Why People Attend Science Festivals: Interests, Motivations and Self-Reported Benefits of Public Engagement with Research

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Science Festival, Science Communication, Public Engagement with Science, Public Understanding of Science, Science Engagement, Public Science Events

Abstract:
As a form of public engagement, science festivals have rapidly expanded in size and number over recent years. However, as with other domains of informal public engagement that are not linked to policy outcomes, existing research does not fully address science festivals' impacts and popularity. This study adduces evidence from surveys and focus groups to elucidate the perspectives of visitors at a large UK science festival. Results show that visitors value the opportunities science festivals afford to interact with scientific researchers and to encounter different types of science engagement aimed at adults, children and families. The most significant self-reported impact of attending a science festival was the development of increased interest and curiosity about new areas of scientific knowledge within a socially stimulating and enjoyable setting.

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In response to government and professional commitments to communicating science to lay publics (Holliman & Jensen, 2009; Jensen & Wagoner, 2009), the UK has seen the proliferation of a diversity of 'science engagement' activities that are not linked directly to government policy. Amongst these activities, science festivals have become a key site for engaging publics with contemporary scientific research. It remains relatively unclear, however, why publics attend such science engagement events and what they believe they are gaining from them. This study evaluates visitors' science engagement interests, motivations and self-reported impacts within the context of a large regional university-led UK science festival. To gain these insights, this study draws upon mixed methods data from on-site surveys (n = 957), a web-based follow-up survey (n = 73) and focus groups (n = 13).

Public Engagement with Science

Calls for expanded public engagement with the sciences have gained widespread support in UK science policy discourse in recent years (House of Lords Select Committee on Science and Technology, 2000; Irwin, 2009). Indeed, "public engagement has become the new mantra (at least in UK and EU science policy)" (MacNaghten, Kearnes, & Wynne, 2005, p. 281). In calling for sustained engagement between the sciences and publics, the House of Lords (2000), Royal Society and other think-tanks and stakeholders (e.g. Stilgoe, Irwin, & Jones, 2006) have argued that the sciences should go well beyond traditional, formal contexts for science communication to engage publics through activities in informal settings, such as science cafes, public lectures and science festivals (Holliman et al., 2009).

'Public engagement' can be seen as an umbrella term within which 'public communication', 'public consultation' and 'public participation' all fall (Rowe & Frewer, 2005). However, Rowe and Frewer (2000, p. 254) distinguish between public participation exercises, where "information of some sort flows from the public to the exercise sponsors", and communication exercises, where information flows "solely from 'sponsors' to the public". The House of Lords Science and Technology report of 2000 articulated the call for a shift away from didactic modes of science communication and towards two-way or dialogic forms of public engagement (House of Lords Select Committee on Science and Technology, 2000).

Scholarship on public participation exercises has been well-developed in journals such as *Public Understanding of Science*. Yet, there is a relative paucity of rigorous empirical and conceptual scholarship addressing how informal (i.e. non-policy linked) public engagement events like science festivals, or 'communication'-oriented engagement activities more generally, are viewed by publics. Drawing upon public feedback to investigate visitors' experience of attending a science festival, this study contributes to on-going theoretical, policy and practical debates about how an informal public engagement infrastructure should best be developed to serve the needs of publics and scientific institutions in contemporary societies.

Science Festivals (Background and Context)

In key UK Government documents defining public engagement, festivals top the list of activities in which researchers can engage publics on a volunteer basis (National Co-ordinating Centre for Public Engagement, 2011; Research Councils UK, 2010). Indeed, while a recent European Science Events Association (EUSCEA) survey described science festivals as a 'relatively new' phenomenon (EUSCEA, 2005, p. 5), science festivals are increasingly prevalent within the broader spectrum of informal science engagement events internationally. For example, a worldwide survey of 94 science festivals in 2008 found that about half of the science festivals in the survey had started between 2006-2008, with only five starting prior to 1995 (Bultitude et al 2011). The UK currently has a comparatively 'vibrant' science festival schedule (Department of Innovation, Universities and Skills 2008), with 11 large science festivals taking place each year (Wellcome Trust, 2010). These events are attended by a small but notable minority of the UK population. Specifically, an Ipsos MORI (2011) UK public opinion survey found that 3% of those surveyed said they had visited a science festival in the last year.

