

“Nah, musing is fine.

You don't have to be 'doing science'”

Emotional and Descriptive Meaning- Making in Online Non-Professional Discussions about Science

Oliver Martin Marsh

UCL

Department of Science and Technology Studies

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Declaration

I, Oliver Martin Marsh, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

In this thesis I use online settings to explore how descriptive and emotional forms of meaning-making interact in non-professional discussions around 'science'. Data was collected from four participatory online fora, from March 2015 to February 2016. Posts and comments from these fora were examined through discourse analysis, supplemented by interviews with participants and computer-aided text analysis, over the period August 2015 to August 2017. Theoretical background drew on Science and Technology Studies (STS) and Fan Studies (FS), to examine how science was presented in both descriptive and emotional terms.

There were two main findings. Firstly, discussions were shaped by an expectation that members should respect mainstream scientific consensus. In a manner familiar from STS, participants treated claims which went against scientific consensus as incorrect or non-credible. Responses also showed emotional aspects which shaped participation. Respect for scientific consensus facilitated social bonding and expression of community values, while disrespect was met with anger and/or ridicule. Through normalisation of such behaviour, scientific authority was maintained by communal sanctions rather than accredited expertise.

The second main finding was a distinction between two forms of discourse, which I refer to as *musings* and *identifying*. In *musings*, participants focussed on specific phenomena, technologies and science-related concepts. Emotional language in such discourse was generally positive, but explicit mentions of people were rare. In *identifying*, participants reflected on processes of discussing and making/assessing claims; in doing so they foregrounded references to people. Emotional references in identifying tended to involve frustration, concern, and scorn.

These findings develop STS understanding of how engagement with science takes place outside of professional research, communication, and/or education; and, more broadly, how discourse around science can be shaped by emotional attachments and informal norms. This thesis also contributes a discourse analytic perspective to recent debates around the interaction of expertise and emotion online.

Acknowledgements

This is a thesis about how emotional interactions shape the production of knowledge. The experience of producing the thesis provided strong corroboratory evidence for that process. I have been extremely fortunate in those I have around me, and their input both intellectually and socially, and this thesis would not be the same (or, indeed, here) without them.

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Glossary and Stylistic Notes

Stylistic Notes

“Double quote marks” indicate direct quotation; ‘single quote marks’ indicate summarisation, paraphrasing, or using a term which is repeated at many points throughout a source. This is necessary as, for ethical reasons (outlined in chapter 3, sec. 3.2), I cannot directly quote all threads studied in this thesis.

All quotations are reported verbatim, with spelling uncorrected.

Online material is referenced in-line, rather than as hyperlinks (except for image sources). Full information appears in the bibliography. To avoid back-searching through any deleted posts (chapter 3, sec. 3.2.2), I do not provide hyperlinks for threads referenced in this thesis. Instead material is cited (subforum, thread title, date(s) material posted). Titles are referenced in truncated form; full titles appear in Appendix 3.

Glossary

Note: This glossary was constructed on the premise, used in this thesis, that concepts gain meaning through use. Each listed description was constructed through engaging with uses of the word, and related terms, across multiple scholarly works; the final descriptions were written towards the end of this project, reflecting on how I had used these terms within the thesis. This was particularly important given my reliance on two very different sets of literature (Science and Technology Studies, and Fan Studies).

These descriptions are intended as clarifications to how they are used in this thesis, rather than strict definitions. References illustrate works used to inform my understanding of the term; they should not be read as drawing definitions directly from the work, unless explicitly quoted. The listed ‘contrasts’ are similarly intended as broad heuristics rather than hard oppositions. For example, while I have listed ‘organisation’ and ‘norms’ as contrasts it would be possible to argue that norms are a form of organisation. However, the aim of this glossary is to clarify how I understood the terms as I used them in the thesis.

Affordance: A concept from media studies, which describes “how a medium or a tool affords uses to individuals” in ways which “become part of the users’ perceptions of what actions are available to them” (Nagy & Neff, 2015, pp. 2, 5).

Community: A group which is connected by more than shared geography or practices, but also through a sense of belonging and/or recognition of shared characteristics (Gibbs 2011; Tönnies 1957).

Computer Aided Text Analysis: Computer aided text analysis has been used for analysing extremely large amounts of textual data in both a quantitative and qualitative fashion. Digital tools which algorithmically derive patterns in textual corpora – for example looking for words which commonly occur together, or uses of positive/negative tone – and producing outputs which display these patterns. Used to guide quantitative and/or qualitative analysis (Hashimi, Hafez, and Mathkour 2015). Related: Text Mining.

Construction: Created of something (such as meaning, identity, or norms) during social interaction, in a manner shaped by features of the interaction. Used in this thesis as a shorthand for ‘social construction’ (Berger and Luckmann 1966).

Descriptive meaning-making: defining, demarcating, representing, and/or interpreting a certain concept.

Emotional meaning-making: engaging with a certain concept in a manner which demonstrates emotional significance, such as the creation of social bonds or constructing an identity within a community.

Hedges: Linguistic features used to downplay objectivity, personal credibility, and/or force of views. Examples include ‘this is just my opinion’ or ‘I may be wrong’ (Baym 1996; Mulkay 1985). Related: qualifiers.

Instrumentalism: The idea that scholarship should aim towards identifying problems and/or opportunities for improving social problems outside of scholarship – including (but not limited to) education, communication, and democratic participation (Hills 2002; Jenkins and Shresthova 2012).

Meaning-Making: The process of making something non-arbitrary; giving a concept distinctive associations, whether by defining it or by attaching particular emotional significance to it (Douglas 1975; Saussure 1974; Wittgenstein 1953).

Non-Normative Participants: People who participate within a community, while behaving in ways which contravene community norms and thereby receiving social sanctioning (Bennett 2009).

Non-Professional: Settings or behaviours which are not explicitly directed at producing professional outcomes; note these may include professional participants.

Norms: Implicit, uncoded expectations of behaviour, encouraged by responses from fellow participants (Bennett 2011). Not to be confused with Robert Merton's use of 'norms' as ideals that a profession should aim for (Merton 1942; Mitroff 1974). Contrasted with *organisation*. Related: Expectations.

Organisation: Physical and/or social factors shaping interactions, which exist prior to and are relatively unchanged by those interactions. Examples include the physical set-up of a dialogue event (Davies 2011) or the professionalisation of scientific institutions (Yearley 1988). Contrasted with norms. Related: institutions, governance, co-ordination.

Participatory websites: Websites which allow users to create as well as consume content (Hughes 2012). Related: Web 2.0.

Phatic: "A type of speech in which ties of union are created by a mere exchange of words... They fulfil a social function and that is their principal aim" (Malinowski 1923, 316).

Post: An online message on a participatory website which begins a thread.

Public Engagement with Science (PES): A collection of practices and arguments, both scholarly and non-scholarly, directed towards encouraging multi-directional transfer of knowledge and perspectives between scientists and non-scientists (Bauer 2009; Stilgoe, Lock, and Wilsdon 2014). Contrasted with Public Understanding of Science. Related: Dialogue, Science in/on/with/for society, science-society relations.

Public Understanding of Science (PUS): A collection of practices and arguments, both scholarly and non-scholarly, directed towards encouraging transfer of knowledge and perspectives *from* scientists *to* non-scientists (Durant, Evans, and Thomas 1989; Miller 1983). Contrasted with Public Engagement with Science. Related: Deficit Model.

Response: A message on a participatory website which either responds to a post (a 'comment') or to another response (a 'reply').

Science communication: The process of communicating material (such as knowledge, news, or perspectives) related to science, whether between professionals or from professionals to non-professionals (Bucchi and Trench 2008).

Scientific Consensus: Used in this thesis to refer to views that are seen to be held as 'facts' by the majority of mainstream scientists. Related terms: "uncontroversial" science (Collins, 1974, 1975), knowledge claims which have been "stabilised as a fact" (Latour & Woolgar, 1979, p. 180).

Social identity: "the individual's knowledge that he [*sic.*] belongs to certain social groups together with some emotional and value significance to him of group membership" (Henri Tajfel, quoted Hogg and Abrams. 1988, 7).

Sanctioning: Forms of response to a participant, such as aggressive responses or jokes at a participants' expense, which make further participation potentially difficult or uncomfortable for them (Baym 2000; Bennett 2009).

Thread: Full list of responses below a post. Can be ordered chronologically, by number of likes/votes, or through other measures.

Topic Modelling: A form of computer aided text analysis; "a collection of methods and algorithms that uncover the hidden thematic structure in document collections by revealing recurring clusters of co-occurring words" (Törnberg and Törnberg 2016, 405).

Values: Broad concepts which are held to be either intrinsically or instrumentally good by a group. Examples discussed in this thesis include intelligence and open-mindedness.

“In Science We Trust”

1: Introduction



Fig 1.1: Image from Facebook post “In Science We Trust” by Facebook page ‘I Fucking Love Science’, posted 12 March 2015. Retrieved from www.facebook.com/IFeakingLoveScience/posts/1060950617259282, 23 March 2015.

Figure 1.1 shows a post from the Facebook page *I Fucking Love Science* (IFLScience). This page began in 2012 as a space for a small group of friends to share “bizarre facts and cool pictures” (Hudson 2012). At the time of writing it has over 25 million subscribers – ten times as many as the Facebook page for the magazine *Scientific American*, and twice that of *Fox News*.¹ Below the post in Figure 1.1 is a comments thread, featuring over ten thousand words’ worth of contributions from its (largely non-specialist) audience. Some commenters display personal enthusiasm for the phrase “In Science We Trust”. Others dispute the

¹ Values retrieved from www.facebook.com/IFeakingLoveScience/, www.facebook.com/ScientificAmerican/, and www.facebook.com/FoxNews/, 18 June 2017.

phrase, arguing science is antithetical to trust. A few express support for world-views such as religion or spiritualism; these are met with ridicule, hostility, and accusations of being 'unscientific'. Many participants post jokes, 'tag' friends to start a discussion with them, or express amusement and/or hostility towards other contributions. In sum, this comments thread combines multiple representations of science with various expressions of emotional attachment and forms of social bonding.

The research question of this thesis is: *how are descriptive and emotional meanings constructed in online non-professional discussions about science?* This is an exploratory question, examining a setting (online non-professional discussions about science) and a phenomenon (ways in which emotion can shape discourse) which have not been widely examined within Science and Technology Studies (STS). I study participatory websites³ such as IFLScience, as these allow access to interactions which occur outside traditional spheres of professional authority (Bennett 2011; Tkacz 2014). The growth of participatory websites provides a challenge to STS, which has largely focussed on settings where professional researchers, communicators, and educators can maintain authority.

I address relationships between science and emotion through the analytical frame of *meaning-making*. When a concept is given 'meaning' it is distinguished from other concepts, and imbued with particular set of associations and significances (Saussure 1974). STS has investigated ways in which 'science' is represented, interpreted, and demarcated (Gieryn 1999; Shapin 1995). I refer to such processes as *descriptive* meaning-making. I also go beyond STS in considering another form of meaning-making: the idea that if something is 'meaningful' to someone, it has an emotional significance that distinguishes it from other concepts (Douglas 1975; Hall 1980). I refer to this as *emotional* meaning-making, and study it by drawing on work from Fan Studies (FS). In considering both descriptive and emotional meaning-making, I explore how the ways in which 'science' is represented and demarcated are related to everyday emotional concerns (such as forming interpersonal bonds, constructing a social identity, or aligning oneself within a community of shared values).

