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Laughing to love science: contextualizing science comedy

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Abstract: Over the last fifteen years, there has been growing interest in the use of comedy within science communication. This paper seeks to contextualize the emergence of science comedy, analyzing the construction of comedy within academic literature as a means for bolstering the cultural authority of science. Drawing specifically from Mikhail Bakhtin's work on power and language, academic constructions of science comedy might be read as an orchestrated moment of carnival, with humor imagined as a means for engineering public support for science, on the premise that science communicators alone should determine what version of science the public receive. However, results from a pilot study interviewing London-based science comedians suggests that such ambitions are not shared by performers. Performers framed the value of science comedy lying predominantly in the opportunity to challenge other science communicators' own attitudes to science. Framing scientists and science communicators as science comedy's most relevant audience, rather than the public, performers envisaged comedy as a space in which the unspoken assumptions of science could be exposed and negotiated.

Keywords: Bakhtin; humor; science comedy; science communication; sociology of science

1 Introduction

Over the last fifteen years, there has been growing interest in the use of comedy within science communication. In an age where the stability of cultural authority of science appears under threat from misinformation, government interference and public disinterest, scientists and science communicators have sought new ways to bolster reverence for science through formats presumed to match the interests of otherwise hard to reach publics. Inspired in part by the success of mainstream comedy shows such *The Big Bang Theory* (CBS, 2007–2019), a sitcom about research scientists that has achieved worldwide success, numerous scholars have begun

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to investigate how well comedy might communicate scientific knowledge, on the assumption that humor and comedy might offer an educative and edifying experience, providing access to legitimate science culture in a way that may have been previously unavailable to various audiences (Li and Orthia 2016; MacIntosh 2014). While some research has attempted to measure knowledge uptake and assess the appropriateness of scientific imagery within existing media, other researchers and practitioners have sought to create their own events in which scientists take center stage (Bultitude 2011; Riesch 2015).

In the United Kingdom, *Bright Club*, launched at University College London in 2009 as ‘the thinking person’s variety night,’ has sought to ‘transfor[m] researchers into stand-up comedians,’ challenging active researchers to deliver a 9-min stand-up based on the content of their research (Bright Club, n.d.). Similar schemes in Portugal, Ireland and the United States have aimed to use comedy to improve both public awareness and appreciation of science, and scientists’ own skills in communicating and controlling the public face of science (Pinto et al. 2015; Roche et al. 2020; Science Riot 2018). By placing scientists center-stage, with the opportunity to discuss their work and professional life in ways perhaps previously unavailable without recourse to humor, science comedy has sought to do more than entertain. By showing scientists in a humorous – and vulnerable – light, public audiences might see the human side of science, dispelling negative visions of science as stilted and remote. If successful, the goodwill shown by audiences to scientists on stage might have a greater use, anchoring the trust and adherence to science necessary for scientists to take a more prominent role in public.

2 The science communication carnival

The literary theorist and semiotician Mikhail Bakhtin has enjoyed substantial interest within comedy studies, particularly for his account of the carnivalesque, developed through his reading of Rabelais’ *Gargantua and Pantagruel*. Bakhtin positions the carnivalesque as a literary and discursive mode that exposes and challenges dominant forms of power and order through laughter, disorder and parody (Bakhtin 1984). Rabelais’ humor is distinctly polyvalent, moving between satire, black comedy, destructive and iconoclastic depictions of order and the celebration of the joy of clan joking as means for building communities and scapegoating and stigmatizing outsiders (Baraz 1983; Huchon 2010). However, the political potential of humor as a generative form of resistance that emerges from this ambiguity dominates Bakhtin’s reading. Most visible within the ritual acts of inversion that occurred in medieval carnival in which the low and profane were celebrated, Bakhtin claimed that the carnivalesque, as a mode of thought and

speech, had significance and political power far beyond the specific periods of carnival time, in demonstrating that the apparent natural order of society, expressed and reinforced through language, was neither inevitable nor arbitrarily imposed (Denith 1995).

Responses to Bakhtin have grappled with the ambivalence of humor, parody and subversion within carnival. Within humor studies, numerous scholars have noted the lack of evidence any genuine political change took place as a result of carnival: while momentarily evoking the possibility of transformation, such change could only be sustained within the specific licensed rites of carnival and appeared to have little impact beyond the days (e.g. Critchley 2002; Morreal 2009). Indeed, historical work that has investigated both medieval and modern invocations of the carnival has highlighted how carnivalesque humor reinforces rather than challenges hegemonic power. Rabelaisian scholars have questioned whether depictions of carnival suggest political subversion (Parkin 2021), while other scholars have argued that rather than emerging as a form of resistance from below, carnival was carefully orchestrated, with revelry licensed from above as a means for preserving and reinforcing social order (Jenks 2003; Saltzman 1994; Stallybrass and White 1986).