The history of UK science festivals can be traced back to the British Association for the Advancement of Science's annual conference, founded in 1831 to encourage discussion between scientists and other learned men in order to promote scientific progress (British Science Association, 2009b). The annual conference was renamed a Festival of Science in the 1980s and is now the British Science Festival. Contemporary science festivals tend to bring together temporary exhibits, museum activities, scientists, arts organisations, school pupils and publics to create time-limited special events. Science Festivals may be managed by different types of organisations, including science museums and centres, universities, independent charities, research councils, local government or government-funded agencies (Buckley & Hordijenko, 2011; EUSCEA, 2005, p. 13). The larger UK science festivals attract visitor numbers ranging from 6,000-50,000+ (Technopolis Group, 2008, p. 57).

Science festivals exemplify the mix of aims and methods that defines contemporary science engagement practice in informal settings (Holliman, et al., 2009; Holliman & Jensen, 2009). As a result of organisational models that tend to involve various partners to deliver the festivals, numerous purposes and motivations for engagement can define one Festival. In this context, Irwin's (2008) taxonomy of 'first', 'second' and 'third' order science engagement offers some conceptual clarity.

Irwin defines 'first order' science engagement as based on the aims of promoting science learning, 'awareness', greater interest in science amongst publics and increased numbers of children ultimately interested in scientific careers. Events framed within a first order public engagement invite publics to learn more about scientific perspectives, but do not require scientists to learn more about publics' perspectives. Such first order framing predominates in science festivals. For example, in the EUSCEA (2005) survey, the most widely shared objective of science festivals was to 'raise public awareness of science'.

According to Irwin (2008), second order public engagement activities are defined by the goal of achieving a two-way 'dialogue', exchanging perspectives and knowledge between sciences

and publics. Framing a public engagement event in second order terms means that both the experts and non-experts are presumed to have valuable knowledge to offer each other. Second order public engagement is also incorporated (albeit with far less prevalence) in some science festivals, including to a limited extent in the present case. Finally, Irwin (2008) defines third order engagement as communication that connects the sciences with a wider social context, wherein techno-scientific development is directed towards social needs. This third order approach involves pluralistic stakeholder perspectives engaging in reflexive, critically-informed discussions and debates about how the sciences can do the most good for society. In this third order frame, the perspectives of sciences and publics become integrated as science is infused with public values. Such third order framing is typically beyond the scope of science festivals, however instances of third order engagement may emerge organically through informal discussions as well as dialogue-oriented events within science festivals such as science cafes.

Considering science festivals' aims, it is noteworthy that distinctive science engagement formats are employed in science festivals alongside more conventional methods of science communication that one might encounter in science museums, science centres and scientists' presentations in schools. The engagement methods found within science festivals include:

- 'Fairs', 'street presentations' and scientist kiosks
- Scientific lectures
- Debate and dialogue events
- Local museum activities and exhibitions
- Hands-on activities
- Laboratory workshops
- Science shows and demonstrations
- Ex situ activities delivered in schools

(Office of Science and Technology, 2004)

A defining characteristic of festivals is their transience: "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, p. 33). Indeed, science festivals, such as the present case, tend to differ from activities provided by science museums and centres both due to their temporary nature and their focus on current scientific research. Festivals tend to offer a wide range of potential experiences within the time-limited science festival context. One consequence of this temporality is that investment may be made in a level of activity which would be hard to sustain for a longer period. For example, many science festivals also have high levels of intensive volunteer participation by scientists, university students, technologists and engineers (Jensen & Buckley, 2011). The number and scope of the involvement of this volunteer scientific expertise plays a key role in positive visitor impacts. Indeed, a comparative study of new US science festivals found that: "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).

Cambridge Science Festival

The case examined in the present study is the UK Cambridge Science Festival ('Festival'), which began in 1995, and takes place during the UK's National Science and Engineering Week in March each year. It is co-ordinated by the University of Cambridge and involves other higher education providers, research institutes, charities, businesses, schools and community partners in organising and delivering activities. The Festival's aims are:

- To engage the public of all ages in issues of scientific interest and concern
- To encourage young people to pursue scientific study and careers

(Cambridge Science Festival, 2009, p. 4)

The objectives of this festival are framed in general terms in order to encompass a wide range of presentations of science and technology in ethical, philosophical, social and historical context. Since 2004, the aims of this festival have been defined using both the words "interest" and "concern" to denote that the UK Cambridge Science Festival was not only aiming to be a celebration of science, but was also allowing for more critical discussions amongst publics with a range of attitudes towards science.

Some of the distinctive characteristics of the Festival stem from its organisation by the University of Cambridge. The University has laboratories, museums and lecture theatres within short distances in a compact city centre, and a large number of events for the public can be hosted within scientific departments and other University buildings. It is funded by the University of Cambridge and charitable and private sponsors. With a small central organising team, the Festival is heavily dependent on voluntary participation by University scientists in particular, so much of its content is generated by "goodwill and enthusiasm" among scientists and university students (cf. Burchell, Franklin, & Holden, 2009).

