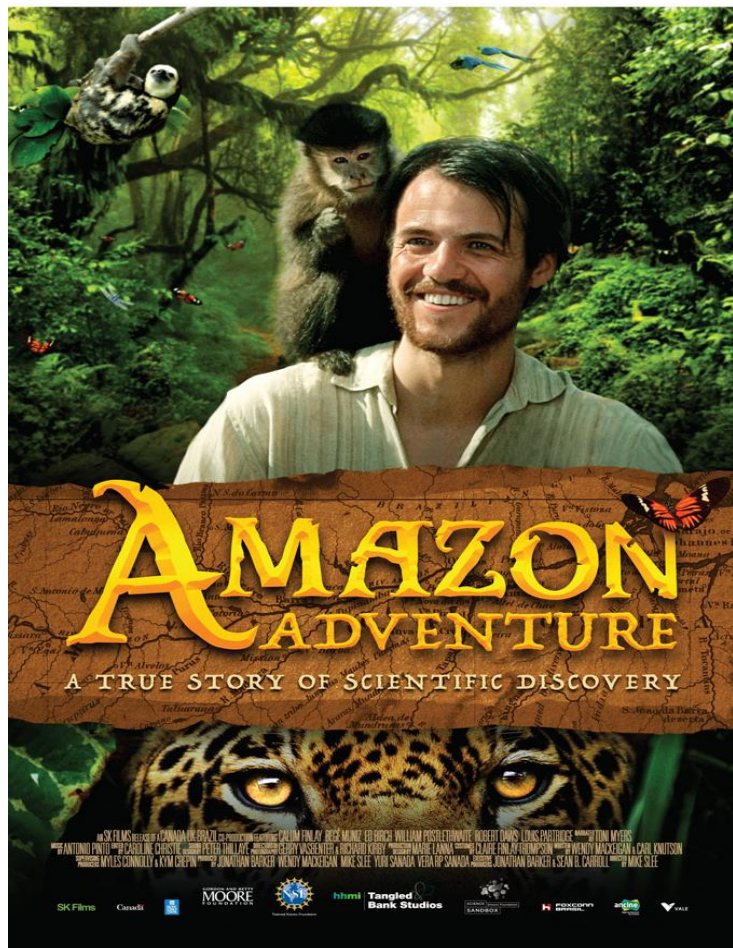


Summative Evaluation of *Amazon Adventure*



Impact on adult viewers' science learning, narrative engagement, and experience of spatial presence

Knight Williams, Inc.

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Table of Contents

Executive summary	4
Introduction	7
Background	8
Evaluation approach.....	8
<i>Amazon Adventure</i> as a narrative.....	9
<i>Amazon Adventure</i> as a giant screen film.....	10
<i>Amazon Adventure</i> as an educational film.....	11
Phase 1: Evaluation of science learning, narrative engagement, and spatial presence	12
Introduction.....	12
Method.....	12
Evaluation design.....	12
Participant information.....	12
Procedure.....	14
Measures	15
Data analysis and reporting.....	18
Findings.....	20
Part 1: Science learning	20
1.1 Knowledge of Bates’ scientific quest, mimicry, and species change	20
1.2 Perceptions of scientist attributes.....	25
Part 2: Narrative engagement.....	26
2.1 Appeal of the film and the story of Bates’ life as a scientist.....	26
2.2 Story and character involvement.....	31
Part 3: Spatial presence	33
Phase 2: Further exploration of Viewers’ science learning and narrative engagement	35
Introduction.....	35
Method.....	35
Recruitment	35
Participants	35
Procedure.....	36
Data analysis and reporting.....	36
Findings.....	37
1.1 Scenes liked most and least.....	37
1.2 Importance of the row of eight butterflies.....	39
1.3 Connection to Henry Bates.....	40
1.4 Perceptions of science or scientists	44

Phase 3: Follow-up evaluation of extended impact.....	46
Method.....	46
Recruitment	46
Participants	47
Procedure.....	47
Data analysis and reporting.....	47
Findings.....	48
1.1 Whether talked about the film	49
1.2 Related media experiences.....	50
1.3 How much thought given to film.....	50
1.4 Aspects of the film thought about.....	51
1.5 Aspects of Henry Bates’ life as a scientist that stood out.....	52
1.6 Aspects of Henry Bates’ character that stood out.....	52
1.7 Most important takeaways from the film	53
1.8 Whether nature was thought about or looked at differently	53
1.9 Whether mimicry was thought about when observing nature	54
1.10 Whether topics from the film were followed up on	55
1.11 Whether online activities related to the film were pursued.....	56
Discussion	57
References.....	62
Appendix A. Evaluation Deliverables	65
Appendix B. Implementation and perceived value of <i>Amazon Adventure</i> at two sites.....	66
Appendix C. Questionnaire items.....	72
Appendix D: Factor analysis of scales.....	75
Acknowledgements.....	81



Executive summary

Funded by the National Science Foundation (NSF), *Amazon Adventure* is an Innovations in Development project directed by Pacific Science Center in partnership with: SK Films; Rutgers, The State University of New Jersey; Embodied Games; and the Howard Hughes Medical Institute's Tangled Bank Studios. The project deliverables produced during the grant period include a giant screen film, live stage presentation for use at informal science education (ISE) institutions, and educational resources.

The centerpiece of the project, the *Amazon Adventure* film, is a 45-minute giant screen film shown in both 2D and 3D flat screen and 2D dome formats. The film is based on the true story of Henry Bates' 11-year journey through the Amazon in the 1850s, focusing on his quest as a young man to find evidence of species change.

As part of the NSF funding for the project, the independent evaluation firm, Knight Williams Inc., conducted a summative evaluation of both the immediate and longer-term impacts of the film on a general audience of adults who self-selected to view *Amazon Adventure* at one of four science center or museum theaters in 2017-2018: Pacific Science Center in Seattle, WA; Museum of Discovery & Science in Fort Lauderdale, FL; Discovery Place in Charlotte, NC; and Museum of Science in Boston, MA.

The evaluation assessed the film's impact with respect to audience knowledge of Bates' scientific quest, mimicry, and species change, as well as perceptions of scientist attributes; engagement with the biographical story of Henry Bates and Bates as a film character; and experience of spatial presence with the giant screen format.

The evaluation was conducted in three phases:

- Phase 1 was based on a separate-sample pre-test/post-test design. A total of 441 adults participated in Phase 1 of the evaluation (212 Pre-Viewers and 229 Viewers).
- Phase 2 comprised on-site interviews with a subset of Viewers who completed Phase 1 (n=33).
- Phase 3 comprised a follow-up online questionnaire completed within 3-4 weeks of viewing by those who participated in both Phase 1 and Phase 2 (n=20).

Key findings from Phase 1

- **Viewing *Amazon Adventure* increased science knowledge.** Viewers of the film scored significantly higher than Pre-Viewers on a set of content questions designed to assess science learning relating to Henry Bates' scientific quest in the Amazon, mimicry, and species change. The size of the overall effect was large and not influenced by demographics or background characteristics.

- **Viewing *Amazon Adventure* modified Viewer understanding of personality characteristics of scientists.** Viewers were significantly more likely than Pre-Viewers to list four attributes that they thought were important for scientists to have: perseverant, passionate, courageous, and observant.
- **Viewers describing what they liked and disliked about the film or about the story of Henry Bates' scientific quest in the Amazon were more likely to offer praise than criticism.** Those asked about the film pointed to liking the visual imagery, the storyline/dramatic narrative, the focus on Amazon wildlife, learning about Bates' quest, and the feeling of being immersed. Those asked about Bates' story most often pointed to learning about his scientific quest and/or learning about Bates as a person. The largest groups said there wasn't anything they disliked about the film or story, although some indicated that they disliked an aspect of the storytelling and/or felt the film was too short.
- **Viewers generally experienced a high level of narrative engagement while watching the film,** as indicated by their high agreement with statements about their level of involvement with the story and Henry Bates as a character in the film.
- **Viewers generally experienced a high level of spatial presence while watching the film,** as indicated by their level of agreement with statements about the feeling of being in the Amazon such that their location had shifted and they were present, taking part in the film's action.

Key findings from Phase 2

- **Scenes from *Amazon Adventure* that appealed to a substantial portion of the 33 interviewed Viewers included those that showcased Bates' scientific process and those that featured close up shots of animals.** No one scene was disliked by more than one-quarter of the Viewers, although some felt that the storyline and/or acting seemed overly dramatic or contrived at times.
- **Nine-tenths of interviewed Viewers correctly explained that the row of eight butterflies Bates pulled from his collection at the end of the film showed that one species changed or evolved into a new species.**
- **Four-fifths of interviewed Viewers stated that they felt a connection with Henry Bates,** with many in this group indicating that they either shared in or felt inspired by Bates' adventurous spirit and/or passion or felt a connection with Bates' process of scientific inquiry. Those who felt a connection generally agreed that the reenactment feature and seeing Bates face obstacles in his life and career played a role in their feeling connected to Bates.
- **Interviewed viewers were equally divided on whether they felt differently or not about science/scientists after watching the film.** Those who felt differently most often said the film gave them an increased appreciation for the challenges and struggles scientists face and/or that it rekindled their interest or motivation to engage in science. Those who did not feel differently thought they already had a positive view of scientists and that the film's portrayal reflected their existing views.

Key findings from Phase 3

- **Viewing of *Amazon Adventure* encouraged related activities in subsequent weeks, as reported by varying portions of the 20 Viewers who completed the follow-up online questionnaire.** Film-related activities included:
 - ▶ Talking to at least one person about the film, typically family members or friends;
 - ▶ Thinking about the film, with the largest group thinking about the row of eight butterflies;
 - ▶ Looking for more information about the film's topics, including Bates himself;
 - ▶ Using social media or blogs to communicate about the film;
 - ▶ Being reminded of the film while using some other media; and
 - ▶ Looking at nature differently, sometimes thinking about mimicry.
- **Memorable aspects of the film's story and Bates' character that stood out weeks after viewing were reported by varying portions of the Viewers who completed the follow-up questionnaire.** Memorable aspects included:
 - ▶ Bates' scientific process, his dedication or perseverance, his contribution to biology, his passion, his intellect/curiosity, and the personal sacrifices/hardships he endured;
 - ▶ Inspiring messages about never giving up and following your passion; and
 - ▶ Knowledge of evolution, natural selection, and/or mimicry.



Introduction

Funded by the National Science Foundation (NSF), *Amazon Adventure* is an Innovations in Development project directed by Pacific Science Center in partnership with: SK Films; Rutgers, The State University of New Jersey; Embodied Games; and the Howard Hughes Medical Institute's Tangled Bank Studios. The project deliverables produced during the grant period include a giant screen film, live stage presentation for use at informal science education (ISE) institutions, and educational resources.

The centerpiece of the project, the *Amazon Adventure* film, is a 45-minute giant screen film shown in both 2D and 3D flat screen and 2D dome format versions. The film is based on the true story of Henry Bates' 11-year journey through the Amazon in the 1850s, focusing on his quest as a young man to find evidence of species change. As summarized in the NSF proposal (2014):

The film will engage audiences emotionally with an inspirational story of a scientist's passion, determination and ultimate success...Bates had an insatiable curiosity about nature and younger audiences will relate to his adventures. His incremental steps of scientific discovery unfold in a compelling way, with a remarkable outcome that can be easily understood by all ages.

As part of the NSF funding for *Amazon Adventure*, the project also supported external research and evaluation studies of the film. The summative evaluation study, the subject of this report, assessed the immediate and longer-term impacts of the film on a general audience of adults who viewed the film in a local science center or museum theater setting.¹ Conducted by the independent evaluation firm, Knight Williams Inc., the evaluation focused on the film's impact with respect to audience knowledge of Bates' scientific quest, mimicry, and species change, as well as perceptions of scientist attributes; engagement with the biographical story of Henry Bates and Bates as a film character; and experience of spatial presence with the giant screen format.

The evaluation findings are presented in three sections, following the three phases used to assess the film's impact (detailed in Figure 2 on the following page):

- Phase 1: Evaluation of science learning, narrative engagement, and spatial presence
- Phase 2: Further exploration of Viewers' science learning and narrative engagement
- Phase 3: Follow-up evaluation of the film's extended impact

¹ The evaluation and research components of the project were designed to have different focuses. While the research investigated differences in students' content learning "*among the various film formats, their unique attributes, and whether format plays a role in science interest and science identity,*" (see [NSF award page](#)), the evaluation prioritized understanding viewers' immediate and longer-term experiences with the film with respect to science learning, narrative engagement, and spatial presence.



Background

Evaluation approach

Leading up to this summative evaluation, the external evaluation team conducted front-end, formative, and implementation evaluation activities, as briefly summarized in Appendix A. The team relied on the findings from this prior evaluation work as well as the following sources to develop the summative evaluation approach: the film’s goals communicated in the NSF proposal; the final film and script; background literature; and input from the project team, including perspectives shared more broadly by the producer and writer, such as those as captured in the quote in Figure 1.

Figure 1. Quote featured in interview with [Women in Film & Video, Washington, DC](#)

The more we can find the human stories about science – the drama of a human’s quest and overcoming obstacles to unravel the mysteries of the world around us – the more we will stay connected to the joys of science and curiosity. The emotional connection to the human quest unlocks greater understanding and appreciation of science.

*Wendy MacKeigan, Producer and Writer
Amazon Adventure, SK Films*

Taken together, the evaluation team arrived at an evaluation approach that focused on assessing the impact of *Amazon Adventure* as a dramatic character-driven historical reenactment story on a general audience of adults who viewed the film in a local science center or museum theater. As the film centered on Henry Bates’ scientific discovery/process told through a classic *struggle to triumph* narrative, the evaluation approach took into consideration the film’s genre, format, and informal science focus. This framing formed the basis for the four evaluation question categories described under Measures on page 15: science learning; narrative engagement; experience of spatial presence; and demographics/ background.

The evaluation process occurred in three phases, as illustrated in Figure 2. Phase 1 was based on a separate-sample pre-test/post-test design, the logistics of which are illustrated in the first four columns of Figure 2. Phase 2 comprised on-site interviews with a subset of Viewers who completed Phase 1. Phase 3 comprised a follow-up online survey completed within 3-4 weeks of viewing by those who participated in both Phase 1 and Phase 2.

Figure 2. Three phases of *Amazon Adventure* summative evaluation



To provide further context to this adult viewer-focused evaluation, the evaluation team also gathered information from representatives at two science centers or museums as to their institutions' implementation and perceived value of the *Amazon Adventure* resources funded by the NSF (see Appendix B for a summary of these findings). The summative plan relating to the preceding evaluation activities was reviewed by an independent IRB and exempted from further review.²

Amazon Adventure as a narrative

The *Amazon Adventure* film is based on the true story of Henry Bates' 11-year journey through the Amazon in the 1850s. The film focuses on Bates as a young man pursuing his quest to find evidence of species change. As shown in Figure 3, the [Amazon Adventure project website](#) further explains that Bates discovered the phenomena of mimicry and species change, and in the process found what Darwin termed "beautiful proof" for natural selection, despite facing ongoing hardships and personal sacrifice.

As a dramatic genre, the film comprises a classic three-act story structure of set up, confrontation, and resolution. Figure 4 outlines the key film content covered in each act.

Figure 3. Screenshot from [Amazon Adventure website](#)

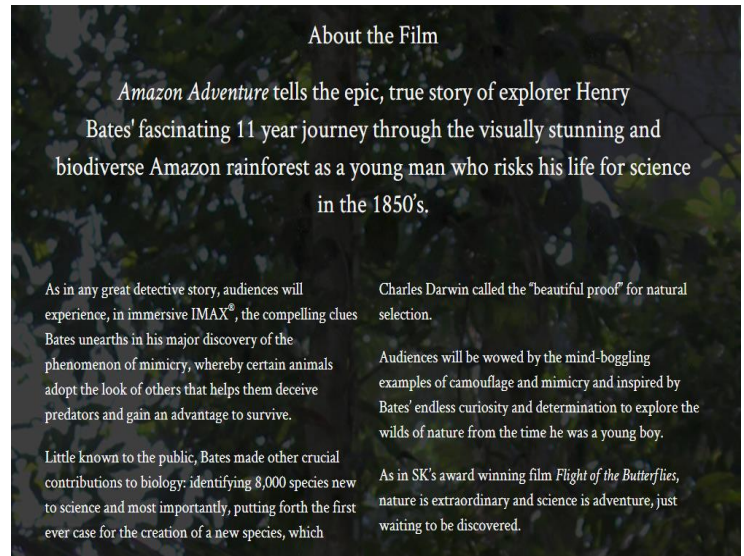
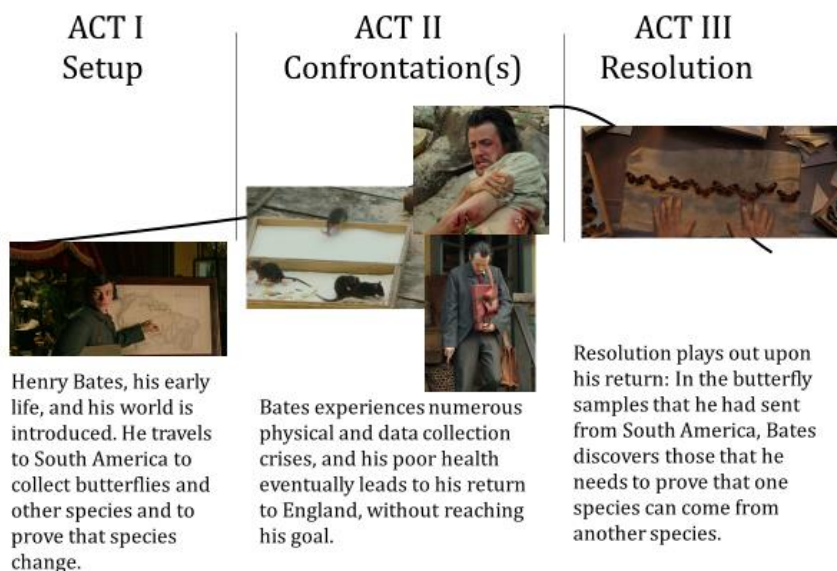


Figure 4. *Amazon Adventure* three-act narrative structure



² Ethical and Independent Review Services IRB exempt certification ID 14082-01, 7/2/14

As part of this classic *struggle to triumph* three-act story, the film portrays Henry Bates' scientific quest with historical reenactments. Among the thirty giant screen films NSF has supported over the prior three decades, *Amazon Adventure* is unique in its biographical presentation of the life and research of a scientist using historical reenactments. Most of the other films have presented multiple science story vignettes with multiple scientist characters, as opposed to a continuous narrative story of one scientist.

Evaluating narrative engagement

Typically, the impact of narrative formats on audiences' interests, beliefs, and behavior been evaluated with adult readers exposed to text stimuli such as novels and biographies; there has been comparatively little research on these outcomes as applied to other narrative-based media (per metaanalysis of Van Laer et al., 2014). This summative evaluation builds on the text-based research and extends that work into a new medium by exploring the impact of the three-act narrative structure on adult viewers' experience of narrative engagement and science learning from a giant screen film.

Narrative engagement as applied in this evaluation refers to the combination of story involvement and character involvement. Specifically:

- ▶ **Story involvement** includes both perceived appeal of a story as well as the phenomenon of being cognitively and affectively engaged by the narrative (Moyer-Gusé, 2008; Slater & Rouner, 2002). Story involvement has been shown to be correlated with character involvement; however, one can be involved with a narrative but not necessarily with the characters, thus separate measures for story and character are needed to obtain a complete assessment of narrative engagement (Johnson, 2011; Moyer-Gusé & Nabi, 2010).
- ▶ **Character involvement** comprises individuals' reactions toward and interactions with characters in a narrative, and the extent to which one becomes involved with characters is proposed to influence perception of personal relevance (Moyer-Gusé, 2008) and message acquisition (Slater & Rouner, 2002).

***Amazon Adventure* as a giant screen film**

When asked about the salient characteristics of the giant screen film experience, audiences most commonly report that they enjoy the feeling of 'being there' in the environment presented in the film (Flagg, 2000; Giant Screen Cinema Association, 2014). In the media research literature, the subjective feeling of being located in a mediated space is referred to as "spatial presence" (Wirth et al., 2007). This concept has most often been applied to virtual reality (Slater & Steed, 2000) but also to video games (Tamborini & Skalski, 2006) and television (Bracken, 2005). Spatial presence emphasizes the experience of 'being' within the narrative world, whereas narrative involvement (discussed above) emphasizes being cognitively and emotionally engaged with the story world (Wirth, 2006).

Applying the spatial presence concept to the viewing of historical reenactments within a giant screen film format, this evaluation assessed the extent to which viewers experienced the

psychological process of being present in Bates' Amazon world as he pursued his scientific quest. As anticipated in the NSF proposal (2014):

The film team will build on the success of its previous film, Flight of the Butterflies, maximizing the power of the giant screen to immerse audiences in one of the most biodiverse environments on earth.

The film team expected that, by leveraging the immersive potential of the giant screen format, the film could produce the sensation among viewers of being present in the Amazon.

Amazon Adventure as an educational film

In addition to its experiential quality, another salient feature of giant screen films that audiences point to is its informative value (Flagg, 2000; Giant Screen Cinema Association, 2014). Evidence of the educational impact of giant screen films, particularly in the area of STEM learning, can be found in the film evaluations funded by the NSF's Advancing Informal STEM Learning (AISL) program, as projects funded by this division have typically included evaluation and/or research components as a condition of funding. As noted above, thirty films have been funded over the past three decades. A review of ten of these summative evaluations (Flagg, 2005) concluded that the films significantly impacted viewers' science-related knowledge, interests, attitudes, and subsequent actions:

Summative evaluations of 10 giant screen films indicate that the NSF's grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers' understanding of what scientists do; and positively impacts viewers' actions after a museum visit. (p. 66).

More recent reviews of giant screen film projects funded by the NSF point to similar positive science learning outcomes among general audiences who see the films in science museum theaters (Apley, 2008; Fenichel & Schweingruber, 2010; Fraser et al., 2012; Nucci, 2015). Thus, it is important for a new film with NSF funding to demonstrate not only that audiences learn, but also what they learn.

For *Amazon Adventure*, the evaluation addressed four areas of adult science learning from the film. The first three areas focused on knowledge outcomes, specifically viewers' knowledge of: Bates' scientific quest, mimicry, and species change. The fourth area focused on viewers' perceptions of scientist attributes, and in particular, the personality characteristics they felt it was important for scientists to have.³

³ Additional information about the measures used to assess science learning, as well as the measures used to evaluate narrative engagement and spatial presence, described on pages 9-11, can be found under Measures starting on page 15, and in Appendices C and D.



Phase 1: Evaluation of science learning, narrative engagement, and spatial presence

Introduction

Phase 1 of the summative evaluation focused on the immediate impact of *Amazon Adventure* viewers who watched the film at one of four science centers or museums hosting the film in 2017-18. The goal of Phase 1 was to assess the impact of the film with respect to science learning, narrative engagement, and spatial presence.

Method

Evaluation design

The Phase 1 portion of the evaluation was based on a separate-sample pre-test/post-test design (see Figure 2, p. 8). This quasi-experimental design is most commonly applied to evaluations of giant screen films in a theater setting for the following reasons:

- ▶ The population to which we want to generalize are self-selected visitors who choose to view such a film. Therefore, this evaluation focuses on visitors who line up to see *Amazon Adventure* on their own accord (naturalistic viewers).
- ▶ Administering a pre-test and post-test to the same group of naturalistic viewers is neither practical, given the challenges of obtaining visitor cooperation, nor desirable, as the pre-test would sensitize viewers to the film's content and affect their post-test responses. Thus, a pre-viewing questionnaire is given to a sample of viewers before they see the film as a control group (Pre-Viewers), and a post-viewing questionnaire is given to a separate sample of viewers (Viewers).

Participant information

Theater sites

The evaluation focused on adults who viewed *Amazon Adventure* at one of four science center or museum theaters: Pacific Science Center in Seattle, WA; Museum of Discovery & Science in Ft. Lauderdale, FL; Discovery Place in Charlotte, NC; and Museum of Science in Boston, MA.⁴ Figure 5 shows the locations of the four institutions.

Figure 5. Science center evaluation sites



⁴ The evaluation was conducted at Pacific Science Center the last week of December 2017 and at Museum of Discovery & Science, Discovery Place, and Museum of Science during the first two weeks of January 2018.

The evaluation and project team chose these four institutions based on the following project-based criteria: the sites were geographically distributed; the sites booked the *Amazon Adventure* live stage show along with the film (described in Appendix B)⁵; the sites were part of the original group of institutions that sent staff to the Educator Workshop in December 2016; and the sites were willing and able to accommodate the evaluation procedure (described on page 14). Additionally, to represent the primary screen types on which audiences would see the film, theater screen type was also factored into the site decision. Accordingly, two of the four institutions showed the film in 3D on a flat screen (Pacific Science Center and Museum of Discovery & Science) and two showed the film on a 2D dome screen (Discovery Place and Museum of Science). As multiple project criteria drove site selection, it is important to note that the summative evaluation was not designed specifically to study the role of theater location or screen type on Viewers' experience with the film. Variations in screen format was a focus of the project's research study (Nucci, pending).

Participants

A total of 441 adults participated in the evaluation. Overall, the group was generally balanced in terms of gender and age (18-40 and 41 and above). Just under three-quarters were White. Most had a college or graduate school-level education experience, and about half had a biology course at or beyond the college level. Most had seen three or more giant screen films previously.⁶

Group comparability

Table 1 summarizes the demographic and background information for the Pre-Viewer (n=212) and Viewer (n=229) groups. Chi-square analyses indicated that the two groups did not differ significantly with respect to the measured variables of: gender, age, race/ethnicity, educational level, last biology course, and number of giant screen films viewed.⁷

Table 1. Participants (N=441)

Demographic/ background factor	Categories	Pre- Viewers (n=212)	Viewers (n=229)
Gender	Female	56%	55%
	Male	44%	45%
Age group	Age range	18-76	18-81
	Mean	41	41
	18 - 40	54%	55%
	41 and above	46%	45%
Racial/ethnic background	White	70%	73%
	Asian	8%	12%
	Multiracial	6%	4%
	Hispanic	7%	6%
	African-American/Black	7%	3%
	Native Hawaiian or Pacific Islander	1%	0%
Highest level of education	Less than high school	1%	7%
	Completed high school/equivalent	8%	7%
	Some college or degree	47%	38%
	Some graduate school or degree	44%	48%
Last biology course	Never	4%	6%
	High school	44%	44%
	In college, another major	40%	34%
	Majored in college	8%	6%
	Graduate school	5%	11%
Number of giant screen films viewed	0	8%	9%
	1	12%	6%
	2	20%	14%
	3	14%	18%
	4 or more	45%	53%

⁵ Note the stage show was not running at any of the sites during the evaluation period.

