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Eric B. Kennedy, Eric A. Jensen & Monae Verbeke

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Preaching to the scientifically converted: evaluating inclusivity in science festival audiences

Eric B. Kennedy [a], Eric A. Jensen[b] and Monae Verbeke[c]

[a]Arizona State University, Tempe, AZ, USA; [b]University of Warwick, Coventry, UK; [c]Institute for Learning Innovation

ABSTRACT

Scientific institutions are increasingly embracing values of inclusivity and public engagement, but how do these two dimensions intersect? Science festivals have rapidly expanded in recent years as an outgrowth of these values, aiming to engage and educate the public about scientific topics and research. While resources invested in public engagement by scientists, universities, and governments are admirable in principle; this study indicates that their ambition to broaden the reach of science may be going unrealized in practice. Using data from three major UK science festivals, we demonstrate such events are disproportionately reaching economically privileged and educated audiences already invested in science, as opposed to diverse and broadly representative samples of the general public. Our results demonstrate that these science festivals are falling short of their aims to make science accessible to a broad audience. There is a clear need for improved practices and on-going evaluation to ensure science festivals include those who are not already scientifically converted.

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Evaluation study; informal education; museum studies; science festival; science communication

Introduction

Underpinned by pro-engagement science policy in Europe (House of Lords, 2000; Jensen & Holliman, 2016; Stilgoe, Irwin, & Jones, 2006), an extensive range of public science communication approaches are currently in use (Holliman, Whitelegg, Scanlon, Smidt, & Thomas, 2009). Scientists, pro-science institutions, and governments invest significant time, money, and expertise in public science communication activities such as science festivals. Yet, there has been surprisingly little demand for robust empirical evidence that such activities offer widespread benefits for society. Here we address the lack of published evaluation evidence about whether science festivals are achieving their goals of expanding engagement with science. In particular, we investigate whether science festivals are attracting audiences that are both *diverse* and *broadly representative* of the population at large. Our results from research at three UK science festivals show they are disproportionately reaching economically privileged and educated audiences that are already invested in science. We present this evidence as a call to action for the scientists, researchers, practitioners, and funders who participate in such events to actively push for more socially inclusive and rigorously evaluated science communication efforts.

Science festivals, evaluation, and participation

Science festivals present an opportunity for engaging an audience ranging from children to adults, many of whom may have limited formal exposure to science through other educational venues.

CONTACT Eric B. Kennedy ericbkennedy@asu.edu

These festivals have been the subject of various academic investigations that have often emphasized the emergence of these formats, the range of on-the-ground practices, and the wide applicability of the festival format (see, for example, Bultitude, McDonald, & Custead, 2011). This research also regularly underscores the learning, attitudinal shifts, and behavioral engagement possible in science festivals (Lloyd, Neilson, King, & Dyball, 2012; OST, 2004). Some individual festivals have taken direct interest in whether they are attracting a diverse and/or representative audience, although the internal nature of many of these reviews can make knowledge sharing more difficult (see, for instance, Jensen & Buckley, 2014). More publicly, Bultitude's (2014) comment entitled 'Science festivals: do they succeed in reaching beyond the "already engaged"?' lays out a valuable collection of interesting case studies of science festivals from around the globe, but fails to address its titular question either theoretically or empirically.

To answer this question empirically and robustly, it's worth first considering what constitutes a science festival, and what makes it unique relative to other forms of engagement. With respect to their structure, the word festival indicates a higher energy and engagement level than is connoted by terms such as meeting, workshop, or event (Gage, 2001). Science festivals are informal, communication-heavy compilations of events where information on contemporary science issues and research flows from sponsors/experts to the public (Rowe & Frewer, 2000). In the UK context, a recent study (Lloyd et al., 2012) found that science festivals reported their typical target audiences as adults (19+) and families (general visitor population). They sometimes include schoolchildren, but this study found that neither primary or secondary schools were a major audience for most UK science festivals (Lloyd et al., 2012, p. 25). The present study focuses on the general visitor population for UK science festivals, not programs specifically targeted at schools.