Over the course of addressing the central research question, I also considered the following subsidiary questions:

³ Participatory websites, also known as 'Web 2.0', allow users to create as well as consume online content (Hughes 2012).

- How might existing STS analyses of descriptive meaning-making be applied to online platforms and/or settings which do not have clear authoritative identities and organisation?
- Can recurrent patterns in emotional-meaning making be discerned in online non-specialist discussions about science? If so, what factors shape these patterns?
- What factors, if any, must be engaged with to specifically understand meaning-making around science, as distinct from meaning-making around other concepts?

These questions, and the thesis as a whole, contribute to STS scholarship an understanding of how engagement with science can take place outside of professional research, communication, and/or education; and, more broadly, how discourse around science can be shaped by emotional attachments and informal norms. Such factors, though pervasive across many settings, have been not been examined in STS to the same extent as questions of professional autonomy and socio-political stakes (Davies 2014). Such an examination is essential for understanding the growing phenomenon of participatory websites, where informal norms can play a greater role than traditional professional|non-professional roles (Jenkins 2006b).

A second intended audience for this work is, more broadly, academic and non-academic commentators on emotion and expertise in online discourse. The data collection for this thesis took place from March 2015 to February 2016, and analysis August 2015 to August 2017. Commentators on Western politics have argued that this period saw a shift away from technocratic politics and into a “post-truth” era, in which expertise is valued less than emotional appeal (Forss and Magro 2016; Suiter 2016). Participatory websites have been held up as one of the key factors in this shift, on the grounds that they encourage polarised, emotionally charged discourse at the expense of expert voices (Hendrickson and Galston 2017). However scholars of emotion have critiqued such binary contrasts between emotion and expertise (Barbalet 2001). This thesis provides a microsociological, discourse analytic examination of how expertise and emotion can interact to shape online behaviour.

Structure of the Thesis

I expand on the key terms of the research question and the intended contribution of this thesis in the literature review (chapter 2). By contrasting STS and FS literature, I clarify the key distinctions between ‘descriptive’ and ‘emotional’ meaning-making. I also draw on FS

scholarship to raise issues faced in analysis of emotion-driven, relatively unregulated online settings. I consider how key themes from STS studies of public engagement with science could be expanded upon by engaging with such settings.

In chapter 3 I present the methodology guiding this research and the methods used to collect and analyse data. This project followed a qualitative, constructivist methodology, which encourages a close focus on both social interactions and the context surrounding them. I discuss my research methods and the decisions underlying them in this chapter, in addition to issues of ethics and data reportage. In chapter 4 I introduce the four case studies in more detail, including elements of technical design, membership, and quantitative patterns of participation.

In chapters 5-8 I present my empirical findings. To maintain a clear focus, in each chapter I limit discussion to a specific form of meaning-making (descriptive or emotional). In chapter 5 I examine emotional meaning-making as expressed through the values, community bonds, and social identities on display within the case studies. I draw on FS concepts to analyse how interactions both conveyed and were shaped by these forms of emotional meaning-making. In chapter 6 I focus on how descriptive meanings were presented through explicit characterisations of 'science' and demarcated from non-science. In chapter 7 I examine how descriptive meanings of science were implicitly constructed through recurrent uses of language. Using computer-aided text analysis, I derive clusters of words which frequently appeared together. In chapter 8 I consider how explicit expressions of emotion were related to contextual factors inside and outside of threads.

In chapter 9 I bring together these findings to address my research questions. I show how the findings of this exploratory thesis could inform further STS work into how everyday emotional factors can shape participation in science, and how emotion and expertise interact within online discourse.

“Can I ask why you're trying to define 'what is a science community'?”⁴

2: Literature Review

In this chapter I contextualise the key concepts of this thesis – emotional and descriptive meaning-making, online behaviour, and non-professional engagement with science – with respect to previous work in Science and Technology Studies (STS), Fan Studies (FS), and other studies of online settings. I begin section 1 with a brief contextualisation of emotion and its relation to science and the contemporary online environment. I then introduce meaning-making, and contrast how this concept has appeared within STS and FS. This draws out the distinction between ‘descriptive’ and ‘emotional’ meaning-making. In section 2 I consider another contrast between STS and FS: differing views on whether academic research should be directed towards serving instrumentalist aims (such as improving knowledge transfer or democratic participation). I address the implications of these contrasting approaches for my research topic.

In sections 3 and 4 I consider two broad themes common to both FS and STS research into non-professional engagement with science: identity (section 3) and the structure of settings within which interactions take place (section 4). In section 5 I reflect on the key themes of this literature review with respect to other STS literature which has engaged with similar themes. In doing so, I aim to clearly delineate the proposed contribution of this project.

Drawing on two very separate fields of scholarship can lead to ambiguity in the use of key terms, and discussing online settings often involves neologisms. I have therefore provided a glossary in the front matter of this thesis.

2.1 Emotional and Descriptive Meaning-Making

This section outlines the key concepts within my research question. I begin by briefly contextualising the approach to emotion taken by this thesis, particularly in relation to science and the contemporary online environment. I then introduce the concept of *meaning-*

⁴ Interviewee XKCD-E.

making, and how this has historically been discussed in STS (section 2.1.2) and FS (2.1.3). In section 2.1.4 I draw out specific contrasts between the two approaches to meaning-making. I summarise these under the headings of ‘descriptive’ and ‘emotional’ meaning-making. I conclude with a section (2.1.5) discussing this contrast in the context of more recent STS work on non-professional engagement with science.

2.1.1 Emotion, Science, and Online Participation

Science has often been contrasted with emotion. Various commentaries on science have argued that emotions lead to biases, and that avoiding emotion is necessary for ‘objectivity’ (Merton 1942). Other accounts have presented science as inherently based on emotion, as emotional attachments – such as the desire to solve puzzles, or the hope of achieving recognition – drive scientific investigations (Koppman, Cain, and Leahey 2014; Mitroff 1974). Outside of research, emotion has been presented as a driver for non-specialists to engage in self-directed learning of scientific knowledge (Bell et al. 2009). Other accounts have brought out roles of negative emotions provoked by encounters with science, from feelings of unwelcomeness (Brickhouse and Potter 2001; Dawson 2014) to fear about the impacts of science (Giddens 1990; Turney 1996). However STS has not, in general, engaged with a recent ‘affective turn’ which has greatly diversified scholarly accounts of emotion across multiple academic disciplines (Gregg and Seigworth 2010; Leys 2011).

The relationship between science and emotion has implications beyond STS. Contrasts between emotion and science, including associated attributes such as ‘rationality’ and ‘objectivity’, have shaped broader scholarly research and ideas of how to be an ‘expert’ (Barbalet 2001; Massumi 2002). This has socio-political implications. Depictions of unemotional experts and emotional people have been important factors in how modern societies are organised (Giddens 1991; Weber 1978). Such questions have become increasingly prominent in the political context within which this thesis was produced. Events such as the Arab Spring of 2010-2012, as well as the 2016 UK Referendum on EU membership and the US Presidential Election, have prompted discussions around the growing impact of highly emotive anti-establishment sentiment (Forss and Magro 2016; Suiter 2016). Events of 2016 in particular have prompted a resurgence in Western media of rhetorical distinctions between rational ‘experts’ and emotions of ‘the people’ (Dawkins, 2017; New Scientist, 2016; for critique see Green et. al., 2016). In 2016 the *Oxford English Dictionary* chose “post-truth” as their word of the year, defining it as “related to or denoting circumstances in which objective facts are less influential in shaping public opinion than

appeals to emotion and personal belief” (OED 2016). In such accounts we see the familiar divide between ‘emotion’ and ‘expertise’ being reproduced.

A new element to these discussions is the role played by participatory websites, particularly newer social media sites such as Facebook and Twitter. These have been seen as tools through which emotion can be turned into mass action (Gerbaudo 2012; Papacharissi 2014), and for providing narratives which can bypass mainstream gatekeepers (Bartlett and Birdwell 2011; Jenkins 2006a). Specifically regarding expertise, there have been concerns that digital media mean people seek information which appeals to them, and ignore ‘expert’ perspectives which challenge them (Hendrickson and Galston 2017; Mitchell and Weisel 2014). This, it is argued, has been facilitated by algorithms designed to show users content which will maximise their enjoyment (Bakshy, Messing, and Adamic 2015; Tufekci 2015). However other commentators have noted that older participatory websites, such as UseNet groups or email lists, can also create environments in which certain views are made to feel welcome and others are forced out through hostility (Baym 1993; Bennett 2013). Though all these specific concerns may have some force, scholars of emotion have criticised arguments which draw general binary divisions between emotion and such concepts as ‘expertise’, ‘objectivity’, or ‘science’ (Barbalet 2001; Sturdy 1988). In particular, such generalisations do not account for how these concepts take on varying forms and uses in different social settings, as shall be discussed further in upcoming sections.

The ways that emotions function in social settings has been studied by a range of disciplines (Gregg and Seigworth 2010; Sturdy 1988). In this thesis I draw on approaches to studying emotion in online discourse from within Fan Studies (FS), as this discipline has a strong heritage of studying emotion in online communities. FS is a scholarly discipline which explores fan activity around various cultural products including media, sport, and well-known individuals. Since fans were early adopters of digital technologies, and as fan behaviour is largely motivated by emotional attachments to a particular ‘object of fandom’, FS has been particularly active at examining how online settings can facilitate, shape, and display emotions (Booth 2010; Jenkins 1995). Many approaches have been taken within FS for studying emotion, from the psychoanalytic (Hills 2005) to the ethnographic (Bacon-Smith 1992). In this thesis I consider how emotion is conveyed through online discourse (Baym 2000). This approach focusses on emotion not as a personal psychological phenomenon, but rather as a socio-linguistic phenomenon. FS scholars argue that the ways emotion is expressed in discourse shapes and is shaped by communal expectations of particular fan groups (or ‘fandoms’), as shall be outlined in full in section 2.3 of this review. This allowed

me to see how emotion was expressed through the same medium – online discourse – as representations and depictions of ‘science’.

Questions around what ‘science’ or ‘expertise’ *is*, and how emotional attachments to such concepts function in social settings, can be subsumed under the wider analytical concept of *meaning-making*. Meaning-making is the process of distinguishing a concept from other concepts, and imbuing it with particular set of associations and significances (Saussure 1974). Philosophers have noted that the ‘meaning’ of a concept cannot be reduced to fixed, universal definitions (Austin 1962; Putnam 1975). Rather, meaning is made and re-made through interactions – in Wittgenstein’s phrase, “the meaning of a word is its use in the language” (1953, sec.43). These works focussed on ‘meaning’ in the sense of definition. Social theorists have entangled this sense of ‘meaning’ with another – the idea that if something is ‘meaningful’ to someone it *matters* to them, it has a personal or communal significance that distinguishes it from other concepts (Douglas 1975; Hall 1980). As with Wittgenstein’s notion of meaning, this sort of emotional significance should not be understood as a fixed or universal property; rather “meaning is contextualised. It grows out of an affective set of experiences” (Jenkins 2006b, 24). In sum, how a concept is *defined* or *represented* can be related to how people *relate to* or *draw emotional experiences* from the concept, and how both of these are shaped by surrounding context. In the remainder of this review I shall argue that such relations between these two forms of meaning have not been fully examined in relation to science.

