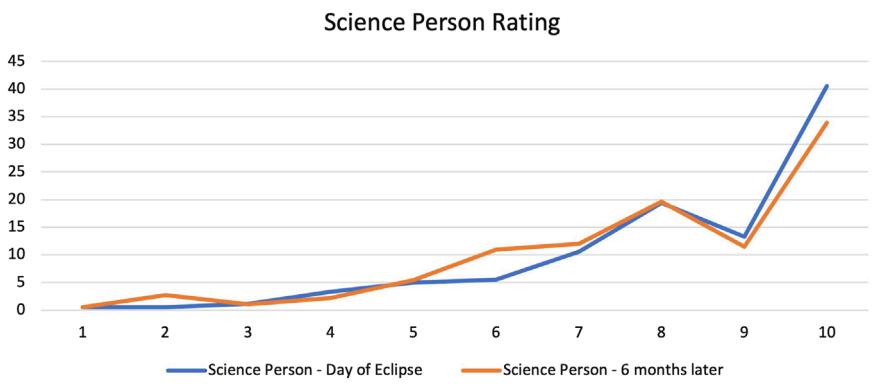

FIGURE 6
Comparison of Science Person Ratings on the Day of the Eclipse and Six Months Later. The blue line represents respondents' ratings of their identity as a "Science Person" on the day of the eclipse, while the red line shows ratings collected 6 months afterward. Both distributions exhibit a general upward trend, with a pronounced peak at the maximum rating of 10, suggesting that overall most respondents have high science identity.

higher awe on the day of the eclipse is modestly associated with stronger science identity both on the day of the eclipse and many months after the eclipse.

To assess the correlation between awe, science identity, and intent to participate in further science-related activities, we used the count of the number of activities they reported they would do (i.e., as stated in the day-of-eclipse survey) and their self-report of what they actually did (in the follow-up survey). We found that the count of activities they said they would do is moderately correlated with science identity ($r = 0.29$; $p < 0.01$) and the count of activities they actually engaged with months later ($r = 0.43$; $p < 0.01$), suggesting that initial intent to do multiple follow up activities is linked to both science identity over time and following up on multiple activities. The count of activities respondents engaged with months after the eclipse also correlates with both science identity ($r = 0.44$; $p < 0.01$) and awe ($r = 0.27$, $p < 0.01$) in the follow-up survey.

5 Discussion

The 2024 Total Solar Eclipse presented a rare opportunity to explore how awe-inspiring natural events, when combined with intentional science engagement, can shape public perceptions of science and cultivate lasting interest. Our findings suggest that participants not only experienced profound awe during the eclipse but that this emotional response remained relatively stable over time. Our results show awe, science identity, and intentions for future science engagement interact in the context of eclipse events. We interpret these results in light of existing literature on informal science learning and emotional engagement, considering both the strengths and limitations of our approach. In doing so, we aim to illuminate the potential of awe as a catalyst for deepening science identity and sustaining public interest in science beyond the moment of spectacle.

Survey responses revealed that participants experienced high levels of awe during the eclipse events, and notably, this sense of awe remained relatively stable even 6 months after the event. Although there was an expected decline in reported awe over time, the emotion persisted at a high level, suggesting that our measure of awe and participants' sense of awe is reasonably stable. However, it is important to acknowledge that participants self-selected into these eclipse engagement events, which may indicate a predisposition toward interest in science or celestial phenomena. Therefore, even though many people reported high levels of awe, not everyone may experience it with the same intensity across all populations. The immediate social and environmental context of the eclipse--such as being surrounded by others and the dramatic visual experience--likely amplified its emotional impact. As those contextual factors faded, some of the intensity likely did too, though the sense of awe remained strong. The themes that emerged from participants' memories of the eclipse reflect the multifaceted nature of the experience, highlighting the interplay between personal reflection, social connection, and scientific wonder.