⁶ The demographics of the evaluation participants are comparable to that of a large sample of 1,068 North American giant screen film viewers, which included 61% women, median age of 44 years, 75% White, and 35% post-graduate education. (Giant Screen Cinema Association (September 2014). *Giant Screen Audience Research Results.*)

⁷ Demographic and background information was gathered in part to help determine whether the two independent samples should be evaluated as having come from the same population.

Participation by site

Of the 229 Viewers who completed a post-viewing questionnaire, 99 saw the film in 3D on a flat screen (62 at Pacific Science Center, 37 at Museum of Discovery & Science), and 130 saw the film in 2D on a dome screen (14 at Discovery Place, 116 at Museum of Science). Among the 212 Pre-Viewers who completed a pre-viewing questionnaire, 97 went on to see the film in 3D on a flat screen (62 at Pacific Science Center, 35 at Museum of Discovery & Science), and 115 went on to see the film in 2D on a dome screen (17 at Discovery Place, 98 at Museum of Science).

Procedure

The evaluation team conducted the evaluation during weekday and weekend showings of the film to help ensure the evaluation recruited a balance of participants who visited the theater at different days and times.

The evaluation occurred at each theater site as follows:

- i. Evaluators approached eligible adult and family theater visitors about the evaluation opportunity as they stood in line to view the film.⁸ Using random assignment, approximately half of these visitors were asked to complete a 5 to 10 minute pre-viewing questionnaire before seeing the film (Pre-Viewers), and half were asked to complete an 8 to 15 minute post-viewing questionnaire following the film (Viewers). Evaluators directed participants to the instructions at the top of the questionnaire, which asked them to complete all questions and to do so without the help of others. They were informed that participation in the evaluation was voluntary and that their responses were confidential.
- ii. Pre-Viewers served as a comparison group for the evaluation. The pre-viewing questionnaire they completed included demographic and background questions about visitors' age, gender, ethnicity/race, educational level, when they took their last course in biology, and number of giant screen films seen. The questionnaire also included a short knowledge assessment of content covered in the film.
- iii. Viewers who had agreed prior to seeing the film to complete a post-viewing questionnaire did so immediately after viewing the film. The post-viewing questionnaire this group completed included the same demographic, background, and content assessment questions asked in the pre-viewing questionnaire, and also included questions about viewers' reactions to the film with respect to narrative engagement and spatial presence.

Pre-Viewers and Viewers who consented to participate received a \$5 gift certificate to the science center or museum gift store or, if that wasn't an option at the participating institution, a \$5 certificate to amazon.com.

Response rate

At two of the four sites, large crowds of visitors arrived at the theater at approximately the same time for some show times. It wasn't possible in these instances to accurately track the number of visitors asked to participate. When feasible, evaluators recorded reasons for not

⁸ Individuals who weren't eligible included: children or youth under 18 years of age, single adults accompanied by children below the age of 5, and individuals who were part of a tour or organized trip.

completing the questionnaires (pre and post), which included: not having time, tending to children’s needs, lack of interest, wanting to eat lunch, having to meet other members of a group, or having parking meter time restrictions.

Measures

The pre- and post-viewing questionnaires (see Appendix C) were developed through an iterative process that involved collaborating with the project team and reviewing the original NSF proposal, prior evaluation findings, the script, and the film. As already noted, the evaluation approach was framed to capture the film’s impact as a dramatic character-driven historical reenactment story of scientific discovery and process in a three-act narrative in a giant screen format, ultimately resulting in the four question categories summarized in Table 2.

Table 2. Amazon Adventure summative question categories

Category	Quantitative	Qualitative
Science learning	<ul style="list-style-type: none"> • Knowledge of Bates’ scientific quest: definition, whether achieved and why, methods used • Knowledge of mimicry in the natural world: definition and example • Knowledge of species change: whether species can change over time, whether one species can change into another species, role of predators in species survival 	Perceptions of personality characteristics most important for scientists to have
Narrative Engagement	<ul style="list-style-type: none"> • Rating for story appeal (1 statement) • Ratings for story involvement (3 cognitive statements and 3 affective statements) • Ratings for character involvement (5 statements about appeal, similarity, and identification including dimensions of empathy, cognitive, and motivation) 	What liked and didn’t like about the film (or the story of Henry Bates)
Spatial presence	<ul style="list-style-type: none"> • Ratings of feeling oneself being located in the Amazon (4 statements) 	
Demographics/ Background	<ul style="list-style-type: none"> • Gender • Age • Race/ethnicity • Level of education • Biology background • Previous experience viewing giant screen films 	

Science learning

As shown at the top of Table 2, the evaluation addressed four areas of science learning. The first three areas relate to science content specifically featured in the film: 1) Bates’ scientific quest in the Amazon with respect to the nature of his quest, whether he achieved it and why/why not, and the methods he used to pursue his quest; 2) the definition and examples of mimicry in the natural world; and 3) species change and the role of time and predators. The fourth area relates more broadly to scientist perceptions, specifically the personality characteristics perceived to be important for scientists to have.

The impact of the Viewers’ science learning with respect to these three content areas was evaluated with a combination of open-ended and forced-choice objective content questions. To assess knowledge gains, Viewers and Pre-Viewers both completed an 18-point “quiz” content assessment that included true/false and short answer questions about three key topics addressed in the film: Bates’ scientific quest in the Amazon, species change, and mimicry. To explore the film’s impact on Viewers’ perceptions of scientists, both groups were also asked to list personality characteristics they thought were important for scientists to have.

Given the lack of established or validated measures on the film’s content as experienced by general audiences, the evaluation team developed and piloted the content assessment questions as part of the rough-cut evaluation. The questions were subsequently reviewed for readability, length, clarity, and level of difficulty. The final set of questions and associated scoring are presented under Findings Part 1. Science Learning.

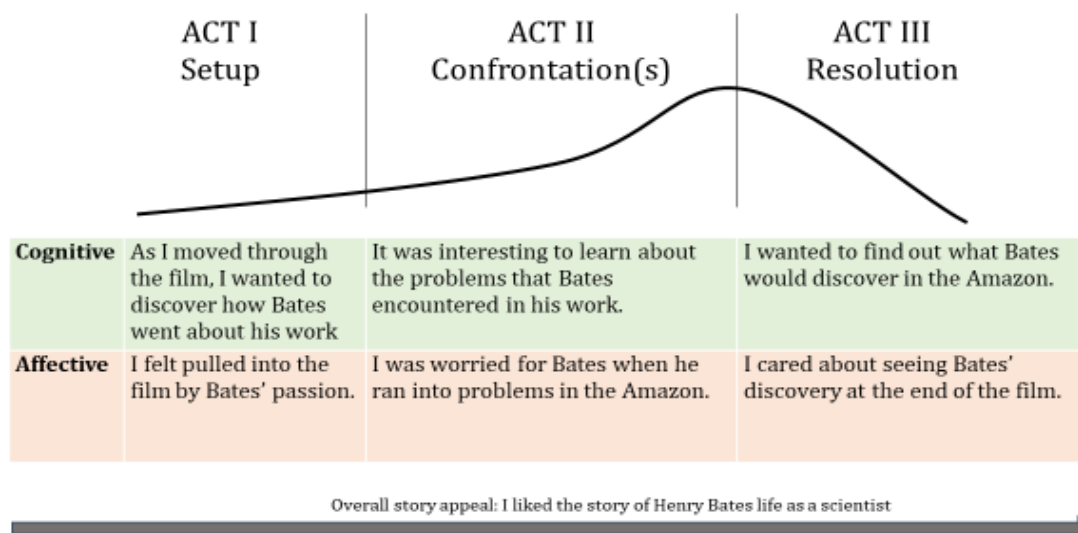
Narrative engagement

The agree-disagree 7-point narrative engagement scale used in the evaluation consists of 12 items: seven story involvement items and five character involvement items, as described below.

Story involvement

The story involvement sub-scale was developed based on prior work on adults’ responses to narrative (Appel et al., 2015; Green & Brock, 2000; Williams et al., 2010). The original sub-scale was further modified by the authors to reflect a three-act story structure for use in narrative-based visual media projects (Knight Williams, 2017a, 2017b). The evaluation’s 7-item sub-scale presents cognitive and affective engagement statements related to the setup, confrontation, and resolution segments of the narrative, as detailed in Figure 6. The top row of agree-disagree statements reflects cognitive involvement in the 3 acts, while the bottom row reflects affective involvement across the 3 acts. A statement about overall story appeal is shown at the bottom of the figure, applying to the story as a whole.

Figure 6. Amazon Adventure story involvement subscale statements in relation to the film’s three-act narrative structure



Character involvement

The character identification sub-scale was developed based on dimensions described by Moyer-Gusé (2008) and Cohen (2001) and adapted from prior character engagement scale work conducted by the authors. The 5-item sub-scale presents agree-disagree statements about character appeal, similarity, and identification elements, as detailed in Table 3.

Table 3. Character involvement sub-scale statements

Character appeal	<ul style="list-style-type: none">• <i>I liked Henry Bates.</i>
Character similarity	<ul style="list-style-type: none">• <i>I felt like Bates and I had things in common.</i>
Character Identification	
Empathy	<ul style="list-style-type: none">• <i>While watching the film, I could feel Bates' emotions.</i>
Cognitive	<ul style="list-style-type: none">• <i>I understood Bates' need to explore the wilds of the Amazon.</i>
Motivational	<ul style="list-style-type: none">• <i>While watching the film, I wanted Bates to reach his scientific goal.</i>

Spatial presence

This evaluation's agree-disagree spatial presence scale draws from the Spatial Presence Experience Scale (SPES) validated by Hartmann et al. (2016) with a variety of media, including text, film, hypertext, and a virtual environment. A search of the literature indicates that this is the first application of Hartmann's scale with a giant screen format.

The four statements in Table 4 are adapted from the self-location items within the SPES (Hartmann et al., 2016). As detailed in the factor analysis presented in Appendix D, the spatial presence scale used in the evaluation originally comprised five statements. A factor analysis showed that four of the five items contributed positively to scale reliability and were retained in the scale. The fifth item did not improve the scale and was removed for the current evaluation to increase internal consistency.

Table 4. Spatial presence scale statements

Self-location	<ul style="list-style-type: none">• <i>It was as though my true location had shifted to the Amazon.</i>• <i>I felt as though I was physically present in the Amazon.</i>• <i>It seemed as though I actually took part in the action of the film.</i>• <i>I felt like I was actually there in the Amazon.</i>
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Data analysis and reporting

Quantitative data

Statistical analyses were conducted on all quantitative data generated from the evaluation using R 3.5.2 (R Core Team, 2018). As shown in Table 2 on page 15, quantitative data was generated from questions about science learning (Bates quest, mimicry, and species change), narrative engagement (story and character involvement), and spatial presence. Viewer and Pre-Viewer answers to the science learning questions were coded and scored as described in Findings Part 1. Science Learning. Viewer ratings statements from the narrative engagement (story and character involvement) and spatial presence scales were based on a 7-point Likert rating scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

To explore for possible significant differences between the Viewer and Pre-Viewer groups on science learning, and within the Viewer group for science learning, narrative engagement and spatial presence, *t*-tests and Chi-Square tests were applied as appropriate. To help evaluate the appropriate test to apply considering that data was collected from four different sites, linear mixed-effect models were fit for each outcome variable of interest to determine if there were significant variations across sites.⁹ Statistically significant findings (hereafter referred to as “significant”) at $p \leq .05$ are reported in the text. All statistical tests were two-tailed unless otherwise indicated.¹⁰

To help determine whether a significant difference was a difference of practical concern, effect sizes were also computed and reported in the text where appropriate.¹¹ While Cohen’s interpretation (Cohen, 1992) is used to help gauge the effect sizes computed, these values should also be considered along with a comparison of the actual difference in raw scores in the context of the topic addressed.

Demographic and background variables used in the subgroup analyses included: gender (female vs. male), age (18-40 vs. 41 and older), last biology class taken (high school or less vs. college or beyond), and number of giant screen films previously seen (0-3 films vs. 4 or more films). Though not a planned comparison for the evaluation, screen type viewed (3D flat screen vs. 2D dome) was also included as a subgroup only for spatial presence.¹² Finally, given

⁹ Unconditional mixed-effects models were run for each of the outcome variables (knowledge, narrative engagement and spatial presence) to calculate the intraclass correlation (ICC) as a measure of the proportion of the total variance of each outcome variable attributable to simply being in the Level 2 group, in this case theater site. The ICC can range from 0 to 1. If the group has little effect on the participants with respect to the outcome variable, the ICC will be “small”; conversely if the opposite is true, the ICC will be “large.” The ICCs for outcome variables are: knowledge (Viewers and Pre-Viewers) = 0.00; knowledge (Viewers only) = 0.02; narrative engagement = 0.06; and spatial presence = 0.09. In this evaluation, a fixed effects model using a dummy code for the theater site variable was used, unless otherwise indicated, considering the following factors: 1) the ICC range from 0.0 to 0.9; 2) the limited number of Level 2 sites (4 theaters); 3) the imbalance of participant groups at the theater sites (see Participation by Site, page 14); and 4) our primary interest is with the level 1 participants.

¹⁰ As the science learning comparison between Viewers and Pre-Viewers was of primary interest in the evaluation, with all other comparisons therefore being of secondary interest, no correction for multiple tests was used to adjust the *p* value. However, all statistical tests performed have been reported.

¹¹ Following Cohen’s (1992) interpretation, for *t*-tests $d=.2$ indicates a small effect, $.5$ a medium effect, and $.8$ a large effect. For non-parametric tests, $r = .10$ indicates a small effect, $.3$ a medium effect, and $.50$ a large effect.

¹²The subgroup of screen type was added as the ICC for spatial presence was 0.09.

the relatively small number of participants with an educational level less than college, as well as the relative imbalance in each of the separate racial/ethnic groups represented, results related to these demographic factors were not explored.

A reliability analysis was performed on all scaled items using Cronbach's alpha, the results of which are reported in the text. Please see Appendix D for factor analyses. As there was minimal item non-response, the study did not explore additional methods of substituting missing values with estimates, either by multiple imputation methods or maximum likelihood procedures.¹³

Qualitative data

Content analyses were performed on the qualitative data generated in the open-ended questions. As shown in Table 2 on page 15, qualitative data was generated from questions on both science learning (scientist perceptions) and narrative engagement (film and story appeal). In both areas, the qualitative analyses were both deductive, drawing on the film's goals, and inductive, by looking for overall themes, keywords, and key phrases. The Viewers' responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder.

¹³ Where evaluators encountered blank questions, they asked respondents if they wished to complete those questions. In each case left blank the respondent indicated and recorded they didn't know or had no response.

Findings

Part 1: Science learning

Overall, Viewers scored significantly higher than Pre-Viewers on a set of content questions designed to assess science learning from the film relating to Henry Bates' scientific quest in the Amazon, mimicry, and species change. Out of a total possible score of 18, Viewers averaged 14.6 correct responses, while Pre-Viewers averaged 6.8 correct responses. In addition to this higher overall total score, Viewers also significantly outperformed Pre-Viewers in each of the three content areas assessed.

Moreover, when asked to list personality characteristics that they thought were important for scientists to have, Viewers were significantly more likely than Pre-Viewers to list four attributes: perseverant, passionate, courageous, and observant.

The impact of *Amazon Adventure* on Viewers' science learning with respect to content knowledge and scientist perceptions was evaluated with a combination of open-ended and forced-choice objective content questions. To assess knowledge gains, Viewers and Pre-Viewers both completed an 18-point "quiz" content assessment that included true/false and short answer questions about three key topics addressed in the film: Bates' scientific quest in the Amazon, species change, and mimicry. To explore the film's impact on Viewers' perceptions of scientists, both groups were also asked to list personality characteristics they thought were important for scientists to have. The findings for each question area are presented in 1.1 – 1.2.

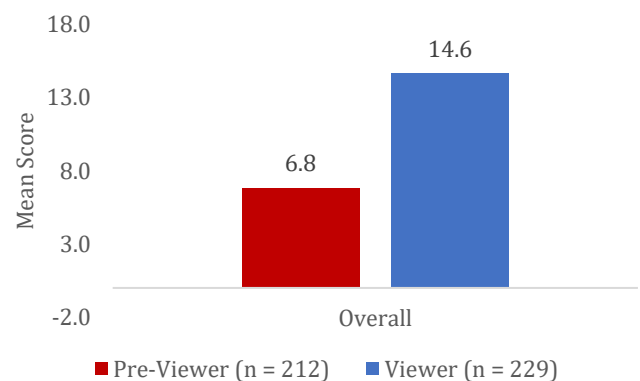
1.1 Knowledge of Bates' scientific quest, mimicry, and species change

Overall

Figure 7 compares the average overall scores of Viewers and Pre-Viewers on the film's science content questions. On average, Viewers scored significantly higher than Pre-Viewers, and the effect size was large.¹⁴ Out of a total possible score of 18, Viewers averaged 14.6 ($SD = 2.88$) correct responses while Pre-Viewers averaged 6.8 ($SD = 3.31$).

Among Viewers, there were no significant differences in the scores among the subgroups evaluated.

Figure 7. Comparison of Viewer and Pre-Viewer scores on science learning questions (overall)



¹⁴ $t(438) = 26.60, p < .001, d = 2.54, 95\% \text{ CI } [7.25, 8.41]$. Explained another way, 99% of the Viewer group will be above the mean of the Pre-Viewer group (Cohen's U_3), 21% of the two groups' scores will overlap, and there is a 96% chance that a person picked at random from the Viewer group will have a higher score than a person picked at random from the Pre-Viewer group (probability of superiority).

By content area

In addition to scoring significantly higher overall, Viewers also scored significantly higher on each content area assessed. Figure 8 compares the average scores of Viewers and Pre-Viewers on each of the three content areas.

Based on a total possible score of 6 for each question set: Viewers averaged 4.3 ($SD = 1.42$) correct responses on the questions about Henry Bates' scientific quest in the Amazon while Pre-Viewers averaged .04 ($SD = 0.12$);¹⁵ Viewers averaged 4.6 ($SD = 1.73$) correct responses on the questions about mimicry while Pre-Viewers averaged 2.0 ($SD = 2.20$);¹⁶ and Viewers averaged 5.7 ($SD = 1.06$) correct responses on the questions about species change while Pre-Viewers averaged 4.7 ($SD = 1.84$).¹⁷

Sections 1.1a - c present additional details about the findings in the three content areas covered in the learning assessment of the film's science content.

1.1a Knowledge of Bates' scientific quest in the Amazon

A three-part question assessed Viewers' learning about Henry Bates' scientific quest while in the Amazon. The question set asked participants to: i) describe what his quest was when he left for the Amazon/what he wanted to achieve; ii) state whether or not he achieved his quest and explain why or why not; and iii) describe the methods or processes he used to pursue his quest.

Figure 9 compares the average scores of Viewers and Pre-Viewers on the Bates' quest question set. Out of a total possible score of 6, Viewers averaged 4.3 correct responses while Pre-Viewers averaged .04.¹⁸ As noted above, Viewers scored significantly higher than did Pre-Viewers, and the effect size was large.

Figure 8. Comparison of Viewer and Pre-Viewer scores on science learning questions (by content area)

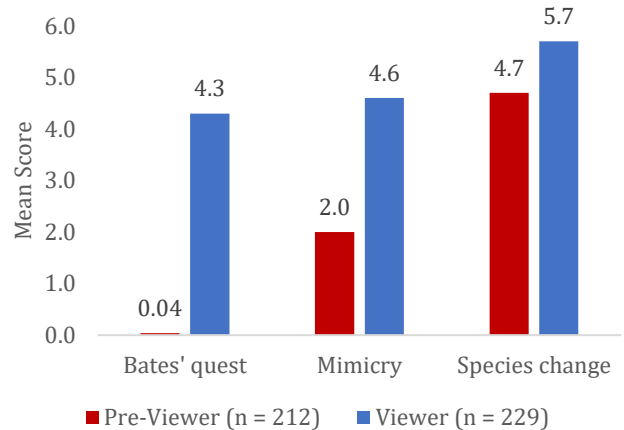
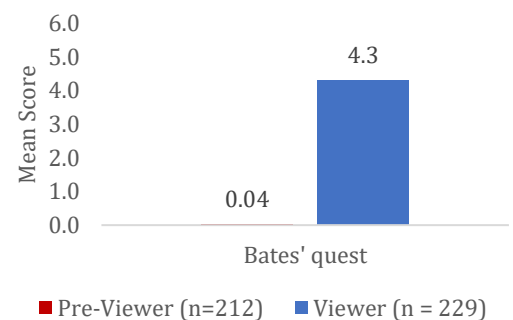


Figure 9. Comparison of Viewer and Pre-Viewer scores on Bates' scientific quest questions



¹⁵ $t(431) = 43.55, p < .001, d = 4.17, 95\% \text{ CI } [4.09, 4.47]$.

¹⁶ $t(439) = 13.90, p < .001, d = 1.33, 95\% \text{ CI } [2.25, 2.98]$.

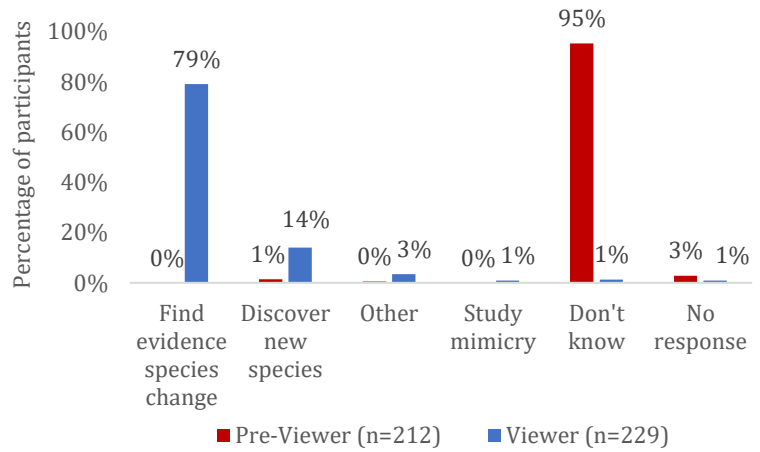
¹⁷ $t(436) = 6.57, p < .001, d = 0.63, 95\% \text{ CI } [0.65, 1.20]$.

¹⁸ The 6-point value for the quest questions (1.1a) was determined as follows. Responses to the question about the nature of Bates' quest (1.1ai) were scored from 0 - 3 as follows: 3 = Correct (addressed species change); 1.5 = Partial correct (addressed the finding/discovering of new or more species or addressed studying/proving mimicry in nature); and 0 = Incorrect (did not address either of the above elements). Responses to the question of whether Bates achieved his quest (1.1aii) were scored from 0 - 0.5 as follows: 0 = No, 0.5 = Yes. Responses to the question of why Bates achieved his quest (1.1aiii) were scored from 0 - 1 as follows: 1 = Correct (addressed species in flux, links in progression of changing from one species to another); 0 = Incorrect (did not address above element). Responses to the question about the methods Bates used to pursue his quest (1.1aiiii) were scored as 0.5 per correct method listed up to 3 methods for a maximum of 1.5 points.

The nature of Bates' quest

Figure 10 shows what Viewers and Pre-Viewers said Henry Bates' scientific quest was in the Amazon. While 79% of Viewers specified that his quest was to find evidence that species change, 95% of Pre-Viewers indicated they did not know what his quest was. The remaining Pre-Viewers didn't answer the question (3%) or said his quest was to discover new species (1%); while the remaining Viewers either gave a partial answer that he sought to discover new species (14%), gave another response (3%), said don't know (1%), or didn't answer the question (1%).

Figure 10. What Viewers and Pre-Viewers said Henry Bates' scientific quest was in the Amazon



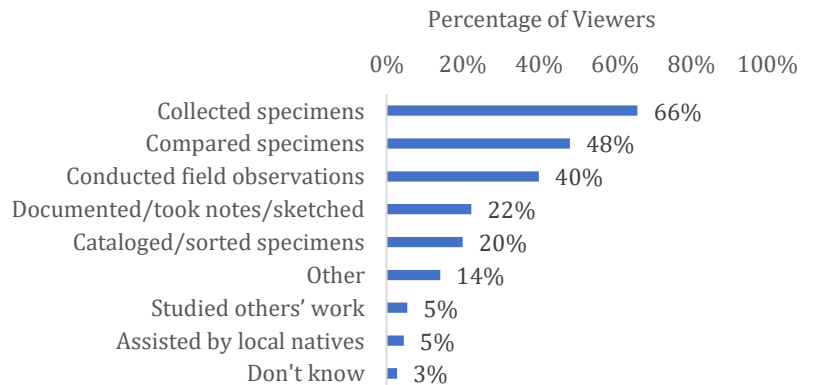
Whether and why Bates achieved his quest

The leftmost bar in Figure 10 shows that none of the Pre-Viewers and 79% of Viewers correctly said Bates' quest involved finding evidence of species change. Of the Viewers with that correct answer, 75% answered that he achieved this quest and explained that he had evidence that showed a species in flux or showed links in progression of changing from one species to another. The remaining 4% felt he didn't achieve his quest for various reasons.

Types of methods or processes that Bates used to pursue his quest

Figure 11 shows the percentage of Viewers who correctly identified types of methods or processes that Henry Bates used to pursue his quest, focusing on the group who received full or partial credit for identifying the nature of Bates' quest (n=220 out of 229). The chart does not include Pre-Viewers since only one of the Pre-Viewers who received credit for the quest question noted a method used by Bates.