2.1.2 Meaning-Making in STS

During the 1960s and 1970s it became clear to philosophers and sociologists of science that the question ‘what does science mean?’ was far from straightforward. Philosophical debates around the ‘problem of demarcation’ had failed to produce a definition of science which both distinguished science from non-science and adequately represented real-world scientific practice (Lakatos and Musgrave 1970). The sociological approach of Merton, which aimed to create a normative account of scientists’ behaviour rather than a descriptive definition, was also criticised for failing to account for examples when scientists contravened those norms (Merton 1942; Mitroff 1974). However during the 1970s the terms of the debate shifted, as sociologists and historians of science critiqued the premise that science *should* have a single referent. Drawing on the works of Wittgenstein, Douglas, and others, new groups of scholars took a constructivist approach to meanings of science (Shapin 1995). Constructivist approaches to meaning deny that there are universally right and wrong

meanings, and instead engage with actors' interpretations of right and wrong meanings (Berger and Luckmann 1966).

Scholars in the new field of Sociology of Scientific Knowledge (SSK) argued that the process of science does not have set 'rules'. Bloor and Barnes in Edinburgh, and Collins in Bath, argued that any 'rules' are constructed and re-constructed as participants carry out something they call 'science' (Bloor 1976; Collins 1985). Another emerging field, Laboratory Studies, anthropologically examined scientific practice *in situ*. These scholars applied ethnographic principles of locally negotiated meaning to illustrate how professional scientists worked with context-dependent practices rather than any universal rules of scientific method (Knorr-Cetina 1981; Latour and Woolgar 1979). Social historians of science illustrated the interpretative flexibility of science through examining periods of conflict, when opposed participants laid claim to being 'scientific' in order to bolster credibility and acquire resources (Barnes and Shapin 1979; Shapin and Schaffer 1985). The meaning of 'scientific' was shown to be an *outcome* of these contests rather than set down in advance (Gieryn 1983).

Constructivists also note how such labels as 'right' and 'wrong' are shaped by social contexts. Though in theory individuals could all develop their own meanings of science, STS scholars showed that social contexts shape which meanings become socially expressed and shared. For instance, the rejection of phrenology as a 'science' in Victorian Edinburgh was determined by the political values of those with authority over university curricula (Shapin 1979). Similarly, beliefs in paranormal phenomena have been widely described as 'unscientific' since the professionalisation of science in the late 19th century (Winter 2000). This representation means that contemporary professional scientists are discouraged, through attitudes of colleagues and threats to career prospects, from investigating paranormal phenomena – which further perpetuates the representation that such concepts are outside of science (Collins and Pinch 1979). Labels such as 'pseudoscience' or 'unscientific' are applied to the work of such outsiders, further denying them the credibility and resources which can be accrued by those with the status of 'scientific'. Gieryn refers to this process, where rhetorically demarcating 'science' and 'non-science' results in monopolisation of authority and resources, as *boundary-work* (Gieryn 1983, 1999). The general point is that the ability to describe one's actions and views as 'scientific' is not determined by any qualities intrinsic to science but by more general social factors of power, authority, and social status (Collins 1983).

2.1.3 Meaning-Making in Fan Studies

Fan Studies (FS) began from a similar starting point to constructivist STS scholarship, by critiquing overly prescriptive approaches to meaning. However where constructivist STS critiqued attempts by scientists and philosophers to delimit a prescribed scientific method, FS critiqued mainstream media attempts to prescribe 'appropriate' emotional responses to media products (Gray, Sandvoss, and Harrington 2007). Many fan scholars trace the emergence of FS as a discipline to Jenkins' 1992 work *Textual Poachers* (Bennett 2014b; Jenkins 1992). This work used de Certeau's notion of 'poaching' to show how readers take only the things that matter to them from texts, rather than those expected by the author or producer. Jenkins set out this approach as a way to analyse fans as "active producers and manipulators of meanings" and question "the ability of media producers to constrain the creation and circulation of meanings" (1992, 23).

The notion of 'meaning' employed within fan scholarship is not equivalent to that employed within STS. In particular, FS has shown less interest in demarcations of 'fans' from 'non-fans'. While some early FS scholarship worked with a binary fan|non-fan distinction (Grossberg 1992; Jensen 1992), as the discipline has developed "cultural judgment has become increasingly detached from the state of being a fan, [and] our attention shift[ed] to the choice of fan object and its surrounding practices" (Gray, Sandvoss, and Harrington 2007, 5). The 'fan object' might be a TV series, sports team, band, or similar; 'fan practices' include viewing habits, knowledge accumulation, content creation, and social activity. Meaning-making is used to refer to the process by which fans, through their engagement with the fan object, develop new personal and/or communal responses to certain motifs or themes.

These responses may take the form of practices such as splicing together filmed footage or writing fan fiction (Green, Jenkins, and Jenkins 1998; Jenkins 1992). Alternatively fans may learn new ways to interpret the object through communal viewing practices, a process Bacon-Smith refers to as bringing "meaning-pleasure" (Bacon-Smith 1992, 180–86). The use of 'pleasure' highlights a second aspect of meaning-making in fan scholarship – the emotional experiences underlying these practices. For FS scholars, studying meaning-making involves relating these emotional experiences to socially shared interpretations of the fan object. For example, fans may use a soap opera as a catalyst for discussing personal experiences (Baym 2000). Others may write and share fan fiction as an outlet for connecting with others who desire alternative narratives to those provided by official outlets (Penley 1997).

Meaning-making in fan scholarship follows similar social constructivist premises as the STS literature discussed in section 2.1.2. While interpretations and emotional experiences of a fan object may seem highly personal, in practice the expression of meanings is shaped by the surrounding group of fans (known as a *fandom*). Jenkins refers to fans learning to 'read the right way', a process of socialisation in which fans learn interpretative practices from those around them (Jenkins 1992). However there is more to studying meanings in fandom than looking solely at how they learn to 'read' the fan object. Fan objects provide a central point around which social interactions occur, but these interactions need not solely focus on the fan object. As Baym argues, "talking only about soaps impedes the group's ability to become a bunch of friends" (Baym 2000, 130), while Hills has argued that a scholarly emphasis on the fan object risks over-rationalising the fan's 'choice' of an object (Hills 2002).

The process of learning to interpret a fan object also includes understanding appropriate ways to engage with others in the fandom (Bacon-Smith 1992). Examples include learning the extent to which physical admiration of performers is accepted or frowned upon (Clerc 2000), or developing in-jokes about opposing teams in sports fandoms (Theodoropoulou 2007). An object may have multiple fandoms, which adopt different expectations of behaviour; for example the 'Estrogen Brigades' discuss Star Trek in an explicitly 'feminised' fashion, in contrast to the 'masculine' spaces of many other Star Trek fandoms (Bury 2005). In sum, when fans develop shared conceptions of right and wrong meanings these refer to expected behaviour within a particular community, both when engaging with the fan object and with other fans.

2.1.4 Descriptive and Emotional Meaning-Making

Contrasts between the notions of 'meaning' employed in STS and FS are central to this thesis, and require elaboration. The first key distinction is an interest in definition and demarcation. As noted in section 2.1.2, constructivist STS scholars shifted demarcation from an analysts' problem (to be settled by philosophers) to an actors' problem (to be settled by scientists); however they shared with earlier philosophical work the central question of what counts as science (Shapin 1995). This focus on establishing what actors think science 'is' or 'should do' is not limited to studying explicit definitions or demarcations of 'science'. Constructivist STS has also considered how certain practices are deemed legitimate or illegitimate amongst professional scientists (Latour 1987) and located recurring patterns in how scientific work is portrayed (Gilbert and Mulkay 1984). These studies showed that shared meanings of 'science' could be constructed without explicitly defining 'science'.

Nonetheless, all these works shared an approach of seeing meaning-making in a descriptive sense – the “attribution of selected characteristics to the institution of science” (Gieryn 1983, 782).

As noted in section 1.2, FS has largely moved away from questions of how ‘fans’ are demarcated from ‘non-fans’. The same applies to the objects of fandom; there is little interest in how, for example, ‘real’ Star Trek is distinct from ‘pseudo’ Star Trek. FS scholars have examined the notion of canon, material which is accepted as legitimate within a fictional universe (Hills 2015; Jenkins 1992). However the processes by which canon becomes legitimate have not been explored as extensively as questions of how scientific claims become accepted as fact, which is a central question in much STS research (Fleck 1979; Latour 1987). When FS scholars discuss ‘right’ and ‘wrong’ meanings, the emphasis is on how fans *respond* to objects of fandom rather than on how these objects are defined or characterized (Bacon-Smith 1992; Bennett 2011). Constructivist FS scholarship examines how sharing these responses construct communities, and how community norms in turn shape responses (Baym 2000). Jenkins has described meaning as “grow[ing] out of an affective set of experiences, and is the vehicle for creating social connections with other people” (Jenkins 2006b, 24). In other words, for FS scholars the social construction of meaning does not refer to the development of shared descriptions or representations; rather, it refers to the emergence of shared emotional attachments and ways of expressing these within a community.

These shared attachments are not necessarily expressed through explicitly emotional references. As Hills has noted, straightforward statements of feelings towards fan objects are both uncommon and cannot adequately represent the emotional experience of fandom (Hills 2002). Instead, emotional attachments and experiences are reflected in how fans interact with one another and create a distinctive community. For instance, the emotional experience of soap opera fandom often involves relating one’s personal life to plots and characters (Baym 2000). Baym notes, in her study of the online fandom rec.arts.tv.soaps, how such emotional attachments are reflected in a normalised “ethic of friendliness” in interactions (discussed further in sec. 2.3.1). The shaping of social interactions by underlying emotional attachments is, of course, not limited to fandoms (Barbalet 2001). However fandoms, being collections of people brought together through emotional attachments to a particular object, provide particularly clear examples.

In order to account for these differences, I shall refer to two forms of meaning-making. *Descriptive meaning-making* involves defining, demarcating, and/or interpreting a certain concept. *Emotional meaning-making* refers to processes of engaging with a certain concept

in a manner which demonstrates emotional significance: examples include sharing emotional experiences with others, or constructing a sense of belonging within a community.

This distinction is heuristic: all discourse involves both descriptive and emotional elements (Barbalet 2001). I propose these labels as analytical frames, rather than as different forms of phenomena. To give one example, the exclusion of parapsychology from professional scientific research has incorporated descriptive demarcations of 'science' from 'pseudoscience'; it has also featured behaviours such as using humour and disapproval to make parapsychologists feel uncomfortable (Collins and Pinch 1979). To analyse these behaviours as a form of descriptive meaning-making would involve examining how discomfort enforced the designation of parapsychology as 'not a science'. By contrast, analysing them through the lens of emotional meaning-making would foreground questions around how the treatment of parapsychology reflects underlying emotional attachments to science.

My argument here is not that STS scholars have ignored emotion. Collins and Pinch (1979) have noted the role of ridicule and disapproval in enforcing the pseudoscientific status of parapsychology, while Gilbert and Mulkay have studied the role of humour amongst professional scientists (Gilbert and Mulkay 1984; Mulkay 1988). However these have been largely treated as background contexts underlying such features as consensus formation (Gilbert & Mulkay 1984) or securing of authority (Collins and Pinch 1979; Secord 1994). One can find occasional references within constructivist STS to figures such as Mary Douglas and Clifford Geertz, who considered the community-forming elements of meaning-making (Bloor 1976; Latour and Woolgar 1979). However these accounts are not drawn on as extensively as those of Wittgenstein, who was concerned with meaning in the sense of building descriptions rather than emotional relations (Bloor 1976; Collins 1985). Though the role of emotion has been acknowledged, constructivist STS accounts STS have framed meaning-making primarily in descriptive terms. Emotional aspects have therefore not been developed into detailed, contextualised accounts in the same manner as demarcations of 'science'.