Participants reported experiencing high levels of awe during the eclipse events, with many describing the moment of totality as one of the most emotionally powerful experiences of their lives. This emotional intensity was not only immediate but also enduring; follow-up responses 6 months later revealed that awe remained a salient and memorable aspect of the experience. The persistence of awe over time aligns with Price et al. (2021), who found that awe in informal learning environments can leave lasting impressions and enhance memory of scientific content. Similarly, Keltner and Haidt, 2003 conceptualization of awe as a response to perceptual vastness and the need for cognitive accommodation helps explain why the eclipse--an event that dramatically alters the sky and defies everyday experience--elicited such strong and sustained reactions. The immersive and communal nature of the events likely amplified these effects, consistent with findings by Piff et al. (2015) and Rudd et al. (2012), who noted that awe can foster a sense of connectedness and openness. While awe is often assumed to be a universal reaction to celestial events, our findings underscore the importance of context—such as the presence of scientific interpretation and community engagement—in shaping the depth and persistence of that emotion.

While there was an overall decrease in reported science identity over time, we found a positive correlation between science identity

over time, suggesting that participants' self-perception as "science people" remained relatively stable, if they reported high science identity on the day of the eclipse, their science identity 6 months later, although lower than before, was still relatively high. It is worth noting that the initial responses were collected in a context where participants actively engaged with science—surrounded by NASA materials, scientists, and fellow enthusiasts—which may have temporarily elevated their sense of science identity. Follow-up responses, collected in more neutral settings, may reflect a more grounded self-assessment. This aligns with Carlone and Johnson's (2007) framework, which emphasizes the importance of recognition and context in shaping science identity. The modest decline in science identity observed in the follow-up survey may reflect a return to more neutral environments, where science is less visible or socially reinforced. Still, the strong correlation between day-of and follow-up science identity scores suggests that for many participants, the eclipse experience reinforced an existing or emerging science identity. This finding supports Avraamidou's (2020) argument that informal science experiences can serve as critical moments in the ongoing development of science identity, particularly when they are emotionally resonant and socially contextualized. Interestingly, our results from the pilot study at the Albuquerque Balloon Fiesta, which attracts a broader general public, showed lower average science identity scores, reinforcing that context and audience composition influence how science identity is expressed.

Participants strongly intended to engage in further science-related activities immediately following the eclipse events. However, follow-up data suggest a gap between intention and action. While many attendees reported plans to visit science museums, attend future events, or learn more about eclipses, fewer followed through. Even when individuals express strong interest or motivation in the moment, translating that into sustained behavior often requires additional support and reinforcement. The long-term impact of such experiences can vary significantly depending on the presence of follow-up opportunities and contextual supports that help bridge this gap (Xia et al., 2025). Nonetheless, many participants did follow through on at least one science-related activity, most commonly learning more about eclipses or NASA's missions. The strong positive sentiment toward NASA observed in participant responses also suggests that trusted science institutions can play a key role in maintaining momentum by offering accessible, follow-up pathways for exploration and participation.

Our findings suggest meaningful relationships between awe, science identity, and continued engagement in science. Awe appears modestly but is significantly associated with science identity, and both are linked to sustained interest in engaging in science-related experiences. These relationships are likely dynamic and reciprocal in nature. For instance, individuals with a stronger science identity may be more attuned to the scientific significance of an eclipse and therefore experience greater awe. The nature of these relationships is consistent with Cuzzolino et al. (2019), who found that individuals with stronger science identities may be more attuned to the scientific significance of awe-inspiring events, while those with less developed identities may experience awe as a gateway to new ways of thinking. Conversely, experiencing awe may enhance appreciation for science and contribute to the development of science identity. These findings suggest that awe can serve as a motivational spark, but additional support may be needed to translate that spark into sustained engagement. This interplay supports the idea that emotional experiences--particularly awe--can shape long-term interest in science (Price et al., 2021). The dynamic nature of these constructs aligns with the Virtuous Cycle of Affect, Engagement, and Learning proposed by Storksdieck and Staus (2023), which posits that emotionally resonant experiences, such as awe, can initiate interest; however, continued engagement depends on reinforcing opportunities for learning and identity development.

5.1 Limitations and future research

While this study offers valuable insights into the impacts of eclipse-related science engagement, several limitations should be acknowledged. First, the follow-up survey had a relatively low response rate (27%), which may introduce response bias, particularly if those who felt more strongly about the experience were more likely to respond. Additionally, all study sites experienced views of the eclipse (some locations, such as Austin and Kerrville, Texas, had cloud cover, but still had views of the eclipse), limiting our ability to perform a natural experiment to compare emotional responses between those who witnessed totality and those who were clouded out. The brevity of the custom survey instrument, while necessary for use in dynamic public settings, also limited the depth of measurement for constructs such as awe and science identity.