Figure 11. Percentage of Viewers who correctly identified the methods Bates used to achieve his quest (n=220)



1.1b Knowledge of mimicry in the natural world

Viewers and Pre-Viewers were asked to: i) define mimicry as it relates to the natural world, and ii) give an example. Figure 12 compares the average scores of Viewers and Pre-Viewers on the mimicry question set. Out of a total possible score of 6, Viewers averaged 4.6 correct responses, while Pre-Viewers averaged 2.0.¹⁹ As noted on page 21, Viewers scored significantly higher than did Pre-Viewers, and the effect size was large.

Defining mimicry

Figure 13 shows the percentages of Viewers and Pre-Viewers who correctly defined mimicry. Fifty-four percent (54%) of Viewers compared to 17% of Pre-Viewers explained that mimicry involves a resemblance between two different kinds of animals or animals and plants and that this resemblance helps the mimic to survive.²⁰ Thirty-eight percent (38%) of Viewers compared to 28% of Pre-Viewers provided a partial definition of mimicry in which their definition mentioned one but not both above aspects of mimicry. The remaining Viewers (8%) and Pre-Viewers (55%) provided an incorrect response or said don't know.

Providing an example of mimicry

Figure 14 shows the percentage of Viewers and Pre-Viewers who identified examples of mimicry. Seventy-eight percent (78%) of Viewers shared an example compared to 33% of Pre-Viewers. The majority of Pre-Viewers (59%) compared to a minority of Viewers (14%) gave an incorrect response or said don't know. Only a small group of Viewers (8%) and Pre-Viewers (7%) gave a partially correct example.

Figure 12. Comparison of Viewer and Pre-Viewer scores on mimicry questions

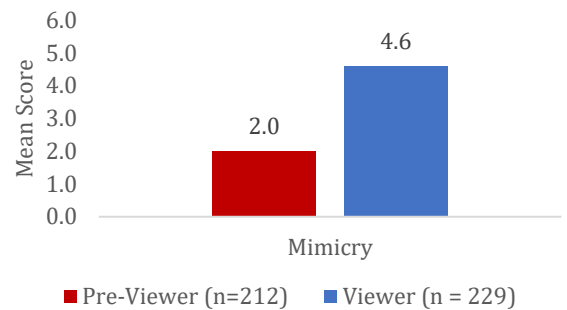


Figure 13. Percentage of Viewers and Pre-Viewers who correctly defined mimicry

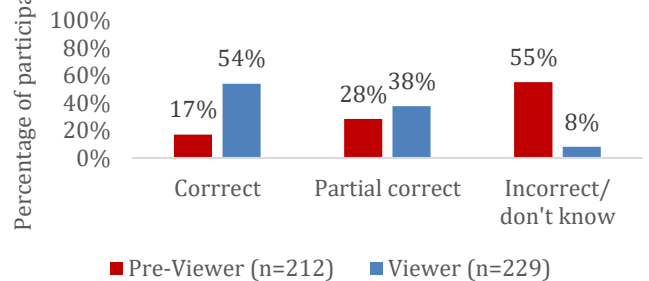
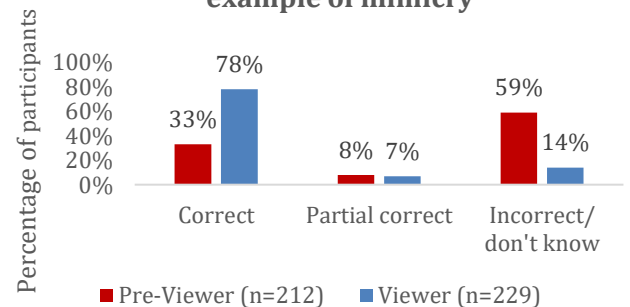


Figure 14. Percentage of Viewers and Pre-Viewers who gave a correct example of mimicry

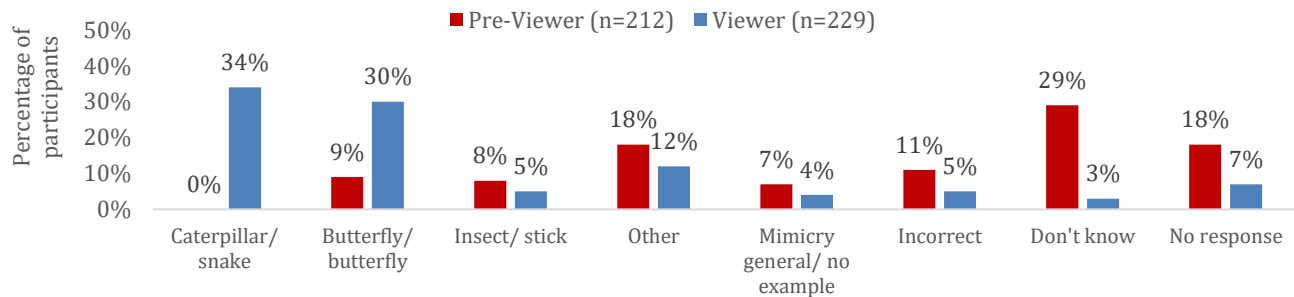


¹⁹ The 6-point value for the mimicry questions was determined as follows. Responses to the question to define mimicry (1.1bi) were scored as follows: 3 = correct (definition indicates basic idea that species/creatures resemble another for some advantage/benefit (e.g., defense, predation)); 1.5 = partial correct (definition mentions component of mimicry but misses one of two ideas expressed above (e.g., resemblance and/or for benefit/advantage)); 0 = incorrect/don't know. Responses to the question to give an example of mimicry (1.1bii) were scored as follows: 3 = correct (gave 1 or more specific examples); 1.5 = partial correct (gave general or insufficient example to be fully correct); 0 = no example.

²⁰ For additional information on the project's definition and examples of mimicry, see the [Amazon Adventure educational poster](#) on mimicry.

Figure 15 shows the main mimicry examples that Viewers and Pre-Viewers provided, all of which appeared in the film. The largest groups of Viewers pointed to examples that involved the following animals and/or plants: viper caterpillar/snake (34%), butterfly/butterfly (30%), and insect/stick (5%). None of the Pre-Viewers pointed to caterpillar/snake (0%) although 9% did point to butterfly/butterfly examples and 8% pointed to insect/stick examples. Fifty-eight percent (58%) of the Pre-Viewers gave an incorrect or no response or said don't know compared to 15% of Viewers.

Figure 15. Mimicry examples identified by Viewers and Pre-Viewers



1.1c Knowledge of species change

Viewers and Pre-Viewers were asked to answer four true/false questions about species change based on content presented in the film. Figure 16 compares the average scores of Viewers and Pre-Viewers on this question set. Out of a total possible score of 6, Viewers averaged 5.7 correct responses while Pre-Viewers averaged 4.7.²¹ As noted on page 21, Viewers scored significantly higher than did Pre-Viewers, and the effect size was medium.

Figure 16. Comparison of Viewer and Pre-Viewer scores on species change questions

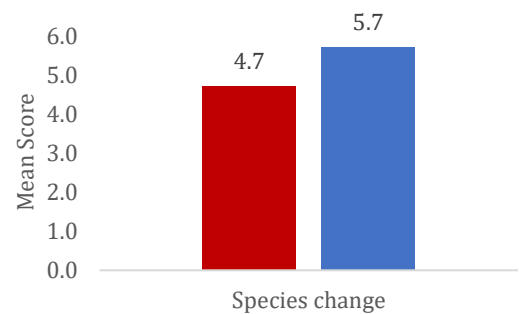
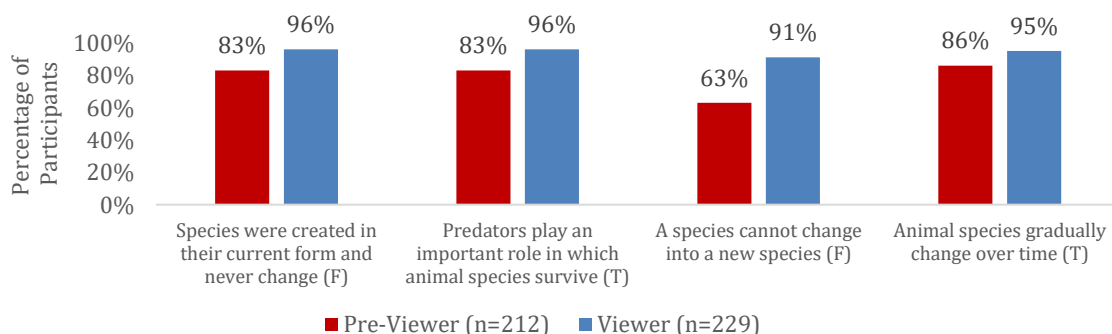


Figure 17 shows the percentages of Viewers and Pre-Viewers that answered each question correctly. More than nine-tenths of Viewers (91%) correctly answered each of the four questions compared to 63% to 86% of Pre-Viewers.

Figure 17. Percentage of Viewers and Pre-Viewers that correctly answered species change T/F questions

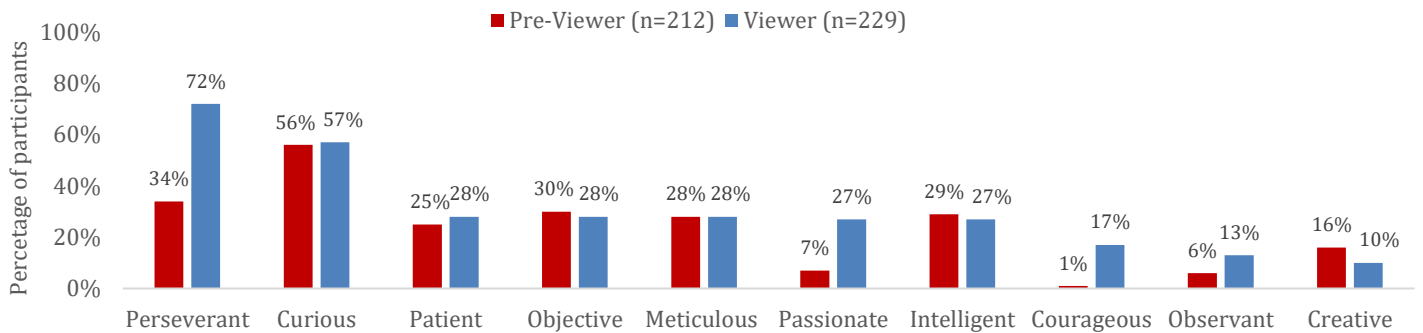


²¹ The 6-point value for the species change questions was determined as follows. Correct responses to each of 4 T/F question were assigned 1.5 points.

1.2 Perceptions of scientist attributes

Viewers and Pre-Viewers were asked to list four personality characteristics that they thought are important for a scientist to have. Figure 18 shows the ten characteristics mentioned by both groups. Viewers were significantly more likely than Pre-Viewers to list four of these characteristics, including: perseverant (72% vs. 34%),²² passionate (27% vs. 7%),²³ courageous (17% vs. 1%),²⁴ and observant (13% vs. 6%).²⁵ Other categories were mentioned by Viewers and Pre-Viewers in similar percentages, including: curious (57% vs. 56%), patient (28% vs. 25%), objective (28% vs. 30%), meticulous (28% each), intelligent (27% vs. 29%), and creative (16% vs. 10%).

Figure 18. Comparison of Viewer and Pre-Viewer examples of personality characteristics that are important for a scientist to have



²² $\chi^2 (1) = 62.74, p < .001$. Based on the odds ratio, the odds of identifying perseverant as a personality characteristic were 4.89 (3.21, 7.50) times higher if they had viewed the film.

²³ $\chi^2 (1) = 32.34, p < .001$. Based on the odds ratio, the odds of identifying passionate as a personality characteristic were 5.23 (2.77, 10.50) times higher if they had viewed the film.

²⁴ $\chi^2 (1) = 31.15, p < .001$. Based on the odds ratio, the odds of identifying courageous as a personality characteristic were 14.24 (4.41, 73.18) times higher if they had viewed the film.

²⁵ $\chi^2 (1) = 5.45, p < .001$. Based on the odds ratio, the odds of identifying observant as a personality characteristic were 2.22 (1.08, 4.79) times higher if they had viewed the film.

Part 2: Narrative engagement

When Viewers were randomly asked to either describe what they liked and disliked about the film or about the story of Henry Bates' scientific quest in the Amazon, both groups were more likely to offer praise than criticism. Those asked about the film most often pointed to liking the visual imagery, the storyline/dramatic narrative, the focus on Amazon wildlife, learning about Bates' quest, and the feeling of being immersed, while those asked about the Bates story most often pointed to learning about Bates' scientific quest and/or about Bates as a person. The largest groups of Viewers in each group said there wasn't anything they disliked about the film or story. Some Viewers in both groups pointed to an aspect of the storytelling and/or the film being too short, but neither dislike category stood out for more than one-quarter of either group.

Viewers also generally experienced a high level of narrative engagement while watching the film, as indicated by their high level of involvement with the story and Henry Bates' character.

To assess narrative engagement, Viewers were asked open-ended questions about what they liked and disliked about either the film or Henry Bates' story, and they were asked to rate their level of disagreement or agreement with twelve statements about their involvement with the film's story and Henry Bates' character. Findings are presented below in 2.1 – 2.2.

2.1 Appeal of the film and the story of Bates' life as a scientist

Approximately half of the Viewers were asked to describe what they liked and didn't like about the film (n=111) while half were asked to describe what they liked and didn't like about the story of Henry Bates' life as a scientist (n=118).

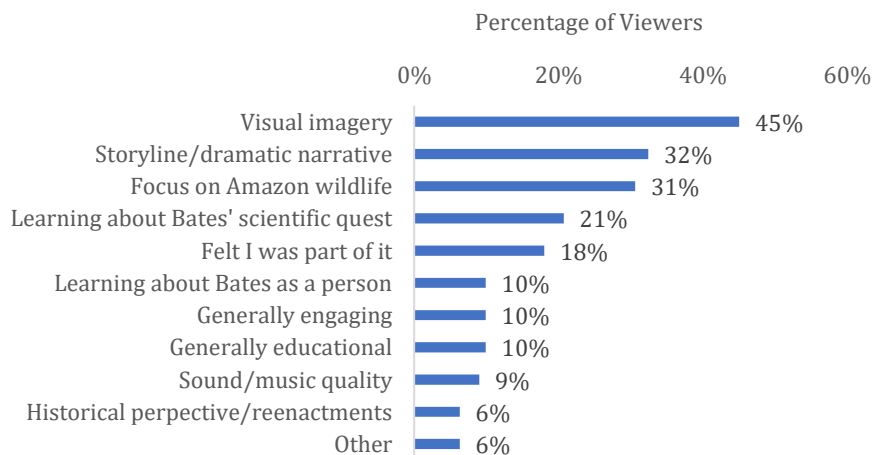
2.1a What Viewers liked about the film and story

Figure 19 shows what Viewers said they liked about the film, while Figure 20 shows what Viewers liked about the story of Henry Bates' life as a scientist. In both Viewer groups, at least eight different appealing aspects were mentioned, although no one aspect stood out for the majority of Viewers in each case.

The film

Viewers asked about the film most often said they liked: the film's visual imagery (45%), the storyline/dramatic narrative (32%), the focus on the Amazon wildlife (31%), learning about Bates' scientific quest (21%), a feeling of being in the film (18%), learning about Bates as a person (10%), and the film being generally engaging (10%) and generally educational (10%).

Figure 19. What Viewers liked about the film (n=111)



The story

Viewers asked about the story of Henry Bates' life as a scientist most often said they liked: learning about Bates' scientific quest (47%), learning about Bates as a person (33%), the focus on the Amazon wildlife (13%), the story being generally engaging (13%), the historical perspective/reenactments (13%), and the visual imagery (10%).

The film compared to story

Figure 21 compares what Viewers asked about Bates' story said they liked (Figure 20) with what Viewers asked about the film said they liked (Figure 19), the latter presented in descending order. The most substantial differences were for learning about Bates' scientific quest (47% story, 21% film) and learning about Bates as a person (33% story, 10% film). Conversely, those asked about the film were more likely to point to the visual imagery (45% vs. 10%), the storyline/dramatic narrative (32% vs. 0%), the focus on Amazon wildlife (31% vs. 13%), and feeling they were part of the film (18% vs. 8%).

Examples of Viewers' responses mentioned by more than 10% of the Viewers are listed in Table 5 on the next page.

Figure 20. What Viewers liked about the story of Bates' life as a scientist (n=118)

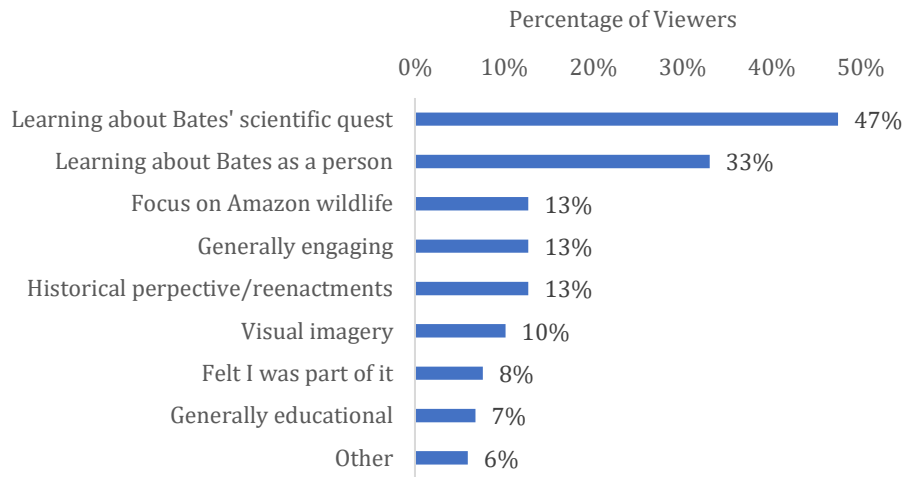


Figure 21. What Viewers liked about the film vs. the story of Henry Bates' life as a scientist

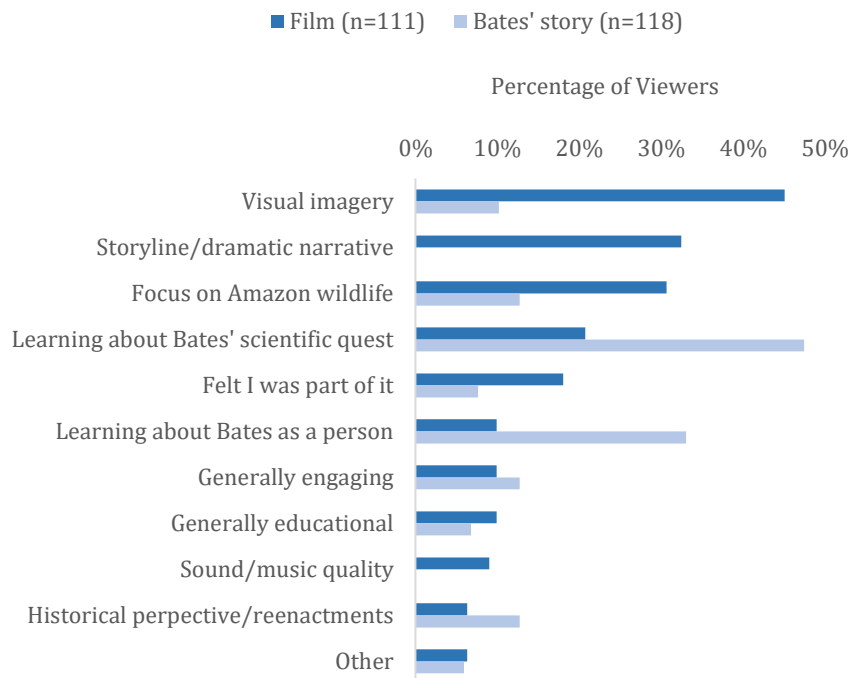


Table 5. What Viewers liked about the film and story of Henry Bates as a scientist

Liked about the film overall (n=111)	Liked about the story of Henry Bates' life as a scientist (n=118)
<p>Visual imagery (45%)</p> <ul style="list-style-type: none"> ➤ Vivid colors, picture composition ➤ I liked that everything was so real. The quality of the film was amazing. ➤ The quality of the photography, the overall feel of the Amazon, the different species captured beautifully and specially the storyline. ➤ Aesthetically it was incredible and wonderful. ➤ The way 3D portrays images, and gives the audience information is so amazing. ➤ The production value was off the charts great; the 3D was the best I've ever seen in many 3D films; the story was fascinating and way better than I expected going in. ➤ Spectacular (viewing) visually. ➤ The photography. Crystal clear and 3D added to the experience. ➤ The cinematography. Picture quality was amazing. 3D glass quality was awesome. Everything was awesome. <p>Storyline/dramatic narrative (32%)</p> <ul style="list-style-type: none"> ➤ How they used people acting out the story. ➤ I loved how it was filmed from the character's point of view instead of narrated. I loved the nature and All the creatures! The way 3D portrays images, and gives the audience information is so amazing. As an older person, you (I) appreciate how information is now relayed. I like how there is a story, giving facts and history. It's easier for me to take in, and keep my attention. ➤ I liked the storyline, and how it educated me on how they found out about different species of butterflies. ➤ The storyline was excellent and how it was told kept you in the film. ➤ Storyline had a life like feeling. ➤ I liked that the journey began with Darwin and ended with Darwin. I liked that it started with Henry Bates being 13 years old. What a great hobby to inspire young people to begin achieving their goals. <p>Focus on Amazon wildlife (31%)</p> <ul style="list-style-type: none"> ➤ I loved seeing the animals. I liked how when an example of an animal was used the audience always had a view of the animal (the snake caterpillar). ➤ Amazon pics and animals. ➤ Seeing close up shots of the animals and the Amazon in general as I will probably never visit there. ➤ The wide variety of animals and insects. ➤ The tiny details like the number of legs on the butterfly. The different animals which you sometimes see in a zoo. <p>Learning about Bates' scientific quest (21%)</p> <ul style="list-style-type: none"> ➤ I enjoyed learning about a naturalist I did not know and his contribution to science. ➤ Educational and told the story of a guy that was very important in discoveries involving evolution, but you only hear about Darwin usually. ➤ That Wallace and Bates had to sacrifice and take risk to get help to Darwin. That Darwin used Bates' discovery to help prove evolution. ➤ As a biologist, I loved the detailed explanation of evolution, and how they shined a light on Bates when Darwin usually gets all the credit. ➤ I liked it showed the proof from beginning to end. ➤ It went through the progression of the discovery of the progression. <p>Felt I was part of it (18%)</p> <ul style="list-style-type: none"> ➤ The feeling of being so close and encompassed by the Amazon. ➤ The message of exploration was transferred. I have been in the tropics and therefore know the full experience. The steamy air, smells, bugs, wetness. ➤ The detail made it easy to feel like you were truly there and could reach out and touch. 	<p>Learning about Bates' scientific quest (47%)</p> <ul style="list-style-type: none"> ➤ Well illustrated the story of Bates. Clearly explained the scientific question Bates was trying to answer. ➤ The film was historic, very realistic, and brought actual events to light. I enjoyed seeing the evolution of ➤ The quest to catalog new species than to link them in an evolutionary chain. ➤ His dedication to finding evidence of evolution. ➤ How a person follow his dream and made a significant difference in understanding the development of new species. ➤ Henry bates continued to ask questions, which led to discoveries that we continue to learn from today. ➤ Well illustrated the story of Bates. Clearly explained the scientific question Bates was trying to answer. ➤ I enjoyed the scenery, the exploration. His passion and perseverance. The wild life shown and the mimicry that appeared. Bates' ability to document and show the evolution of the changing butterfly. <p>Learning about Bates as person (33%)</p> <ul style="list-style-type: none"> ➤ His thought process, the ups and downs. ➤ Personal story and strife. ➤ I like that it told of his success and his struggles. ➤ I loved that although his health deteriorated, he continued on his search. ➤ How a person follow his dream and made a significant difference in understanding the development of new species. ➤ His personal story made me more interested in a topic I wouldn't have cared about. ➤ I liked that you shared his perspective and thought process. For students, it's good to see that answers don't come immediately. (I'm a teacher). ➤ Illustration of sacrifice, challenges, persistence, obsession to do this kind of work well. ➤ His experience, growth and struggle as a scientist. <p>Focus on Amazon wildlife (13%)</p> <ul style="list-style-type: none"> ➤ I enjoyed the scenery, the wild life shown and the mimicry that appeared. ➤ We liked how the storyline included many different species in the Amazon including historical context. ➤ The scenic Amazon. ➤ The animals displayed in the film. <p>Generally engaging (13%)</p> <ul style="list-style-type: none"> ➤ I enjoyed the whole film. Would like to see more like this. ➤ I like it presented scientific concepts in an entertaining way. ➤ Whole thing <p>Historical perspective/reenactments (13%)</p> <ul style="list-style-type: none"> ➤ The film was historic, very realistic, and brought actual events to light. I enjoyed seeing the evolution of ➤ Period drama, wide shots of nature. ➤ It humanized an important piece of history ➤ The period reproduction in thoughts and mannerisms. The recreation of the times reflected in a personal manner.

2.1b What Viewers disliked about the film and story

Figure 22 shows what Viewers said they disliked about the film, while Figure 23 shows what Viewers disliked about the story of Henry Bates' life as a scientist. In each case, the largest percentages of Viewers said they didn't dislike anything (39% film, 49% story). At least four different dislike categories were identified within each group, although no one category stood out for the majority of Viewers in each case.

The film

Viewers asked about the film most often said they disliked: an aspect of the film's storytelling (24%), theater viewing issues (13%), and the film being too short (12%), with these Viewers generally wanting more detail about content presented.

The story

Viewers asked about the story of Henry Bates' life as a scientist most often disliked that the film seemed too short (20%), with these Viewers similarly wanting more detail about content presented, and/or they pointed to an aspect of the film's storytelling (18%).

The film compared to the story

Figure 24 compares what Viewers asked about Bates' story said they disliked (Figure 23) with what Viewers asked about the film said they disliked (Figure 22), the latter presented in descending order. Both groups pointed to disliking an aspect of the film's storytelling, although this category was mentioned somewhat more frequently by those asked about the film (24% vs. 18%). Both groups also pointed to the film being too short, although this was more often an issue for those asked about Bates' story (20% vs. 12%). Meanwhile, only those asked about the film mentioned theater viewing issues (13%).