2.1.5 Meanings in Public Engagement with Science

In the previous sections I have focussed on STS studies of professional scientific practices, as it was largely through these that constructivist approaches to meaning-making emerged in STS. However, as this thesis focusses on discussions occurring outside of professional

scientific practice, in this section I shall consider how meaning-making features in STS studies of interactions between scientists and non-scientists. During the late 1980s and early 1990s constructivist studies of science-in-practice were increasingly drawn upon to examine the use of science in broader society (Jasanoff 1987; Yearley 1988). Most notably Wynne – a graduate of the Edinburgh Science Studies Unit, home of Bloor, Barnes, Shapin, and others – took up the task of “applying sociology of scientific knowledge insights to the construction of scientific and political authority in public domains” (Wynne 1992, 121). With Irwin, Wynne brought the idea of meanings of science to their influential edited collection *Misunderstanding Science* (Wynne and Irwin 1996). Wynne and Irwin’s key questions involved looking at the “...various ways [people] understand, interpret, and represent ‘science’” (Wynne 1992, 112) and “how do we understand what different public groups mean?... how are collective meanings constructed as representative meanings, in the public sphere?” (Wynne 2014, 64). In this, they were taking descriptive ideas of meaning-making outside of studies of professional science.

Irwin and Wynne’s work played an important role in a movement STS scholars have called the ‘dialogic turn’, or the movement from Public Understanding of Science (PUS) to Public Engagement with Science (PES) (Lock 2011). In PUS science communication was largely seen as one-way of transfer of knowledge from scientists to the general public; after the dialogic turn science communication was promoted as a form of dialogue between different scientists and other groups (Bauer 2009). The work of Wynne and Irwin played a role in this shift by empirically demonstrating that audiences interpreted scientific knowledge in many different ways, disputing the PUS image of audiences as passive receivers of scientific knowledge (Gregory and Lock 2008).

In this respect Wynne and Irwin can be seen as making a similar argument to Jenkins (1992) that audiences make meaning based on what matters to them, not what matters to the producers. However where Jenkins saw fans as ‘poachers’ who circulated meanings outside of official control, Wynne and Irwin focused on the ways in which officials (scientists, policymakers, and communication professionals) disempowered non-official accounts of science by labelling them as ‘misunderstandings’ (Wynne and Irwin 1996). Both of these approaches continue to play a substantial role in contemporary research within their respective disciplines (Bennett 2011; Stilgoe, Lock, and Wilsdon 2014).

The dialogic turn raised questions over the role of emotion in public participation in science. One of the central premises of PUS was that ‘to know science is to love it’ – in other words, that as people gain scientific knowledge they feel more positive about it (Turney 1996). This account was problematised by studies finding that suspicions of professional scientific

research were not addressed by increased familiarity with scientific knowledge (Epstein 1996; Gregory and Lock 2008). UK surveys of Public Understanding of Science were replaced with Public Attitudes Surveys (OST/Wellcome Trust 2000). These surveys developed a typology of attitudinal groups, such as 'The Concerned' and 'Confident Engagers', which accommodate variations in both knowledge of *and* feelings towards science (Ipsos MORI 2011). However across these developments the processes of how emotions take on shared expression within particular social contexts – the social construction of emotional meanings – has not been examined in detail.

It should also be noted that the prominence of 'meaning' within STS studies into PES has varied since Wynne and Irwin's work. In some ways, the dialogic turn decreased the attention paid to the question of what 'science' means. Where 1970s-1980s constructivist STS scholars opposed demarcationist philosophers of science, constructivist scholars of PUS and PES presented themselves as alternatives to survey research into public attitudes (Bauer 2009; Lock 2008). Unlike demarcationist philosophers, survey researchers agreed that trying to pin 'science' to a singular meaning was not a key issue (Miller 1998; Thomas and Durant 1987). Discussions of 'meaning' therefore dropped out of scholarly discourse around PES (Wynne 2014). At the turn of the century Yearley, a proponent of constructivist approaches to studies of science-in-public, wrote an article entitled 'What Does 'Science' mean in the Public Understanding of Science' without once mentioning work on the interpretative flexibility of science (Yearley 2000). Instead Yearley, like many of his colleagues, discussed the social construction of facts or knowledge, rather than of 'science' as a concept (see also Irwin and Michael 2003). Key questions since the dialogic turn have generally focussed on the questions around improving public influence in professional scientific processes (Stilgoe, Lock, and Wilsdon 2014) or surveying attitudes of public groups towards science (Bauer, Allum, and Miller 2007).

However other recent STS work has re-opened questions around ways in which public groups interpret and represent 'science'. These works have largely focussed on mediated communication, including the growth of digital tools. Nisbet has proposed that Goffman's notion of framing can be used to understand responses to scientific news (Nisbet 2009). Frames are "schemata of interpretation" that "help individuals negotiate meaning through the lens of existing cultural beliefs and world views" (p.44). Nisbet locates recurrent frames across various public science debates, though Brossard argues these may have to be re-considered to account for the influence of digital tools such as search engines (Brossard 2013). Studies of science blogs have also drawn on constructivist STS approaches to meaning-making, particularly Gieryn's concept of boundary-work. Marie-Claire Shanahan

has described hyperlinks and comments threads as tools for “bringing together diverse sources of information to create linked webs of meaning” (Shanahan 2011, 906). These works suggest that digital tools are presenting new ways in which public groups make meaning from scientific information, as well as new spaces for scholars to investigate such processes.

The opportunities presented by digital sites for studying meaning-making has been a particular concern of the emerging field of Issues Mapping, which draws on both constructivist STS and digital sociology. Issues mapping scholars use digital methods to track the emergence of issues in public discourse and the formation of groups around them, particularly in highly visible settings such as Twitter (Marres and Gerlitz 2014). Findings are used to analyse how public groups “can be characterized in terms of distinctive issue articulations” – or, in other words, how public groups form due to shared interpretations of particular socio-political issues (Marres 2007, 776). Issues Mapping offers notable points of comparison with FS scholarship. Both work on the basis that group identities are constructed around shared interpretations of things that matter to them (Marres and Rogers 2005). Both also engage with digital platforms as a tool for observing meaning-making in live social interactions (Venturini 2010a). However a key point of contrast is that Issues Mapping focusses on engagement with socio-political controversies, an emphasis which is generally avoided (even criticised) by FS scholars. The contrast between these two approaches goes beyond the case of Issues Mapping, as much STS research is heavily inflected by an emphasis on socio-political issues. The potential implications of this contrast for this research is the subject of the next section.

2.2. Instrumentalism

In 1993, introducing the third edition of his work *Against Method*, the philosopher Feyerabend remarked on changes since the first edition (Feyerabend 1975, 1993). He noted that “many intellectuals have adapted what they have learned at universities and special schools to make their knowledge more efficient and more humane” (Feyerabend 1993, ix). FS scholars have argued against such approaches to research. Hills has criticised a “fantasy of academic power and a fantasy of the idealist transformation of society” (Hills 2002, 81), while Jenkins and Shresthova have pushed against attempts to “instrumentalize fandom [...] to turn what many of us do for fun into something more serious” (2012, 1.9). In this section I shall focus on such notions of *instrumentalism*, that scholarship

should aim to identify problems and/or opportunities for improving science-public relations – including (but not limited to) education, communication, and democratic participation.

This question of whether, and how, academic research should be used for instrumentalist aims shows an important distinction between methodological approaches in STS and FS literature. I shall begin in section 2.2.1 by discussing how attempts to ‘instrumentalise’ participation have shaped STS research into science-in-public. In section 2.2.2 I introduce FS criticisms of such approaches in more detail. In section 2.2.3 I consider these criticisms in the context of STS research into PES, particularly of online settings, in order to clarify and justify the stance of this thesis.

2.2.1. Instrumentalism in STS

Constructivist STS scholars of the 1970s and 1980s agreed with the philosophers of demarcation that ‘science’ is a label with great cultural authority, and that uses of this authority should be examined (Barnes and Shapin 1979; Popper 1963). Constructivists took a critical attitude towards the power exercised by science in society, to an extent that they were sometimes accused of being antagonistic towards science – a charge disputed by Shapin (1992). During the dialogic turn this critical attitude to scientific authority took an explicitly politicised direction. In particular Wynne (a member of the Network for Nuclear Concern) aligned his work more closely with the activism of the radical science movement than the intellectualism of many of his predecessors (Wynne, Antonsen, and Nilsen 2013, p.33).

The work of Wynne and colleagues also reflected the constructivist STS approach of focussing on situations of disputes and controversy (Gieryn 1995). Looking to the Misunderstanding Science project (Wynne and Irwin 1996), the choice of case studies drew almost exclusively on disputes: the alleged contamination of livestock in Cumbrian farms (Wynne 1996b), perceptions of nearby hazardous industries amongst residents (Irwin, Dale, and Smith 1996), and patients’ understandings of a specific metabolic disorder (Lambert and Rose 1996). Even studies which did not deal with obvious cases of dispute – such as MacDonald’s work on London’s Science Museum, and Mike Michael’s narrative interviews with members of the public about their attitudes towards science – still focussed on questions of empowerment and disempowerment (MacDonald 1996; Micheal 1996). This emphasis has been de facto accepted in much STS work into science-public relations; as

Nowotny has retrospectively remarked, “our collective tacit understanding was that public engagement with science had to do with linking science to politics” (Nowotny 2014, 17).

Recent scholarship on PES has argued that concepts developed within politically-inflected STS should be extended to (and by) studies which do not relate to policy (Davies et al. 2009). Nonetheless, such work still takes an instrumentalist approach of locating problems and/or opportunities for improvement in science-public relations. Scholars have examined how power and social capital shape participation in public dialogue events (Davies 2011) and museum visits (Dawson 2014). Studies of science blogs have considered how blogging networks can act as exclusionary spaces (Bell 2012). Beyond specific settings, the concept of ‘dialogue’ has been explored as a tool for improving science education (McCallie et al. 2009); while the role of humour in science communication has been critiqued for the ways in which it can reproduce exclusionary social structures (Riesch 2015).

Recent STS scholarship has argued that the prevalence of instrumentalist approaches has diverted attention away from certain phenomena and perspectives. Davies has argued that analysis of PES events “tends to take a normative perspective by outlining what should have happened in any particular process” (2014, 91); quoting Harvey (2009, 146) she argues that this misses the fact that such events can be “sites of intense emotion, argument, tension, and humor” (Davies 2014, 94). Similarly, Horst and Michael have suggested that science communicators and analysts tend to frame certain behaviours, such as joking around within an exhibition, as not ‘serious’. However for participants such behaviours may serve “the highly serious situated enactment of their social relations within a group of girls” (Horst and Michael 2011, 300). The disjunction between the perspectives of analysts and actors has broader ramifications for research. Horst and Michael argue that science communicators and analysts may have been “implicitly letting pre-existing norms of proper scientific citizenship shape the reaction to unanticipated behaviours” (pp.300-301). From a reflexive perspective, we should note that it is ‘reactions’ of analysts which ultimately shapes research outputs. This raises questions of how a scholar’s perspective may shape how they understand the subjective emotional experience of participants. Such questions have been explored extensively within FS literature.