Science festivals are often well-liked events that attendees believe are beneficial (Jensen & Buckley, 2014). Indeed, science festivals have been described by a recent Wellcome Trust-funded review as one of the keystone sectors within the broader science education community (Falk et al., 2012). This event genre is usually characterized by its transience and setting within a particular city (Office of Science and Technology, 2004). Known as a 'popular science event with an emphasis on science as being fun' (Nolin, Bragesjö, & Kasperowski, 2003, p. 2), science festivals are typically run with substantial volunteer participation by scientists, students, and some professional science communicators (Jensen & Buckley, 2011).

Science festivals bring together a wide range of experiences for their audiences, from lectures and demonstrations to highly participatory, hands-on activities, within a single overarching short-term event. Organization and sponsorship can come from a variety of organizations, including science museums and centers, universities, charities, research councils, businesses and government (Buckley & Hordijenko, 2011; EUSCEA, 2005). These festivals are also believed to have economic, tourism, and profile-raising benefits for organizations involved (Bultitude et al., 2011).

One defining characteristic of science festivals is their impermanence. This is essential to enable the energy and the spirit of the festival, as it would be difficult to induce and sustain the same sense of occasion and excitement if such an event was to be held more frequently (Derrett, 2004; Weihe, 2014). This holds true for participants and volunteers alike, as festivals are able to leverage their time-bounded nature to draw heavier volunteer participation from scientists, students, organizers, and educators (Jensen & Buckley, 2011). Such involvement and commitment greatly affects the value of the science festivals for attendees, as a comparative study recently reported: Interaction with science professionals during festival events is the strongest predictor of better outcomes for attendees (attendees reporting an interaction with a science professional were 15%–19% more likely to report positive learning impacts) (Science Festival Alliance, 2012, p. 24).

In the UK, the history of science festivals can be traced back to the annual conference of the British Association for the Advancement of Science, which was founded in 1831 to encourage discussion and promote scientific progress (British Science Association, 2009) and has since been renamed to the British Science Festival. The number of science festivals has grown drastically since then, including the three that we consider in depth in this paper.

Outlining the context: science festivals in Eastern, southern and northern UK

To develop a robust understanding of the profile of science festival attendees, we present empirical research about public visitors to three UK science festivals. We refer to these festivals using anonymised regional labels to avoid singling out the very festivals that have demonstrated a desire to learn about their potential shortcomings, when the patterns we found are likely to be both nationally and globally applicable. Before turning to the methods we used for studying the attendance of these events, we briefly introduce the three medium-to-large sized science festivals below.

Each of these festivals is well established and runs annually. The youngest of the festivals is nearly a decade old. All of the festivals examined rely heavily on volunteer staff, including local university students, the staff of universities or museums and public volunteers.

Eastern science festival

The Eastern Science Festival is supported and led by a local university, with involvement from a wide variety of other partners including educational institutions, research institutes, charities, business, and community partners. The festival has two primary stated aims: to increase public interest in science and scientific issues, and to encourage more young people to consider science education and careers. Access to laboratories, museums, and lecture halls means that many of the events can be hosted on campus. Almost all events are free to the public in this festival, with numerous lectures, panels, exhibitions, tours, and open days providing access to university-based experts.

Southern science festival

Led by a non-profit organization specializing in public engagement festivals, this festival draws heavily on science communication professionals and is largely populated by paid events. Its ethos has more of a cultural event flavor, with relatively limited involvement from museums and universities. The festival aims to attract new audiences and extend participation from other cultural activities and festivals to also include science. While leaning more heavily towards celebrity scientist appearances and paid events, there are a variety of activities included in the program, such as paid workshops and discussions, free talks and workshops and hands-on activities.

Northern science festival

The Northern Science Festival is an annual festival that aims to engage and inspire the public with science, building confidence in their ability to engage with science. This festival is led by a museum. It takes place across multiple venues and with a broad set of local partners such as other museums and local universities. This festival includes a range of activities, from workshops to performances, exhibitions, and other public engagement experiences. Most activities for this festival are free.

Methods

To test the question of whether science festivals are attracting a diverse and broadly representative sample of the public, we empirically examined three major UK science festivals. As an external evaluator commissioned by these festivals, author Jensen oversaw the administration of audience surveys to evaluate demographics, cultural consumption practices, interests, self-reported benefits of attending, learning indicators and attitudes.