Figure 22. What Viewers disliked about the film (n=111)

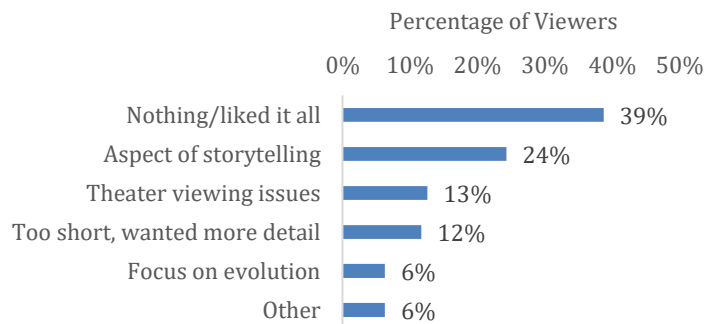


Figure 23. What Viewers disliked about the story of Henry Bates' life as a scientist (n=118)

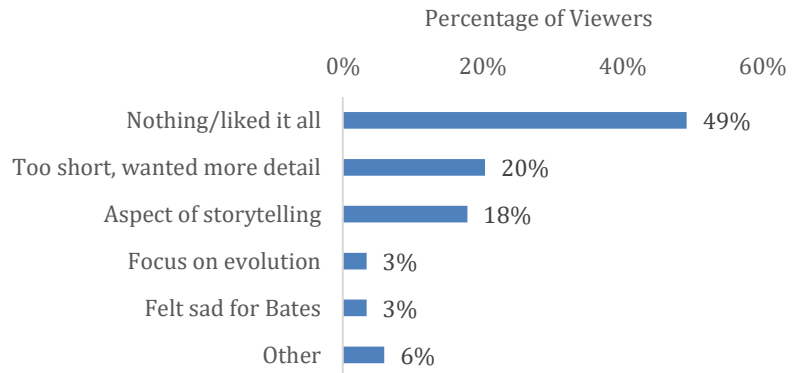
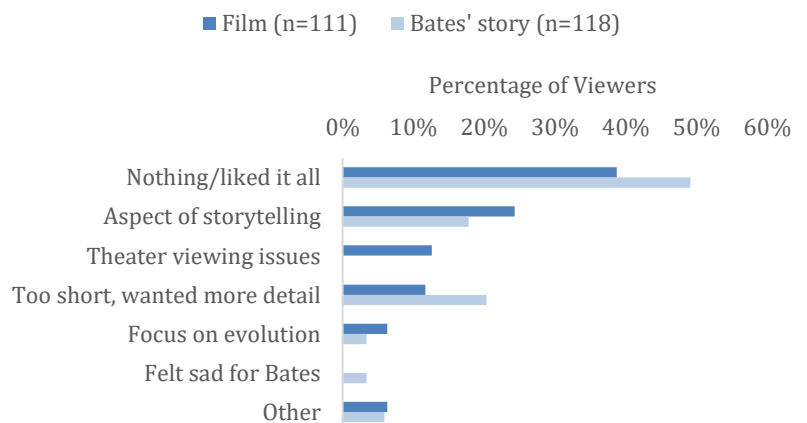


Figure 24. What Viewers disliked about the film vs. the story of Henry Bates' life as a scientist



Examples of Viewers' responses on elements mentioned by more than 10% of Viewers are in Table 6.

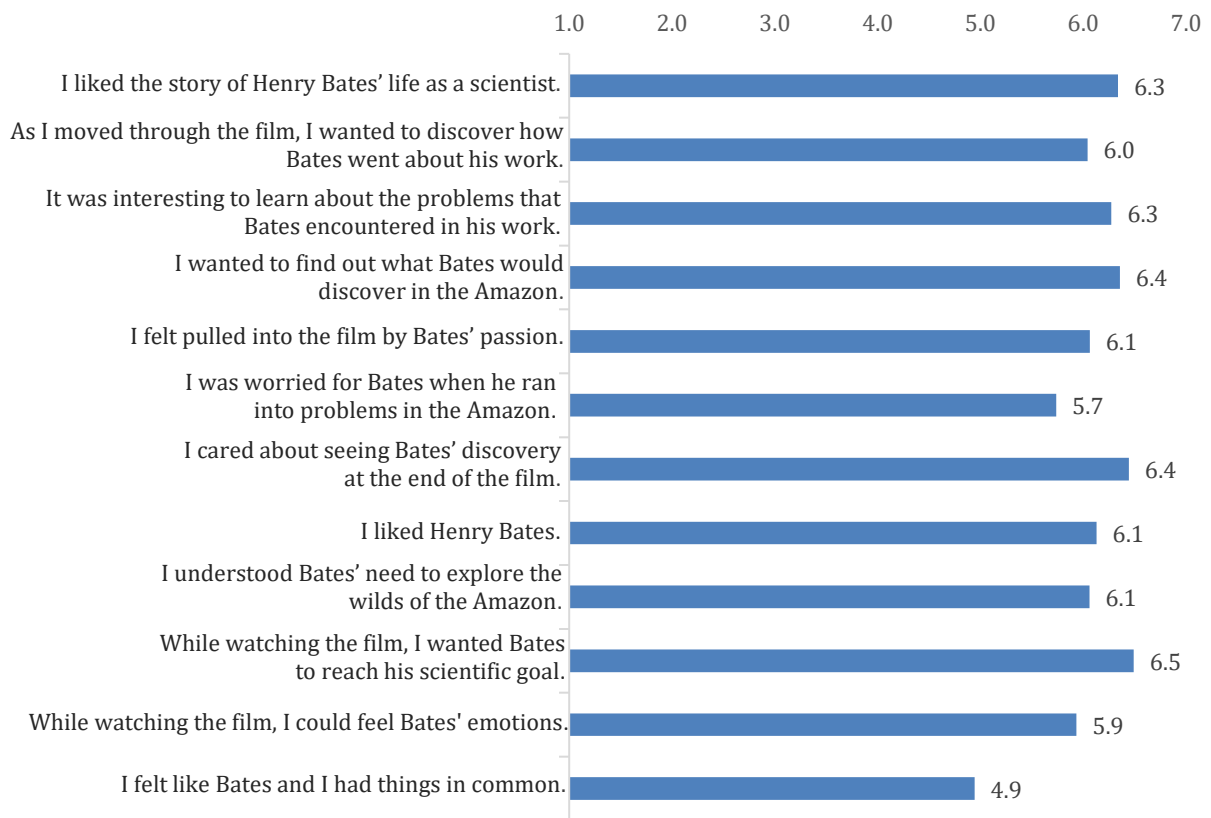
Table 6. What Viewers disliked about the film and story of Henry Bates as a scientist	
Disliked about the film (n=111)	Disliked about the story of Henry Bates as a scientist (n=118)
<p>Aspect of storytelling (24%)</p> <ul style="list-style-type: none"> ➤ A minor observation. The actor for the guide seemed to speak with a perfect American accent. ➤ I didn't like the acting and some of the writing. ➤ It was a bit monotonous for my taste of movies. ➤ Narrative tended to be long at times. ➤ Not more info on Bates' personal life if any. ➤ Overacting. ➤ Some of the acting/script was kind of cheesy. ➤ Some parts became boring, dragged on. ➤ The acting was subpar. ➤ The story was a bit contrived. ➤ Was not clear, acting was boring, story was dry. I fell asleep. <p>Theater viewing issues (13%)</p> <ul style="list-style-type: none"> ➤ 3D makes me dizzy. ➤ Screen was a bit too large. I began to get dizzy. ➤ Some of the quick movement made it have a slight dizzying effect. ➤ Sometimes I wish the pictures were smaller. ➤ Sometimes things seemed so close they made me dizzy. ➤ The glasses were too heavy to put on top of my own. ➤ The sitting area is very steep. <p>Too short/wanted more detail (12%)</p> <ul style="list-style-type: none"> ➤ Could have spent some more time on explaining Bates/Darwin's theories. ➤ I liked everything. I probably would have liked it to be longer, was eager for more. ➤ I'd like to see more animal footage. ➤ It never explained how Wallace's explorations ended. Also, it should have been longer. ➤ It was too short. ➤ More details and explanations of the animals. For instance, what was the large cat? A jaguar? what was the dolphin they fed the fish to? ➤ Sorry, can't seem to come up with a dislike except would have liked the film to be twice as long, if not more. ➤ Would have liked more description of animals and insects shown. 	<p>Too short/wanted more detail (20%)</p> <ul style="list-style-type: none"> ➤ Nothing, except perhaps more explanation at certain times. ➤ It could have been a little faster paced. ➤ Would like to see more cultural context of the local people. ➤ It would've been cool to see how his finding tied in with Wallace's mom. ➤ A little more about genes. ➤ I wish that it was longer/showed more species. ➤ I wish the diseases that affected Bates were better described. <p>Aspect of storytelling (18%)</p> <ul style="list-style-type: none"> ➤ I didn't really feel the 13 year old Bates. ➤ Native life seemed a bit plastic. ➤ The story was nice, but a little bland. ➤ The narration (tacky). ➤ Slightly unrealistic, over dramatized. ➤ The end felt rushed. I liked the fact that there was a story, but I think many of the movies tell their stories a bit better. ➤ Some of the story seemed a bit boring. ➤ Hokey acting. ➤ It was a little slow, it could be more interactive. ➤ Dialogue was stilted.

2.2 Story and character involvement

To assess the extent to which Viewers experienced the story and character involvement components of narrative engagement, Viewers were asked to rate their level of agreement with twelve statements on a scale from 1.0 (*strongly disagree*) to 7.0 (*strongly agree*), with 4.0 being neutral in each case. The total scale reliability coefficient was .94, 95% CI [0.93, 0.95]. Given the reliability and single factor results of the analysis, a composite score of the scale was appropriate for use in the evaluation. Please see Appendix D for additional scale details including factor analysis.

Figure 25 shows the overall and individual mean ratings for the 12 statements. As shown by the overall mean rating ($M = 6.1$, $SD = 0.83$), Viewers on average experienced a high level of narrative engagement while watching the film.

Figure 25. Viewers' mean narrative engagement ratings (n=229)
Overall Mean Rating: 6.1



$\alpha = .94$, 95% CI [.93, .95] (*ordinal alpha*)

With respect to subgroup differences, those who last took a college or higher-level biology class reported feeling significantly higher levels of involvement than did those who either last took a biology class in high school or never took biology ($M = 6.2$, $SD = 0.6$ vs. 5.9 , $SD = 1.0$).²⁶ The effect size was small.

²⁶ $t(225) = 2.53$, $p = .012$, $d = 0.34$, 95% CI [0.06, 0.47]. College or higher-level biology class ordinal $\alpha = .93$, 95% CI [.91, .95]; high school or never took biology class ordinal $\alpha = .94$, 95% CI [.92, .96].

2.2a Story involvement

Table 7 shows the frequency distribution for the story involvement scale items. Although Viewers shared a range of ratings across the seven statements, as a group they mostly agreed or strongly agreed with the statements, indicating that overall, as shown by the sub-scale mean rating of 6.2, the Viewers experienced a high level of involvement with the story.

Table 7. Frequency distribution of Viewers' story involvement ratings (n=229)							
	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I liked the story of Henry Bates' life as a scientist.	0%	1%	0%	3%	4%	41%	50%
As I moved through the film, I wanted to discover how Bates went about his work.	1%	1%	1%	6%	12%	38%	41%
It was interesting to learn about the problems that Bates encountered in his work.	0%	1%	1%	3%	11%	33%	51%
I wanted to find out what Bates would discover in the Amazon.	1%	0%	0%	3%	8%	31%	56%
I felt pulled into the film by Bates' passion.	0%	2%	3%	7%	12%	27%	49%
I was worried for Bates when he ran into problems in the Amazon.	1%	1%	4%	14%	11%	32%	36%
I cared about seeing Bates' discovery at the end of the film.	1%	0%	0%	4%	8%	20%	67%

2.2b Character involvement

Table 8 shows the frequency distribution for the character involvement scale items. Although Viewers shared a range of ratings across the five statements, as a group they mostly agreed or strongly agreed with the statements, indicating that overall, as shown by the sub-scale mean rating of 5.9, the Viewers experienced a high level of involvement with the Bates character.

Table 8. Frequency distribution of Viewers' character involvement ratings (n=229)							
	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I liked Henry Bates.	0%	0%	1%	6%	11%	41%	41%
I understood Bates' need to explore the wilds of the Amazon.	0%	1%	2%	7%	14%	35%	42%
While watching the film, I wanted Bates to reach his scientific goal.	0%	1%	0%	4%	4%	25%	66%
While watching the film, I could feel Bates' emotions.	0%	1%	2%	10%	18%	27%	42%
I felt like Bates and I had things in common.	3%	5%	6%	19%	28%	23%	16%

Part 3: Spatial presence

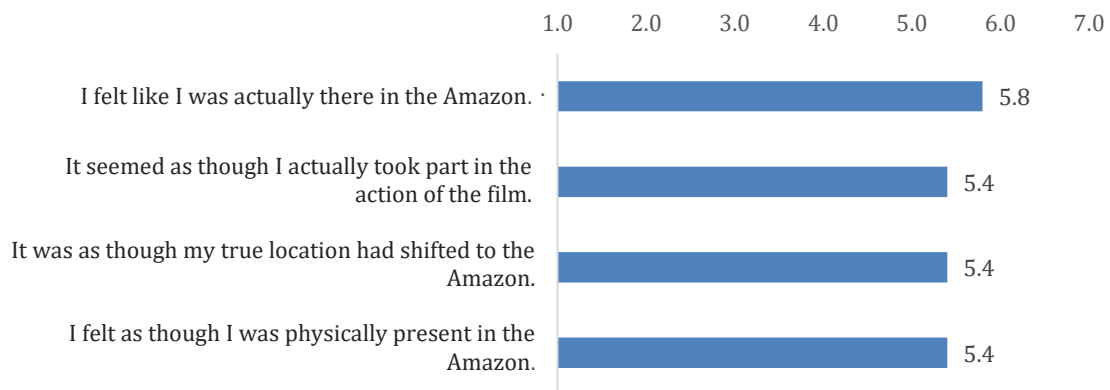
Viewers generally experienced a high level of spatial presence while watching the film, as indicated by their level of agreement with statements about the feeling of being in the Amazon such that their location had shifted and they were present, taking part in the film's action.

To assess whether and how Viewers experienced a feeling of spatial presence watching the film, they were asked to rate a set of four statements on a scale from 1.0 (*strongly disagree*) to 7.0 (*strongly agree*), with 4.0 being neutral in each case. The total scale reliability coefficient was .91, 95% CI [0.89, 0.93]. Given the reliability and single factor results of the analysis, a composite score of the scale was appropriate for use in the evaluation. Please see Appendix D for additional scale details including factor analysis.

Figure 26 shows the overall and individual mean ratings for the four statements. As shown by the overall mean rating ($M = 5.5$, $SD = 1.24$), Viewers generally experienced a high level of spatial presence with the film.

Figure 26. Viewers' mean spatial presence ratings (n=229)

Overall mean rating: 5.5



$\alpha = .91$, 95% CI [.89, .93] (*ordinal alpha*)

Subgroup analyses showed significant differences with respect to age, gender, and screen type. Older Viewers (41 and older) reported feeling higher levels of spatial presence than did younger Viewers ($M = 5.8$, $SD = 1.05$ vs. $M = 5.3$, $SD = 1.34$).²⁷ Women also reported feeling higher levels of spatial presence than did men ($M = 5.7$, $SD = 1.1$ vs. $M = 5.3$, $SD = 1.35$).²⁸ The effect sizes were small in each case. Finally, Viewers who saw the film on a 3D flat screen reported feeling higher levels of spatial presence than did those who viewed the film on a 2D dome screen ($M = 5.9$, $SD = 0.92$ vs. $M = 5.2$, $SD = 1.34$).²⁹ This difference was a medium effect.

²⁷ $t(225) = 2.31$, $p = .022$, $d = 0.31$, 95% CI [0.06, 0.67]. Older ordinal $\alpha = .88$, 95% CI [.84, .92]; younger ordinal $\alpha = .88$, 95% CI [.84, .91].

²⁸ $t(225) = 2.41$, $p = .017$, $d = 0.32$, 95% CI [0.07, 0.68]. Women ordinal $\alpha = .87$, 95% CI [.84, .91]; men ordinal $\alpha = .87$, 95% CI [.83, .91].

²⁹ $t(225) = 5.09$, $p < .001$, $d = 0.66$, 95% CI [0.47, 1.06]. 3D flat screen ordinal $\alpha = .88$, 95% CI [.84, .92]; 2D dome screen ordinal $\alpha = .88$, 95% CI [.84, .91]. Welch's t-test was used as the comparison was directed at the group level variable. Chi-square tests were used to explore if Viewers who saw the film on a 3D flat screen were significantly different from Viewers who saw the film on a 2D dome screen with respect to age and gender.

Although no gender difference was found, Viewers who watched the film on a 3D screen were significantly older,

Table 9 shows the frequency distribution for the spatial presence items. Although Viewers shared a range of ratings across the five statements, as a group they mostly agreed or strongly agreed with the statements, indicating that overall, as shown by the scale mean rating of 5.5, Viewers experienced a high level of spatial presence with the film.

Table 9. Frequency distribution of Viewers' spatial presence ratings (n=229)							
	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I felt like I was actually there in the Amazon.	0%	3%	2%	6%	27%	25%	38%
It seemed as though I actually took part in the action of the film.	1%	3%	6%	14%	26%	22%	27%
It was as though my true location had shifted to the Amazon.	1%	3%	5%	11%	26%	27%	26%
I felt as though I was physically present in the Amazon.	1%	3%	6%	13%	26%	24%	27%

both with respect to mean age and group category (41 and older) (55% vs 38%), $\chi^2(1) = 5.86, p < .015$. It is possible that one or both spatial presence findings (with respect to screen type and age) may be different or insignificant if the number of Viewers who saw the film on a 3D flat screen and 2D dome screen were evenly distributed by age, thereby removing the confounding effect.



Phase 2: Further exploration of Viewers' science learning and narrative engagement

Introduction

To further explore aspects of Viewers' science learning and narrative engagement that could not be captured through the survey method but were still of interest to the project team, a subset of Viewers who completed a post-viewing survey were invited to provide additional feedback through a 10-12 minute individual interview with a member of the evaluation team. Phase 2 of the evaluation was conducted within minutes of Viewers seeing the film and focused on the following four questions:

- *What scenes from the film did Viewers like most and least?*
- *How did Viewers interpret the importance of the row of eight butterflies at the film's end?*
- *Did Viewers indicate that they felt a connection to Henry Bates while watching, and, if so, did the film's reenactment feature and portrayal of Bates' struggles play a role in their feeling connected?*
- *Did Viewers indicate that they felt differently about science or scientists after watching?*

Method

Recruitment

Viewers without small children present were informed of the opportunity to participate in the interviews when they submitted their post-viewing surveys. Those who consented to participate received a \$5 gift certificate to the science center or museum gift store or, if that wasn't an option at the participating institution, a \$5 certificate to amazon.com.

The evaluation aimed for approximately 30-40 interviews and completed a total of 33.

Participants

Table 10 on the next page presents basic demographic and background information for the 33 Viewers who participated in the post-viewing interview. The group was generally balanced in terms of gender and the two main age groupings of 18-40 and 41 and above. Just over two-thirds were White. More than half had a graduate school degree or experience and more than half had a biology course at or beyond the college level. The group as a whole had prior giant screen film viewing experience, with about 80% having seen at least three films before.

Procedure

All interviews were held in open public spaces adjacent to the theater exit area. The interviewer informed participants: that their participation was voluntary; that their opinion mattered and there were no right or wrong answers; that their names and identities would be protected in the reporting; and that, as with the questionnaires, the interviews were made possible with support from the National Science Foundation.

Data analysis and reporting

Basic descriptive statistics were conducted on the quantitative data gathered. Two evaluators prepared the qualitative analysis of open-ended responses. The analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

Table 10. Post-viewing interview demographic and background information

Demographic/ background factor	Categories	Participants (n=33)
Gender	Female	58%
	Male	42%
Age group	Age range	18-81
	Mean	45
	18-40	48%
	41 and above	52%
Racial/ethnic group	White	67%
	Asian	15%
	Multiracial	6%
	African-American/Black	3%
	Native American Indian or Alaskan Native	0%
	Native Hawaiian or Pacific Islander	0%
	Hispanic origin	9%
Highest level of education	Less than high school	6%
	Completed high school or equivalent	9%
	Some college or degree	27%
	Some graduate school or degree	58%
Last biology course	Never	6%
	High school	27%
	In college, another major	52%
	Majored in college	0%
	Graduate school	15%
Number of giant screen films viewed	0	3%
	1	6%
	2	12%
	3	15%
	4 or more	64%

Findings

Favorite and least favorite scenes (1.1)

The 33 Viewers interviewed after seeing the film found various scenes appealing. Most often these Viewers described liking scenes featuring Bates' scientific process and/or animal close up shots, followed by the mimicry examples, the tsunami scene where Bates' boat capsizes, the panoramic view of the Amazon, and the row of eight butterflies that Bates pulled from his collection at the end of the film.

No one scene was disliked by the majority of Viewers, although three film elements rather than specific scenes were each mentioned by one-quarter of the group. In these instances, Viewers pointed to the storyline and/or acting seeming overdramatic or contrived, and/or expressed that they felt concern, rather than dislike, during scenes where Bates' well-being was at stake.

Interpretation of row of eight butterflies (1.2)

Nine-tenths of the interviewed Viewers correctly explained that the row of eight butterflies showed that one species changed or evolved into a new species, and all but two Viewers felt this section was clearly presented and that further explanation wasn't needed.

Whether a connection was felt with Henry Bates (1.3)

Four-fifths of the Viewers stated that they *did* feel a connection with Henry Bates while watching the film, with many of these Viewers indicating they shared in or felt inspired by Bates' adventurous spirit or passion, and/or that they felt a connection with Bates' process of scientific inquiry. Those who felt a connection generally thought the reenactment feature and seeing Bates face obstacles in his life and career played a role in their feeling connected to Bates. The minority of respondents who felt they couldn't connect with the Bates character generally commented that they did not feel engaged by or could not relate to Bates for various reasons, including that he was from a different time, that he had a different lifestyle or life circumstances, was of a different age than they were, or indicated they weren't sure why they couldn't connect with him.

Whether felt differently about science or scientists (1.4)

Viewers were split on whether they felt differently about science or scientists after watching the film. Those who *did* most often said the film gave them an increased appreciation for the challenges and struggles scientists face and/or that it rekindled their interest or motivation to engage in science. Those who *didn't* indicated it was because they already had a positive view of scientists and the film's portrayal reflected their existing views.

To further explore aspects of Viewers' film-related science learning and narrative engagement, the 33 interviewed Viewers were asked several open-ended questions about: their favorite and least favorite scenes; how they interpreted the importance of the row of eight butterflies at the film's end; whether they felt a connection with Henry Bates while watching, and, if so, whether the film's reenactment feature and portrayal of Bates' struggles played a role; and whether and how they felt differently about science or scientists as a result of seeing the film. Findings are presented below in 1.1 – 1.4.

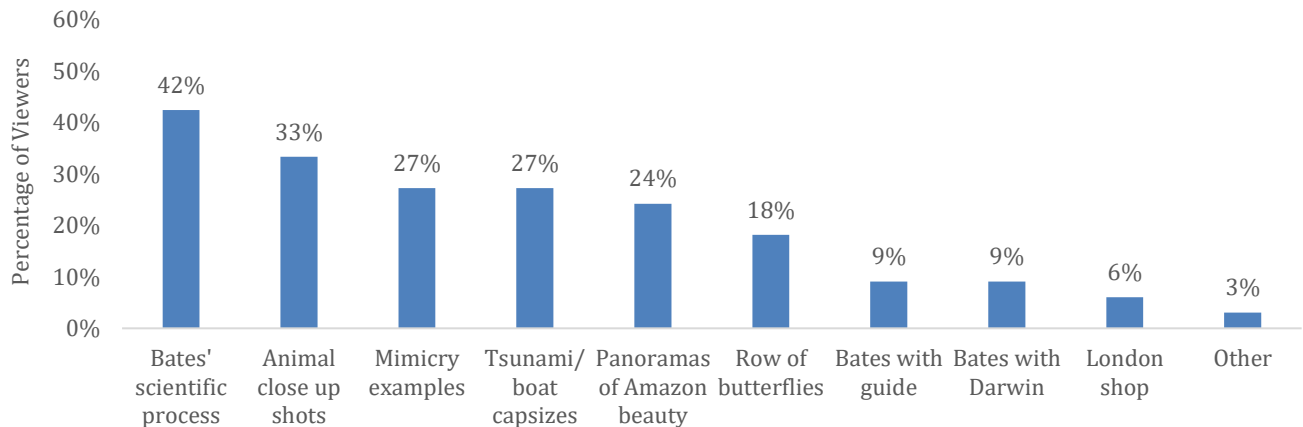
1.1 Scenes liked most and least

1.1a Scenes Viewers liked most

Figure 27 on the next page shows the scenes from the film that Viewers said they liked most. As Figure 27 shows, no one particular scene stood out for the majority of Viewers, and while some pointed to *one* scene from the film, others pointed a *type* of scene that they enjoyed. Specifically, about two-fifths of Viewers (42%) mentioned scenes that showcased Bates'

scientific process, while a third (33%) mentioned scenes that featured close up shots of animals. Approximately one-quarter each pointed to the scene when Bates' boat capsized from the tsunami (27%), scenes that depicted examples of mimicry, most often the caterpillar or snake (27%), and/or scenes that showed panoramic views of the Amazon topography and/or wildlife (24%). Just under one-fifth (18%) favored the scene showing the row of butterflies Bates pulled from his collection at the end of the film showing how one species changed or evolved into a new species, while smaller groups pointed to scenes of Bates with his guide Tando (9%), scenes of Bates with Darwin (9%), scenes in the London shop where Bates talked with the shopkeeper (6%), or other scenes (3%).