Future research should examine the longevity of awe and its effects. For instance, would participants recall the eclipse with the same emotional intensity a year or more after the event? Additionally, comparative studies of awe induced by other natural phenomena could help determine whether in-person experiences are uniquely impactful or whether mediated experiences (e.g., watching auroras in a planetarium) can produce similar effects. Additionally, future research can explore the dynamics between awe and science identity further and build on research done by Price et al. (2021), which identified that prior knowledge was a strong predictor of positive awe, suggesting that individuals who come prepared or informed are more likely to experience awe and retain what they learn. Finally, this study raises questions about the validity and stability of simple measures of intense emotions, such as awe, and foundational constructs like identity. These simple measures could become valuable tools for evaluating informal science learning and public engagement efforts if such measures prove reliable in additional studies.

6 Conclusion

This study confirms that total solar eclipses are powerful emotional experiences that can evoke profound feelings of awe and spark interest in science. Participants who attended eclipse engagement events reported overwhelmingly high levels of awe during the event, and notably, this emotional response remained relatively stable even 6 months later. While awe naturally diminished somewhat over time, it did not disappear, suggesting that the eclipse left a lasting impression. These findings support the idea that eclipses are visually spectacular and emotionally immersive experiences

that can serve as effective entry points into scientific curiosity and engagement.

These findings offer important implications for science education and public engagement. First, they highlight the value of emotionally resonant experiences--particularly those that evoke awe--as powerful entry points into science learning. Events like total solar eclipses provide a rare convergence of spectacle, community, and scientific relevance, making them ideal opportunities for informal science education. As Falk and Dierking (2010) and the National Research Council (2009) have emphasized, informal learning environments can foster curiosity and long-term interest, especially when they engage learners emotionally. Our results suggest that awe can catalyze this process, particularly when paired with accessible, hands-on activities and opportunities for reflection. Educators and science communicators might consider designing programs around other awe-inspiring phenomena—such as auroras, meteor showers, or even local natural events (e.g., animal migrations or phenology) — to replicate this effect. Moreover, the strong public response to NASA's presence at these events underscores the importance of trusted institutions in facilitating meaningful science engagement. By intentionally designing experiences that combine emotional impact with scientific interpretation, educators can help bridge the gap between momentary inspiration and sustained interest in science.

It is worth noting, however, that not everyone had the opportunity to witness the eclipse, whether due to weather, location, or other barriers. This highlights the importance of equitable access to awe-inspiring experiences and underscores the need for innovative approaches to share these moments with broader audiences. Whether through live events, virtual simulations, or community-based programming, the goal should be to make the wonder of science accessible to all.

Data availability statement

The original contributions presented in the study are publicly available. This data can be found here: https://doi.org/10.7267/tt44pw407.

Ethics statement

The studies involving humans were approved by Oregon State University Division of Research and Innovation Human Research Protection Program and Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their verbal informed consent to participate in this study. NASA reserves the right to use any photograph/video taken at any NASA event without the express written permission of those included within the photograph/video. NASA may use the photograph/video in publications or other media material produced, used, or contracted by NASA.

Author contributions

HF: Data curation, Supervision, Methodology, Writing – review and editing, Software, Investigation, Validation, Conceptualization, Formal Analysis, Writing – original draft, Resources, Visualization, Funding acquisition, Project administration. VS: Visualization, Validation, Writing – review and editing, Data curation, Formal Analysis, Methodology, Conceptualization. MS: Funding acquisition, Conceptualization, Writing – review and editing, Investigation, Supervision.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Generative AI was used in the creation of this manuscript. This study employed artificial intelligence (AI) in a limited, transparent, and human-guided manner to support both the analytical and writing processes. Microsoft CoPilot was used during manuscript development to assist with outlining, refining organization, and improving clarity. All content, interpretation, and writing, including theme generation, data analysis, and final framing, were conducted by the authors. AI was used exclusively as a tool to enhance reflexivity and clarity, not as a substitute for scholarly judgment or qualitative reasoning. CoPilot was also used initially to explore broad thematic directions from the raw qualitative data. The final determination of themes in the qualitative data was completed through traditional qualitative analysis by two human coders.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fspas.2025.1662996/full#supplementary-material

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