This ambivalence of carnival is large pre-empted by Bakhtin's broader philosophy of language, where language is imagined as a 'succession of utterances,' acting as a site of continual negotiation and potential transformation of future meaning, while carrying a 'taste' of the historical contestations of meaning that had occurred (Bakhtin 1981; Bostad et al. 2004). Individuals are involved in the continual orchestration of the voices that have come before them, using language for new purposes but never being able to speak entirely autonomously or dispense with the historical meaning of language. Consequently, the inversion of the language of power and domination within carnival ensures its continuation, even when demonstrating that power relations could be different, by failing to produce a new way of speaking. In this sense, the motif of the carnival retains analytical purchase, by providing a lens with which to examine moments in which humor, power and invocations of order being inverted come together (Saltzman 1994). These moments have gained particular pertinence within a contemporary cultural context in which humor has been increasingly valorized, as a self-evident social good, tool of resistance and means for speaking truth to power which may obscure discussion of the relationship between power and humor (Billig 2005; Friedman 2015).

In contrast to the absolute power of the medieval state, the position of the science in the twenty-first century seems less certain, being viewed by scientists and policy makers as continually under threat (Archer et al. 2015; Jasanoff 2014). The field of science communication is frequently imagined to serve as science's last defense, by cultivating public acceptance of and enthusiasm for preserving the role of science and technology in society (Smallman et al. 2020). Alongside academic scientists

disseminating their research publicly, science communication includes a raft of professional roles, including professional science presenters, PR and social media officers, and administrators working within academic institutions to coordinate public-facing activity and build relationships between academia and other communities (Gascoigne et al. 2010).

The development of science communication as a discrete form of research and public work has relied on substantiating the public as a threat to social order, through their ignorance and apathy in relation to science and technology. In the United Kingdom, science communication work was catalyzed by the publication of the 1985 Bodmer Report by the Royal Society, which painted a grim picture of public loss of trust in science, primarily through the proliferation of profound public knowledge deficits (Bodmer 1985; Stilgoe et al. 2014). This deficit approach to science communication was thus motivated by a straightforward, though difficult, goal of remedying such deficits through programs of public information, education and exposure to science. A parallel research track has focused on developing knowledge of public attitudes towards science, evaluating different communication styles and finding appropriate ways to tailor scientific content to ensure maximal uptake (Bauer et al. 2007; Smallman 2016).

The basic premise of the deficit model, namely that public discontent with science and technology and policy and technology can be ascribed to a lack of technical knowledge, has been criticized on empirical and ethical grounds. Studies of scientific controversies have frequently demonstrated that public concerns relate to more fundamental differences in worldview, which are exacerbated by the limits of scientific imagination, in presuming that social problems can be understood through a solely scientific lens (Gregory and Miller 1998; Welsh and Wynne 2013). The greatest threat to public order, in this view, is the resistance of scientific institutions to imagining alternatives and allowing for democratic oversight, consequently requiring the creation of structures that would allow for a wider range of voices to participate in the governance of science and technology (Wilsdon et al. 2005). Attempts to operationalize these aspirations have been broadly referred to as the 'dialogue' model, through projects including consensus conferences, community-led research and 'upstream engagement' in which non-expert groups are involved in all stages of the research process, as well as a discursive shift that stresses the public as equal partners in the governance of science. The dialogue model has sought to repurpose the language of science communication predicated on public deficit to imagine forms of engagement with science that decidedly more transformative.

The traces of deficit and distrust in the public have proven very difficult to erase from the discourse and practice of science communication. The language of 'dialogue' has been rapidly adopted within science communication without necessarily

involving a concomitant change in viewing the public as anything but a threat to social order. In mainstream science communication, the shift from deficit to dialogue has been framed as a sign of the field's maturity in developing a more complex understanding of the public, with descriptions of practice usually couched in terms of mutual benefit, shared enterprise and the public as equal partners within events. Greater attention has been placed upon identifying and anticipating the needs and interests of audiences, reflected in both the styles of events produced and the training urged for participating scientists and communicators (Baram-Tsabari and Lewenstein 2013; Dahlstrom 2014). However, critics of this work have noted that latent 'deficit' assumptions remain and indeed dominate practice (Burns and Medvecky 2018; de Saille 2015). Mainstream science communication may seek to make scientific knowledge more accessible and relevant to the diverse lives of the public, but not with the intention that audience perspectives might transform the governance of science. In this view, traditional approaches to educating the public are ineffective rather than ethically questionable, requiring greater attention to knowing the public, so they can be brought back into conventional order with greater efficiency.