Almost all Festival events are offered to the public for free. Many events are organised on a 'drop in' basis. Some take the form of 'open days' in laboratories, with scientists showing displays, posters and providing hands-on activities for visitors to do. Some University halls are devoted to kiosk-type formats, wherein scientists provide posters and table-top activities while standing ready to discuss scientific research with visitors. There are numerous public lectures, panel discussions, question and answer sessions, as well as exhibitions, walking tours and other activities.

The Festival offers a range of events aimed at all ages. For example, its two 'Science on Saturdays' events during the festival each include 50+ events targeting families and children (although open to all ages). This family focus is reinforced a large number of activities in the festival that have been categorised as 'hands-on'. In the 2009 CSF programme, 84 out of 165 events listed were in the category 'hands-on', out of a range of categories, including 'Talk/discussion', 'Performance', etc. These 'hands-on' events target children and families, often aiming to provide content that would interest parents at the same time as children. Examples of 'hands-on' event titles

include 'Physics of the bicycle' (model-making), 'Hands on maths fair' (games and puzzles), and 'Medicines under the microscope' (Water-flea heart rate experiments with drugs such as caffeine and alcohol). The evening lecture and discussion programme on weekdays is mostly attended by adults, featuring presentations by both Cambridge-based scientists and external speakers. There is also a “Schools’ Roadshow” programme and “Schools’ Masterclass” programme for visiting school groups and teachers.

The science festival experience for visitors is managed in very limited ways, due in part to the large number of events offered for free by University scientific departments, with only a small central event team responsible for logistics and publicity. Very brief descriptions of events are provided and a minority of events, mostly on weekday evenings, require prior booking. However, the organisers’ assumption is that visitors will self-select their individual pathways through the festival. Overall then, the particular case examined in this study encompasses a wide range of science engagement activities from which individual members of the public may select or encounter. This variegated context raises a number of methodological challenges, such as (1) collecting data from a transitory visitor population in a crowded informal context, (2) designing survey questions that can accommodate feedback on a broad range of public engagement activities, and (3) analyzing the diversity of feedback on this multi-faceted experiences in a way that allows common patterns to emerge. In this study we have taken a mixed methods approach with data collection up to seven weeks after the science festival, with the individual visitor’s experience as the primary unit of analysis.

Prior Visitor Research on Science Festivals

Most prior studies of visitor responses at science festivals have been practically-oriented evaluations of outputs and attendance. These studies were carried out by festival organisers or (less frequently) by commissioned external evaluators. Very few studies have focused on visitors’ views and reached the quality threshold (Jensen, 2011) to be published in a peer-reviewed journal.

The few studies on visitor responses at science festivals that can be found in the public domain are often very limited methodologically and focused on specific, individual events, not the full experience of attending the science festival as a whole. For example, 57% of respondents indicated they understood the description on the poster at a ‘radiation fair’ in Osaka, Japan, in 1996, after viewing a display and description of irradiated potatoes (Furuta et al., 1998). This kind of self-reported understanding offers little insight into the impact or value of the session or the science-related fair overall. At the 2003 Cheltenham Science Festival, there was a panel discussion and question and answer session called ‘Recycling is Rubbish’. An event-specific evaluation of this session found that only 28% of the audience recycled plastic before the event, but 48% claimed they would continue or start to do so by the end (Grant, 2005, pp. 170-171). Such individual event evaluations offer limited insight into science festival visitors’ overall experiences, which involve attending multiple events on multiple subjects in a distinctive festive setting.

On the occasions when evaluations have reported on visitors’ responses to science festivals, only closed-ended response questions are typically used, thereby limiting validity (e.g. British Science Association, 2009a; Oxfordshire Science Festival, 2009). Generally, festival evaluations

tend to find that a majority of visitors report satisfaction with science festival events (British Science Association, 2009a; Grant, 2004; Oxfordshire Science Festival, 2009), and that visitors' most commonly self-reported benefits of attendance are related to learning more scientific information and an increased interest in science (Nash & Haste, 2007; Oxfordshire Science Festival, 2009). An unpublished evaluation of the 2004 Cheltenham Science Festival came to similar conclusions (Grant, 2004). Their evaluation survey asked 93 visitors on-site to circle three words from a list of 13 adjectives[1] (both positive and negative) describing the Festival overall. The most commonly selected words were 'interesting' and 'informative'. However, given that these words were the researcher's and not the visitors', the validity of this data is questionable. The over-reliance on closed-response survey questions in previous studies does not allow for a detailed understanding of processes of visitor reception of science festival events. As such, little is known about why publics visit such festivals and what they believe they gain from them.