2.2.2 The FS Critique of Instrumentalism

For FS scholars, instrumentalism raises complicated methodological questions with respect to the study of emotion. To understand these concerns, we must first engage with broader

methodological debates within the discipline. Many scholars enter FS by studying fandoms which they are members of, opening up questions of how personal bias could feature prominently within the discipline as a whole (Stein 2011). In addition, early FS encountered some antipathy to ideas that academic scholarship could develop new 'explanations' of fan behaviour which had not been considered by fans themselves; after all, such fans noted, there exists a long-standing tradition of reflective writing within many fandoms (Green, Jenkins, and Jenkins 1998). A deeply reflexive questioning of the role of the scholar therefore runs deep within the discipline (Evans and Stasi 2014).

Hills has applied such questions to the study of emotion. He has disputed the idea that anyone – whether fan or scholar – can ever “‘explain’ and ‘justify’ our own most intensely private or personal moments of fandom” (Hills 2002, 72). He argues that all analyses of emotion are inevitably partial, and will to some extent follow from attachments of the analyst (pp.72-81). This is a familiar argument within constructivist analyses of meaning-making, which argue that analysis is not a ‘discovery’ of meaning but rather a collaborative construction of meaning between actors and analysts (Charmaz 2000). However this argument is compounded by the deeply subjective nature of analysing emotion, in which both actors and analysts may be influenced by attachments which they are unaware of and/or unable to fully articulate (Hills 2005). The full extent of Hills’ ‘autoethnographic’ stance has not been accepted by all FS scholars. However his argument that understanding emotion can be compromised by unwarranted attention on instrumental issues has been largely taken up within FS (Evans and Stasi 2014; Stein 2011). Gray argues that FS offers a counterpoint to media studies which see the “ills of neoliberalism and capital as the only things truly worth noting in academic work” (Gray 2011). Jenkins has suggested that even well-resourced media conglomerates fail to grasp what their audiences see as “meaningful participation” because of instrumentalist concerns (around distribution and commodification) underlying their monitoring (Jenkins, Ford, and Green 2013, 177). The central theme running through these arguments is that a scholar who looks at emotional meaning through an instrumental lens risks seeing different emotional meanings to one who rejects instrumentalism.

However, this methodological stance does not entail a rejection of the social and political concerns which underlie instrumentalism. The influential FS collection of Gray, Sandvoss, and Harrington opens with the question “why study fans? [...] What contribution can the study of fans make to a world faced with war, ethnic conflicts, widening inequality...?” (2007, 1). The answer to this question has varied somewhat throughout the history of the discipline. Early fan scholarship largely portrayed fandoms as spaces for individuals

‘Othered’⁶ by society for their emotional attachments to media products (Jensen 1992; Jindra 1994). Scholarship of the late 1990s and early 2000s instead considered fandoms as shaped by the social, cultural, and economic inequalities of broader society (Gray, Sandvoss, and Harrington 2007; Harris and Alexander 1998). Fan Studies has also engaged with the social and political engagements of fans themselves; whether in disputes with media franchises (Pearson 2010), as social activists (Jenkins and Shresthova 2012), or in drawing on social values espoused by their fan object (Bennett, 2013).

However a distinction is drawn between instrumentalism as an aim of scholarship, and engaging with socio-political concerns as a contextual factor in analysis. While pushing against an exclusive focus on the “ills of neoliberalism”, Gray argues that “those ills need charting, but they only scratch the surface of the depths of commentary we might offer on most media” (Gray 2011). In sum, the FS argument is not that scholars should ignore instrumental issues such as exclusive social structures, unequal distributions of power, or lack of effective engagement between elites and non-elites. Rather, the argument is that ‘depth of commentary’ comes from understanding the relevance of those issues to the community under investigation. In this thesis I aim to maintain the distinction between instrumentalism as an aim of scholarship, and instrumentalist concerns as one potential factor shaping participants’ behaviour. I avoid adopting the former, while aiming to adopt the latter. In the following section, I outline the particular relevance of this approach to STS.

2.3 Identity: Between ‘A Priori’ and ‘Constructed’

Within scholarship of digital media, a recurring question has been how online platforms shape the construction of identity (boyd 2014; Rainie and Wellman 2012; Turkle 1995). In this section I examine how STS and FS literature has considered the topic of identity in relation to non-professional participation and online settings. In section 2.3.1 I reflect on how contrasts between offline and online identity might apply to existing work on identity in STS. In section 2.3.2 I focus on how people adopt roles within interactions, focussing particularly on STS discussions of experts.

⁶ ‘Othering’ is a term used within cultural studies, including FS, to describe the process of portraying certain people or types of people as separate to oneself (Hall 1997).

2.3.1 Identity and Participation

STS has shown that the identity a person brings to a science-related interaction heavily shapes how they are able to participate. Studies into long-term engagement with science have developed the concept of *science identity*, a “construct that can explain an individual’s learning, meaning-making, and actions as they confront science content” (Fraser and Ward 2009, 4). Science identity has largely been developed in the context of understanding school learners’ trajectories into or away from science-related careers (Brickhouse and Potter 2001; Carlone and Johnson 2007). Such studies have shown that a person’s science identity is significantly related to self-perceptions based on demographic factors of race, class, and gender (Brickhouse, Lowery, and Schultz 2000; Carlone et al. 2008). This finding is corroborated by surveys of participation in science (both professional and non-professional) which show a significant under-representation of certain demographic groups (Archer et al. 2013; Royal Society 2014). This demographic patterning has been explicitly codified in the development of a ‘science capital’ measure for “understanding the production of classed patterns in the formation and production of children’s science aspirations” (Archer et al. 2015). Though a diverse range of personal experiences shape people’s engagement with science, scholars of science capital argue that these must be considered with reference to relatively fixed demographic identities which participants bring to interactions (Dawson and Jensen 2011).

The role of demographic identities is complicated somewhat – though certainly not rendered irrelevant – by the online setting, where participants can create pseudonyms and avatars (Turkle 2011). This directs analytical attention onto the ways in which identity is constructed through text, and how this is shaped by social contexts. Such contexts include expectations attached to demographic identities. For example Baym argues that the non-confrontational ‘ethic of friendliness’ of soap opera fandoms reflects both the emotional nature of soap operas and forms of social bonding associated with feminized⁷ spaces (Baym 1996). However, associations of soap opera audiences with stereotypes of working class women were rejected in many participants’ self-presentations (Baym 2000). Another example comes from Jenkins’ (1995) study of an online fandom of *Twin Peaks*, a detective series

⁷ Many FS scholars have drawn on Susan Herring’s distinction between ‘masculine’ discourse, which expresses objective and individualistic stances, and ‘feminine’ discourse which focusses more on building interpersonal links while playing down elements of competitiveness (Herring 1996). Note that the distinction does not mean that individual men and women use different writing styles online, but rather that expectations of a group’s gendered membership shape how people participate within that group.

directed by David Lynch. The series provided fans with a space to construct identities as problem-solvers and/or experts in director Lynch's other works. This fandom featured a more competitive, masculinized discourse, in which the online setting was used to "deflect rather than explore personal questions" (p.126). In both cases, group and individual identities are seen as constructed through discourse; a contrast to the STS literature, in which identity is seen as embodied and brought to interactions. However the way in which identities are constructed through text is still shaped by expectations attached to both certain fandoms and to broader demographic groups.

2.3.2 Roles

In addition to demographic identities, we can also consider the roles and functions adopted by people within interactions. In engagement with science a key role is that of 'experts', most particularly professional scientific experts. The 20th-century emergence of science as a profession – with associated training, institutions, and resources – has provided both tools and incentives for scientists to claim a monopoly over regulating meanings of science (Yearley 1988). STS scholarship also considers other forms of expertise, including expertise in organizing decision-making settings (Irwin 2001), and forms of 'lay expertise' possessed by public groups (Wynne 1996a). However the interaction between these different forms of expertise often results in scientists having greater power to shape dialogue (Davies 2011; Irwin 2006) and in any outputs produced (Smallman 2015). Non-specialists may even downplay their own abilities to contribute, presenting their views as an "adjunct, rather than an alternative, to expert dominance of discussion and decision making" (Kerr, Cunningham-Burley, and Tutton 2007, 407). As with the demographic identities discussed in section 2.3.1, 'expert' and 'non-expert' identities are set prior to the engagement.

Within a fandom, fans may become recognised through their contributions for particular "fannish functions" (Hellekson and Busse 2006, 12). These may take quite specialised forms, such as creating videos, artworks, or fiction, or codifying fan knowledge through the creation of glossaries or databases (Booth 2010; Jenkins 2006c). Alternatively fannish functions may involve more general communicative skills, such as humour or an ability to facilitate welcoming discussions (Baym 2000). While these roles may draw on experiences outside of the fandom, becoming *recognised* for a fannish function is a process of construction which takes place through interactions in the fandom. These individual functions are co-created with features of the fandom. For example, becoming recognised for a particular skill is related to expectations of what counts as 'skilful' within a community, whether re-interpretation of media products (Jenkins 1992) or interpersonal ability (Baym

2000). Such performances also demonstrate the values and expectations of what makes a good discussion, which shapes behaviour within the fandom more broadly (Bacon-Smith 1992; Bennett 2011). Individual and group identity are thereby co-constructed.

The contrast I have drawn between the two disciplines – STS employing a rigid *a priori* notion of identity which people bring to interactions, versus FS considering identity as more fluid and constructed during interactions – is oversimplified. Both disciplines have considered how the two notions of identity can interact. In STS the question of how an expert identity could be constructed through interactions has been fiercely debated (Collins and Evans 2003; Rip 2003). Though cases in which public groups have effectively constructed identities as technical experts are rare, there are examples of great social significance such as activist AIDS sufferers (Epstein 1996). At a more macrosociological level, STS work within the co-productionist idiom has shown how identities such as ‘scientist’ and ‘the public’ are constructed alongside institutions such as ‘the state’ or ‘the laboratory’ (Jasanoff 2004). Equally, hierarchies within fandoms are shaped by features which fans possess prior to an interaction: examples include technical competence, recognition in other fandoms, and/or privileged access to the production team of a show (Hills 2015; MacDonald 1998). Despite these complexities, the division between ‘expert’ and ‘non-expert’ has been central to much STS research, and it is important to consider how this might function in the online setting.

I suggest there is a gap in research on the topic of the identity of a ‘scientific expert’ might be constructed within online discussions. Many of the most studied forms of engagement with science online draw on familiar offline forms of expert/non-expert divide. Online newspapers (Allgaier et al. 2013; Fahy and Nisbet 2011) and science blogs (Ranger and Bultitude 2016; Shanahan 2011) are still largely written by professional scientists and science journalists, while citizen science projects are designed and run by scientists (Grey 2009; Haklay 2013). When audiences have been addressed these have often taken the form of an undifferentiated non-expert group (Kouper 2010), an “imagined audience” (Bell 2012) of the blogger, or else readers who are also themselves bloggers or journalists (Riesch and Mendel 2014). However Hine has noted that construction of expert identity within science-related discussions can challenge familiar notions of scientific expertise (2014). In her analysis of headlice-related discussions on Mumsnet, Hine notes that the online forum replaces traditional forms of expertise – the “role of formally appointed intermediaries such as healthcare professionals” – with “mechanisms of filtering access to information sources which often include peers instead of formally credentialed experts” (p.578). Studies of new social media platforms, in particular Twitter, have shown how science-related debates can

be dominated by people with expertise in politics (institutional or activist) rather than domain-specific knowledge (Hopke and Simis 2017; Newman 2017). Such works illustrate that there are questions to be asked about the role and construction of different forms of science-related expertise during online interactions.