Within the serious world of science communication, the use of humor and comedy as tools of cultivating public acceptance for science and technology might appear incongruent or even paradoxical. Questions of the legitimacy of comedy have dominated academic discussion, with many scholars expressing the concern that comedy might trivialize or decenter the serious concerns that motivate science communication work (Bore and Reid 2014; Pinto et al. 2015). Indeed, early press coverage of Bright Club in the United Kingdom frequently highlighted the apparent contradiction between the levity of comedy and the seriousness of science, suggesting that Bright Club for the first time offered public audiences the chance to see the funny side of scientific research, or that researchers were (or could be) funny. However, the initial disbelief in the very possibility of science comedy that rapidly dissipates once scientist take the stage would seem crucial to its purpose in the field of science communication, by invoking the possibility of transgressing science's cultural authority and seriousness in order to correct the public's presumed knowledge and attitudinal deficits. Audiences might be lured by the seemingly carnivalesque opportunity for exposing the conventions of science and then witness the ingenuity and trustworthiness of scientists: a Rabelaisian and carnivalesque humor engineered for science can simultaneously appear profane, destructive, generative and joyful, playing with notions of transgression to bring the public back into order (Parkin 2021).

The viability of science comedy as a tool of science communication relies on a broader historical shift in the consumption of stand-up comedy, alongside a long history of scientific joking that through science comedy has gone public. Historical

accounts of comedy have traced a transformation in the social status of comedy, moving from a mode of performance denigrated for its vulgarity, populism and provincialism to an aesthetically and political powerful form of speech, typified in the United Kingdom through the rise of Alternative Comedy (Bennett et al. 2009; Cook 2001; Dacre 2009; Mills 2010; Sayle 2016). Elite forms of comedy that prizes originality, experimentation and political expression, seeking to educate as well as entertain their audience have gained cultural legitimacy and dominated academic and critical discussion that has sought to valorize the power of comedy as a tool of transformation and resistance (Friedman 2015; Stott 2014). The possibility for comedy to challenge conventional images of science has frequently been attested within the history of science, as the discourse of professional publications and private spaces of science have been replete with in-jokes and humor (Cain 2019; Findlen 1990; Lewin 1983). The most extensive treatment of scientists' joking is offered by Gilbert and Mulkay's analysis of joking within the laboratory, the circulation of in-jokes, fake journals and deliberate hoaxes, and the ritual forms of humor encoded in events such as the Nobel Prize banquet (Gilbert and Mulkay 1984). For Gilbert and Mulkay, the frequent highlighting of incongruity in scientific humor, most often through contrasts between what scientists officially say and what they really mean, serves a more serious purpose, marking insiders by their ability to get the joke and quarantining discussion of error, contingency and the unexpected within scientific practice as a topic of private joking, not to be shared with the public.

Outside of these private scientific spaces, scientific imagery has been repeatedly incorporated into mainstream comedy. Alongside stand-up comedians such as Dara Ó Briain, Tim Minchin and Ricky Gervais, who frame their shows as celebrating and communicating science and rationality (as well as mocking their opposites, whether pseudo-science, irrationality or religion), scientific imagery recurs across a range of formats and shows, though rarely with the explicit goal of public science education. *The Simpsons* (20th Television, 1989-) frequently employs scientific, and particularly mathematical, imagery into its visual style, often in the form of 'freeze-frame gags' where equations and puns relying upon mathematical knowledge are displayed in the backgrounds of scenes (Singh 2013), and concerns a town dominated by a nuclear power plant. *Futurama* (20th Television; Comedy Central, 1999–2013) similarly draws frequently from popular depictions of scientists, science and technology and science fiction in creating the future New York in which the show is set. As a narrative tool, contemporary public debates about science and technology are frequently featured in *South Park* (Comedy Central, 1997-), with contemporary issues such as stem cell research, debates about evolution and alternative medicine being used as a narrative tool for the show's exploration of small-town American life.

Within British comedy, several shows have taken science as their central theme. Both *Green Wing* (Channel 4, 2004–2007) and *Getting On* (BBC Four, 2009–2012) are set in hospitals, and feature medical staff as their central characters. More widely, science and technology have frequently been used as a means for developing shows' comic worlds. In *The Day Today* (BBC Two, 1994) and *Brasseys* (Channel 4, 1997–2001), both created by Chris Morris as satires of news reporting and investigative journalism, science is frequently employed to highlight the meaningless of news discourse. The program had real-world ramifications: a segment about the dangers of the fictional synthetic drug 'Cake' led to the safety of the drug being discussed in Parliament. The show's most controversial episode, 'Paedogeddon!,' which sought to expose the moral panic surrounding pedophilia, again drew on scientific repertoires, inviting media personalities in the UK to state on camera that new technology was turning children 2D, and that pedophiles had a DNA profile more akin to a crab than a human.