To survey the visitors of each festival, we used a combination of linking to the online ticketing system[1] for festivals to deliver a pre-visit questionnaire via email, as well as on-site, face-to-face administration of a pre-visit questionnaire as people enter festival events. Each survey used a combination of closed-ended questions (e.g. demographic data and Likert scales about attitudes and

Table 1. Comparison of educational attainment of UK national population and participating science festival visitors

	National population	Science festival sample				
Qualifications	% of National population	Festival	*n* =	% of Visitor Population	*95% CI*	Range
Bachelor degree	27	North	1011	71	±2.8	68.2%–73.8%
		South	171	74	±6.57	67.43%–80.57%
		East	592	80	±3.22	76.78%–83.22%
Postgraduate degree	11	North	1011	31	±2.85	28.15%–33.85%
		South	171	30	±6.87	23.13%–36.87%
		East	592	45	±4.01	40.99%–49.01%
No qualification	27	North	1011	3	±1.05	1.95%–4.05%
		South	171	2	±2.1	−0.1%–4.1%
		East	592	1	±0.8	0.2%–1.8%

Note: UK population figures based on Office for National Statistics (2011), which includes a sample of 43 million and a confidence interval of ±0.01.

priorities) and open-ended questions (e.g. 'what comes to mind when you think of "science"') to gather a comprehensive set of data. The questions that were analysed for this study include a combination of quantitative categorical data (e.g. household income and number of science festivals attended previously), as well as a series of Likert questions from strongly disagree to strongly agree on positively and negatively coded attitudinal issues related to science (e.g. agreement or disagreement with the statement 'science is not for me').

Responses were collected by a team of evaluation assistants who received training prior to the start of each festival. We gathered pre-visit data from a 2014 science festival in eastern England ($n = 592$), a 2013 festival in southern England ($n = 171$), and a 2014 festival in northern England ($n = 1011$). We used a saturation-based approach to sampling, wherein all persons who purchased online tickets were emailed and invited to participate in the online, pre-visit questionnaires. On-the-ground data collection was also used to improve response rates and to establish coverage of visitors who had acquired tickets in person. Once the data was collected, we analysed means, medians, and distributions on the Likert type questions, as well as proportions, confidence intervals, and ranges on the categorical questions (see Tables 1 and 2).

Here, we focus on three key visitor attributes measured through pre-visit surveys: pre-existing participation in other scientific and cultural activities beyond the science festival, pre-existing interest in science and demographic variables indicative of social inclusion.

Results

For the vast majority of attendees, science festivals are simply one of many activities on the agenda of highly culturally active citizens (Jensen & Wright, 2015). At the northern science festival, for instance, 65% of respondents reported already attending other science festivals, events, or activities.[2] In the east, 73% of respondents indicated they were (either agreed or strongly agreed) frequent visitor [s] to museums. In comparison, the 2014 national Public Attitudes to Science (PAS) survey found that 3% of its national UK sample reported attending a science festival (Ipsos MORI, 2014; Smith & Jensen, 2016). When broadened to include museum, theater, zoo or other cultural attractions, 84% of northern respondents and 95% of southern respondents indicated having visited a cultural institution within the prior 6 months. Similar to our findings, the national PAS report states:

Table 2. Annual household income distribution of respondents relative to median at eastern and northern science festivals.

	<£14,000	£14,001–24,000	£24,001–34,000	£34,001–44,000	>£44,001
	Below median		Above median		
Eastern ($n = 271$)	13% ($n = 35$)	11% ($n = 31$)	15% ($n = 41$)	13% ($n = 36$)	47% ($n = 128$)
Northern ($n = 112$)	10% ($n = 11$)	25% ($n = 28$)	13% ($n = 15$)	19% ($n = 21$)	33% ($n = 37$)

Note: The approximate median annual household income for the UK is £24,000 (Office for National Statistics, 2011).

> The two-thirds who have undertaken a science-related activity are also more likely to have taken part in a non-science related cultural activity over the same period, such as a visit to an art gallery, another non-science related museum or a literature festival. This indicates that there is a single group of people who typically go to all sorts of cultural activities, whether science or arts-related. (Ipsos MORI, 2014, p. 6)

Not only were visitors already highly engaged in cultural and scientific events prior to their science festival attendance, but they also displayed high pre-visit levels of interest in science. In both the southern and eastern festivals, 88% and 92% (respectively) of visitors agreed they were personally interested in science[3] before visiting the festivals. Moreover, 83% of the pre-visit respondents at both the northern and eastern festivals indicated that they already followed science-related stories in news media.