Building on the connections between STS and FS could also broaden STS notions of online identity construction beyond questions of expertise. For instance Riesch and Mendel (2015) have shown the importance of being a humorous performer in interpersonal relations of the *Bad Science* blogging community. Curtis (2015) has also noted the development of distinctive identities through the chat function of the citizen science website FoldIt. Some of these relied on specific expertise in the FoldIt puzzles or programming knowledge to become a 'teacher' or 'technical expert'. However a group known as the 'hand-folders' (players who eschewed automated tools designed to speed up puzzle-solving) were associated with less technical and more emotional factors – they were described as “committed” to an older style of problem-solving (p.174), and becoming “revered” by other players (p.108). Such roles bring together a distinctive aspect of a science project (the fact that protein folding is a laborious task) with features of identity performance and communal recognition familiar from FS literature. We could similarly note that participants on the multi-project citizen science platform Zooniverse frequently join multiple projects of the same discipline, but rarely cross disciplines (Luczak-Rösch et al. 2014). There are questions to be asked about how professional identities and disciplinary divides may play a role in socialising and the formation of communities.

2.2.3 Instrumentalism and Online Engagement with Science

Studies of public engagement with science online have generally taken an instrumentalist approach. Recurring questions have included how the internet can benefit multi-directional transfers of knowledge (Cacciatore, Scheufele, and Corley 2012; Trench 2008) or open new possibilities for non-expert participation in science (Grey 2009; Shanahan 2011). Studies of non-expert participation, such as comments threads or Tweets, are often focussed on socio-political issues such as pollution (Delos Santos and Shanahan 2012), animal experimentation (Laslo, Baram-Tsabari, and Lewenstein 2011), or the effect of uncivil comments on online science discussions (Anderson et al. 2013). Newer online platforms such as Twitter have largely been analysed using case studies with high socio-political stakes, in particular climate change (McKinnon et al. 2016; Newman 2017) and new technologies (Veltri 2013). Alternatively, such platforms are framed as tools to help scientists

and science communicators share knowledge more widely (Wolf 2017; Yeo et al. 2017). While such studies are important, I argue that these instrumentalist framings are potentially limiting for two reasons. The first relates to the empirical choices of topics to focus attention upon. The second is a methodological problem around how STS scholarship addresses the study of non-specialist engagement. I shall address each in turn.

Instrumentalist framings can draw attention away from phenomena which do not directly address the issues under investigation. For instance Trench (2012) found that popular blogs about climate change achieved a higher-than-average comment count, but so did blogs about theoretical physics – and “paradoxically in aspects of that discipline where there was very little of obvious public value at stake in commercial, ethical or political terms” (p.281). However Trench does not analyse this finding further, focussing discussion on the climate debates. In Delos Santos and Shanahan’s study of online newspaper comments (2012) any comment which did not refer directly to the article’s discussion of oil sands was not analysed, leading to an exclusion of 75% of the comments. However Baym (2000) has noted how lengthy off-topic discussions known as ‘TANs’ (short for tangents) – which can involve anything from extended jokes to sharing of personal worries – play an important role in shaping wider communal norms, a topic I shall discuss further in section 2.4.

STS studies of science online have shown various forms of behaviour which could be fruitfully explored outside of an instrumentalist framing. For instance studies of online citizen science projects⁸ have found that features such as sociability and identification with a community are appreciated by participants (Jennett et al. 2013; Nov, Arazy, and Anderson 2011). In an analysis of the citizen science project FoldIt, Curtis noted that “in addition to these technical discussions, players use the global chat to get to know one another by discussing more personal topics...such as our families, jobs, and hobbies” (2015, 105). Studies of science bloggers by Bell (2012) and Riesch and Mendel (Riesch and Mendel 2014) hint at the important role of community amongst science bloggers – one of Bell’s interviewees states that “I’m always grateful for the larger science blogging community. I live for those little ‘Nice post’ comments” (p.255), while Riesch and Mendel note the importance of mutual respect amongst community members (pp.8-9). A study of the hashtag #DistractinglySexy, aimed at highlighting sexism within professional science,⁹ found that the most-cited benefit was the creation of a supportive *ad hoc* community, in which women could

⁸ Citizen science refers to “forms of organized research in which members of the public engage in the process of scientific investigations” (Bonney 2012).

⁹ The hashtag was a response to comments by the prominent biochemist Tim Hunt that the “trouble with girls” is that “three things happen when they are in the lab: you fall in love with them, they fall in love with you, and when you criticize them they cry” (Ratcliffe 2015).

identify with others who shared similar experiences (Golbeck, Ash, and Cabrera 2017). These studies analyse such features in instrumentalist terms of attracting and retaining audiences to citizen science projects, or in dealing with issues of exclusion within professional science. Nonetheless, they suggest there is potential for analyses of how a sense of community shapes and is shaped by different forms of engagement with science.

The second concern with respect to instrumentalism is a broader methodological one, around how STS scholarship frames digital participation. For instance, Trench's argument that an interest in topics where "little of obvious public value [is] at stake" (Trench 2012, 281) is "paradoxical" builds on a long-standing notion in studies of science communication that topics of public interest are largely those with high 'news values' – factors such as topicality or high stakes, which drive mass media reportage (Gregory and Miller 1998). However FS literature raises questions as to how paradoxical Trench's finding is, arguing that topics of interest depend heavily on the group in question (MacDonald 1998). In section 2.1.5 I discussed how Nisbet (2009) has used Goffman's notion of framing to analyse depictions of science in the public sphere. However each of Nisbet's frames is presented by how it "defines [a] science-related issue" (p.46). Methodologically this work has focussed attention on how existing frames can be used by actors to take stances on contested views – arguing that "science debates are little different from political controversies" (p.42) – rather than how meanings are socially constructed by actors, and shaped by contexts outside of the contested topic.

I also noted that the project of this thesis shares many interests with the field of Issues Mapping, which uses digital tools to examine how public groups form around shared interpretations of particular socio-political issues. However Issues Mapping is an explicitly instrumental field, developed to address questions of democratic participation (Marres 2007). The issues studied include public participation in carbon accounting (Marres 2011), and climate change (Marres and Gerlitz 2014); methodologies build on previous STS work in 'controversy analysis' 'controversies' in general (Marres 2015; Venturini 2010b). Public debates are defined as "situations where actors disagree" but the selected disagreements are solely around questions of policy and social wellbeing (Venturini, 2010, p. 796). This does not acknowledge the fact that many online actors disagree about non-political subjects, and moreover that such disagreements may reveal how participation is shaped by issues which matter to actors (Bennett 2013; Bury 2005). Methods such as 'hashtacking', (selecting and following particular hashtags, particularly on Twitter) can risk directing data collection entirely towards content which is explicitly aligned with instrumentalist issues, and cutting out broader discussions (McKinnon et al. 2016). Issues Mapping takes an extremely

reflexive approach to digital research, arguing that empirical work should be used to develop “natively digital” research methods (Marres and Weltevrede 2013). Such approaches have been taken up by digital social scientists beyond the field of STS (Rogers 2013). Approaches to instrumentalism and non-instrumentalism within STS work on digital participation could therefore act to shape digital research more broadly.

In sum, I suggest that an instrumentalist drive limits STS studies of how people construct emotional meanings of science. This is a problem which cannot be solved by broadening the range of empirical phenomenon studied within STS, but calls for a methodological departure from instrumentalism. Nonetheless, as I discussed in section 2.2.2, even non-instrumental approaches to scholarship should engage with instrumental factors as contexts which shape participation.

2.4 Shaping of meaning: Between Organisation and Norms

As noted in section 2.2, analysing social construction of meaning requires understanding the processes by which some meanings become shared - the *social* in social constructivism. In this section I begin by drawing a contrast between the STS focus on how meanings are shaped by forms of *organisation*, both physical and social. I contrast this with the FS focus on informal *norms* which continually shape and are shaped by participation. One aspect of such shaping is that certain forms of meaning-making are excluded or inhibited. A key question is how apparently ‘excluded’ meanings can impact upon more socially accepted forms of meaning-making. I consider this further in section 2.4.2.

2.4.1 Organisation and Norms

STS scholars have noted that the authority of expert identities is supported by the organisation of settings within which interactions take place. By ‘organisation’ I mean physical and/or social factors shaping interactions, which exist prior to and are relatively unchanged by those interactions. For example Davies (2011) illustrates how the arrangement of PES events – such as the division between experts on a stage and audience on a floor, or access to microphones – gives experts much greater power to control discussions. Topics to be discussed are usually set in advance by professional experts, often working on a premise that ‘technical’ scientific topics are not part of the agenda (Irwin 2001).

Such organisation can be hard to enforce in online platforms, where pseudonymity and lack of spatial co-presence make traditional methods of enforcing rules difficult. There are distinctively online techniques such as moderators banning user accounts. However these can be circumvented by users creating new accounts, or risk being accused of heavy-handed authoritarianism by other group members (Bennett 2011). If enough members choose to behave in a certain way, even longstanding hierarchical structures within fandoms can be overturned (Baym 2000). When discussions move into unexpected or unwanted areas it can be challenging to direct the discussion back onto the 'intended' topic (Bennett 2013). And if going against the expected behaviour of a fandom proves too difficult, fans can start an alternative fandom around the same object (Clerc 2000). This is not to argue that fandoms are 'anything goes' spaces of total freedom. As noted in sections 2.2.2 and 2.3.1, FS scholars have shown that fandoms reflect expectations of society at large. However, the online setting does require a re-consideration of how expected behaviour is enforced.

FS scholars examine how online fandoms are regulated by norms: implicit expectations of behaviour, encouraged by responses from fellow participants (Bennett 2011).¹⁰ Rather than having one's contribution written out by bureaucratic procedures, or discounted by figures of accredited authority, fans who transgress these norms find themselves sanctioned by disapproval, insult, or group ostracization (Baym 2000; Bennett 2009). An important feature here is that norms are shaped by the object of fandom and how members interpret it. This is not to say that norms are entirely *determined* by the object of fandom; we saw in section 2.3.1 how alternative 'masculine' and 'feminine' fandoms have emerged around the fan object of *Star Trek*. But features of the fan object can nonetheless be reflected in the norms of fandoms. For example Jenkins notes the importance of *Star Trek* producer Gene Roddenberry's socially progressive views in fan interpretations and re-interpretations of episodes (Jenkins 1988), while Bennett has shown how discussions amongst fans of the band R.E.M. reflect liberal values held by the musicians (Bennett 2009).

Fandoms can develop their own communal approaches for dealing those whose behaviour runs counter to these values. For instance, the R.E.M. fandom *Murmurs* regards discussions about band member's physical attributes as 'unintelligent', running counter to the intellectualism associated with the band (Bennett 2013). Such behaviour has acquired the label of 'drooling' within *Murmurs* which, similarly to labels such as 'pseudoscience' (sec 2.1.2), is used to visibly exclude different forms of meaning-making. However, unlike

¹⁰ This is not to be confused with 'norms' in the sense of normative ideals, used by Merton (1942).

pseudoscience, 'drooling' is a label arising specifically within the context of the *Murmurs* fandom. Again, behaviour within fandoms is understood with reference to the fan object. One of the tasks of this thesis will be to examine how, if at all, the concept of 'science' shapes norms.