Where these shows might seem to be 'about' science, so too has science been used in shows that engage with very different themes. *Nighty Night* (BBC Three, 2004–05), written by Julia Davis, follows the seemingly sociopathic Jill Tyrell's attempts to seduce her neighbor's husband, hindered by her own husband recovering from the cancer she has told everyone has killed him. Jill's ability to manipulate scientific and medical language, and the credulity of the medical professionals she encounters, drives her ability to get what she wants. In the Australian show *Get Krack'n* (ABC TV, 2017–2019), scientific and medical imagery are frequently employed as a means of deconstructing the mechanics of breakfast television, which the show parodies, alongside broader issues relating to gender, race and indigeneity in Australia (for instance, by including a purported medical expert who describes Mindfulness as meditation "without all the Asian-y bits, so it's scientific now"). In *Absolutely Fabulous* (BBC Two, 1992; BBC One, 1994–2012), focused on the lives on Edina Monsoon and Patsy Stone and their obsession with fashion and fads as a way of trying to stay young, science and medicine, as forms of fashion, are often used as a plot device, for instance in Patsy's use of the chemical weapon 'Parallox,' developed at Porton Down, as an anti-wrinkle treatment.

While not seeking to explicitly communicate science, the use of scientific imagery hints at the potential for radical transformation. As a tool for characters within comedies and for writers, the malleability of scientific discourse demonstrates the possibility that scientific knowledge might be used with little regulation. Scientific discourse serves primarily as a reservoir of ideas and images (Erikson 2005), that can be orchestrated to tell stories that do not need to be 'about' science, nor celebrate the position of science and technology in society. Science can be used to comment on the faddish commercial products in *Absolutely Fabulous* and *Get Krack'n*, as a test case of celebrity gullibility in *The Day Today*, or in exemplifying the town

of South Park's moral ambiguity, precisely because the movement of scientific discourse away from its sites of production demonstrate the multiple meanings that science might have. The depictions of science would rarely appear combative, as jokes are usually aimed to ridiculing misunderstanding or the misappropriation of scientific knowledge, suggesting an assumption that the audience would recognize the appropriate uses of science and technology that the characters are allowed to transgress. However, the ability of scientific discourse to be reshaped through comedy might suggest that the unspoken legitimacy of scientific culture is contingent on the ways in which scientific discourse is employed.

For science communication, the malleability of scientific discourse serves as a latent threat for public-facing work. Attempts to introduce previously private scientific discourse into the public sphere as a means for inculcating knowledge and positive attitudes towards science amongst the public cannot be in scientists' sole control, as the proliferation of scientific discourse will create new opportunities for the negotiation and transformation of meaning (Bakhtin 1981; Denith 1995). Yet the use of comedy within science communication reflects a desire for control, in seeking to ensure that comedy enables the public to appreciate science in the correct way by being permitted to laugh only as a means for building reverence (Bore and Reid 2014; Pinto et al. 2015). Numerous empirical studies in the last five years have sought to assess the suitability of comedy and humor, often by asking how much humor is enough (and too much) to better reach a resistant public. This has included comparisons of serious and comic versions of similar texts to measure the extent to which humor successfully communicates specific scientific messages (Anderson and Becker 2018; Moyer-Gusé et al. 2019), attempts to identify the types of humor most likely to convey accurate information (Brewer and McKnight 2015; McKasy 2019; Su et al. 2022), and the likelihood that humor will encourage positive attitudes towards scientists and science communicators (Cacciatore et al. 2020; Dubovi and Tabak 2021; Yeo et al. 2021). While this research has universally noted a public receptiveness in the use of humor in discussing science, practitioners are themselves more reticent, concerned that comedy might decenter pure scientific messaging and fail to create the emotional attachments required for real engagement.

Research to measure public responses to science comedy rely on a highly static view of scientific knowledge, in which comedy serves primarily as a vehicle, capable of distorting or hiding knowledge, while preventing any scope for new understandings of science to emerge (Hilgartner 1990). 'Humorous' and 'serious' versions of science are delineated and presented as self-evident. For example in Yeo et al. (2021, S1), one experiment compared a diagram of two atoms with the non-humorous messaging of 'Atoms are composed of electrons, protons, and neutrons'. When an atom loses an electron, it becomes more positive #science #fact" and the

use of humorous wordplay captioning the image: “Two atoms are talking. One says, “I think I’ve lost an electron.” “Are you sure?,” “Yeah, I’m positive.” #science #funny.’ Presenting the two messages as ultimately identical, the research could claim not only that humor improved public uptake of scientific knowledge, but that a single understanding of science – controlled by science communicators – existed. In this frame, comedy might backfire, making certain publics more likely to reject scientific knowledge (Anderson and Becker 2018; Brewer and McKnight 2015; Moyer-Gusé et al. 2019), but there is no allowance for the public reaching an understanding unanticipated by science communicators, or indeed negotiating new meanings for scientific knowledge. Indeed, the experimental models used have uniformly found that science comedy is most effective on publics that already possess a strong interest in science and are primed to be measured as consuming science in the correct way (Yeo et al. 2020, 2021).