Drawing upon the Cambridge Science Festival's external evaluation and a linked academic research report, this study investigates visitors' views on the Festival experience in-depth through quantitative and qualitative analysis of survey responses and focus groups. Key research questions addressed through this study include: What are the patterns of visitor interest and reception at the Cambridge Science Festival? What, if anything, about the science festival experience is valued by visiting publics?

Methods

A combination of methods was employed in this study with the aim of methodological triangulation. Methodological triangulation compensates for the strengths and weaknesses inherent in any one data collection method by using overlapping methods on the same topic. In the present case, quantitative data from the on-site questionnaire (n=958) provided the overview perspective of general patterns of visitor motivations and reception of science festival events, while the online questionnaire and focus groups offered the opportunity to explore these patterns in greater depth. The science festival experience is inherently variegated. The visitor experience unfolds based on the interaction between individual interests and available science engagement activities. As such, we make no pretence in this study that all respondents were exposed to the same experience. Rather, we have collected data on a large set of individual experiences and examined these accounts for common themes.

On-Site Survey

A short questionnaire was administered during the Festival following a cluster sampling strategy wherein questionnaires were distributed at as many available opportunities as possible by volunteers and organisers at both open kiosk-based areas and seated lecture events. This survey was designed to gather visitors' immediate thoughts on the Festival. A large sample size (n = 957) and the recency of visitors' experiences at the point of data collection are the main strengths of this component of the mixed methods study. However, the fact that on-site survey data were collected from visitors at only one point in time is a notable methodological weakness. It would have been

preferable to have linked pre-visit and post-visit data on the same visitors to allow comparison and direct measures of impact.

The on-site sample[2] comprises roughly equal numbers of men (52%) and women (48%). However, the sample skews towards white (88%) as compared to non-white (12%) respondents. Respondents tended to hold either an undergraduate (26%) or postgraduate (36%) degree, with 37% of respondents reporting educational attainment below bachelor's degree level. Respondents were asked to indicate both their own age and the age of anyone else visiting with them. This yielded the following breakdown of visitor groups by age: 0-10 (*n*=22); age 11-14 *(n*=47); age 15-18 (*n*=50; age 19-30 (*n*=124); age 31–45 (*n*=135); age 46–59 (*n*=191); age 60+ (*n*=140); no age given (*n*=124). This large on-site survey sample became the basis for the smaller scale follow-up web survey and focus group samples.

Extended Web-based Survey

Following on from the on-site survey, the expanded web-based survey targeted adults and older adolescents from the on-site survey, with e-mailed invitations to participate sent to those indicating they were aged 16+[3,4]. This post-festival online questionnaire had additional questions designed to delve in-depth into why individuals attended the Festival, what they liked or disliked about it, and what they felt they gained (or lost) from the experience. It allowed for a more in-depth qualitative investigation of individual visitors' views about the Festival than was possible with the on-site survey. Moreover, because this follow-up survey was distributed starting one week post-Festival, respondents could reflect upon the entire science festival experience and incorporate that reflection into their answers. This smaller sample (*n* = 73) was 44% female, 52% male (with 4% not indicating their gender). 86% described themselves as White, 5% as Asian or Asian British, 1% as 'other' and 7% did not give their ethnic background. No respondents self-identified as Black or Black British. The most obvious weakness of this aspect of the larger study, is the risk of a self-selection bias in terms of which of the original on-site respondents chose to respond to the online survey.

Focus Groups

Finally, all of the web-based survey respondents were invited to participate in two focus groups (*n* = 13) held seven weeks post-festival. As with the extended web-based survey, the timing of these focus groups allowed access to participants' views after having the benefit of seven weeks to reflect on the Festival. A focus group approach was selected to gather a range of visitor views about the experience of visiting the science festival. Sociologist Erving Goffman (1961) explicated the methodology of focus groups under the synonym 'focused gatherings', defining them in terms of their "single cognitive focus of attention; a mutual and preferential openness to verbal communication" (Goffman 1961: 18). Kitzinger and Barbour (1999, pp. 4-5) extend this definition: "Focus groups are group discussions exploring a specific set of issues. The group is 'focused' in that it involves some kind of collective activity - such as […] debating a set of questions". Thus, focus groups can facilitate analysis of the similarity and diversity of viewpoints on a particular issue from a range of research participants (Kitzinger, 1994). Indeed, focus groups were selected as a research method for this study because they allow us to gain a more in-depth perspective from a

number of participants about their experiences. The focus groups for the present study were conducted on 9 May 2009, each lasting approximately three hours. They were recorded and transcribed for subsequent in-depth qualitative data analysis.