2.4.2 Excluded Meanings

Science-related discussions are not only shaped by organisation within specific interactions; there are larger, longer-term social and institutional forms of organisation to consider. The professionalisation of science has produced a series of institutions – in particular laboratories, universities, and peer-reviewed publications – which are largely considered to be authoritative producers of scientific knowledge (Yearley 1988). Those already working within such institutions are expected to disagree with one another to a certain extent, though overturning widely held consensus is unlikely (Kuhn 1962). However any attempts to produce 'scientific' claims outside of these institutions are unlikely to be counted as credible, unless these are expressed as collaboration with professionals (Haklay 2013; Yearley 1988). Any such attempts which *disagree* with professional accounts are likely to be labelled as pseudoscience, greatly decreasing their credibility (Collins and Pinch 1979; Gieryn 1999). There have been examples of 'alternative' scientific research which have impacted upon professional science (Epstein 1996; Kaiser 2011). However these are extremely rare. This means that the pattern described in section 2.4.1 – that the power to put meanings of science into wider circulation largely lies in the hands of professional scientists, facilitated by policymakers and science communicators – also occurs on a much wider social scale.

The story is somewhat different in FS. There is certainly a divide between 'official' institutions (writers, performers, media conglomerates) and fan audiences. However the changing media landscape, and a gradual de-stigmatisation of the fan identity, has increased official institutions' engagement with fan audiences (Gray, Sandvoss, and Harrington 2007; Pearson 2010). The extent to which fan activity, for example the writing of fan fiction, can actually shape official production is complicated (Hills 2015; Jenkins 2006c). There are also cases in which official institutions threaten fan creativity with intellectual property law, though this too is becoming increasingly complex (Noda 2010). The key contrast with non-specialist engagement with science is that fan activity produces a diverse proliferation of 'alternative' approaches to a fan object. Unlike in disputes around science, such unofficial groups are not cut off from vital resources or positions of authority, and

‘alternative’ accounts are not dismissed in the same manner as ‘pseudoscience’ or lay ‘misunderstandings’.

This is not to argue that all interpretations are permitted within fan interactions; the role of norms, after all, is to encourage some forms of meaning-making and discourage others. However these apparently ‘excluded’ meanings can have influence within fandoms. Bennett has illustrated that forms of social sanctioning which enforce norms need not lead to exclusion from the fandom (Bennett 2009). She describes how ‘non-normative’ fans still participate as individuals and/or as sub-groups within the fandom despite actively going against norms. Such behaviour shapes the practices and self-presentation of normative fans, as they try to distance themselves from undesirable behaviour. In the words of sports fan scholar Avra Theodoropoulou, “...emotional investment in anti-fandom is significant to the construction of fan identity... the definitive mechanism of distinction to the outsider and enable[s] identification with the team.” (2007, 317). The ways in which fans sanction or ‘Other’ forms of undesirable behaviour are extremely valuable for both new fans and analysts to see, by contrast, what the fandom regards as desirable.

There are numerous resources within STS for considering how opposition might shape desirable behaviour within science-related discussions. As noted by Gieryn, representations of science depend on a perceived ‘opponent’. When the opponent is religion, scientists may emphasise the practical outcomes of science; presenting more metaphysical elements of science can be used to distance science from engineering (Gieryn 1983). However STS scholarship, particularly of contemporary PES, has presented a certain conception of ‘science’ (professional practices and institutions) as dominant and able to exclude other interpretations. FS has examined how various alternative meanings circulate and collide outside of official spaces. A key recurrent theme in this thesis is how these two different approaches to shaping meaning interact.

2.5 Alternative STS Approaches

This research works from the premise that STS could use online settings to explore the interplay of emotional and descriptive meaning-making around science. Over the previous sections I have argued that, in order to do so, analysis should focus on the construction of identity during interactions, and the regulation of participation through informal norms. There have been previous STS accounts which have discussed ideas of meaning-making by

drawing on many of these ideas. I therefore conclude this review by considering these accounts, to illustrate the distinctive contribution intended by this thesis.

2.5.1 Informal Science Education

A first example of STS work that has drawn on ideas of meaning-making which are not self-evidently 'descriptive' is research into Informal Science Education (ISE) – education outside of formal settings such as schools or universities. Rather than draw on the constructivist STS literature discussed in section 2.1.2, these works have built on ideas of meaning-making from social psychology. In their research on science museums, Falk and Dierking have defined meaning-making as “a constant process of relating past experiences to the present... this process is at the root of all learning” (2000, 61). Similarly a US-based report on ISE suggests that “meaning-making (i.e. interpreting experiences to give them personal significance) has become so central to descriptions of learning in informal environments that it is sometimes regarded as the essential learning behaviour” (Bell et al. 2009, 143).

These studies engage with many of the themes I have raised in this review. Firstly, ISE settings illustrate important roles for emotion and identity in motivating participants to undertake self-directed learning. The Bell et. al. report (2009) presents 'six strands' of science learning, noting that the strands relating to emotional experiences (strand 1) and to developing personal identities (strand 6) are especially worth considering in relation to ISE. The work of Falk ties emotional responses to forms of identity construction, relating learners' motivations to their 'little-I' identities: “identities that respond to the needs and realities of the specific moment and situation” (Falk 2009, 73). These more fluid identities relate to both more rigid demographic identities and the particular setting; for example, Archer *et. al.* (2015) noted that a socially disadvantaged family experienced feelings of disorientation and other-ness in an unfamiliar museum setting, while still enjoying the time as a family.

The approach I take in this thesis diverges from ISE studies in two respects. The emphasis on 'learning' is different to the approach of this thesis; as part of avoiding an instrumentalist framing I do not tie meaning-making to any particular conception of participation which may not capture participants' self-conceptions of their activities. For example, it is not clear that participants in TANs (sec. 2.2.2) would describe their activities as 'learning'. Secondly these studies focus on emotion as individual motivations, rather than as social expressions. Nonetheless, ISE studies illustrate that understanding associations between emotion and engagement with science can be deepened by considering the interplay of identity

construction and social context. These studies also illustrate that such phenomena are of interest outside of online platforms, extending the potential relevance of this thesis.

2.5.2 Science and Social Identities

Some recent works within STS have raised questions of how to relate science to everyday, informal social behaviours. The work of Horst and Michael (2011), in which they aim to account for unexpected participant behaviour within a science communication installation, has already been considered in section 2.2 (see also Horst 2011; Michael 2012). There I discussed how their work has presented a challenge to instrumentalist framings of science communication, by noting a disjunct between analysts' and participants' perspectives. Horst and Michael argue that some behaviours – teenagers playing with the exhibit's CCTV camera – *could* be dismissed as unimportant by analysts. However such interactions are potentially very important from the perspective of teenagers trying to build and maintain social bonds (2011). They introduce the analytical category of 'idiotic' to describe the teenagers' behaviour. The label of 'idiot' here is not a slur, but rather draws on Stengers' notion of the idiot: someone who does not participate in ways that can be meaningfully understood by those around them, forcing others to re-consider their assumptions of what counts as meaningful¹¹ participation (Stengers 2005). In considering 'idiotic' behaviour Horst and Michael address a concern I raised in section 2.4.2, that certain forms of meaning-making can be written out of STS accounts of engagement with science. We can raise a comparison with Bennett's (2009) non-normative participants; by engaging with those who do not participate in expected ways (and responses to them), analysts can better understand more expected forms of participation.

To better account for both expected and idiotic behaviour, Horst and Michael propose that we see science communication as an 'event': "the coming together of different elements through which novel relations and identities can emerge" (2011, 286). They argue that this encourages analysts to think how different meanings of 'science' are constructed alongside – and interact with – different identities and forms of participation. This approach addresses many of the arguments I have made in this review. In the event, identities, social context, and meanings of science are constructed. Moreover, the event can encompass both

¹¹ Recall from the discussion of meaning-making in sec. 2.1.1 that 'meaningful' behaviour can be seen as the opposite of arbitrary, random behaviour.

descriptive and emotional meaning-making as interpretations of 'science' and 'society' emerge alongside shared experiences and social bonds.

Despite the close parallels between Horst and Michael's work and the intended project of this thesis, there is a disjunction which is important to mention. I suggest that a potential risk of focussing on science communication as event is the downplaying of how events are shaped by their shared label of 'science'. The sorts of idiotic behaviours noted by Horst and Michael may have occurred irrespective of whether the installation was communicating science or another cultural concept. However apparently 'off-topic' forms of participation, such as the TANs studied by Baym (sec. 2.2.2), can also be understood with respect to features of the object of fandom, in conjunction with broader social factors such as gendered expectations of audience behaviour. A similar question – what role does 'science' play in these accounts – can be asked of Falk and Dierking's work, which uses research on science museums to present arguments about museum visits in general (2000, 2013). Similarly Jensen and Wright have argued against the introduction of a specific measure of 'science capital' to research in science education, suggesting instead adopting Bourdieu's notion of 'cultural capital' more broadly (Jensen and Wright 2015).

The role of 'science' in informal social behaviour has been studied by Riesch, with a particular emphasis on communal identity amongst professional scientists. Riesch (2010) draws on the concept of *Social Identity*, defined as "the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of group membership" (Henri Tajfel, quoted Hogg and Abrams. 1988, 7). He relates social identity to Gieryn's concept of boundary-work, arguing that presentations of 'science' and 'non-science' can be related to psycho-social phenomena of positively framing one's own in-group and negatively stereotyping out-groups. This brings together distinctive ideas associated with perceptions of science as an authoritative practice, and broader questions of how individuals align their personal identities with a surrounding community. Riesch has explored these questions in relation to science-related humour (Riesch 2015) and to community formation within the *Bad Science* blogging community (Riesch and Mendel 2014). This latter study is of particular relevance to this thesis. Through a study of comments threads, Riesch and Mendel found "a wider community identification of the bloggers with science as a shared worldview" (2014, 11). In particular they note how Merton's norm of universalism provided a shared social value for the community. This illustrates how online discourse can be a site in which associations with 'science' can be studied in relation to community-forming practices.

However the scope of Riesch's empirical work is, at present, relatively narrow and focused upon professional or semi-professional settings. Science-related humour is largely discussed, by Riesch and others, in terms of how it is used by professional scientists and science communicators (Pinto, Marçal, and Vaz 2013; Riesch 2015). The *Bad Science* blogging community studied by Riesch and Mendel (2014) is a small, specific group; it combines relatively high (even professional) levels of expertise with a distinctively activist approach to science communication. In this study I aim to consider how community formation interacts with ideas of science, in relation to a wider range of social contexts. This informs my use of multiple case studies, as discussed in the next chapter. However the broad finding that formation of community norms can be associated with factors related to 'science' is one which this study aims to build on.

Conclusion

In this chapter I have contextualised the research question of this thesis with respect to literature from STS and FS. I elaborated on each of the key themes of the question – emotional and descriptive meaning-making, non-professional engagement with science, and online settings – and how they have been addressed in previous scholarship. I also examined contrasts between STS and FS literature, in particular around their differing depictions of online engagement, to delineate potential areas of exploration for this thesis.

Drawing on studies of meaning-making within STS and FS (section 2.1), I clarified the distinction between the two forms of meaning I refer to in this thesis. *Descriptive meaning-making* is the defining, demarcating, and/or interpreting of a certain concept. *Emotional meaning-making* refers to processes of engaging with a certain concept in a manner which demonstrates emotional significance, such as the creation of social bonds or constructing an identity within a community. I argued that STS scholarship has focussed on descriptive meaning-making, but noted instances in which emotion has featured in these accounts. By drawing on concepts from FS, I proposed that a greater engagement with emotional meaning-making could develop more detailed, contextually sensitive analyses of roles for emotion.