The careful orchestration of science and humor, both in the content offered to the public and the frames used within science communication, cannot entirely prevent slippages, however. While science communicators have sought to offer the public carefully constructed moments of licensed revelry as a means for bolstering conventional understandings of science, humor might highlight the existence of previously private versions of science. In 2013, the hashtag #overlyhonestmethods trended on Twitter, with laboratory scientists appearing to offer ‘honest’ descriptions of their work, reported by *The Guardian* as reflecting ‘less than scientific methods.’ Examples collated within the press included: “This dye was selected because the bottle was within reach,” “Sample size was smaller than planned because I had been in grad school for 10 years & my advisor wanted me to graduate” and “We don’t know how the results were obtained. The postdoc who did all the work has since left to start a bakery.” Though the episode was generally reported positively in the press, and there was some sense the hashtag could counteract negative stereotypes around scientists (Lorch 2013), academics expressed concern that the tweets could undermine public trust in science by challenging the public image of science gaining its credibility by adherence to scientific method (Bezuidenhout 2015; Simis-Wilkinson et al. 2018). The public could not be permitted to joke about science in the same ways that scientists did, even when the humor of the laboratory entered the public sphere. Humor that might reveal the artifice of conventional public science was a threat to social order, and in the view of these scholars, needed to be contained.

Traces of the carnival recur in these attempts to simultaneously offer science comedy to the public and curtail any potential for humor to challenge the ordered and singular version of science that science communicators presume the public lack and need. Rather than evoking Bakhtin’s idealized view of carnival as a moment where the inversion of public order demonstrates its artifice and contingency,

science comedy reflects the licensed forms of transgression and revelry noted by Bakhtin's critics: humor might initially appear transgressive to the seriousness of science, but the appeal of humor for science communicators has been the confidence in which such transgression will be rapidly reincorporated into conventional order (Jenks 2003). The possibility of witnessing a profane and debased version of science on stage or social media is a lure for the audience, but not a promise that the possibility of new versions of science will be anything but an ephemeral feature of performance. The more idealized view of the political potential carnival explored by Bakhtin seems distinctly undesirable, with humor valued primarily for offering a more effective means for scientists to control their audiences (Malow 2010; Pilcher 2010). Rather than the audience being crowned as carnival monarchs and temporarily given power in carefully orchestrated rites, science comedy foregrounds scientists appearing to cede their power and join the commons, through a form of communication that is at once popular and elite. Science comedy provides a means for demonstrating that scientists understand mass culture and popular concerns, through a form of communication that has gained increasingly cultural and relevance for its ability to educate and edify its audience.

From these contexts, a working definition of science comedy might be discerned, as the deliberate attempt to orchestrate humorous performances of science as a tool for managing public responses to science. Borrowing the formats, venues and rationales of comedy, and particularly the aesthetic and political goals of alternative comedy, the trappings of comedy have been instrumentalized in the service of science communication, valued only so far as comedy can ensure public awareness and acceptance of scientific knowledge and culture (Bell 2011). While the movement of scientific discourse within comedy might reveal the inherent ambiguity and slipperiness of any attempt to enforce singularity and certainty, this remains the goal of science comedy, resisting comedy's adeptness for uncovering new possible meanings and instead engineering opportunities to maintain and defend the hegemonic power of science. Science comedy aims to present scientists as funny, relatable, vulnerable and trustworthy and in doing so cement the notion that scientists alone have the right to arbitrate social problems in which scientists offer one, though rarely the only, answer.

3 Scientists on stage

Where academic interest in science comedy has enabled the translation of absolute notions of publics, science and the nature and quality of comedy within the parameters of science communication discourse, for performers on stage, the experience of performing on stage has often engendered very different notions of

purpose and success. Between 2017 and 2019, as part of a broader ethnographic study of science communication in the United Kingdom, a pilot study was conducted into British science comedy, consisting of qualitative interviews with 18 performers in London, in which they discussed their routes into science comedy, their experiences within the science communication sector and their views regarding the purpose of being on stage. In London, a network of comedy nights for science had flourished by the time of the study, with some, like Bright Club, affiliated to academic institutions, while others, such as Science Showoff, being run independently in small-scale comedy venues. The performers interviewed were either early-career scientists, generally completing doctoral research, or practitioners working in the science communication sector following scientific training. Each had discovered science comedy events through their pre-existing affiliations to science communication work, often by attending events as an audience member or meeting other performers through their professional work. Thus when discussing science comedy, performers did so with the understanding that it was closely related to the broader world of science communication.