As with the web-based survey, there is a risk that the focus group participants are not representative of the larger visitor population, given the continued risk of self-selection bias. Yet this limitation is mitigated by the fact that the purpose of the focus groups was to draw out a range of viewpoints on the science festival experience, not to establish the prevalence of identified patterns amongst science festival visitors.

Data Analysis

Grounded Theory Approach

Qualitative data analysis for this study followed a grounded theory approach (e.g. Jensen, 2008; Jensen & Holliman, 2009; Strauss & Corbin, 1998). The analysis began inductively with line-by-line 'open coding' to identify emergent patterns. This coding process involved interrogating the data, making comparisons and developing labels and groupings for similar phenomena (Strauss & Corbin, 1998). The next step in the sequence for the grounded analysis approach is 'axial coding', which involves restructuring data to make new connections and refine the categories for the analysis. These categories are then applied deductively at this stage to systematically identify all data relevant to each coding category. Finally representative quotations are selected from the most substantial categories for inclusion in the write-up of the results. These analytic procedures were carried out using the computer-aided qualitative data analysis software programme *Atlas.ti*.

Grounded Content Analysis of On-Site Survey Data

The on-site survey yielded a large qualitative data set, which was first analysed inductively to identify coding categories for a quantitative content analysis. This means that content analysis codes were derived from the data rather than imposing codes based on an *a priori* framework. For the quantitative analysis, all content matching the definitions of the different coding categories were systematically identified. In so doing, the qualitative data was converted into quantitative data. This quantitative content analysis process was conducted by a trained undergraduate communication studies student.

Table 1 provides exemplar extracts from the data to illustrate the codes. First, generic 'good' or 'bad' festival experiences overall were coded as 'positive' or 'negative'. The second dimension reported in the present study is 'Self-Reported Impact'. Specifically, the range of perceived beneficial aspects of the science festival were coded, with the three most frequently identified codes reported in Table 1.

Table 1: Coding of Generic Comments and Self-reported Impacts

Positive	**General**	• "excellent" • "well worth coming"
Negative	**General**	• "not science, biased religious propaganda has no place at a science festival" • "terrible, nothing of value"
Creating Interest	**Self-reported Impact**	• "informative insights, provocative", • "exciting, colourful, creative, unusual, inspiring, bright"
Knowledge	**Self-reported Impact**	• "an informative discussion", • "it was very informative and everything was very relevant"
Participation	**Self-reported Impact**	• "very informative and interactive - good to see so much audience participation" • "Excellent! Generated lively debate between speakers and audience"

Subsequently, the coded on-site survey data were treated as comprising a quantitative dependent variable.

On-Site Survey Results

The key questions in the on-site questionnaire related to visitors' experience of the Festival were: (1) a 5-point Likert scale asking respondents to rate the event they attended from 'Excellent' to 'Poor' and (2) an open-ended question asking "what did you think of the event?". This section begins with general results based on these two questions.

Overall levels of satisfaction with the science festival events was very high[5]. With '1' as 'Poor' and '5' as 'Excellent', the mean rating was 4.53. Qualitative responses to the question asking what visitors thought of the festival were converted into quantitative data through content analysis, as described above. General comments about the science festival were overwhelmingly positive, as can be seen in Table 2. Responses related to 'Self-reported Impact' emphasised that the science festival was valued most for 'Creating Interest' and enhancing 'Knowledge'. The three most frequently occurring self-reported impacts are reported in Table 2.

Table 2 – General Views and Self-reported Impacts

Code Category	Code	Number
General	Positive	156
General	Negative	6
Self-reported	Creating Interest	230

Code Category	Code	Number
Impact		
Self-reported Impact	Knowledge	125
Self-reported Impact	Interactivity	23

It is noteworthy that 'creating interest' was mentioned with a higher frequency than direct knowledge gains. This dimension of inspiring interest and curiosity in science is the most significant contribution of the science festival experience for attendees, based on this analysis. Moreover, as the extended survey and focus group results indicate, 'creating interest' is connected to the psychological immediacy of the live, highly social science engagement experience, which distinguishes science festivals from many other science engagement contexts.