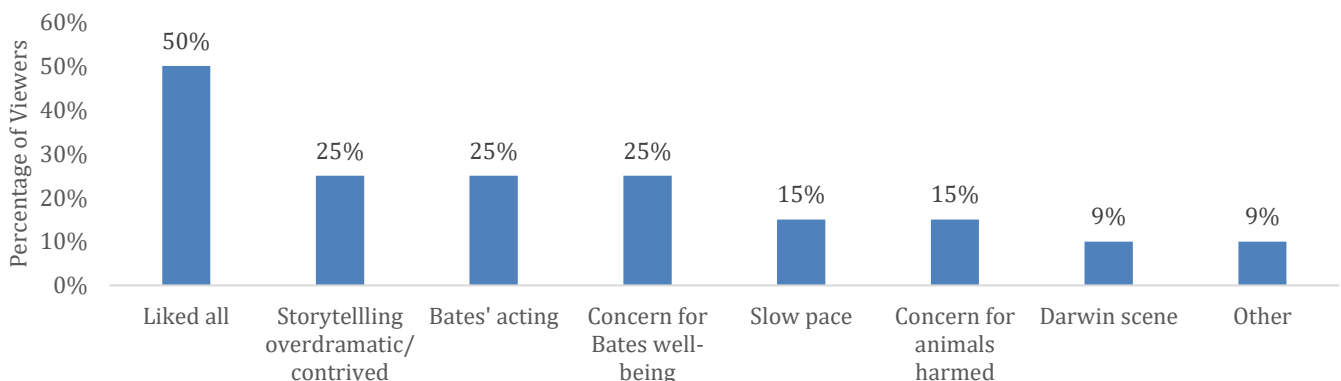
Figure 27. Scenes from the film Viewers liked most (n=33)



1.1b Scenes Viewers liked least

Figure 28 shows the scenes from the film that Viewers said they liked least. Whereas half (50%) of the Viewers said there was no scene they disliked, one-quarter each (25%) mentioned something related to the storyline and/or acting seeming overdramatic or contrived. Another quarter said they felt concern, rather than dislike, during scenes where Bates' well-being was at stake. A few Viewers expressed concern about scenes where animals faced potential harm (15%), while a few others said they felt the film had a slow pace at times (15%). Finally, a few Viewers took issue with the ending scenes with Darwin in terms of the focus on evolution (9%) or shared other responses (9%).

Figure 28. Scenes from the film Viewers liked least (n=33)



1.2 Importance of the row of eight butterflies

Figure 29 shows how Viewers interpreted the importance of the row of eight butterflies Bates pulled from his collection at the end of the film, as captured in Figure 30. Most interviewed Viewers (88%) were able to explain that the row of butterflies showed that one species changed or evolved into a new species. Just a few stated more generally that the row of butterflies showed proof of Darwin's theory of evolution (12%), while a couple of others more broadly observed that the row showed Bates' efforts to compare butterfly species (6%). All but two Viewers (94%) felt this section was clearly presented and that further explanation wasn't needed to clarify the significance. Their questions included:

- *I got it to a point, that it had to do with the links between the butterfly species. Again, maybe a little more explanation on that would be great. It seemed as if there [was] a little more in-depth explanation needed. I wished he would have talked to himself even a little more to reflect on what he found, and how he interpreted the rows from 1 to 8, left to right.*
- *I know about natural selection and evolution but I didn't see an exact match with that scene, so I found that a little confusing. So like it showed the three and the blanks and then in the row I wondered what was changing. Maybe if they pulled that out further so we could see how he saw them change in each of the 5. It was clear which ones changed but how did they change and what did he notice that had him prepared to show Darwin what he did?*

Figure 29. Viewers' interpretation of the importance of the row of eight butterflies (n=33)

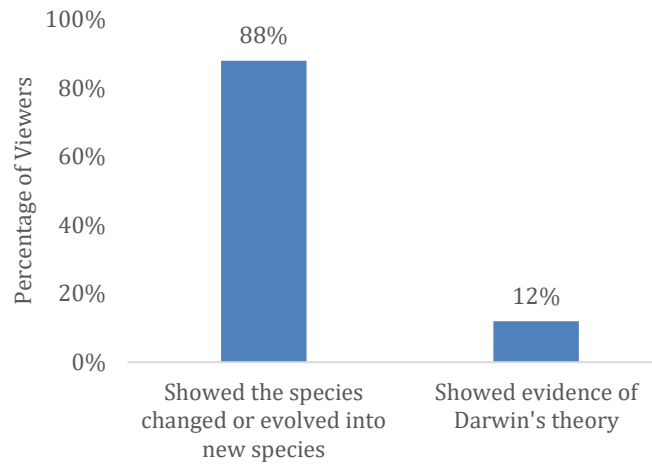


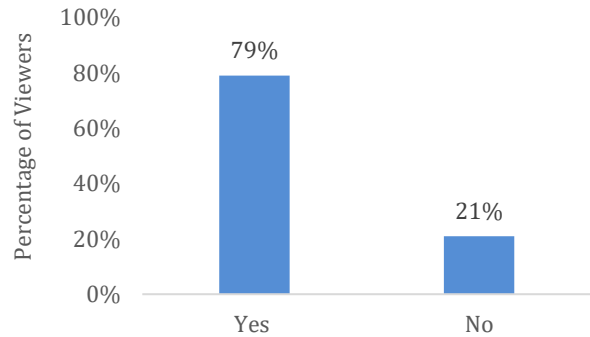
Figure 30. Scene showing row of eight butterflies from Bates' collection



1.3 Connection to Henry Bates

Figure 31 shows whether Viewers indicated that they felt a connection with the Henry Bates character while watching the film. Four-fifths (79%) stated that they *did* feel a connection. When these 26 Viewers were asked to elaborate, more than two-thirds (n=18) indicated they either shared in or felt inspired by Bates' adventurous spirit and/or passion. Half (n=13) indicated they felt a connection with Bates' process of scientific inquiry, particularly the many years he spent working to fulfill his quest, from dream to realization. Several (n=6) said they felt sympathy or empathy as Bates encountered struggles, with a few adding that they rooted for him to overcome these obstacles. A couple of Viewers said that they connected with Bates in some other way (n=2).

Figure 31. Whether Viewers felt connected to the character of Henry Bates while watching the film (n=33)



Conversely, about one-fifth (21%) of Viewers felt they did not connect with the character of Henry Bates or weren't sure if they did. These respondents generally commented that they did not feel engaged by or could not relate to Bates for various reasons, including that he was from a different time, that he had a different lifestyle or life circumstances, was of a different age than they were, or indicated they weren't sure why they couldn't connect with him.

A sampling of the Viewers' explanations as to why they did or didn't feel a connection are provided in Table 11.

Table 11. Viewers' explanations as to why they felt or didn't feel a connection with the character of Henry Bates (n=33)

Felt a connection (79%)

Adventurous spirit/sense of passion (n=18)

- *His adventurous spirit. How he explored. I like hiking and with my kids we like to collect bones and skulls and different things so I felt like you were there with him, that we were doing the same thing and that you could relate. I think we also saw Flight of the butterflies and that was sort of the same but not as strong as I think they came back as an older couple and this one he came back as a younger man and we saw him over time, and as a young boy and man. I think that made it more relatable to my kids. But yeah, it was his spirit, I could connect with that.*
- *In a certain way yes...I thought the presentation of him was more for younger audiences but I like that he was adventurous. I thought of myself as an artist and as an adventurous person like him. Even in the small things he did, maybe more than the big things. It helped me understand him better. Like how he started off as a curious child who loved nature and then the deeper he got into his explorations it required more of him on so many levels and then he got deeper into a process, so a larger context forced him into a smaller context. Societal demands played on him and he had to navigate a lot of constraints. He had to become shrewd and figure out how to outsmart the critics and non-believers and couldn't just be free to do the pure scientific work. As an artist, I related to that experience.*
- *I really appreciated seeing his passion. He was passionate about his field. He reminded me of Neil Degrasse Tyson (who I just saw on Colbert), now THAT man is passionate about science.*
- *I felt connected to his passion. He's really into his work, and you're rooting for him!*
- *I felt some personality connection. He's very adventurous, very curious, and I'm the same way.*

Scientific inquiry/his journey from dream to realization (n=13)

- *Because it started with Henry Bates at 13 and it ended with his relationship with Darwin and his proof. It began with his dream and ended with his vindication. All of what he did never would have been possible if he didn't have a dream he was willing to pursue and the film showed everything coming full circle, from dream to realization. It was inspiring to see this because it made me feel like I too*

could go out in nature and explore in ways that no one has thought to do before, but we have so much more at our disposal than he did. We have all kinds of tools and technologies that can help with the discovery process.

- I liked actually seeing the perseverance that it takes, the patience, the keen observation, and the documentation.
- There are a couple of things I think he did that helped with that. The yellow fever really got to me. It nearly killed him and it showed his utter dedication and sacrifice. I feel he lived his work and would have died right there if that is what it too. Most people in the mainstream wouldn't go to that length. He also continued after all his sicknesses and did what it took to meet with Darwin, as ailed as he was, and publish his work in scientific journals. That took a whole other skill set and discipline, and I found it deeply compelling.
- I think the way he approached his work, his dedication and patience to keep going, the ends justified the challenging means. I work in research though in a very different field but it requires patience and the long view. I appreciated all he had to go through.
- I've been involved in research but at times I get tired and weary and his story was inspiring to remind me of the the pure resaearch opportunites from observing nature. It reminded me to feel science not just think about it and go through the repetitive processes if that makes sense to get the proof or evidence you need to make a case.
- I think whenever he asked a question overload, I liked that. Instead of listening to narrative, it was as though he was saying what he was thinking. I felt like I was in his hear or alongside him, we were part of the mystery solving, so listening to the questions he had and his thiking about the questions, it put me in his position. The other thing is experiencing what he experienced, like seeing his drawings ruined, when he was sick, or when the boat went over and the species were lost, I was concerned for him and worried.
- I felt like I was part of his life. It felt like you were given a journal of his life, like you were living his tale and piggybacking on his story.

Concern/sympathy for his struggles (n=6)

- The other thing is experiencing what he experienced, like seeing his drawings ruined, when he was sick, or when the boat went over and the species were lost, I was concerned for him and worried.
- I had sympathy for him, I was rooting for him.

Didn't feel a connection (21%)

Couldn't relate to character , wasn't engaged (n=7)

- I liked watching the journey, and I didn't dislike Bates, but I wasn't engaged.
- I enjoyed the film just wan't engaged with him
- I couldn't empathize with him that deeply. The acting was okay but I'm spoiled by Oscar-winning actors, I watch a lot of movies. I also tend to like IMAX films that explore nature more.
- Not on a personal level, no. I don't think I had ever heard of him before.
- His lifestyle is vastly different than mine. Has freedoms I can only imagine.

1.3a Whether Viewers felt the film's reenactment feature and portrayal of Bates' struggles played a role in their feeling connected to Bates

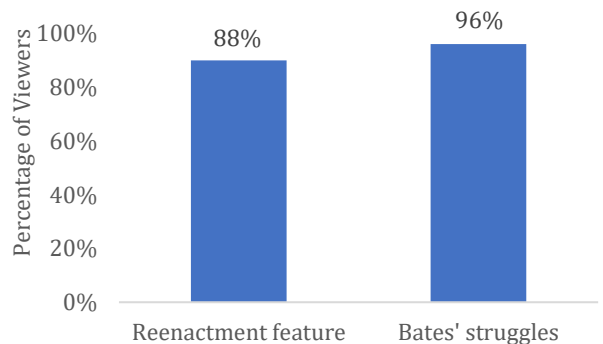
Those who felt a connection to Bates (n = 26) were asked two additional questions relating to the role of the reenactment feature and seeing Bates face obstacles in his life and career. As shown in Figure 32, most Viewers felt both film elements played a role in their feeling of connection, as summarized below.

Role of the reenactment feature

To explore the role of the reenactment feature in Viewers feeling connected, Viewers were asked the following question: *Giant screen films often include scientists but this film is a reenactment of Bates' life. What role, if any, did the reenactment feature of the film play in your feeling connected to Henry Bates?*

Among the 26 Viewers who said they felt connected to the character of Henry Bates, all but three (88%) indicated that the reenactments did play a role in their feeling connected. When asked to elaborate, these 23 Viewers most often said that the reenactments helped personalize Bates' story by allowing them to see it through his eyes (n=17) or indicated that the reenactments made the science more interesting (n=17), with some elaborating that the reenactments helped them to see the scientific process and methods that Bates used depicted

Figure 32. Whether Viewers felt the reenactment feature and seeing Bates' struggle played a role in their feeling connected to Bates (n=26)



visually. Smaller groups noted that the reenactments brought the time period in which Bates lived to life (n=4) or they gave other reasons (n=4). The three Viewers who didn't feel the reenactments played a role focused on this film element perhaps being more suitable for younger audiences or felt at times a voiceover narration might have been preferable. A sampling of the Viewers' explanations as to why they did or didn't feel a connection are provided in Table 12.

Table 12. Viewers' explanations as to why the reenactment feature helped or didn't help them connect to the character of Henry Bates (n=26)

Reenactment played a role in feeling a connection (88%)

Story was more personal/through his eyes (n=17)

- *Absolutely, it wasn't just scientists talking. It was a human story on every level. He had humble beginnings, really no future in science. He was a poor guy working in the mill and determined to follow his curious ties. The adversities he had to fight through, from poverty to a difficult father it sounds like, to the problems he encountered in the amazon, all this set him up to have the tenacity and will power to be able to deal with the challenges of surviving the odds, proving his case, and ultimately being a key contributor to Darwin and what we know about evolution really.*
- *Definitely. As opposed to hearing something else talk about Bates - you can actually see him going through these things, and see how devastated he was during hard times.*
- *It was good to see what he observed through his eyes. I could connect with the experience of his discovery.*
- *I loved the fact that it was a reenactment. It helped me connect with Bates and made me feel like this is a real person. It helped to see his beginnings as a child., all the way from the beetles to the amazon to the moment with Darwin.*
- *I think the 3d aspect on the large screen made for a more intense experience and the story made for a more personal experience, so the two together really drew me in to feel like I could walk in his shoes, from his beginnings in field as a boy to his selling his mission in the shop all the way to his meeting Darwin in his yard with his proof, all of it seemed relatable.*
- *Yes I do. I liked that rather than have to rely on a narrator to take us through his life, it was more engaging to follow his story as he experienced it. I noticed that at the end when the narrator came on as she did, I disconnected a bit, it was like a mental shift to ok now we are out of the story, it was fine, it was time to end, but I noticed that I was mentally pulling back a bit. wouldn't have come across didactic.*

Science process was more interesting/easier to visualize (n=17)

- *So I liked hearing from him, and overhearing his conversations with like Darwin and Wallace and hearing him talk about his drawing and specimen's outload. It made me want to see more, and I didn't realize it took over 11 years to do all he did and I'd like to see more. It was helpful seeing it done as a reenactment, I know they can't cover everything and we missed a lot of the in-between work, but I felt like I had a good feel for the main contributions he made and what he went through to get to that. Yeah, it wasn't so stale, so rather than just watching a movie about a scientist who did this this is this, there was a lot of context about his science they could weave in, and going this route helped to make it a fuller more interesting thing to watch.*
- *It definitely did because if a narrator just told you, for example, about the mice eating his samples, it would have been easy to disconnect from the story. Seeing his frustration helped reinforce the story.*
- *It's different from a textbook in that it really brings you into the story and gives you a better feeling of how this kind of work was done.*
- *This aspect is definitely more powerful than just explaining it. This isn't a story that gets told, I wasn't familiar with it. I liked the elaboration of the fact that proof is required and people work pretty hard to show that proof. I also liked the portrayal of the messiness of science.*

Brought the period to life (n=4)

- *The film did a good job of bringing us back to the time period that Henry Bates lived and showing us what people looked like, what they were doing, what the concerns of the day were, how they dressed, how they did science, what was in the news and all the political and religious thinking....all that context you could never really get from a straight documentary, I don't think. Yes, because it gives you a sense of time and place, and makes it more real. This was a very important feature.*
- *Yes especially with the period clothing. It was 150 years ago and you could feel the essence of the period from how they were dressed, what they endured, like when he had yellow fever, how he learned from the natives and had to trust them to advance his science and just survive, watching him go through all that, you could feel it through the reenactments.*

Reenactment did not play a role in feeling a connection (12%)

Reenactment did not help connect (n=3)

- *Yes more based on younger people relating to this though I think, as I believe they are the main audience. I found myself at times feeling a little disconnected from the reenactment but reminded myself that younger audiences who are into more of a scholarly mode would probably follow it better, see something of relevance to what they are studying, and probably google it afterwards! I haven't thought about mimicry or new species or how they change in a long time!*
- *There were a couple of lines that, as I was watching, I thought would have been better as voiceover. One was when he was asking why species were different. I think that voiceover still should have been done by the actor though, just not as a reenactment. I noticed those lines, it kind of took me out of it.*

Role of seeing Bates face obstacles in his life and science career

To explore the role of seeing Bates face obstacles, Viewers were asked the following question: *Henry Bates faced obstacles in his life and science career. What role, if any, did seeing Bates face these obstacles play in your feeling connected to him?* Among the 26 Viewers who felt connected to the character of Henry Bates, all but one Viewer (96%) felt seeing Bates face obstacles in his life and science career played a role in their feeling connected to his character. When asked to elaborate, these 25 Viewers most often said that they felt the portrayal of obstacles made Bates seem more relatable (n=16), with some further observing that dealing with struggle and challenges is part of the human experience. A slightly smaller group (n=13) observed that showing Bates' experience with obstacles gave them a fuller understanding/greater appreciation of the sacrifices he made (and/or that other scientists make) to advance the field of science.

The one Viewer (4%) who felt seeing Bates face obstacles didn't play a role in his or her connecting with the Bates character indicated that, nonetheless, the obstacle theme was still interesting to learn about.

A sampling of the Viewers' explanations as to why they did or didn't feel a connection are provided in Table 13.

Table 13. Viewers' explanations as to why seeing Bates face obstacles helped or didn't help them connect to the character of Henry Bates (n=26)

Seeing obstacles played a role in feeling a connection (96%)

Made him more relatable (n=16)

- *"Yes, we all struggle as humans, don't we? So seeing his struggles was good to see, and I felt added to his relatability. If people just read about him or saw a documentary about this man Bates they wouldn't really get the scope of his struggles and what it took to persevere. The drama really shows that well. I think it is a bit like an artist. They say the struggling artist, well what is that about? They are often poor, no one buys their work or really appreciates it until years later, often after they are dead. So there is some similarity there.*
- *Yes, he had a lot of troubles and tough things happened to him and frankly some of those things could happen to other people, pretty much in any walk of life, not just science so I think that made him relatable.*
- *Yes. Being an Eagle Scout, I've dealt with these kinds of obstacles before. One thing Bates did wrong though was that he didn't get a guide until later. He went there thinking he knew it all, but he didn't know half of what he didn't know.*
- *I think I already touched on this, when I talked about the process an artist follows to create art vs how a scientist has to prove a theory, the dedication it takes, the chance of facing ridicule and public opposition, the lack of financial backing and appreciation often until years later, and the having to work within societal norms that are not only constraining but often debilitating. so yeah, on all those levels I related. I had heard of Darwin and his struggles to prove evolution but I didn't know this part of the story with Bates and how big a deal it was. The film puts all this in better perspective for me. I was grateful he got to meet Darwin and become lifelong friends. The self-satisfaction he must have felt stepping off that train and being in the company of someone who could truly appreciate and build off his work, that must have been amazing. There must be a real deep bond between scientists rather like artists who need a community to advance must feel. The community of peers as it were.*
- *It made it all feel more realistic and relatable to me. Just seeing all the positives, the fairytale story and ending wouldn't be nearly as interesting or emotional to watch as the ups and downs. He did struggle, he did doubt himself but he responded and didn't fold. The times are different in terms what he had to endure as I'm not sure we would have the same pitfalls now with technology for example but some of the experience is still relatable and inspiring.*
- *Yes seeing his obstacles does make him more believable more relatable. Inspiring to kids I think in terms of what you can endure and still succeed.*
- *Yes, it showed he was human like anyone else. I could relate to him more because he wasn't a rich kid with a silver spoon. He had a passion and seeing him work through his passion made it more relatable. I will tell my kids to not rely on what your family gave you, figure out who and what you are and run with it. it also raised questions for me. Like of his being sick, did he get better ever? I doubt it. Did he die or live into his 40s or beyond? Probably not 90 but what? What toll did his work have on his personal life, beyond what we saw in the amazon? I guess I wanted to know what price he paid? What were the consequence? What was the cost of pursuing his passion?*

Better understanding/empathy of sacrifice (n=13)

- *I felt compassion and appreciation for sure. Like I felt a certain depletion I think when he got sick, or lost his evidence, or got shipwrecked, or experienced sheer exhaustion. He was running on low so much of the time that I felt I took that on a bit actually. But when it all came together and there was hope and ultimately so much to show for all that perseverance, it was a great way to end. I was actually worried he*

might not make it, he was so frail and weak at times, so a big relief too. Not every science or discovery story always ends so well, so I thought it could go either way.

- Yes, especially when he got sick or had to rebuild his boat and his species got destroyed, it wasn't so much like I could relate to that personally but it was the human element. A few times I thought he was going to give up or just have to abandon his work, either he was going to get eaten, get sick and die, or shipwreck and drown. The fact that he made it through all of that is pretty amazing and I wanted to know more. I wanted to learn more of his process. It did make me wonder how he knew to do all the things he did, about how to collect, how to categorize, how to come up with theories and what it takes to have proof. From his background, I'm not sure the film really laid the groundwork for how he got these skills to apply in the field. Maybe there are things we missed or they didn't put in the film but I really wondered how he knew HOW to approach the field work without formal training or schooling, or maybe he did but I missed it.
- Yes, it made me more curious about his legacy, all the work he left behind and the sacrifice it took. I wondered if he felt the obstacles were worth it all and how society judged him and all that he did. Would he do it again?
- I felt empathetic towards him. He didn't have vaccines or any of that stuff, poor guy, and yet he persisted, his passions were so great. He also survived because of Tando, who knew how to live in the Amazon.
- It helped put what he discovered in context, and how the little and big things he did at the time made a real difference in his ultimate contributions. It really is amazing how it took 11 years of physical and mental struggle, with no certainty there would be a fairytale ending, yet he kept going. He sacrificed a lot to gain what he did – his health, career, and even his personal life, he aged terribly, but wow, what a contribution to humankind.
- Who doesn't love an underdog? You definitely want to see him succeed. It would have been different if he had been a rich kid, but you saw how hard he had to work for everything. And who doesn't love rebelling against the parents?

Seeing obstacles did not play a role in feeling a connection (4%)

Seeing obstacles was interesting but did not help connect (n=1)

- No. I didn't feel that connected to Bates. Though it was interesting to learn about his personal obstacles, and class/society in England during this time.

1.4 Perceptions of science or scientists

Figure 33 shows whether interviewed Viewers indicated that they felt differently about science or scientists after watching the film.

The group was nearly evenly split on the question, with just over half (52%) saying that they did feel differently. Among the 17 Viewers who indicated the film did affect how they thought or felt about science or scientists, the largest group said the film gave them an increased appreciation for the challenges and struggles scientists face (n=13) and/or that it rekindled their interest in or motivation to engage in science (n=10). A few Viewers (n=3) felt the film showed them that science is more accessible than they previously thought. All of those who said they didn't feel differently about science or scientists after viewing (48%) indicated that this was because they already had a very positive view of scientists and that the film's portrayal reflected their existing views.

Table 14 on the next page gives a sampling of the Viewers' explanations as to why they did or didn't feel differently about science or scientists after watching the film.