While science comedy was understood as a form of science communication, it was not one for the non-scientific general public found in academic literature. Organizers of science comedy nights could rely on small willing audiences to fill venues, many of whom were friends and family or had an established interest in scientific culture, primed to already understand and appreciate scientists explaining their frustrations at experiments gone wrong, revealing that they didn't love science and were not as clever as the public might presume, or were secretly lazy. Inverted and profane images of science were manifest, with performers often discussing sex and secretions in the natural world to show how nature and its study were secretly disgusting, and appearing to subvert their own authority by stressing how they were just like everyone else, finding humor in the incongruities of science's apparent self-image. These performers appeared to evoke the imagery of the carnivalesque, both from above and below, as performers proclaimed an intention to shed the usual authority of science, shrouded in seriousness and self-importance, and did so by evoking the humor of the carnival crowd, reveling in comic imagery that appeared to challenge the authority of science, either through the suggestion of profanity or by highlighting that scientific story-telling need not be positive and celebratory. Science comedy displayed a transgressive impulse on stage, but one that was distinctly safe, playing with radical images of science to small audiences already on the inside, who could be trusted not to see the true picture of science revealed through comedy as a call for its destruction (Bell 2011; Jenks 2003; Stallybrass and White 1986).

The transgressive impulse to challenge the authority of science while maintaining an elevated position as an arbiter of the public dissemination of scientific

knowledge reflected many comedians' views of themselves within the field as both insiders and outsiders, gaining access to science comedy performances on the basis of their prior scientific training and experience in science communication, which simultaneously feeling excluded by the science communication mainstream. When discussing their experiences of performing science comedy, participants invariably turned to negative valuations of science comedy elsewhere, as lacking quality and sophistication and being impeded by a desire to educate their audiences:

Anna: I think [the difference between science and mainstream comedy], it's seen as, there are bad comedians in both, but if you're a comedian that's bad in mainstream comedy, you can't justify yourself, and you just have to get better, but I think it was perceived as, if you're a science comedian you could then just make the excuse and be lazy of, oh well I'm not a proper comedian, but I'm not going to like, try and get better.

Good science communication was a recipe for bad comedy, particularly when viewed simply as a vehicle for traditional methods of knowledge transmission. Science comedians and communicators elsewhere were positioned as lazy and unwilling to learn, believing that being a scientist was enough to succeed as a science comedian. One consequence, according to participants, was that science comedy had already restricted its audience to groups who already loved science and did not attend events in the expectation of witnessing good comedy. One comedian related their prior work in science comedy as primarily involving performing to crowds overrun with 'nerds':

Toby: Loads of people who worked for universities and loved Pub Science gigs would start coming to our events, and it got to the point where I could name about 3 quarters of the audience and they're the same people who went to Robin Ince's shows and we wanted comedy fans, we didn't want, nerds...

Science comedy had failed in its purported purpose of reaching new audiences, instead playing to a familiar crowd of science fans who wanted their scientific identities to be validated on stage, often, in participants' views, through easy jokes targeting the supposed ignorance and apathy of the public. Yet such an audience was essential for these science comedians, as they possessed the requisite knowledge and experience of research and laboratory to notice the incongruities that would enable a transgressive account of science. A more general public seemed unlikely to notice that they were witnessing a conscious attempt to challenge the conventions of science communication, as both comedians' critiques of other performances and their work on stage increasingly focused on a single target: mainstream science comedians and communicators.

When discussing the purpose of science comedy in interviews, science comedians frequently evoked notions of the transformational and transgressive

potential of comedy in relation to changing the attitudes and behavior not of the public, but other science communicators and science fans. Often coupled with highly negative assessments of British science communication and communicators, participants in the study framed humor as means for educating their mainstream counterparts, by showing that scientists did not need to treat themselves with dour reverence:

ETB: Do people make jokes when they're presenting in conferences?

Jamie: No, no way. People don't do that. No, you have to be confident to the point of being an arsehole to make a joke during an academic talk – I hope I'm not an arsehole, I think I just, also, as it got towards the end of my PhD, I just stopped giving a shit about what they thought of me. At first it was terrifying and intimidating, but by – towards the end I was like, these people are as ridiculous as me, I'm just going to have some fun myself [...] but if I'm giving an academic talk to maybe 100 people who are not going to care if I made a joke, or forget what I'm talking about, they just don't care, like no one cares, so it was like, we just need to be a bit more humble about the whole thing.