Extended Web-based Survey Results: Most 'Successful' and 'Unsuccessful' Aspects

Firstly, there was clear evidence of self-reported benefits of attendance in the domain of improved 'Knowledge and Understanding' for a majority of web-based survey respondents (*n* = 45). For example:

> I feel that I now have a greater understanding of mathematics and astronomy. I am also aware of what educational opportunities may be available to my sons.
>
> F[6], web-based survey

In the following extract, the respondent indicates that she gained an increased knowledge about the science of sound through informal discussion with a psychology researcher:

> Learned a lot from talking to a man in [Experimental Psychology] about compression of sound in relation to hearing aids and digital recording of music.
>
> F, web-based survey

Responses such as these suggest informal discussions between scientists and publics within the science festival, were viewed by some respondents as useful means for developing 'knowledge and understanding'. It is worth noting that in these particular cases, the engagement that is taking place is more or less 'first order'. The focus in these comments on such self-reported first order engagement outcomes signals a positive orientation towards this category of public engagement.

When asked directly about what the most successful element of the festival was for them, most responses named individual events, with particular lecturers often singled out. The most common answer could be categorised as ‘lectures in general’.

> The talks I attended were great because they were aimed at a general audience of educated adults and they kept it fun, relevant, and informative (not too dry or technical).
>
> F, web-based survey

Respondents who had attended with children were more likely to identify the hands-on events and ‘family’ talks as particularly successful:

> As always [the most successful element was] the lectures and the chemistry labs where the children wear the lab coats and goggles and actually get to 'do' the experiments themselves.
>
> F, web-based survey

The two extracts included above show respondents praising different kinds of science festival event formats. These data indicate that respondents value the inclusion within the Festival programme of a range of different types of science engagement aimed at different ages and levels of scientific interest.

Unsuccessful Aspects of Science Festival

In identifying the ‘least successful’ element of the science festival, 12 respondents named individual events and specified what they found disappointing. At one level, these responses show that is important for Festivals to maintain oversight over the quality of individual lectures and events. At another level though, there was a pattern in the event dissatisfaction expressed by these respondents, centring on the lack of authentic debate evident in the events they attended. For example, the following extract cites the unwillingness of the speakers to engage with each other and with the perspectives of the audience:

> God and Darwin [debate event.] Lack of discussion on the panel. Largely a Q&A session with the audience but failed to really engage with them.
>
> M, web-based survey

Similarly, two other respondents identified a disappointment with a lack of real debate amongst speakers, including the following comment:

> Sometimes too much time spent on the initial talks by speakers leaving too little for questions and discussion. Hearing experts debate, argue and defend their views is arguably the best way of presenting science to the public.
>
> M, web-based survey

This comment implies that a potential strength of the science festival context, unrealised in this particular event, is to deliver and display debates and discussions presenting a range of viewpoints

for visiting audiences. The fact that such displays of dissensus are valued by respondents suggests potential public interest in being given access to a more authentic and 'in process' form of scientific knowledge, rather than just the 'ready made' science that science advocates may wish to display.

Focus Group Results

The focus group results highlighted the special role of the science festival, which was perceived as creating stronger, more memorable impressions by virtue of its status as a time-limited 'live event'.

M1 One of the things is that you make an effort when something special comes on that's in a confined time. [...].

M3 The science festival is like a giant classroom. It had presentations and it had lectures, and exhibitions. But that kind of interactivity- you just learn better you know. […]

M6 There's also the fact that you're going specifically to something, and you probably make more effort to concentrate. I wrote quite extensive notes at the two sessions I went to.

M1 And you can go and chat to the talkers after they've finished. [...]

Audience Focus Group 2- Cambridge

As this focus group discussion continued, the interactive, 'live' science festival experience was compared with science broadcasting. This discussion suggests that the 'buzz' of the science festival context may reach individuals at a different level than science broadcasts, as well as possibly allowing for discussion of more complex topics.

M3 To have the opportunity of just going and meeting people in the flesh: It's very exciting. It's the difference between watching a film and going to the theatre. You are actually seeing the thing live, and [you have] the opportunity to hear other people ask questions and ask questions yourself.[...]

M5 I think it does tend to make it [a] more memorable experience, because [...] you've got the interactivity and […] the buzz of the rest of the audience there.

M4 [...] The science festival, [...] it can go at a much higher level than TV. There are not many TV programmes that are presented by leaders in their field talking at degree level. It's normally the dumbed down *Daily Mail* [tabloid

news] level, so I think it's serving a different purpose.