Figure 33. Whether Viewers felt differently about science or scientists after viewing the film (n=33)

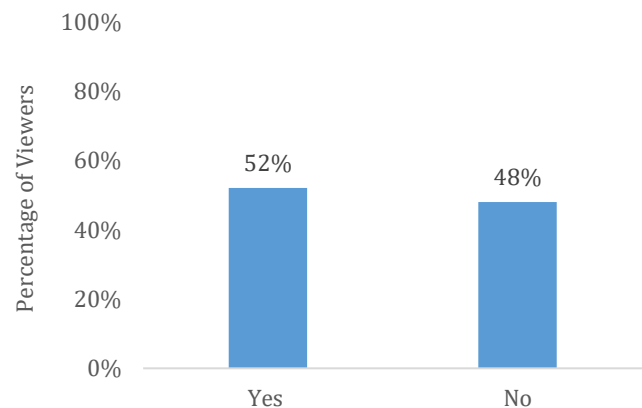


Table 14. Viewers' explanations as to why seeing the film did or did not affect how they thought or felt about science or scientists (n=33)

The film affected thoughts or feelings about science or scientists (52%)

Appreciation for scientist struggles and how overcome (n=13)

- *I was and I think my son (8 year old) was. I think I was inspired about the amazing discoveries scientists can make and he was inspired in terms of confidence, that what Bates did is something he too could do. I have always been impressed by scientists and what they do but this film held rekindle I think that appreciation.*
- *"Yes, what he had to do to go through discovering new species. I kept thinking about scientists today, how they have it made in comparison, with the protective clothing, the vaccines, the radio communications. It made me much more appreciative of how early scientists in particular had to work and the kinds of conditions they had to endure. The film showed this very well. We also saw the Flight of the Butterflies with the monarchs and I kept thinking something was relevant here as they kept saying something was related and i kept thinking this is the moment for that connection but then bates said this was something new. So I was trying to see if there was a connection but it's not really the same thing.*
- *How they can face danger and challenges and still persevere and be successful and the fact that this was in the old days when it was far more dangerous I presume than it would be today.*
- *I didn't appreciate how difficult field work can be. When he was getting sick and it was difficult to survive, that was a sacrifice and risk I hadn't thought about before. Things have improved in terms of conditions but there are still likely risks in field work.*
- *Well, I'd say yes, but in the sense that it reminded me of something I've somewhat lost touch with. I haven't been in the science mix for a while so I haven't really thought about it but the film just reminded and reinforced that scientists are passionate, hardworking, and willing to sacrifice to follow their mission.*
- *You think of scientists being bookish nerds, but this pointed out how brave they are, how completely fearless. And you really have to have courage to put your ideas out there when they're not popular.*
- *I think they have to be unusually passionate and persistent. They didn't have the community of support that they might have now and had day to day challenges, facing criticism and hardship. I have a great appreciation for scientists of yesterday for sure but also what the process of science involves and so that part I would say is still alive in science today.*

Rekindled science interest/motivation (n=10)

- *It's not that I want to become a scientist now (laughs), but it encouraged me to encourage kids in our family to learn more and pursue science. I like these kinds of films because they help kids dream and see what they can accomplish.*
- *I love science, I feel like I am naturally curious like a scientist but I have a greater appreciation for what it takes to observe nature and have a singular purpose to be able to prove anything specific at all. To advance knowledge I have a better sense of what it takes to be able to prove your case and the dedication involved in getting there as well as the process it takes.*
- *It's been a while since I've thought about scientists and science. I came here today to the museum to scope it out for my grandson. I found myself enthralled. I saw a Leonardo Davinci exhibit and that was great but the Amazon film description drew me in. I just hadn't thought about the explorer aspect it all and the level of scientific process involved in discovery and proving a theory. the level that this man, Dr. Bates, went to was amazing. He was consumed by passion, much like artists are, so I found this reinforced my early thinking about science, a view I had long ago but somehow had lost track of. seeing it relate to my being an artist helped personalize the connection. Of course I was hoping to see a woman figure into all this. There was the story of friendship, help from a guide, the store keeper, Darwin, all men though, so I just didn't see that and I had hoped too. Guess it wasn't in the story though*
- *When you see the word science you typically think white coat in the lab and dry. When you see Bates in the field there are many different types of scientific process happening. It brings science to life.*
- *I've always had great admiration for scientists and the sacrifices they make not just physically but also intellectually and the ridicule they face. History is my passion so I came into the film with all of this but I was amazed at how much Bates suffered*
- *yes and no. I come from a science background so I read about Darwin and even Bates but I still found it enduring and it re-energized my love of science and the scientific method.*
- *I feel more motivated because I am a scientist.*

The film didn't affect thoughts or feelings about science or scientists (48%)

Already knew/understood/felt this way (n=16)

- *I already felt that scientists were good leaders and could be passionate and do great things in the field but I can see the value for others who may not have this perspective.*
- *I always hold scientists in high esteem. My husband is a scientist – an engineer. My best friend is an epidemiologist. And I thought about majoring in biology in college but I wasn't smart enough, so I did graphic design instead. Growing up in the 60s, science was extremely important in terms of helping humanity. It only benefits humanity. So I treasure science, we really need to listen to scientists or else (makes sinking whistle sound) that's going to be the way of the future.*
- *Not in a bad way though. It didn't change things because I already felt this way. It did reinforce my understandings though. I took a history of evolution class in college, so this was all familiar. I liked seeing the story in a movie like this.*
- *I am already very pro-science. We live in a very anti-science time though, which is why these kinds of films are important.*
- *I'm fairly educated, and believe in evolution and species change and natural selection and know how scientists works so I'm already in that camp I'd say.*
- *I'm a retired marine biologist. The film deepens my appreciation for nature, but not for science or scientists. Also, the dogmatic presentation of evolution [in the film] saddens me. Mutations would be lethal, they wouldn't lead to a new species.*



Phase 3: Follow-up evaluation of extended impact

To explore the longer-term impact of the *Amazon Adventure* film, a follow-up online questionnaire was sent to Viewers who: a) completed a post-viewing survey, b) completed a post-viewing interview, and c) indicated that they were willing to be contacted via email and an online questionnaire to provide additional feedback on the film within 3-4 weeks. Phase 3 of the summative evaluation focused on the question areas outlined in Table 15.

Table 15. *Amazon Adventure* follow-up question categories

Question category	Questions
Post-viewing film conversations, related media experiences, and thought given to film	<ul style="list-style-type: none"> • <i>Did Viewers talk with others about the film and if so what did they talk about?</i> • <i>Were Viewers reminded of the film when engaging in other media?</i> • <i>Did Viewers continue to think about the film in the weeks after watching, and if so what did they think about?</i>
Most memorable aspects of the film	<ul style="list-style-type: none"> • <i>What aspects of the film’s story of Henry Bates as a scientist stood out to Viewers?</i> • <i>What aspects of the character of Henry Bates stood out to Viewers?</i> • <i>What did Viewers identify as the most important things they learned or took away from the film?</i>
Post-viewing thoughts about nature and mimicry	<ul style="list-style-type: none"> • <i>Did Viewers think about nature differently?</i> • <i>Did Viewers think about the concept of mimicry (or any other film concepts) in their observations of nature?</i>
Post-viewing efforts to follow up on film topics	<ul style="list-style-type: none"> • <i>What topics from the film did Viewers follow up on?</i> • <i>What online activities did Viewers do related to the film?</i>

Method

Recruitment

Viewers who completed an interview were informed of the opportunity to participate in the follow-up survey at the end of their interviews. The invitation requested that respondents share their name and email address if they were interested in participating in a brief online questionnaire in 3-4 weeks. They were informed that they would receive a \$12 gift certificate to amazon.com as a thank you for their participation.

Participants

Table 16 presents basic demographic and background information for the 20 Viewers who participated in the follow-up survey. The group was generally balanced in terms of gender and the two main age groupings of 18-40 and 41 and above. About two-thirds were White. Four-fifths had a college or graduate school degree or experience and more than half had a biology course at or beyond the college level. The group as a whole had prior giant screen film viewing experience, with more than four-fifths having seen at least three films before.

Procedure

Within 3-4 weeks of their seeing the film, an email with a link to the [online questionnaire](#) was sent to 29 interviewed Viewers who provided contact information for the follow-up survey. A total of 20 completed the online questionnaire within the evaluation timeframe, resulting in a completion rate of 69%.

Data analysis and reporting

Basic descriptive statistics were conducted on the quantitative data gathered from participants' ratings and background information. Two evaluators prepared the qualitative analysis of open-ended responses. The analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

Table 16. Follow-up Viewer demographic and background information

Demographic/ background factor	Categories	Participants (n=20)
Gender	Female	50%
	Male	50%
Age group	Age range	18-81
	Mean	45
	18 -40	50%
	41 and above	50%
Racial/ethnic group	White	65%
	Asian	10%
	Multiracial	10%
	African-American/Black	5%
	Native American Indian or Alaskan Native	0%
	Native Hawaiian or Pacific Islander	0%
	Other	0%
	Hispanic origin	10%
Highest level of education	Less than high school	5%
	Completed high school or equivalent	15%
	Some college or degree	40%
	Some graduate school or degree	40%
Last biology course	Never	5%
	High school	30%
	In college, another major	40%
	Majored in college	0%
	Graduate school	25%
Number of giant screen films viewed	0	5%
	1	5%
	2	5%
	3	20%
	4 or more	65%

Findings

Post-viewing film conversations, related media experiences, and thought given to film (1.1 - 1.4)

- Three-quarters of the 20 Viewers who completed an online survey within 3-4 weeks of seeing the film said they talked to at least one person about the film. The majority of these Viewers said they talked to family members or friends. Most often they talked about Bates' story and/or recommended the film.
- Three-fifths of the Viewers said they were reminded of the film while watching something on television, online, or in a movie or video. One-fifth were reminded of the film while reading something, such as a book, magazine, newspaper, or online article. One Viewer was reminded of the film while listening to something on the radio, online, or on a podcast.
- Nine-tenths of the Viewers said they thought about the film to at least some extent in the weeks since viewing. More than two-thirds said they thought about the row of eight butterflies, while somewhat smaller groups, though still more than one-third in each case, thought about one or more of the following: the obstacles/struggles Bates faced, specific scenes they liked, the film's reenactment feature, and/or their perceptions of science or scientists.

Most memorable aspects of the film (1.5 - 1.7)

- When asked about the aspects of the film's story of Henry Bates' life as a scientist that still stood out to them 3-4 weeks after viewing, four aspects were each mentioned by about one-third of the group: Bates' scientific process, his dedication, his contribution to biology fields, and/or his passion. Smaller groups pointed to his childhood science interest or other aspects of his life. When asked about the aspects of Henry Bates' character that still stood out to them, three-fifths pointed to his overall perseverance/dedication to his work, two-fifths each pointed to personal sacrifices/hardships he endured or his intellect/curiosity, and one-fifth or less each pointed to his passion and/or his sense of adventure.
- Viewers often identified more than one important thing that they learned or took away from the film. More than four-fifths were left impressed with valuable life lessons or inspiring messages, including ideas such as *never give up*, *dream big*, *hard work pays*, *grit brings results*, and *follow your passion*. More than two-thirds each took away a greater appreciation of Bates' historical significance and/or gained increased knowledge of evolution, natural selection, and/or mimicry. Two-fifths each pointed to having a greater appreciation for science and/or the wonder/beauty of nature. A few Viewers took away something about the giant screen format or mentioned something else.

Post-viewing thoughts about nature (1.8 - 1.9)

- The group was evenly divided on whether they thought about or looked at nature differently in the few weeks since viewing. Those who felt they *did* look at nature differently most often pointed to having a greater appreciation for, awareness of, and/or sense of wonder about nature. Those who felt they *didn't* see nature differently most often pointed to having a prior awareness or appreciation.
- When asked if they had thought about mimicry in their observations of nature in the few weeks since viewing, not quite half said *yes*, one-quarter said *no*, and less than one-third said they *hadn't yet had* a chance to observe nature. Those who said they *had* thought about mimicry most often described looking for examples in nature and noticing the different forms mimicry can take. Those who said they *hadn't* indicated that they were already aware of mimicry, hadn't come across examples, or hadn't thought it about since seeing the film.

Post-viewing follow up of film topics (1.10 - 1.11)

- Although no one topic was followed up on by the majority of Viewers, each of the seven listed areas of possible follow up were mentioned by at least one-fifth of the group. Between one-quarter and one-half said they looked into Henry Bates' scientific work, his personal life, the Amazon, and/or animals featured in the film. Slightly smaller groups of one-fifth each said they looked into mimicry, how species change, and evolution or natural selection. About a third of the Viewers indicated that they hadn't followed up on any of these topics.
- Similarly, although no one online activity was pursued by the majority of Viewers, four different activities were mentioned by at least one-fifth of the group. Between one-quarter and one-third "Googled" or searched topics featured in the film and/or looked for information about the film on the Web or social media. One-fifth each tweeted, blogged, or used Facebook to discuss the film and/or visited the *Amazon Adventure* website. One Viewer "Liked" the film's Facebook page, while a couple of Viewers did other activities online such as visiting Wikipedia to learn about Henry Bates. Half of the Viewers indicated that they hadn't engaged in any of these online activities.

To explore the extended influences of the film, the subset of 20 Viewers who completed the follow-up online questionnaire 3-4 weeks after viewing were asked several forced choice and open-ended questions focused on the following four general areas: their film conversations, related media experiences, and thoughts about the film; the most memorable aspects of the film that still stood out for them; their thoughts about nature and mimicry since viewing; and their efforts to follow up on film topics. Findings are presented below in 1.1 – 1.11.

1.1 Whether talked about the film

As Figure 34 shows, three-quarters (75%) of the Viewers said they talked to at least one person about the film in the weeks since watching. Among this group of 15, the majority said they talked to family members (n=10) including spouses, kids, parents, or siblings. Several said they talked to friends (n=6). A couple of Viewers said they talked to colleagues (n=1) or didn't specify (n=1).

Among this group who talked to at least one person, just over half (n=8) said they talked about Bates' story and just under half (n=7) said they recommended the film to others. Smaller groups of Viewers said they talked about the film's portrayal of the dedication of scientists (n=3), the film's focus on mimicry (n=2), the film's nature scenes (n=2), or said they summarized the content of the film to another (n=2). Examples of their comments are in Table 17.

Figure 34. Whether Viewers talked to anyone about the film (n=20)

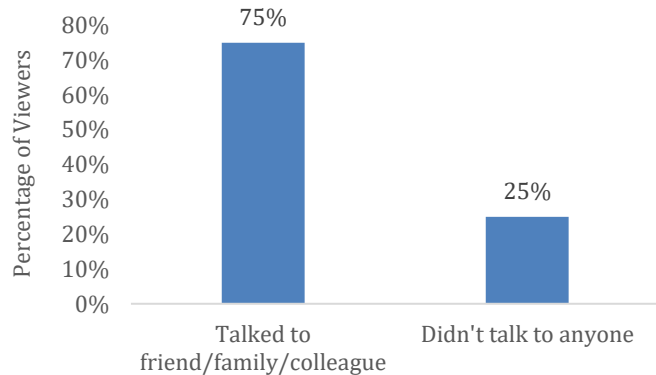


Table 17. What about the film Viewers said they talked about to others (n=15)

Bates' Story (n=8)

- *I told my parents about the film and how much they would enjoy it - especially my father who loves history and nature. I also talked with my close friend about the film and recommended she go and take her kids. We were talking about the flu virus and how it mutates into different strains, which made me think of the worm that evolved to look like a snake for survival. I told her about this and how the spots on the caterpillar were random and didn't resemble a snake at first, but how the ones that didn't have this pattern got eaten, so the worms that had spots like a snake survived, and that is how they evolved. We talked about how maybe the flu virus is just trying to survive. Scary, but thrilling. I also told her how Henry Bates needed evidence to prove how species evolved and that he spent years, and sacrificed his health even, to finally find proof in a row of butterflies that showed the progression of how they changed over time.*
- *I encouraged many friends of mine (single, married and few who has kids) to watch the movie. It was very enlightening to me to know about Henry Bates. I was a science major and have studied evolution during my college education. Learning about life of Henry Bates was very inspiring because he lived a tough life in Amazon proving the theory of evolution.*
- *I talked to my girlfriend about the film. I told her what I said in my first interview after the film: I like it, but my favorite omni films about nature are focused on the flora and fauna and the threats that they face. I had never heard of the man that the story focused on and that was interesting, but my preference for films on a massive screen with a massive audio system are to be more in the vein of the Planet Earth series.*

Suggested/recommended it (n=7)

- *Yes. Friends. How interesting the story was and what we learned from the Amazon Adventure. We recommended that they go see Amazon Adventure.*
- *I encouraged many friends of mine (single, married and few who has kids) to watch the movie. It was very enlightening to me to know about Henry Bates. I was a science major and have studied evolution during my college education. Learning about life of Henry Bates was very inspiring because he lived a tough life in Amazon proving the theory of evolution.*
- *I spoke with a friend who has a child interested in Darwin - I recommended the movie because I thought it might shed some information in an entertaining way.*

Dedication of scientists (n=3)

> About how the information we receive sometimes comes from people who risk their lives and who are passionate about nature and animals.

Mimicry (n=2)

I told my parents about the film and how much they would enjoy it - especially my father who loves history and nature. I also talked with my close friend about the film and recommended she go and take her kids. We were talking about the flu virus and how it mutates into different strains, which made me think of the worm that evolved to look like a snake for survival. I told her about this and how the spots on the caterpillar were random and didn't resemble a snake at first, but how the ones that didn't have this pattern got eaten, so the worms that had spots like a snake survived, and that is how they evolved. We talked about how maybe the flu virus is just trying to survive. Scary, but thrilling. I also told her how Henry Bates needed evidence to prove how species evolved and that he spent years, and sacrificed his health even, to finally find proof in a row of butterflies that showed the progression of how they changed over time.

Nature/Amazon content (n=2)

> *I talked with some co-workers and people with children. We discussed about how this would be an entertaining and educational film for people with a nature sense and how their children can get some science and nature lessons from it.*

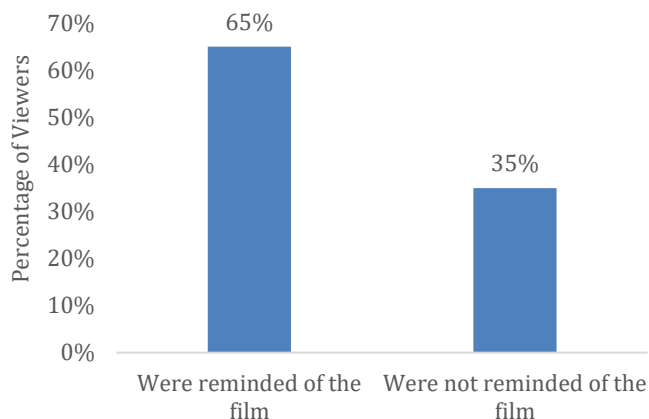
Summarized film (n=2)

> *Talked about it with my husband and with my daughter. They asked me what the movie was about and I told them.*

1.2 Related media experiences

As Figure 35 shows, two-thirds (65%) of the Viewers said they were reminded of the film by various media in the weeks since watching. Among this group of 13, all but one said they were reminded of the film while watching something on television, online, or in a movie or video (n=12). A few said they were reminded of the film in something they read, such as a book, magazine, newspaper, or online article (n=4). One Viewer was reminded of the film while listening to something on the radio, online, or on a podcast.

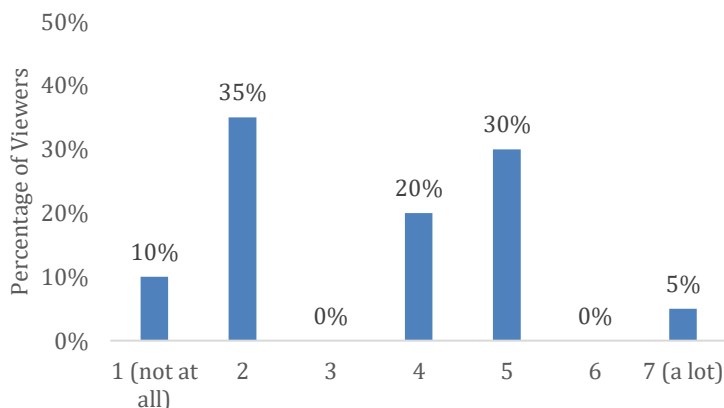
Figure 35. Whether Viewers were reminded of the film when engaged in various media experiences (n=20)



1.3 How much thought given to film

Figure 36 shows that nearly all (90%) of the Viewers surveyed indicated that they thought about the film to some extent in the weeks since viewing. On a scale from 1.0 (*not at all*) to 7.0 (*a lot*), their ratings ranged from 1 to 5, with a median rating of 4.

Figure 36. How much Viewers thought about the film in the weeks since viewing (n=20)



1.4 Aspects of the film thought about

Figure 37 shows the aspects of the film that Viewers thought about in the weeks since viewing. Most often they thought about the row of eight butterflies shown at the end of the film (70%), followed by the obstacles/struggles Bates faced (45%), specific scenes they liked (40%), the reenactment feature of the film (35%), and/or their perceptions of science or scientists (35%).

When asked to describe what else, if anything, they thought about, a few additional themes emerged. A few each said they thought about the immersive theater experience (n=3), the visual elements of the film (n=2), or other aspects of the film (n=3). A sampling of Viewers' comments on all of the above themes follow in Table 18.

Figure 37. Aspects of the film Viewers thought about in the weeks since viewing (n=20)

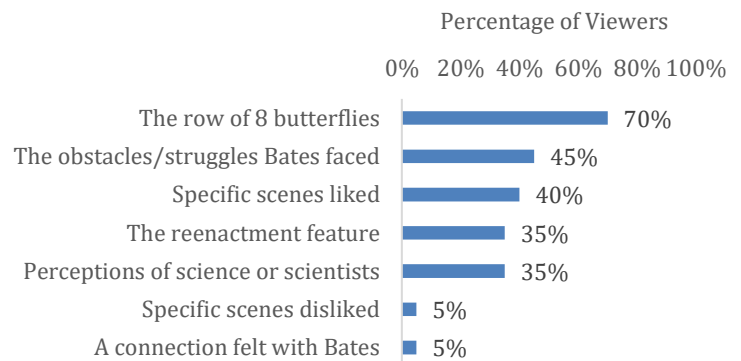


Table 18. What Viewers said they thought about (n=20)

The row of eight butterflies (n=14)

- *Our family talked about whether the lining up of the butterflies is actually evidence that they evolved that way or simply reflecting the wide variety of morphologies among the butterflies.*
- *It was interesting to see him put together the correlation between the different butterflies in his collection in order to prove a point about natural selection*
- *The butterfly scene and what was involved in having to show the links. What it took Bates to do this.*
- *The row of butterflies stuck in my mind as proof of how species evolve and change.*
- *The eight butterflies were the perfect ending.*
- *Used the butterflies as an example in a discussion.*
- *I believe he observed the row of butterflies and wrongly concluded that because outer characteristics appeared to change in a periodic or linear fashion, it represented an evolution from one species to another.*

The obstacles/struggles Bates faced (n=9)

- *He sacrificed his health for his scientific pursuits.*
- *Thinking of the struggles of discovery and the sacrifice that pioneering exacts.*
- *I thought about passion and curiosity and how Bates followed his dream despite the struggles. Inspiring.*
- *I appreciated Henry Bates' struggles as he worked so hard to search for specimens and diligently took notes, and felt heartbroken when his work was washed away on the boat. I also appreciated him as a scientist and how his passion for science motivated him to keep going even after he was sick and money ran out.*
- *I keep thinking of scientist life in that era. What kind of financial support they had and how they survive the tough life. It is intriguing to think how they were able to keep their faith in theories which goes against various religious belief, and still kept working to prove them.*

Specific scenes liked (n=8)

- *I have thought about the natural setting and animals, insects, etc that were in the film. Seeing them close up. Watching them move. The jungle. I also liked the scenes with the "shops" and stores because I like that time in history and all the cool stuff in them.*
- *I really enjoyed the scenes that showed the wildlife in the Amazon area because I thought it added some excitement and beauty to the movie (especially the sloth footage)*
- *I liked the scene when Henry Bates meet Darwin. There [is not much] dialogue but seeing two amazing scientists coming together is iconic moment and kind of complimenting.*

The reenactment feature (n=7)

- *I enjoyed learning about Henry Bates, of whom I had not heard before.*
- *I liked how the end of the film showed the beginning of Henry Bates' friendship with Charles Darwin. It made me want to learn more about their relationship and continue the story.*
- *The story was certainly interesting but the reenactment did not ring entirely true.*

Perception of science or scientists (n=7)

- *I was wondering how my daughter was viewing Henry as a scientist and if she could relate to his exploration with any of her experiences hiking in the woods. Planting seeds for growth!*
- *The film reminded me of the important work that scientists and naturalists do and their contribution to continuing knowledge.*
- *I have worked in scientific research for 7 years and my husband is a scientist. I totally understand the hard work scientist put to prove a theory, do years of research before a drug comes to market, or a basic scientist working on cellular level trying to come up with theories through various experiment. It is a noble profession requiring tons of patience along with brilliant mind.*
- *It made me think about how hard scientists work and it drove home the idea that this work took a lifetime and was not about instant gratification.*

Immersive theater experience (n=3)

- *Being immersed in the experience of the adventure at the Omni Theater.*
- *I got to visit a rain forest by watching in a theater.*

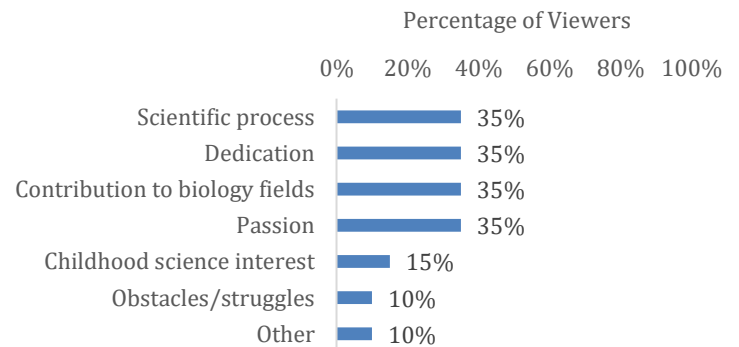
Visual elements (n=2)

- *The photography was a perfect complement to the story.*

1.5 Aspects of Henry Bates' life as a scientist that stood out

Figure 38 shows the aspects of the film's story of Henry Bates' life as a scientist that stood out to Viewers a few weeks after watching the film. Four aspects of his story were each mentioned by more than one-third of the Viewers, including his scientific process (35%), dedication (35%), contribution to biology fields (35%), and/or his passion (35%). Smaller groups pointed to his childhood science interest (15%), his obstacles/struggles (10%), or other aspects (10%).

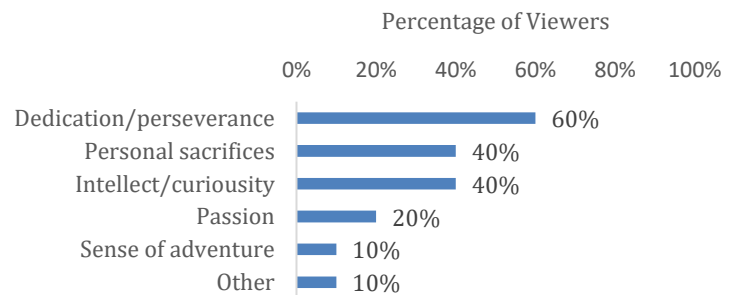
Figure 38. Aspects of Henry Bates' life as a scientist that stood out for Viewers (n=20)



1.6 Aspects of Henry Bates' character that stood out

Figure 39 shows the aspects of Henry Bates' character that stood out to Viewers a few weeks after watching the film. Most often they pointed to his dedication/perseverance (60%), personal sacrifices (40%), and/or his intellect/curiosity (40%), followed by his passion (20%), sense of adventure (10%), and other aspects of his character (10%).