We asked several questions—both positively and negatively phrased—to validate these results. For instance, we measured disagreement with the statements science is boring and science is not for me among respondents before attending the festival. At the northern festival, 88% disagreed with the idea that 'science is boring', while 97% disagreed with the statement science is not for me. A similarly high 83% of eastern respondents indicated having a favorable science identity by disagreeing with the statement 'science is not for me'. In similar measures of self-confidence in their engagement with science, 78% of eastern respondents disagreed with the statement 'I don't understand scientific research' prior to attending, while at the northern festival 87% agreed they were 'able to understand science' before attending. These results indicate that science festival audience members were already convinced of the value of science prior to attending.

In addition, we found that adult attendees were more highly educated and economically advantaged than the UK population (Table 1). A large proportion of visitors to each festival held bachelor or postgraduate degrees (80% and 45% respectively in the eastern city, 71% and 30% in the southern, and 74% and 31% in the northern). This compares to an average of 38% of UK adults with undergraduate degrees (Office for National Statistics, 2013) and 11% of UK adults with postgraduate degrees.[4]

Reported qualifications of science festival visitors were compared to the UK population using a 95% confidence interval (indicating there is less than a 5% chance that the true value lies somewhere outside the range of values given here). This analysis reveals that the share of degree holders in the science festival sample significantly exceeded the percentage in the national population in all three festivals. Compared to the national population, the share of degree holders was 44% greater at the northern science festival (95% CI = 68.2–73.8), 47% greater at the southern science festival (95% CI = 67.43–80.57) and 53% greater at the eastern science festival (95% CI = 76.78–83.22). Likewise, science festival visitors held postgraduate degrees at a significantly higher rate than in the national population, exceeding the UK percentage by 20% at the northern science festival (95% CI = 28.15–33.85), 19% at the southern festival (95% CI = 23.13–36.87) and 34% at the eastern science festival (95% CI = 40.99–49.01).

At the other end of the educational spectrum, adult attendees with no qualifications were underrepresented within the science festival visitors in our study. As shown in Table 1, a small proportion (less than 5%) of attendees at each festival did not have any educational qualifications. This compares to an average of 22% of UK adults having not obtained an educational qualification. This gap between the national rate of postgraduate qualifications and science festival respondents was 19% at the northern science festival (95% CI = 1.95–4.05), 20% at the southern festival (95% CI = −0.1–4.1) and 21% deficit at the eastern science festival (95% CI = 0.2 to 1.8). In sum, science festival respondents at all three festivals held higher qualifications at a rate significantly higher than the UK population.

The advantageous position of science festival visitors extends beyond scientific interests and educational qualifications. Visitors were also economically advantaged compared to the national population. To evaluate household income, we asked respondents at two of the science festivals in our sample—the northern and eastern science festivals—an ordinal survey question about their level

of household income (with categories ranging from less than £14,000 up to £44,001 or more) (Table 2).

Results show a clear skew in the income distribution of science festival audiences towards higher incomes. In the northern festival ($n = 112$), the most populous income category (33%, $n = 37$) was comprised of those with an annual income of £44,001 or more. Only 10% of visitors ($n = 11$) reported an income lower than £14,000. The skew in the eastern science festival data ($n = 271$) was even more prominent, with 47% of respondents ($n = 128$) reporting an income of £44,001 or more. The percentage reporting less than £14,000 was similarly low at only 13% ($n = 35$).

These data suggest that the visitors to both science festivals were substantially better off economically than the UK average (Table 2). The approximate median annual household income for the UK is £24,000 (Office for National Statistics, 2011), which would mean 50% of people would have an income above that value and the other 50% below. Yet, at the northern science festival, 65% ($n = 73$) had an income above £24,001, and the eastern science festival had an even higher proportion, 76% ($n = 205$). This indicates that the rate of above average income households amongst science festival visitors is 15% greater than expected at the northern festival (95% CI = 54.06–75.94) and 26% greater at the eastern science festival (95% CI = 68–80).

A final indicator of economic inclusivity we consider here is the level of unemployed visitors at the science festival. We found that only 2% of southern and eastern science festival attendees reported being unemployed, compared to the UKs overall unemployment rate of 6%[5] in the 3rd quarter of 2014 (Office for National Statistics, 2014). This gap between the rate of unemployed respondents at these science festivals (southern science festival: 95% CI = −0.1–4.1; eastern science festival: 95% CI = 0.87–3.13) and the national population is statistically significant.