Audience Focus Group 2 – Cambridge

The potential for 'higher level' first order engagement enabled by interaction with scientific researchers ('leaders in their field') is emphasised above. Similarly, one focus group participant commented on the unusual opportunity to delve beyond the surface level of science afforded by scientists' participation in the Festival.

M A vast number of the population don't understand what science is about and what it means when it says on the news, 'Scientists say that…'; What does that actually mean? How have they drawn those conclusions? The Science Festival is an opportunity to say, 'This is how science works, how it knows what it knows' [...], which is really important […] whether you want to be a scientist or not. To understand what science is, is important […] not just to understand the end results.

Audience Focus Group 1 – Cambridge

While the benefits of attending the festival enumerated by most focus group participants centre on first order engagement within Irwin's (2008) taxonomy, the extract above suggests a connection to third order engagement concerns with the context of science and its role in society.

Beyond interaction with scientists, the diversity of science engagement formats was also highlighted as a positive aspect of the science festival. One discussion focused on positive adult-oriented experiences, balanced against a broader appreciation for the fact that there were also many activities oriented towards children:

M3 I was pleasantly surprised. Most of the talks I went to were very intelligently portrayed, and they assumed a certain amount of maturity on the part of the audience.

M1 I found [there were…] some extremely good talks […] and really enjoyed when I learnt something new. The very first talk I went to with my wife was about, I think, 'why we like to eat', or something like that. And I learnt that it's not only the endocrines that give off hormones, but our fat gives off hormones that suppress our desire to eat. That was something I didn't know before and I think it's a relatively new finding. But also, the last thing I went to was a talk on light in the Cavendish Laboratories. And when I came out from that I thought, I will see what else is here. […] I was interested to see what was there for children. And I thought this is fantastic for kids. They

can have fantastic fun making rockets that were being launched […]. And there were all sorts of demonstrations and exhibits that were hands on. And I thought that was great, because it seems to me that we need more scientists, and that's a good way of getting kids interested in science. […]

M2 [My interest at the festival was that] I wanted to, A, learn something, and, B, find out what some of the latest developments were in science.

Audience Focus Group 2 – Cambridge

Taken together, the focus group results suggest the potential for science festivals to provide publics with information and conceptual tools to understand scientific developments in a diversity of subject areas. These experiences are underpinned by the unique context that brings together the excitement or "buzz" of a festival with the unusual opportunity for publics to interact with active scientific researchers and experience a wide range of different science engagement activities. Third order engagement may arise unplanned at a micro-level within science festivals, as they provide opportunities for publics to critical discuss scientific development with scientists and other publics.

Discussion

This research casts light on publics' experiences in science festivals, as one increasingly widespread manifestation of the ascendant public engagement agenda in UK and EU public policy. The fact that public engagement events more generally are sometimes well attended is one indicator that this agenda may have some purchase with some publics. However, this study goes further to develop an understanding of what visitors find valuable (or not) about informal science engagement events and activities within a festival setting.

Respondents valued both presentations and informal interactions with active scientific researchers who gave insights into "how science works; how it knows what it knows" and opportunities to "go and chat" with practicing scientists. These experiences are underpinned by the unique science festival context that brings together the diverse cultural appeal of a festival (including open days, performances, talks and activities), with the unusual opportunity for publics to interact with active scientific researchers. 'Hands-on' activities of the kind seen in many science centres also feature heavily in the overall science festival programme and the availability of such family-friendly activities was valued by visitors.

An aspect of visitor responses to the festival that was notable for its absence, was the lack of negative comments about the predominately first order public engagement on offer at the festival. Rather, visitors reported that they enjoyed developing new areas of scientific interest and enhanced scientific understanding of the world around them. While many festival activities are interactive, they typically take place within a general first order framework of the knowledgeable scientific expert educating or inspiring less scientifically knowledgeable publics- not entering into an authentic second order dialogue between equals.

There was no evidence that publics were seeking a fundamental shift away from first order public engagement. Indeed, the results of this study could be considered as supporting the continuation of a 'mixed economy' of different 'orders' of public engagement in the field of science engagement (see Holliman & Jensen, 2009). Based on the present study, we would argue that practitioners should recognise and employ a range of engagement methods to meet the requirements of particular contexts and publics. Certainly, this study indicates that 'first order' forms of public engagement aimed at 'informing', 'enthusing' or 'educating' should not be assumed *a priori* to be inherently flawed. At the same time, the possibility of spontaneously arising third order public engagement occurring within predominately first order settings, casts doubt on the idea that these orders of engagement are necessarily linked to deep "intellectual and political roots" (Irwin, 2008: 203).