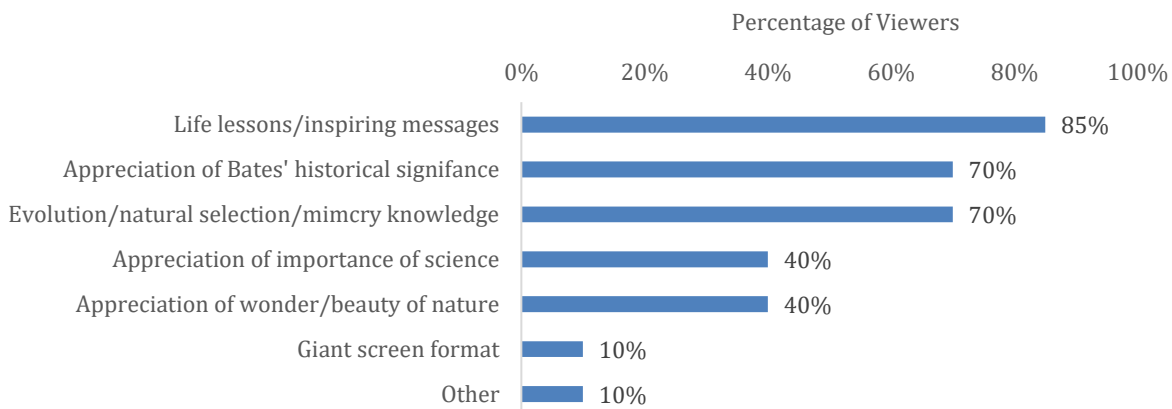
Figure 39. Aspects of Henry Bates' character that Viewers thought about in the weeks since viewing (n=20)



1.7 Most important takeaways from the film

Figure 40 shows what Viewers pointed to as the most important things they learned or took away from the film since viewing. Most (85%) felt they were left impressed with valuable life lessons or inspiring messages, including ideas such as *never give up*, *dream big*, *hard work pays*, *grit brings results*, and *follow your passion*. Most also indicated they took away a greater appreciation of Bates' historical significance (70%) and/or increased knowledge of evolution, natural selection, and/or mimicry (70%). Somewhat smaller groups pointed to having a greater appreciation of science (40%) and/or the wonder/beauty of nature (40%). A few Viewers pointed to an aspect of the giant screen format (10%) and/or felt they took away something else (10%).

Figure 40. What Viewers thought were the most important takeaways from the film in the weeks since viewing (n=20)



1.8 Whether nature was thought about or looked at differently

Figure 41 shows whether Viewers said they thought about or looked at nature differently in the few weeks since watching the film. The group was evenly divided on this question.

The ten Viewers who felt they *did* look at nature differently most often pointed to having a greater appreciation, awareness, and/or sense of wonder about nature. The ten Viewers who felt they *didn't* see nature differently most often pointed to their prior awareness or appreciation, with a couple of Viewers noting that the film didn't make a particularly strong impression on them in this regard. Viewers' comments are provided in Table 19 on the next page.

Figure 41. Whether Viewers thought about nature differently after viewing (n=20)

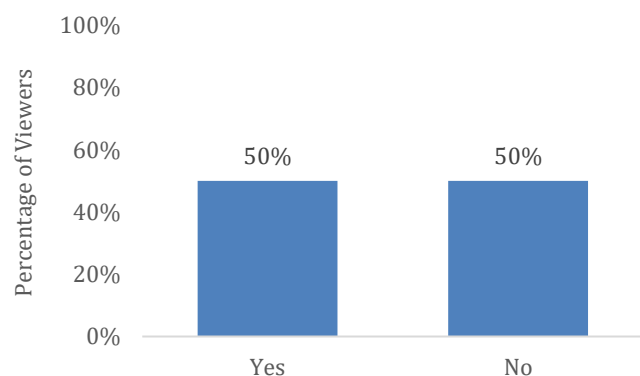


Table 19. Whether Viewers felt they thought about or looked at nature differently in the weeks since viewing (n=20)

Looked at nature differently (n= 10)	Didn't look at nature differently (n=10)
<ul style="list-style-type: none"> ➤ Greater appreciation of its complexity, awestruck by evolution and role of mimicry in nature. ➤ How different creatures today have evolved and what caused them to develop the features that they have today. ➤ How scientific contribution can come from simple but dedicated observation and persistence. Inspired me to try! ➤ I knew about mimicry before, but now I find myself looking for examples. ➤ I look at species and wonder how they evolved from other species ➤ Nature is very intriguing hiding so many secrets. ➤ Outside with my kids I've looked at trees and moss and thought about how long they have been growing this way and that they always have a purpose. ➤ That if I were to collect a large sampling of some species, I might observe natural selection in "real time" unlike man who took millions of years to evolve. ➤ The biggest part of being a scientist is observation and questioning why things work as they do. ➤ Yes, I like to see little things outside my back yard, like birds, insects 	<ul style="list-style-type: none"> ➤ Being an Eagle Scout, our Outdoor Code makes us fully aware of our surroundings and our need to leave things as nature intended. ➤ I have a degree in biology and already think this way ➤ I have always liked nature ➤ I think that I have a fairly progressive view of nature. I already love animals, nature docs, believe in science. ➤ I was aware of the concept and am in awe of the concept of evolution ➤ I'm not sure there has been a substantial difference in how I think about nature. ➤ It didn't make that strong of an impression on me ➤ Nature appears to me the same before and after watching the film, although the film showed the beauty and complexity of our world in a wonderful way. ➤ The movie reinforced existing opinions rather than created new ones. ➤ While mostly well done, the movie didn't teach me anything new.

1.9 Whether mimicry was thought about when observing nature

Figure 42 shows whether Viewers said they thought about mimicry in their observations of nature in the few weeks after watching the film. Nearly half (45%) said yes, 30% said they hadn't yet had a chance to observe nature, and 25% said no.

The nine Viewers who said they *had* thought about mimicry when observing nature most often described looking for examples in nature and/or noticing the different forms mimicry can take. The five Viewers who said they *hadn't* thought about mimicry while observing nature said they were already aware of mimicry, hadn't come across examples, or hadn't thought it about since seeing the film.

Viewers' comments are provided in Table 20 on the next page.

Figure 42 . Whether Viewers thought about the concept of mimicry in their observations of nature since viewing (n=20)

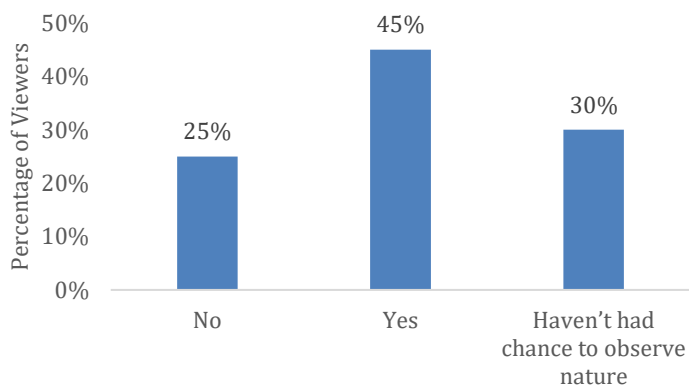
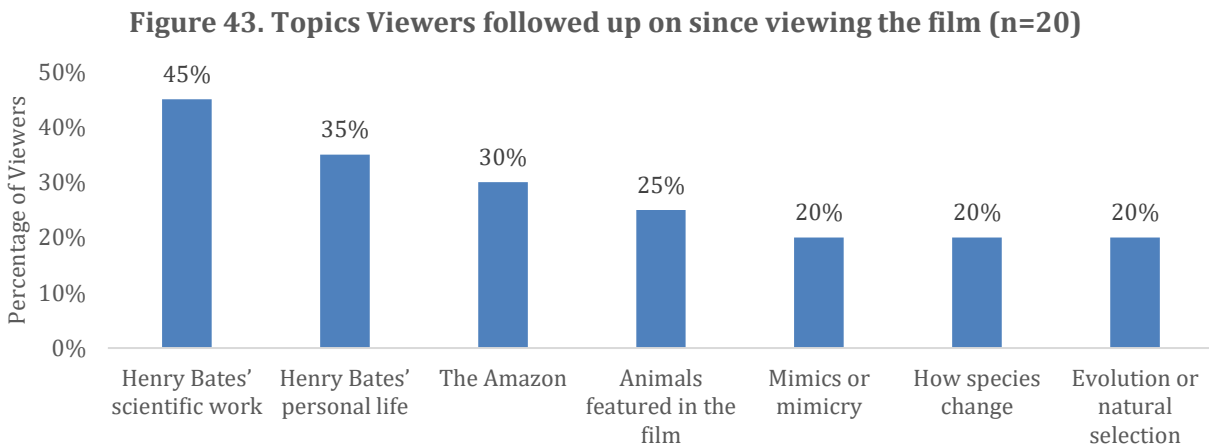


Table 20. Whether Viewers felt they thought about the concept of mimicry in their observations of nature since viewing (n=20)	
Thought about mimicry (n=9)	Didn't think about mimicry (n=5)
<ul style="list-style-type: none"> ➤ How everything is connected or similar in a way...veins in the human body looking like veins in leaves. ➤ found about other species who does mimicry- Western hognose snake, tiger pistol shrimp etc. ➤ I think of the ape that has learnt how to communicate using sign language and birds who use tools such as sticks and stones to break objects they need to eat ➤ I've just looked for examples - realizing how many there are around us. ➤ I've looked for examples, not been too easy to see except for stick bugs where I live! ➤ I've thought about how it isn't just looking different with mimicry, it can be a lot of different ways of resembling, so how an animal acts, tastes, etc....it can be complex. ➤ Mimicry is a powerful protection for defenseless species. it is clearly observable throughout the animal kingdom. I think that there is a butterfly that mimics an owl - how wonderful is that! ➤ More like a notice. But again, it's nothing new. Most of us learned about the moths in England during the industrial revolution in school. ➤ The film made me start to question how certain aspects and tendencies of animals came forth to what we see today. 	<ul style="list-style-type: none"> ➤ Because I was already aware of mimicry and other concepts ➤ Have not come across examples recently ➤ I haven't thought about mimicry in nature since the film. Also, haven't been out in nature during the winter. ➤ Not sure.

1.10 Whether topics from the film were followed up on

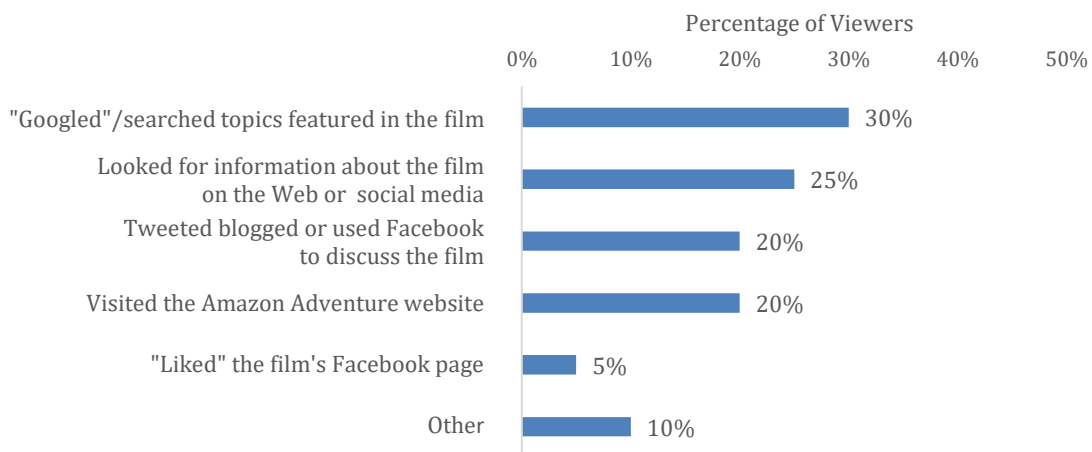
Figure 43 shows whether Viewers followed up on specific topics from the film. Although no one topic was followed up on by most Viewers, one-fifth or more of the group said they followed up on each of the seven topics listed as possible areas of follow up. Henry Bates' scientific work (45%) and his personal life (35%) were most frequently mentioned, followed by the Amazon (30%) and animals featured in the film (25%). Slightly smaller groups of one-fifth each (20%) said they looked into mimics or mimicry, how species change, and/or evolution or natural selection. Finally, though not shown in Figure 43, about a third (30%) of the Viewers indicated that they hadn't followed up on any of these topics.



1.11 Whether online activities related to the film were pursued

Figure 44 shows whether Viewers engaged in any of the five possible online activities they were asked about related to the film. Although no one activity was pursued by the majority of Viewers, nearly one-third (30%) "Googled" or searched topics featured in the film; while one-quarter (25%) looked for information about the film on the Web or social media; and one-fifth each (20%) tweeted, blogged, or used Facebook to discuss the film and/or visited the *Amazon Adventure* website. One Viewer "Liked" the film's Facebook page, while a couple of other Viewers did other activities online such as visiting Wikipedia to learn about Henry Bates. Finally, though not shown in Figure 44, half (50%) of the Viewers indicated that they hadn't engaged in any of these online activities.

Figure 44. Film-related online activities Viewers pursued since viewing (n=20)



Some of the Viewers shared comments about what they looked into while online, as follows:

- *I shared the Amazon Adventure page ... with my friends and said how much I enjoyed the film with my kids.*
- *Researched to see if it would be available to purchase in the future.*
- *Think about it, and recommend the movie. But I was looking into more about his story.*
- *I wanted to learn more about Bates' life, so I googled to learn more. It didn't even occur to me that there were social media accounts about the movie.*
- *Always curious about historical characters in films. Read the Wikipedia article.*
- *I read the Wikipedia article on Henry Bates.*
- *I have shared this film with colleagues and friends on social media. The website was a great help as to sending them to a place to better explain my reactions and findings.*
- *I wanted to learn more about Henry Bates. I had never heard of him previously.*



Discussion

The summative evaluation gathered audience feedback on *Amazon Adventure* at four science center or museum theaters in three phases: (1) on-site pre-viewing questionnaires with 212 adults (Pre-Viewers) and post-viewing questionnaires with 229 adults (Viewers); (2) on-site interviews with 33 Viewers who had completed the post-viewing questionnaire; and (3) follow-up online questionnaires with 20 Viewers who had previously been interviewed.

The evaluation results indicate that the film was well-received and had a positive impact on the adult audience recruited for the evaluation, both overall and within each of the three impact areas detailed in the introduction of this report: science learning, narrative engagement, and spatial presence. This Discussion section reflects on the findings that emerged in each area across the three phases of evaluation.

Science learning

Science knowledge and curiosity

The theater-based evaluation with 441 adults showed that Viewers of *Amazon Adventure* significantly outperformed Pre-Viewers on a set of content questions designed to assess science learning from the film relating to Henry Bates' scientific quest in the Amazon, mimicry, and species change. Not only was there a statistically significant impact of the film on immediate science knowledge, but the size of the overall effect was large and was not influenced by demographics or background characteristics. Exposure to *Amazon Adventure* created a substantially meaningful gain in science knowledge such that the average test score of the Viewer group exceeded 99% of test scores of the Pre-Viewer group.

As additional evidence of impact on learning, post-viewing interviews with the subset of 33 Viewers found that nine-tenths of those interviewed could explain that the row of eight butterflies Bates pulled from his collection at the end of the film provided evidence that one species changed or evolved into a new species. This is an understanding that is critically important to the film's success, as it speaks to the goals of the *Amazon Adventure* project. As summarized in the NSF proposal (2014), the project aimed "...to [showcase] the scientific evidence of biological mimicry that acted as critical proof for natural selection and, in turn, evolution."

Bates' row of eight butterflies also left a lasting impression. When the 20 Viewers who went on to complete the follow-up questionnaire were asked if they had thought about any aspects of the film in the 3-4 weeks since viewing, more than two-thirds pointed to the row of butterflies. This aspect of the film was mentioned more than any other aspect.

When this same follow-up group was asked to reflect on the most important things they learned or took away from the film since viewing, more than two-thirds each pointed to: life lessons/inspiring messages that still resonated with them; having a greater appreciation of

Bates' historical significance; and increased knowledge about evolution, natural selection, and mimicry.

The film also influenced many Viewers' subsequent experience with nature. Half of the follow-up group reported thinking about or looking at nature differently, most often feeling a greater appreciation for, awareness of, and/or sense of wonder about nature. Nearly half reported thinking about mimicry, most often looking for examples in nature and/or noticing different forms that mimicry can take.

Seeing *Amazon Adventure* also sparked many Viewers' curiosity enough to encourage further self-directed science learning in the weeks following their viewing. More than two-thirds of this group followed up on one or more film topics. Nearly half looked into Henry Bates' scientific work and more than one-third followed up on something related to his personal life. Somewhat smaller groups looked into the film's science topics relating to: the Amazon, showcased animals, mimicry, how species change, and/or evolution or natural selection.

Looking across the three phases of evaluation, Viewers' top of the mind learning from and lingering curiosities about topics featured in *Amazon Adventure* support an observation made by Russell and Jacobsen (2002) nearly twenty years ago relating to the learning potential of giant screen films:

While viewers value the thrills and sense of immersion that are fundamental to the giant screen experience, they also look to giant screen films for their educational values and inspirational qualities (p. 74).

Perceptions of scientists/science

Viewers surveyed immediately following the film were significantly more likely than Pre-Viewers to list four personality characteristics that they thought were important for scientists to have: perseverant, passionate, courageous, and observant. These are all important scientist attributes portrayed by the Henry Bates character in the film. This finding adds to results from other giant screen film evaluations in which onscreen scientists are similarly described by audience members as dedicated, persistent, and passionate (Flagg, 2017).

About half of the interviewed Viewers said they already had a positive view of scientists and that the film's portrayal reflected their existing views, whereas the other half reported that they felt differently about science or scientists after watching the film. Most noted that the film gave them an increased appreciation for the challenges and struggles scientists face and/or that it rekindled their interest or motivation to engage in science. This *Amazon Adventure* result with adults complements recent findings with students in which stories modeling how scientists achieve success through failures yielded improvement in students' science learning and motivation (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016).

In the follow-up questionnaire, when Viewers were asked to describe any aspects of the film's story of Henry Bates' life as a scientist that still stood out to them weeks later, four aspects were each mentioned by about one-third of the group: Bates' scientific process; his dedication; his contribution to biology fields; and his passion. When asked if there were any aspects of Henry Bates' character that still stood out to them, more than half pointed to his

dedication/perseverance, while between one-fifth and two-fifths each pointed to: his personal sacrifices; his intellect/curiosity; and his passion.

These findings highlight the educational value of the film's use of a biographical narrative with a lead scientist character and the use of historical reenactments. Given the apparent staying power of Henry Bates' story weeks after viewing, future studies might look more closely at the role that these production elements play in having an extended influence on the audience's perceptions of science and scientists.

Narrative engagement

Story and character involvement

Viewers surveyed immediately after exiting the theater indicated that they experienced a high level of narrative engagement while watching the film. Their ratings showed a high level of involvement with both the Henry Bates' story and his character. One subgroup difference was detected as those who had last taken a biology class in college or beyond reported feeling significantly higher levels of involvement than did those who never took biology or last took it in high school. Perhaps more exposure to formal biology made the film's story more comprehensible and thus more involving. Although this is one possible interpretation of the finding, it is important to note that the statistical difference detected was a small effect. Additional studies are needed to explore how viewers of different backgrounds and demographics experience narrative engagement when watching a giant screen film. The lack of studies in this area is not surprising considering that to date most of the NSF-supported giant screen films have not utilized the classic three-act narrative structure but instead featured a series of related thematic vignettes, typically about locations, natural events, animals, or science phenomena.

From a qualitative standpoint, the evaluation findings provide some additional evidence of the ways in which Viewers became involved with Bates' story and character. Of the interviewed Viewers, four-fifths indicated that they felt a connection with Henry Bates, most often noting that they either shared in or felt inspired by Bates' adventurous spirit and/or passion or felt connected to Bates' process of scientific inquiry. These Viewers generally agreed that the reenactment features and seeing Bates face obstacles in his life and career helped elicit these feelings. In particular:

- *Reenactments*: Those commenting on the reenactments most often observed that they helped personalize Bates' story by seeing it through his eyes and/or indicated that the reenactments made the science more interesting, with some elaborating that the reenactments helped them see the scientific process and methods that Bates used depicted visually. This result adds to findings from recent studies that have shown dramatic historical reenactments to be an effective production method in enhancing audience feelings of engagement as well as interest in and understanding of film content (Glaser, Garsoffky, Schwan, 2012; Knight Williams Inc., 2016).
- *Bates' struggles*: Those commenting on Bates' struggles most often said that the film's portrayal of the obstacles Bates faced made him seem more relatable. Some further observed that dealing with struggle and challenges is part of the human experience, while others felt Bates' experience with obstacles gave them a fuller understanding/greater

appreciation of the sacrifices he made (and/or that other scientists often make) to advance the field of science. Scientist struggle themes are common in educational media but little is known about their impact within a narrative storyline. A recent study by Lin-Siegler et al. (2016) found that depicting scientists' struggle stories was a promising way to enhance student motivation and science learning. As the authors reasoned:

The most impactful stories are usually detailed, honest, personal, and involve struggles: "When you want to motivate, persuade, or be remembered, start with a story of human struggle and eventual triumph" (Zak, 2014). Such stories are memorable because people become emotionally involved in the lives of the characters, see the world as they do, or imagine situations that may be similar to theirs. (p. 316)

Although the *Amazon Adventure* evaluation explored the reenactment format and the struggle theme in a limited way, the findings are encouraging and suggest that future studies look more closely at these approaches with adult learners in informal science settings.

Film and story appeal

The post-viewing questions that asked half of the Viewers to describe what they liked and disliked about the film and half to describe what they liked and disliked about the story of Henry Bates' scientific quest in the Amazon yielded more praise than criticism. In both Viewer groups, at least eight different appealing aspects were mentioned, and these typically related to the major qualities of the giant screen film as discussed in the background section of this report: the informative quality; the dramatic narrative; and the elicited feeling of being there. Those asked about the film liked learning about Bates' quest; the focus on Amazon wildlife; the storyline/dramatic narrative; the feeling that they were in the film; and the visual imagery (with many in this group commenting on the feeling of being immersed). Those asked about Bates' story commented on the film's informative quality - learning about Bates' scientific quest - and/or about the film's dramatic narrative revealing Bates as a person. Pointing to what was disliked about the film or story, one-sixth of respondents felt the film was too short and one-fifth cited some aspect of the storytelling.

When asked in the post-viewing interviews to describe the scenes they liked most from the film, no one scene stood out for the majority of Viewers, although six scenes were mentioned by between about one-fifth to two-fifths of the group. These scenes typically featured scientific content and reenactments, including: Bates' scientific process; animal close-up shots; mimicry examples; the tsunami scene where the boat capsizes; panoramic views of the Amazon; and the row of eight butterflies that Bates pulled from his collection at the end of the film. No one film scene was disliked by a majority of the group, although one-quarter each of the interviewed Viewers felt that the storyline and/or acting seemed overly dramatic or contrived at times; and another quarter felt concern, rather than dislike, during scenes where Bates' well-being was at stake.

In response to the follow-up questionnaire, Viewers revealed that the story and film stayed with them weeks after viewing. Nine-tenths of these Viewers indicated that they had thought about the film since their theater visit. Most often they thought about the row of eight butterflies; the obstacles/struggles Bates faced; specific scenes they liked; the reenactment features; and/or their perceptions of science or scientists.

Viewers further indicated that they talked about the film and connected it to other media experiences. Three-quarters of the follow-up group said they had talked to at least one person about the film. They most often talked about Bates' story and/or recommended the film to others, although some talked about the film's portrayal of dedicated scientists, the focus on mimicry, and Amazon nature/wildlife scenes. Three-fifths of Viewers were also reminded of the film while watching something on television, online, or in a movie or video, while one-fifth were reminded of the film while reading a book, magazine, newspaper, or online article.

Taken together, the *Amazon Adventure* appeal findings provide further support for an observation made by Korenic (2000) in her capacity as a museum director of educational programming. Reflecting on her knowledge of giant screen films shown in various science centers or museums around the country, she observed that "*Giant screen films have excellent audience appeal by their ability to create excitement, interest, and curiosity about a topic*" (p. 53). *Amazon Adventure* appealed to Viewers in these same ways.

Spatial presence

Viewers surveyed immediately following the film generally experienced a high level of spatial presence while watching *Amazon Adventure*, as indicated by their level of agreement with statements about the feeling of being in the Amazon such that their location had shifted and they were present, taking part in the action.

With respect to subgroup differences, older Viewers reported feeling significantly higher levels of spatial presence than did younger Viewers, and women reported feeling significantly higher levels of spatial presence than did men. The evaluation study was not designed to explore differential impacts of the film on subgroups, and the effects were small. Nonetheless, the findings suggest the need for future studies to understand how the feeling of spatial presence operates as a part of the experience of giant screen film viewing for different types of viewers.

Additionally, Viewers who saw the film in 3D on a flat screen reported feeling higher levels of spatial presence than did those who viewed the film on a 2D dome screen. Particular caution should be taken in interpreting the significance of this format finding, as this evaluation was not designed to investigate systematically the role of screen type on adults' experience of spatial presence with the goal of contributing to generalizable knowledge. Conversely, the research study associated with *Amazon Adventure* was designed to investigate the impact of different film formats, and the role of presence, in this case on middle students' science knowledge, interest, and identity after viewing the film (Nucci, pending).

Final remarks

In closing, this summative evaluation of *Amazon Adventure* recruited adults at four sites reflective of the typical audiences of North American giant screen theaters with respect to gender, age, race/ethnicity, and education (Giant Screen Cinema Association, 2014). The results indicate that the film was well-received and had a positive impact on this audience, both overall and individually on science learning, narrative engagement, and spatial presence.