While aware that the use of humor might be read as a form of arrogance, humor and comedy were positioned for fostering humility, teaching other scientists that funny scientists could be serious producers of knowledge. Participants hoped that humor could be employed not to denigrate research, nor with the calculated attempt of manipulating public attitudes to science, but rather as a means for opening scientific spaces to a wider range of voices.

If humor could foster greater humility amongst scientists, performers also reported a hope that more challenging depictions of science would directly challenge conventional science audiences' attitudes and knowledge towards science and technology, in part by making the scientific public's own ignorance and assumptions the butt of the joke. Participants reported that they often encouraged one another to confront the audience with stories that demonstrated the links between science and systematic oppression, such as their own experiences of sexism and racism in the lab, or to build sets based on historical episodes such the Tuskegee syphilis trials or Eugenics. With the goal of both challenging and educating their audience, participants acknowledged that jokes might misfire, particularly when audiences did not anticipate the joke being on them:

Alex: [I'd go] on Cheltenham Science Festival and say, I know what you're thinking, how can anybody look this good and know about optics, well it turns out those things aren't related.

ETB: How did that go down?

Alex: They laughed at the wrong place. They laughed at the idea that someone might look this good and know optics ha ha ha! Hilarious. I don't think people got the point, but there is a case

for like, if the majority of people don't get it, a few people it trickles down later, and a few people are like, oh my god I feel heard, then maybe there is a point to it. But I am so glad that some people walked out of our show.

Having adopted a combative persona, seeking to speak truth to power from the side-lines of the field, audiences walking out of shows could serve as a mark of distinction, evidencing that science comedians had succeeded in exposing the untenable presumptions of their audience. Echoing the British traditions of alternative comedy, participants saw the necessity of forms of comedy performance that were difficult and provoking to their audiences (Sayle 2016; Wilmot and Rosengard 1989). While able to access science comedy spaces only because of their conventional credentials, by working within the science communication sector and having the formal scientific training that enabled them to stand on stage as a credible scientific voice, many comedians viewed their role as more subversive, in their ability to employ comedy to transform the conventions of science entertainment and consumption:

Toby: I constantly joke now about how I built the cultural capital of science audiences by exposing them to stuff that's – more entertaining? – than they've seen at other science comedy shows.[...] The whole point about doing comedy is that you're allowed to say things that you wouldn't otherwise say because you've always got the, I'm just doing a joke, you've got the jester, I am pushing at the edges of what society will allow me. There's no point in doing that to have a whole audience going "We hate homeopathy don't we," so I, I would always prefer stuff that is making the audience slightly uncomfortable but in a good way, and challenging them and kind of exposing them a little bit

Evoking the carnivalesque role of the Jester as a figure of truth and disruption, science comedians highlighted their desire to expose the falsity and arbitrariness of conventional love for science. However, the ambiguity of the liminal figure of the jester bears greater relevance for science comedy, as a figure who gains their voice simultaneously from their position at the periphery of conventional discourse and as an established feature of court life. The jester is specifically licensed to challenge and deride figures of authority yet does so precisely as part of the court's ongoing maintenance and performance of power (Jenks 2003; Stallybrass and White 1986). Science comedians may have sought to effect transformation in the field in relation to the stories told about science and the people who gained prominence as science communicators, yet this transformation was dependent on a commitment to the continuation and growth of a field both by educating mainstream science communicators out of their naïve love of science, and secondly by securing science comedians' own position in the field by cementing the seemingly transgressive and profane depictions of scientific practice they offered on stage as credible and legitimate stories about science.

As both insiders and outsiders, science comedians' position within the field and their performances on stage were heavily inflected by the dominant logic of science communication. In interviews, participants often evoked carnivalesque notions of transgression and the inversion of established norms to accentuate their difference to the mainstream and to parse critiques of other performers, yet in doing so, they relied heavily on the existing languages and presumptions of science communication, unable to discuss science comedy without reproducing the dominant language of the field (Bakhtin 1981; Bostad et al. 2004). While they rejected the paternalism and arrogance they felt existed elsewhere when science communicators met the public, they could only frame an alternative in almost identical terms, envisioning a form of science comedy that would educate and correct attitudinal deficit, albeit that of their fellow communicators, rather than the public, who were almost ignored in these discussions of comedy.