Discussion

While prior research has indicated that audiences find science festivals to be enjoyable and beneficial (Jensen & Buckley, 2014), our findings cast doubt on their current effectiveness as vehicles for engaging a socio-economically diverse public with science. The audience patterns presented here suggest that current practices need rethinking to minimize exclusion along social class and educational lines (also see Dawson & Jensen, 2011; Jensen, Dawson, & Falk, 2011). Science festivals also need to raise their game when it comes to including those who are not already scientifically converted and invested. To address the equity challenge in public science communication, new tools and communication approaches are needed, underpinned by more regular and rigorous evaluation to identify shortcomings and solutions (Jensen, 2015).

In many ways, our findings are unsurprising: Those attending science festivals do so because they are already interested in and comfortable with science, and tend to be privileged on a number of socioeconomic dimensions. These observations are unlikely to be new, even if they are rarely articulated in published literature or prioritized for discussion in science communication practice. The problem of exclusion in public science communication is chronic and long-term, requiring sustained attention and resources to address.

Scientists, funding agencies, and public science communication organizations need to acknowledge these problems, re-focusing their efforts on the types of people they reach and with what effects. Individual scientists should be squeaky wheels, demanding evidence of the social inclusion ethos and practices of the public science communication initiatives they support with their time and goodwill. Funding agencies should insist on more robust measures of diversity at public science communication events, tracking progress over time and emphasizing that raw visitor numbers are not the priority. Moreover, effective social inclusion efforts should be viewed as a key mark of event quality. For organizers, there is an opportunity to push further with efforts at inclusivity, whether related to socio-economic status, ethnic diversity, disability, education levels or pre-existing interests. Science festivals and other engagement events that are making serious improvements can differentiate themselves for funding and support.

Additional research could also assist with identifying how best to address the social inclusion challenge in science festivals and other science communication initiatives. First, the widespread nature of the social inclusion problem in science engagement signals that there may be barriers at the level of professional norms and values that define this sector (see Jensen & Holliman, 2016). It would be useful, for instance, to interview event organizers and conduct ethnographic observation of the event design processes to better understand who the events are implicitly and explicitly designed for, and what stages of the design process would be amenable to inclusion of broader audiences. It would also be helpful to document promising practices for inclusion from events around the globe, and to share these practices as a way of encouraging further evolution in the events. Moreover, further research of non-attenders' interests, concerns, motivations and attitudes would be useful to considering how to better achieve social inclusion (Dawson & Jensen, 2011). For example, prior research in the museum context found that explicit invitations to previously excluded individuals from low socio-economic status backgrounds was an effective way to achieve greater participation (Jensen, 2013).

In principle, science is for everyone, both in terms of its benefits and risks. Economic factors already circumscribe educational opportunities in formal education. Non-formal activities such as science festivals should be a countervailing force to such exclusion, working to ensure that science is not an exclusive club like fine art, opera, or other forms of high culture (Jensen & Wright, 2015). In sum, science festivals should ameliorate—rather than reinforce—disparities in access to science learning. A fresh focus is required to ensure that new, more diverse and at times discordant voices are welcomed to the table (Stilgoe, Lock, & Wilsdon, 2014, p. 11) in science communication.

Notes

1. Online ticketing systems are often used even for free events to avoid overcrowding at any one activity within the science festival.
2. At the northern festival, this question was asked as a five-point agreement scale to the statement I attend science events or activities (outside of the Science Festival). In the east, this question was asked as a seven-point agreement scale for the statement 'I attend a lot of science events or activities.' 48% agreed or strongly agreed with this statement, and a further 17% neither agreed nor disagreed.
3. In the east and south, this question was asked as a seven-point agreement scale to the statement I am interested in science.
4. The Sutton Trust: *The Postgraduate Premium Revisiting Trends in Social Mobility and Educational Inequalities in Britain and America* 2013, Available at http://www.suttontrust.com/researcharchive/the-postgraduate-premium
5. According to the Office of National Statistics (2014), the UK rate of unemployment varied from 6% to 6.8% over the course of 2014.

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ORCID

Eric B. Kennedy http://orcid.org/0000-0003-0056-1521

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