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Appendix A. Evaluation Deliverables

Amazon Adventure Evaluation Deliverables Knight Williams Inc.		
Evaluation deliverable	When completed	Description
<i>Amazon Adventure</i> front-end report	December 2016	A front-end evaluation among prospective <i>Amazon Adventure</i> Science Educator Workshop attendees. This evaluation compiled responses from a short baseline survey shared with workshop attendees prior to the Pacific Science Center Science Educator Workshop. Completed by 22 educators, the goal of the baseline survey was to generate input that would guide the direction that Pacific Science Center took in planning the <i>Amazon Adventure</i> project.
<i>Amazon Adventure</i> rough cut public screening report	December 2016	A formative evaluation of a rough-cut version of the <i>Amazon Adventure</i> film with a public audience. This evaluation gathered feedback from 86 Pacific Science Center members and visitors who watched a rough-cut version of the film and provided feedback on the film’s appeal, clarity, and learning value through a post-viewing questionnaire.
<i>Amazon Adventure</i> rough cut educator screening report	December 2016	A formative evaluation of a rough-cut version of the <i>Amazon Adventure</i> film with a professional audience. This evaluation gathered feedback from 32 educators and representatives from science centers and museums in the U.S. and Canada who watched a rough-cut version of <i>Amazon Adventure</i> and provided feedback through a post-viewing questionnaire. This evaluation further explored the educators’ needs, experiences, and recommendations relating to the film and its potential learning value among their theater audiences.
<i>Amazon Adventure</i> workshop evaluation report	March 2017	An implementation evaluation of the <i>Amazon Adventure</i> Science Educator Workshop. This evaluation gathered 28 workshop participants’ reflections on: the workshop they attended at Pacific Science Center on December 15 and 16, 2016; a rough-cut version of the film they viewed; and related educational resources they reviewed, including a live stage presentation, mimicry game, and educational classroom poster.
ASTC conference presentation	September 2018	A presentation of evaluation findings at the annual conference of the Association of Science-Technology Centers. Members of the evaluation team presented preliminary summative evaluation findings at the conference session titled: <i>Researching science identity, learning, and narrative engagement in different formats: From lecture to IMAX 3D.</i>
<i>Amazon Adventure</i> summative evaluation report	December 2018/ June 2019	A summative evaluation of the <i>Amazon Adventure</i> film. This evaluation focused on the immediate and longer-term impacts of the film on a general adult audience of 441 viewers who viewed <i>Amazon Adventure</i> at a giant screen theater at one of the following institutions: Pacific Science Center, the Museum of Discovery & Science, Discovery Place, and the Museum of Science. A draft report was submitted December 2018, with an updated report and summary of findings delivered July, 2019.

Appendix B. Implementation and perceived value of *Amazon Adventure* at two sites



Illustration of implementation and perceived value of the *Amazon Adventure* film and resources at two sites

To provide further context for the summative evaluation, the evaluation team sought feedback from representatives of science centers or museums that hosted the *Amazon Adventure* film, focusing on their institutions' implementation of the film and related educational resources.

Representatives³⁰ from two institutions participated in this follow-up evaluation activity by completing a questionnaire, either through written survey or phone interview as they preferred. They were informed that their feedback was an important part of the information collected for the independent evaluation funded by the National Science Foundation (NSF), that their input would be combined with feedback gathered from other science center or museum representatives, and that the evaluation reporting would not mention names or other identifying information.

The representatives' feedback on their experience with the *Amazon Adventure* film, live stage presentation, educational posters, One Sheets, and related film activities implemented in their educational settings is summarized below.

***Amazon Adventure* film**

Perceived value

Using the scale from 1 (*not at all valuable*) to 5 (*extremely valuable*), both representatives assessed that the film was *extremely valuable* to their institution's educational setting, further elaborating, as follows:

- *Amazon Adventure* is a film that's appealing to all audiences. Educators love it because it touches on scientific topics such as camouflage, mimicry, and natural selection. Families like it because it's beautifully filmed, and the true story is very compelling.

³⁰ The representatives generally had experience in their institution's education programs, theater management, visitor services, and/or marketing.

- *Whether or not people knew about the film and the ecosystems shown in the film, it showed this, but it also showed how to do science and the tools of science ... that wasn't as obvious to people going in but it was definitely an added value whether or not they knew it was going to be in the film.*

Whether the film met expectations

Both representatives reflected that, from their perspective, the film met institutional expectations. One representative elaborated, saying, *"Yes. We are very pleased with the film quality, story, narrative, and educational value."*

Highlights of hosting the film

Both representatives pointed to opportunities *Amazon Adventure* gave their institutions to leverage the film's science content with other educational programs at their institutions to create, as one representative put it, *"Wonderful programs, lab[s] and demonstrations for schools and the general public: Educators were eager to bring their students to see the film and families were pleased with the content."*

Challenges or barriers in hosting the film

Both representatives indicated that they were not aware of barriers or challenges in hosting the film. One noted that the film didn't raise any issues that their institution didn't typically face when hosting films, for example challenges related to issues of access and helping facilitate and coordinate fieldtrips.

Perceived effectiveness of the film in conveying scientific content themes

Using a scale from 1 (*not at all effective*) to 5 (*extremely effective*), the representatives reflected that the film was either *very* or *extremely effective* in conveying nine different content themes to their theater audiences (5th grade and older), including: what Henry Bates' quest was when he left for the Amazon; the fact that Henry Bates achieved his quest; the methods or processes that Henry Bates used to pursue his quest; the concept of mimicry and examples of mimicry; the importance of the row of eight butterflies that Henry Bates pulled from his collection; the idea that the scientific process often involves collaboration; the kinds of struggles that scientists often face in the pursuit of scientific knowledge; the idea that scientists are often driven by passion and curiosity; and the idea that scientists are often dedicated and persistent in their pursuit of scientific knowledge. When invited to elaborate on these ratings the representatives noted:

- *This film was produced extremely well. It covered all the elements above and little was left to improve.*
- *The way that the film humanized science and helped to explain and that this isn't the isolated process we sometimes think it is, which is how it is sometimes taught, as an individual pursuit. I think that was important and valuable to show. Science is a collaborative process and is not something you already know the answer to. I think the film did a nice job of showing that.*

Perceived effectiveness of the film in conveying scientific concepts

Using a scale from 1 (*not at all effective*) to 5 (*extremely effective*), the representatives reflected that the film was either *very* or *extremely effective* in conveying four different scientific concepts to theater audiences (5th grade and older), including that: species can

change, one species can become another species, animal species gradually change over time, and predators play an important role in which animal species survive. When invited to elaborate on these ratings one representative reaffirmed generally that *“All the elements above are important and were conveyed well.”* The other representative pointed to the statement about predators, adding that the film is very focused on showing the role predators play in which animal species survive, it's important information, and that the film was extremely effective in illustrating the concept.

Perceived effectiveness of the film in using various production elements to convey Bates' scientific quest

Again using a scale from 1 (*not at all effective*) to 5 (*extremely effective*), the representatives reflected that the film was *very* or *extremely effective* in using five different production elements to convey Henry Bates' scientific quest to their theater audiences (5th grade and older), including: the giant screen format to help viewers feel they were present/immersed in Henry Bates' scientific quest; a dramatic storyline to help viewers feel involved in Henry Bates' scientific quest; a dramatic portrayal of Henry Bates to help viewers feel involved with his character; historical reenactments to help viewers feel connected to Henry Bates' life and scientific quest; and a focus on the obstacles Henry Bates faced in his life and scientific quest to help viewers feel connected to him.

When invited to elaborate on these ratings, one representative noted that with respect to the last statement, *“Covering Henry Bates' obstacles was important but not as important as the overall accomplishment.”* The other representative observed that the effectiveness of the production elements could depend on the context in which the film is seen, noting that school groups, for example, often arrive with considerable energy, elaborating: *“These are like the emotional connection and impacts on the viewer or visitor and I don't know it is kind of hard to comment on that. When people are coming on a fieldtrip their emotional levels are all over the place. The impact of that emotional connection may be impacted by that experience. Just the fact that kids are already wound up and many have not been to the science center/museum or [giant screen theater] before so they could be pretty distracted. I think it would be interesting to survey or test people who are general attendees versus folks who are there in that social group environment.”* This representative went on to praise the film's use of the giant screen format, noting: *“I think the beauty of the giant screen ... with the experience going into your peripheral vision ... the engagement for folks is you feel your body is moving you feel like you are there, your senses are transporting you to a different place. I feel like the film did a nice job of that, it is so visually stunning and [the Amazon] is beautiful. I think the format is good for this.”*

Perceived value of film for middle school students as part of school field trip

Using a scale from 1 (*not at all valuable*) to 5 (*extremely valuable*), one representative reflected that the film was *extremely valuable* for middle school students seeing the film as part of a school field trip, and one reflected that it was *very valuable* in this regard, elaborating that: *“Middle school is important because they are really starting to learn these scientific concepts more in detail. On the other hand, it's very difficult to get a middle school student to really focus on anything when they are on a field trip.”* The theme of focusing middle school students who are visiting the science center or museum was also touched on by the other representative, who elaborated: *“I see it happening almost every trip they are always rushing.... there is a lot going on, that energy level I see it every day, they were getting moved. There is so much excitement they are just overstimulated.”* The same representative had also observed

earlier that the film may have different emotional impacts on viewers depending on their visiting and viewing context.

***Amazon Adventure* live stage presentation**

The *Amazon Adventure* live stage presentation was used in both institutions' educational settings. In one case the presentation was used for the film's opening weekend and at least two other weekends for shows geared to the general public. The presentation was customized so that program staff could incorporate live animals from the institution's collection. When asked to rate the value of the presentation to their educational setting on a scale from 1 (*not at all valuable*) to 5 (*extremely valuable*), this representative saw it as *moderately valuable*, noting that the program itself was "good" but that other programming they put in place related to the film was "*particularly well-received by guests.*"

In the other institution, the presentation was done on a live stage where live animal presentations and other science shows (e.g., liquid nitrogen demonstrations) are held. The representative noted that references and tie-ins were made to the film and other exhibits at the institution where, for example, there were examples of mimicry and natural history themes. The presentation was conducted solely by one presenter who did the show a couple of times when the film premiered. The representative reflected that the presentation was not done more often likely due to a variety of factors including scheduling issues, the lead-time needed to market and promote the presentation (often 2 months), other projects going on at the time, and the location of the live stage area with respect to other parts of the institution that had related exhibits or programming. When asked to rate the value of the presentation to their educational setting on a scale from 1 (*not at all valuable*) to 5 (*extremely valuable*), this representative saw it as *very valuable*, adding: "*It was a high value but not a high reach.*"

The representative also noted that presentations at their institution are typically live and unscripted, so the opportunity to use a pre-scripted show was a different experience. This was shared as neither a negative nor positive commentary, as in: "*The thing that is central and key to how we do live presentations is we don't use scripts, we do all the development of shows in-house. The fact that there was a script was unusual for us ... It was different. It wasn't harder or better or worse, just different.*"

Other activities implemented related to the film

When asked if their institutions also coordinated existing exhibits, programming, and other resources to reinforce, extend, or otherwise complement the film, both representatives indicated they had, with one noting that their institution had implemented at least five different labs and demonstrations that highlighted science topics related to the film.

When asked if they developed any new exhibits, programming, or resources to reinforce, extend, or otherwise complement the film, one representative indicated that they had, in particular two different program weekends focused on butterflies. The other representative recalled live presentations on genetic mutation and biomimicry and perhaps themed presentations on butterflies with a local entomology expert, but wasn't sure of the extent these should or would be considered part of a "*themed experience*" with the film.

Amazon Adventure educational posters

One representative reported that the two *Amazon Adventure* educational posters on mimicry and camouflage (pictured below, also available on the [Amazon Adventure website](#)) were used in their institution's educational setting. Most often the posters were distributed to educators when they visited during field trips. When asked to reflect on the value of the posters on a scale from 1 (*not at all valuable*) to 5 (*extremely valuable*), the representative said that both posters were *very valuable*, adding the following caveat: "We distributed the posters to educators but we do not know how they used them."



The other representative did not recall seeing the posters but did point out that the film and related resources were featured in the institution's printed annual field trip guide.

Amazon Adventure One Sheets

Both representatives noted that, to their knowledge, their institutions did not use the *Amazon Adventure* One Sheets pictured below (also available on the [Amazon Adventure website](#)). These are titled *Mimicry, A time of change, The pictorial museum of animated nature, and Wildlife featured in the film*. One representative was unaware of the One Sheets and one noted that educators in their educational setting used their own materials.



Final reflections

Finally, when asked if there was anything else they wanted to share about their experience with the *Amazon Adventure* film or resources, one representative praised the available marketing and promotional materials, as follows: *“All the marketing and promotional materials for Amazon Adventure were very well done and extremely helpful in promoting the film.”* The other representative took the opportunity to praise the film’s multidisciplinary element, observing: *“I just want to say one more time that the multidisciplinary aspect of this film made it extra awesome for schools in particular. More and more this is what schools need to see ... this is definitely a science film and there are different aspects to it, from exploring to biology, but it also has the nature of science and what it means to be a scientist and this connection to history and social studies and [the] human aspects of doing science.”*

Appendix C. Questionnaire items

Amazon Adventure Phase 1 questionnaire items (Grouped by question category)

Science learning questions

What was Henry Bates' scientific quest when he left his home in London to work in the Amazon?
What did he want to achieve?

As best you can, please describe as many of the methods or processes that Bates used to pursue his quest.

To the best of your knowledge, do you think that Bates achieved his quest?

Yes No Not Sure

a. Please explain below why you think he did or did not achieve his quest, or why you aren't sure.

As best you can, please define what mimicry is as it relates to the natural world and give an example.

a. Definition of mimicry:

b. Example of mimicry:

For each statement below, please circle True (T), False (F), or Don't Know (DK)			
Species were created in their current form and never change.	T	F	DK
Predators play an important role in selecting which animal species survive.	T	F	DK
A species cannot change into a new species.	T	F	DK
Animal species change gradually over time.	T	F	DK

Please list four personality characteristics that are important for a scientist to have.

a. _____

b. _____

c. _____

d. _____

Narrative engagement questions

For each statement below, please circle one number to show how much you agree or disagree using the scale from 1 (strongly disagree) to 7 (strongly agree). Please read each statement carefully. While some statements may seem similar, they are each different in some way.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I liked the giant screen quality of the film.	1	2	3	4	5	6	7
I felt like I was actually there in the Amazon.	1	2	3	4	5	6	7
It seemed as though I actually took part in the action of the film.	1	2	3	4	5	6	7
It was as though my true location had shifted to the Amazon.	1	2	3	4	5	6	7
I felt as though I was physically present in the Amazon.	1	2	3	4	5	6	7

For each statement below, please circle one number to show how much you agree or disagree. Please read each statement carefully. While some statements may seem similar, they are each different in

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I liked the story of Henry Bates' life as a scientist.	1	2	3	4	5	6	7
As I moved through the film, I wanted to discover how Bates went about his work.	1	2	3	4	5	6	7
It was interesting to learn about the problems that Bates encountered in his work.	1	2	3	4	5	6	7
I wanted to find out what Bates would discover in the Amazon.	1	2	3	4	5	6	7
I felt pulled into the film by Bates' passion.	1	2	3	4	5	6	7
I was worried for Bates when he ran into problems in the Amazon.	1	2	3	4	5	6	7
I cared about seeing Bates' discovery at the end of the film.	1	2	3	4	5	6	7

Version A

What did you like and not like about the film and why?

- What did you like about the film, and why?
- What did you not like about the film, and why?

Version B

The film tells the story of Henry Bates' life as a scientist.

- What did you like about this story?
- What did you not like about this story?

Spatial presence questions

For each statement below, please circle one number to show how much you agree or disagree.

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I liked Henry Bates.	1	2	3	4	5	6	7
I understood Bates' need to explore the wilds of the Amazon.	1	2	3	4	5	6	7
While watching the film, I wanted Bates to reach his scientific goal.	1	2	3	4	5	6	7
While watching the film, I could feel Bates' emotions.	1	2	3	4	5	6	7
I felt like Bates and I had things in common.	1	2	3	4	5	6	7

Demographic and background questions

How old are you? _____

What is your gender? _____

Please check one or more boxes to describe your major racial/ethnic background:

- | | |
|--|--|
| <input type="checkbox"/> African-American/Black | <input type="checkbox"/> Native Hawaiian or Pacific Islander |
| <input type="checkbox"/> Asian (e.g., Asian Indian, Chinese, Japanese) | <input type="checkbox"/> White |
| <input type="checkbox"/> Hispanic, Latino, or Spanish origin | <input type="checkbox"/> Other: Please describe: _____ |
| <input type="checkbox"/> Native American Indian or Alaskan Native | |

What is the highest level of education you have completed?

- Less than high school High school Some college or degree Some grad school or degree

When did you take your last course in biology?

- Never High school In college as part of another major Majored in college Graduate school

Not counting today's film, how many giant screen/IMAX films have you seen?

- 0 1 2 3 4 or more

Appendix D: Factor analysis of scales

Narrative Engagement Scale

The Narrative Engagement Scale is a twelve statement 7-point rating scale constructed based on the combination of three response categories: story appeal, story involvement, and character involvement. The scale was assessed using participants in the Viewer group.

Descriptive statistics

All questions were presented to each participant with seven response categories ordered from 1 to 7 as follows: *strongly disagree*, *disagree*, *somewhat disagree*, *neutral*, *somewhat agree*, *agree*, *strongly agree*. Table 1 presents descriptive statistics for the scale statements, ordered by mean rating.

Items in scale	Mean	Median	Std Dev
1. I felt like Bates and I had things in common.	4.94	5	1.52
2. I was worried for Bates when he ran into problems in the Amazon.	5.74	6	1.34
3. While watching the film, I could feel Bates' emotions.	5.93	6	1.16
4. As I moved through the film, I wanted to discover how Bates went about his work.	6.04	6	1.12
5. I understood Bates' need to explore the wilds of the Amazon.	6.06	6	1.06
6. I felt pulled into the film by Bates' passion.	6.07	6	1.21
7. I liked Henry Bates.	6.13	6	0.97
8. It was interesting to learn about the problems that Bates encountered in his work.	6.28	7	0.95
9. I liked the story of Henry Bates' life as a scientist.	6.34	6	0.86
10. I wanted to find out what Bates would discover in the Amazon.	6.36	7	0.95
11. I cared about seeing Bates' discovery at the end of the film.	6.45	7	0.99
12. While watching the film, I wanted Bates to reach his scientific goal.	6.49	7	0.89
Total Scale	6.07	6	0.83

Reliability

To assess the homogeneity of items within the scale, ordinal (polychoric) alpha was used as it has been shown to estimate reliability more accurately for Likert-type ordinal (not continuous) response formats.³¹

³¹ Gaderman, A.M., Guhn, M., & Zumbo, B. D. (2102). Estimating ordinal reliability for Likert-type and ordinal item response data: A conceptual, empirical, and practical guide. *Practical Assessment, Research & Evaluation*, 17(3), 1-13.

Polychoric alpha coefficients are presented in Table 2. The total scale reliability coefficient is .94. The large (> .9) individual item and total scale coefficients are appropriate for basic research purposes³² and “*very good*” as rated by DeVillis.³³ Eight of the twelve items contribute positively to scale reliability and were retained in the scale. The remaining four items did not improve the scale if deleted and were retained in the scale used in the summative evaluation.

Table 2. Polychoric Reliability	
Items in scale	Polychoric reliability if item dropped
1. I felt like Bates and I had things in common.	0.94
2. I was worried for Bates when he ran into problems in the Amazon.	0.94
3. While watching the film, I could feel Bates’ emotions.	0.94
4. As I moved through the film, I wanted to discover how Bates went about his work.	0.93
5. I understood Bates’ need to explore the wilds of the Amazon.	0.94
6. I felt pulled into the film by Bates’ passion.	0.93
7. I liked Henry Bates.	0.93
8. It was interesting to learn about the problems that Bates encountered in his work.	0.93
9. I liked the story of Henry Bates’ life as a scientist.	0.93
10. I wanted to find out what Bates would discover in the Amazon.	0.93
11. I cared about seeing Bates’ discovery at the end of the film.	0.93
12. While watching the film, I wanted Bates to reach his scientific goal.	0.93
Total Scale	0.94, CI [0.93, 0.95]

Exploratory factor analysis

Through exploratory factor analysis, the goal is to assess how well the scale scores reflect a single common dimension or reflect multiple dimensions. It was determined if the data were suitable for factor analysis by looking at several measures of sampling adequacy:³⁴ KMO (Kaiser-Meyer-Olkin) index equaled a “*marvelous*” .94, above the lowest acceptable value of .5; Bartlett’s test was highly significant ($\chi^2 (66) = 1849, p < .001$); and all inter-item correlations were greater than .3. Thus, factor analysis was appropriate for the data set.

³² Nunnally, J.C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

³³ DeVillis, R. F. (2012). *Scale Development: Theory and Applications* (3rd ed. Vol. 26). Thousand Oaks, CA: Sage Publications. Note, however, the very high values in Table 2 also could mean that scale items are redundant, and the scale may benefit by eliminating highly correlated items.

³⁴ Dziuban, C. D., & Shirkey, E.C., (1974). When is a correlation matrix appropriate for factor analysis? Some decision rules. *Psychological Bulletin*, 81, 358-361.

The exploratory factor analysis was performed in R 3.5.2³⁵ and followed tested recommendations for the most appropriate procedure in applied research to examine dimensionality underlying Likert-scored items. For each of the ordinal scales, parallel analysis using minimum rank factor analysis, promax rotation, and polychoric correlations were performed.

High factor loadings on each item in a one-factor model were produced (Table 3). Costello and Osborne³⁶ recommend that “5 or more strongly loading items (.50 or better) are desirable and indicate a solid factor” (p. 5). The proportion of common variance explained by the unidimensional model is 58%. Parallel analysis also advised a one-factor solution. Thus, the scale scores reflect a single common dimension.

Items in scale	Factor 1 Loading
1. I felt like Bates and I had things in common.	0.58
2. I was worried for Bates when he ran into problems in the Amazon.	0.71
3. While watching the film, I could feel Bates’ emotions.	0.73
4. As I moved through the film, I wanted to discover how Bates went about his work.	0.76
5. I understood Bates’ need to explore the wilds of the Amazon.	0.72
6. I felt pulled into the film by Bates’ passion.	0.81
7. I liked Henry Bates.	0.78
8. It was interesting to learn about the problems that Bates encountered in his work.	0.79
9. I liked the story of Henry Bates’ life as a scientist.	0.80
10. I wanted to find out what Bates would discover in the Amazon.	0.77
11. I cared about seeing Bates’ discovery at the end of the film.	0.84
12. While watching the film, I wanted Bates to reach his scientific goal.	0.84

Scale application

Given the reliability and single factor results of the analysis, a composite score of the narrative engagement was appropriate for use in the evaluation.

³⁵ R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

³⁶ Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation*, 10(7).

Spatial Presence Scale

For the purposes of the evaluation, this scale originally included an appeal statement of *I liked the giant screen quality of the film* added to the four statement 7-point Spatial Presence Experience Scale (SPES) validated by Hartmann et al. (2016) with a variety of media, including text, film, hypertext, and a virtual environment. To increase reliability (see below), the appeal statement was dropped and the four-statement SPES was used in the report analysis. A search of the literature indicates that this is the first application of Hartmann's scale with a giant screen format.

Descriptive statistics

All questions were presented to each participant with seven response categories ordered from 1 to 7 as follows: *strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, strongly agree*. Table 4 presents descriptive statistics for the scale statements, ordered by mean rating.

Items in scale	Mean	Median	Std Dev
1. It seemed as though I actually took part in the action of the film.	5.36	5	1.43
2. I felt as though I was physically present in the Amazon.	5.38	6	1.43
3. It was as though my true location had shifted to the Amazon.	5.43	6	1.40
4. I felt like I was actually there in the Amazon.	5.84	6	1.20
5. I liked the giant screen quality of the film.	6.53	7	0.77
Original Total Scale	5.71	6	1.07
Revised Total Scale without item 5	5.50	6	1.24

Reliability

To assess the homogeneity of items within the scale, ordinal (polychoric) alpha was used as it has been shown to estimate reliability more accurately for Likert-type ordinal (not continuous) response formats.³⁷

Polychoric alpha coefficients are presented in Table 5 on the next page. The total scale reliability coefficient is .90 with all five items, and .91 by removing the fifth item. The large (>.8) individual item and total scale coefficients are appropriate for basic research purposes³⁸ and "very good" as rated by DeVillis.³⁹ The first four items contribute positively to scale reliability and were retained in the scale. The fifth item did not improve the scale and was removed for the current evaluation.⁴⁰

³⁷ Gaderman, A.M., Guhn, M., & Zumbo, B. D. (2102). Estimating ordinal reliability for Likert-type and ordinal item response data: A conceptual, empirical, and practical guide. *Practical Assessment, Research & Evaluation, 17*(3), 1-13.

³⁸ Nunnally, J.C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

³⁹ DeVillis, R. F. (2012). *Scale Development: Theory and Applications* (3rd ed. Vol. 26). Thousand Oaks, CA: Sage Publications.

⁴⁰ Polychoric reliability if item dropped was 0.91.

Table 5. Polychoric Reliability	
Items in scale	Polychoric reliability if item dropped
1. It seemed as though I actually took part in the action of the film.	0.89
2. I felt as though I was physically present in the Amazon.	0.88
3. It was as though my true location had shifted to the Amazon.	0.88
4. I felt like I was actually there in the Amazon.	0.88
Total Scale	0.91, CI [0.89, 0.93]

Exploratory factor analysis

Through exploratory factor analysis, the goal is to assess how well the scale scores reflect a single common dimension or reflect multiple dimensions. It was determined if the data were suitable for factor analysis by looking at several measures of sampling adequacy:⁴¹ KMO (Kaiser-Meyer-Olkin) index equaled a “meritorious” .84, above the lowest acceptable value of .5; Bartlett’s test was highly significant ($\chi^2(6) = 732, p < .001$); and all inter-item correlations were greater than .3. Thus, factor analysis was appropriate for the data set.

The exploratory factor analysis was performed in R 3.5.2⁴² and followed tested recommendations for the most appropriate procedure in applied research to examine dimensionality underlying Likert-scored items. For each of the ordinal scales, parallel analysis using minimum rank factor analysis, promax rotation, and polychoric correlations were performed.

High factor loadings on each item in a one-factor model were produced (Table 6 on the next page). Costello and Osborne⁴³ recommend that “5 or more strongly loading items (.50 or better) are desirable and indicate a solid factor” (p. 5). The proportion of common variance explained by the unidimensional model is 73%. Parallel analysis also advised a one-factor solution. Thus, the scale scores reflect a single common dimension.

⁴¹ Dziuban, C. D., & Shirkey, E.C., (1974). When is a correlation matrix appropriate for factor analysis? Some decision rules. *Psychological Bulletin, 81*, 358-361.

⁴² R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

⁴³ Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation, 10*(7).

Table 6. Factor Loadings	
Items in spatial presence scale	Factor 1 Loading
1. It seemed as though I actually took part in the action of the film.	0.84
2. I felt as though I was physically present in the Amazon.	0.87
3. It was as though my true location had shifted to the Amazon.	0.85
4. I felt like I was actually there in the Amazon.	0.85

Scale application

Given the reliability and single factor results of the analysis, a composite score of the spatial presence scale was appropriate for use in the evaluation.



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