As Bakhtin's own account of language stresses, the ability of individual comedians to speak autonomously, or for a group to envisage an entirely new form of science communication was severely restricted by the historical voices that remained in the language that they used, but science comedians in this study also appeared to have little motivation to transgress the norms of the field so far that science communication was radically transformed. While they may have differed in whom they felt in need of education, participants endorsed the view that it was for science communicators to control the public face of science, with little clear interest in involving the public beyond their role as an audience for science comedians' performances. As one participant in the study noted, who had been unable to afford to pursue academic research and had gained a senior role in public engagement, science comedy on stage often seemed distasteful:

Lizzie: ... as an audience member, when there's someone complaining about an incredibly privileged life, 'oh how hard it is to this thing that you weren't able to do, because you couldn't afford it.' [...] a guy got up and did 'I'm a PhD student but I'm really lazy and I hate it, I'm working on this particular medical condition and I spend most of my time playing with pipettes in the lab,' and then the next person who got on was [], and went 'I've got that condition, thanks for taking it so seriously.' I just, it was brilliant as a moment, calling out like, you know people have that and it's really really fucking serious, you could maybe be a bit more respectful.

In seeking to expose the arbitrariness and falsity of mainstream science communication, science comedy might too readily reveal a more unsavory truth, that science comedy was not a means for bringing the public into science, as they were still treated with contempt. Rather than the public failing to understand the joke or recognize the scientific knowledge they were presumed to need, they might need recognize that notions of care and responsibility and the need for public involvement in science and technology were all too often played for laughs.

4 Conclusion

Discussions about comedy invariably reveal more about the social worlds in which joking and humor occur than they illuminate any substantive feature of comedy itself. The broader meta-languages of comedy, as a means for constructing notions of purpose, meaning, and appropriateness, enable the delineation of preferred forms of consumption and appreciation and to quantify the value of a form of communication often presumed to be an unequivocally good thing (Kuipers 2011; Lockyer and Pickering 2005). As science comedy has gained increased interest within science communication research and practice, science comedians and scholars have sought to define science comedy precisely through broader imaginaries of science-society relationships that for many science communicators mandate that public knowledge of and appreciation for science be secured by any means necessary. While science communicators have celebrated the potential of humor and comedy, this enthusiasm has depended on the ability of humor and comedy to serve as vehicles for the transmission of scientific knowledge capable of reaching audiences who might otherwise resist engagement with science and technology.

Simultaneously, discussion of science comedy in the pages of academic science communication and amongst science comedians has enabled new ways for science communicators to imagine the purpose and value of their work, comment on the public and one another, and identify the problems for which science communication is the answer. In some venues, humor could be imagined as a lure, sweetening the public's entry into the serious world of science, a task that did not require justification or critique. In others, the performances of comedy and humor elsewhere was a demonstration of science communication gone wrong, which could be remedied only by making the powerful the butt of the joke. The opportunity to transgress the perceived conventions of normal science communication was alluring, but only when such transgression could be insulated from the possibility of more destabilizing transformation. Where comedy presented the possibility of multiple understandings of science, the legitimacy of science communication's self-appointed role in delineating legitimate public encounters with science might come into question. Traces of the carnival may emerge in science comedy, at least when viewed within the readings of carnival offered by Bakhtin's critics and Bakhtin's own broader philosophy of language. Science comedy could appear to revel in the opportunity to momentarily debase science and invert conventional notions of seriousness and appropriacy, but only when such moments could succeed in making the field more robust. Science communicators may well seek to challenge who should be allowed to adopt the mantle of the science communicator, while

maintaining that science communication alone can rectify public transgressions against social and political order. If science comedy were read in terms of Bakhtin's more idealized view of the political potential of the carnival, it would be clearly be found wanting, not least for the public being disallowed their own humor and being expected solely to witness scientists' own performances on stage, with their own voices silenced beyond laughter and applause.

There is no intrinsic reason why comedy about science must align with science communication agendas, nor why comedians must presume the sanctity of contemporary science and technology so that deviations serve as the only source of humor. Exploring science comedy suggests a broader range of problems and limitations than are discussed in contemporary work, where humor and comedy are problematized only so far as they obscure scientific messaging. Reducing questions of science and comedy to technical matters of measuring audience understanding and attitudinal change obscures far broader questions of power, purpose and appropriacy. The very notion of scientists taking to the stage could easily appear distasteful, not for debasing scientific knowledge, but rather for adopting the trappings of comedy to obscure the powerlessness of many groups to impact on social issues that, while relevant to science and technology, extend far beyond the technical expertise of working scientists. Appealing to a restricted audience that broadly already loves science, comedy might easily embolden the impulse to laugh at those thought to be too stupid to understand. Whether it will be possible for the carnival to last longer, and for the assumptions and prerogatives of science communication to be exposed with the possibility of meaningful change, remains to be seen as comedy gains increasing traction within a rapidly developing and ambitious field.

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