The present research highlights the need for greater conceptual clarity about the distinctions that exist *within* each of the 'orders' of public engagement identified by Irwin (2008). Negative visitor comments about the lack of debate *between speakers* (not between speakers and publics) at the science festival may indicate one of the potential fault lines for science engagement events such as this. Specifically, publics may be seeking access to a more processual account of scientific knowledge within a first order public engagement setting, rather than just the 'ready made' science that the public relations end of the science engagement field might advocate. This points to the importance of first order public engagement activities maintaining an openness and honesty with visiting publics about the uncertainties inherent in scientific research. Seeking to downplay scientific disagreements and only presenting a sanitised public relations version of science to publics, risks damaging the very science/society relationship and scientific citizenship that science festivals and other venues for public engagement with research are supposed to nourish.

The potential for the science festival experience to reinforce an unrealistic vision of science must be taken into account when evaluating its role as a site for informal science engagement. The motivations of the volunteer scientists participating in the festival tend to be on the side of persuading people that science is an enjoyable and worthwhile activity (Holliman & Jensen, 2009; Holliman et al., 2009). The ways in which this message is conveyed and the enjoyment-centric context of the festival, may frame science as a kind of activity that it is typically not. Of course, scientific practice is by and large a matter of painstaking labour, and this aspect of science is heavily downplayed in the science festival context in order to maintain the focus on enjoyment that most institutions, including television and museums, see as essential for gaining and maintaining a broad public audience. The question of whether the impacts of such representations of science are ultimately negative for visiting publics would require a different form of evaluation than that employed for the present study. An evaluation that directly measured individuals' thinking about science before, during and after the festival experience would more fully address the risk that some individuals may value and enjoy science festival experiences, yet be worse off in terms of their understanding of science. This impact question holds clear implications for any judgement about the effectiveness of science festivals as intermediary spaces facilitating engagement between sciences and publics (Jensen & Wagoner, 2012).

Conclusion

This study has identified distinctive patterns of visitor reception relating to the 'live' engagement context of a science festival. The on-site survey showed that the self-reported festival impact of 'creating interest' was by far the most frequently reported by survey respondents. This suggests that while knowledge acquisition is an important benefit of science festival attendance for some, the opportunity to encounter science in an "exciting" or "inspiring" context is a much more commonly perceived benefit of attendance. This finding makes sense given the time-limited nature of the science festival experience. Treating the festival as an opportunity to dabble in a number of different scientific domains in order to identify areas of interest for later development, emerged as a typical visitor reception pattern across the three data sets examined in this study. Thus, the value of 'first order' science engagement for science festival visitors is clearly not a simple matter of knowledge acquisition. Participants emphasised the immediacy and interactivity of the science festival experience, the diversity of public engagement formats, opportunities for social interaction and learning and access to active scientific researchers as a unique combination not offered by other science engagement settings.

Large-scale surveys continue to suggest that the British public generally values scientific research (MORI, 2011; Research Councils UK, 2008). Where this public support for science comes from remains under-explored. Science festivals and other modes of engagement may explain part of this macro-sociological pattern. However, to further develop understanding in this domain, future research should consider the long-term impacts of science festivals well beyond the seven week time threshold covered in the present study (Dawson & Jensen, 2011). In addition, the ways in which science festivals interlock with other forms of science engagement, such as museums and science broadcasts, could be fruitfully explored using idiographic methods (e.g. Wagoner, 2008; Wagoner & Jensen, 2010). Such long-term impact evaluation holds the key to understanding informal science engagement's role in people's lives. Moreover, it can help assess the relative contribution of informal science engagement to the development of a healthy relationship between science and society.

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Endnotes

[1] The adjectives provided in this evaluation were: Unfriendly, informative, tedious, fun, dull, challenging, boring, frustrating, interactive, uninteresting, friendly, interesting.

[2] These percentages only count those who responded to these demographic questions. That is, those who elected not to provide such details are not included in these percentages.

[3] However, there were three responses from 13-year-olds who were members of families who had been emailed to invite to take part. In total, 5% of responses were from those aged 17 or under.

[4] A small incentive was provided: entry into a prize draw to win an illustrated book on the history of the University of Cambridge.

[5] A handful of respondents indicated their rating as between two numbers on the scale (e.g. between 3 and 4). In such cases, a mid-point was assumed (e.g. '3.5' was used to replace a mark between 3 and 4).

[6] In data extracts in this article, female respondents are denoted by an 'F' and male respondents by an 'M'. In the focus group data extracts, when there is more than one male or female participant in the data extract, a unique identifier has been added to the gender notation (e.g. 'M2' means 2nd male participant).