The online setting provides opportunities and challenges for many STS concepts. Questions of how interactions are shaped by the presence of experts (section 2.3) and institutional and social organisation (section 2.4) are central to much STS work. However the pseudonymous and hard-to-regulate nature of many online settings, as illustrated by much FS literature,

may require some re-consideration of these ideas. Online settings may also provide greater visibility to perspectives of non-professionals, which can be limited or downplayed in more organised settings. I argued that to derive the full analytical benefit from these settings requires moving beyond an instrumentalist perspective, which emphasises the role of research in locating problems and/or proposing improvements to non-specialist engagement with science (section 2.2). I aligned the approach of this thesis with FS approaches to instrumentalism. I aim to engage with the social and political problems illustrated by STS research into public engagement with science, but not emphasise these factors over others which may be of greater relevance to participants.

I also suggested (section 2.5) that such research should draw on STS research into descriptive meaning-making in order to draw out features distinctive to emotional meaning-making around *science*. Throughout this review I discussed STS accounts of online engagement with science which suggest that features often associated with science, such as technical expertise and disciplinarity, play a role in shaping online participation. The social constructivist approaches of STS suggest that any analytical approach of the form ‘what is special about *science*’ should be treated with some caution. Nonetheless, by considering the interplay of descriptive and emotional meanings of science I aim to account for both the interpretative flexibility *and* distinctive features associated with science; just as an object of fandom can be interpreted in many ways, yet still play recognisably recurrent roles in shaping participation.

“Predict, test, check for confirmation or refutation. Egad! It's science!”¹²

3: Methods and Methodology

This thesis examines interactions between emotional and descriptive forms of meaning-making around science. This involves understanding the context-specific details of social interactions, rather than quantifying recurring features. In other words, this research took a qualitative approach (Robson 2011; Silverman 2001). In this chapter I outline how I selected and used data from a collection of online case studies to address my research question. This is presented chronologically through five sections: case study selection, setting up ethical precautions, data collection, techniques for analysis, and reporting data. In each section I combine relevant discussions of *methodology*, the theoretical and epistemological commitments underlying research approaches, with *methods*, the practices used to collect and analyse data.

It should be noted that, for reasons outlined in section 3.4 of this chapter, variations of my analysis methods were used in different chapters. I therefore defer discussions of specific sampling and coding procedures to the relevant chapters. However, all chapters were based on the same basic pattern of carrying out *constructivist discourse analysis* of discussions based on *thematic analysis* across *multiple case studies*. These are the key concepts which I shall introduce and reflect on this chapter.

3.1 Online Settings and Case Studies

The data for this thesis was drawn from four case studies of online fora designed for hosting discussions about ‘science’. I begin this section by outlining the rationale for this approach, before introducing the selection criteria for my case studies. I also provide a very brief introduction to the selected case studies, but as the case studies involved a variety of technical and social factors I dedicate chapter 4 to outlining each in full.

¹² Comment on the thread *SkepticsSTM IMAP* (Apr 2015).

3.1.1 Online Fora as Case Studies

While my research question could be asked of numerous forms of social interaction, I focussed on the online setting. In my literature review I argued that STS research has focussed too strongly on organised, high-stakes encounters between scientists and non-scientists. FS scholars have shown that online settings are a useful source of less organised, lower stakes encounters which permit a variety of emotional meaning-making (Evans and Stasi 2014). Online settings also allow researchers to study 'natural' encounters – i.e. behaviour which occurs independently of the researcher, and is observed without the researcher's presence causing disturbance – which can preserve the informal, everyday nature of observed behaviour (Bultitude and Sardo 2012; James and Busher 2012). The existence of multiple online communities, with different social norms and technical features, allows analysts to compare forms of online social interaction (Hine 2000). Online interactions also generally leave a durable record, which can be preserved for detailed analysis of language choice (Herring 2004a). Taken together, these features made online settings a valuable space for this study.

Researchers must choose how to bound the online setting under investigation (Schneider and Foot 2005). This can be accomplished in numerous ways, from focussing on the experience of individual users (Turkle 2011) to following key terms through multiple appearances (Marres and Gerlitz 2014; Papacharissi 2014). In this project I was interested in the role of communal norms, and as such looked at social behaviour within online fora (Baym 1993). This was an exploratory project, i.e. trying to develop new knowledge of an under-explored phenomenon rather than test existing hypotheses or theories. I was asking *how* are meanings of science constructed, rather than questions of *who* joins online communities or *what* variants of online communities exist. All these requirements lent themselves to a *case study approach* (Yin 2014).

Various definitions of 'case study' exist, which Thomas (2011a) subsumes into the most general:

systems that are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame — an object — within which the study is conducted and which the case illuminates and explicates (p. 513).

The *object* in my case was the construction of emotional and descriptive meanings within discourse. My decision to use multiple cases (or 'subjects of inquiry') was taken based on issues raised in my literature review. STS scholars have expressed concerns that analyses

of case studies do not draw wider conclusions which go beyond the case(s) under investigation (Irwin, Jensen, and Jones 2013; Stilgoe, Lock, and Wilsdon 2014). As this was an exploratory project, I did not assume I could draw wider conclusions by reference to existing research. Such circumstances pointed to use of multiple case studies in order to draw more generalisable conclusions.

Though online settings are varied, there are factors which generally distinguish them from offline settings. Online interactions often exhibit lower levels of politeness and empathy than face-to-face interactions, a phenomenon referred to as the 'online disinhibition effect' (Santana 2014). Platforms can feature a range of affordances, such as options to combine text and images, and to communicate either synchronously or asynchronously (Boyd and Ellison 2008; Nagy and Neff 2015).¹³ These allow for hybrid forms of interaction not commonly seen offline, such as moving seamlessly from extended textual messages to real-time image sharing (Jenkins 2006a). Hyperlinks and multi-tab browsers mean that participants can instantly access (or be directed to) material elsewhere on the web, meaning that a single online text is part of a much broader network (Schneider and Foot 2005). More recent social media sites are built around a 'newsfeed', in which material from multiple sources – friends, media outlets, pages a user has subscribed to – are algorithmically combined in a single view (Bakshy, Messing, and Adamic 2015). Engaging with such factors is necessary to analyse online interactions; it also provided opportunities to explore features which are novel to STS. Nonetheless this research also aimed to draw out features of interaction which could feasibly be generalised beyond online settings, while being alive to the specificities of the setting.

3.1.2 Selection of Cases

There are many approaches to selecting multiple case studies. Gerring (2007) suggests a typology of nine techniques. Of these I have used *extreme* and *diverse* cases, which Gerring proposes as useful for exploratory research. Extreme cases display the object of interest in an exceptionally strong form. While my object of investigation – discourse which displays emotional and descriptive meaning-making around science – could occur in a range of online environments, I looked for settings in which these sorts of discussions were likely to

¹³ In synchronous communication, participants interact in 'real time'; in asynchronous communication, there may be extended breaks between turns (Schiek and Ullrich 2017).

appear regularly. The criteria for selection were developed following arguments outlined in my literature review, and are presented in Table 3.1.

Table 3.1: Selection criteria for case studies.

	Feature	Excludes...	Reasoning
A1	Sites which presented themselves as aimed at an audience interested in 'science', conceived broadly.	Sites focussed purely on technology, medical sciences, or a particular scientific discipline.	In order to study meanings of 'science' as a broad concept.
A2	Sites which did not incorporate distinctions between 'communicators' and 'audiences', or 'professionals' and 'non-professionals', into the design of the websites.	Blogs, online newspapers, and sites which require institutional log-in.	To look at how meanings were constructed in the absence of formal organisation.
A3	Sites which did not direct users to follow a particular goal.	Citizen science websites and groups based around online educational courses.	To provide an alternative to the instrumentalist focus outlined in the literature review.

Selecting *diverse* cases means choosing cases which show variation across selected features which are relevant to the object of interest (Gerring 2007, 97). The features I varied across the cases are presented in Table 3.2.

Table 3.2: Features varied across case studies.

	Feature	Reasoning
B1	The size and rate of interaction on the page.	Behaviour in an online group is influenced by size of the group and how frequently other people post (Preece, Nonnecke, and Andrews 2004; r/science meta 2014).
B2	General level of scientific expertise within discussions.	Scientific expertise is a major factor shaping even non-specialist participation in science (see literature review, sec. 2.3.2); popular commentary on online engagement with science suggests that general level of scientific expertise is a significant factor in attitudes towards online science-related discussions (Maddox 2012; Thomas 2015).
B3	Website platforms.	Websites provide different <i>affordances</i> : technical features which allow users to interact with content in different ways (Nagy and Neff 2015).

There were also some pragmatic concerns common to all groups. Firstly, that the sites had sufficiently high membership and rates of usage that they would be unlikely to cease interaction during data collection. Secondly, that the sites provided means to contact other users, so I could introduce myself to the moderators and interview users. Thirdly, to avoid violating privacy, I chose sites which did not require creating an account to read material. Fourthly, that I was able to design web scraping software for the sites.

I selected the cases in *parallel* rather than *sequentially*, i.e. all cases were selected prior to analysis rather than selecting later cases based on analysis of earlier cases (Thomas, 2011a). This maximised the limited time available for analysis of a large quantity of data. It also ensured I was developing generalisable cross-case conclusions from an early stage. Searching, assessment, and selection occurred over January-March 2014. Candidates were found by using search engines, asking for recommendations over Twitter and Facebook, and following up mentions in popular literature.

Using the selection criteria outlined above I narrowed down potential options to four final choices, which provided a sufficient balance between variety and manageable quantity of data. The selected case-studies will be discussed fully in chapter 4, but are summarised in Table 3.3.

Table 3.3: Summary of case studies. The reasoning and information used for these classifications are discussed fully in chapter 4.

Case Study	Size of membership across data collection (# active participants as order of magnitude)	General level of scientific expertise	Forum and Platform ¹⁵
IFLScience	Very large (10^5)	Low	Facebook
r/EverythingScience	Large (10^3)	Medium	Reddit
XKCDScience	Medium (10^2)	High	The XKCD Forum; phpBB ¹⁶
SkepticsSTM	Small (10^1)	Low	The Skeptics Society Forum; phpBB

As noted in Table 3.3, each of these case-studies was one sub-forum within a larger forum. Each forum also included other sub-fora which were not focussed on science. At points in this project these non-science comparison groups were useful as comparisons to elucidate features that were distinctive in science-related discussions. Details will be discussed in chapter 4.

3.2 Ethical Considerations

Online research raises distinctive ethical problems, which must be considered in light of particular projects (Orton-Johnson 2010). I therefore built upon key general ethical considerations from other internet researchers (Eynon, Fry, and Schroeder 2008; Sharf 1999). The two main ethical issues raised by this project were informed consent and protecting the identity of participants. I shall address each in turn.

¹⁵ I use 'forum' to mean the broader website to which a participant must subscribe in order to participate, and 'platform' to mean the technical infrastructure upon which the forum is constructed. Facebook and reddit are constructed using technical infrastructures which are unique to them.

¹⁶ phpBB is form of open-source language used to create web forums, discussed further in chapter 4.

This project received ethical approval from the UCL Department of Science and Technology Studies before commencing data collection (reference number Z6364106/2015/01/10, see Appendix 1 sec.1 for a copy of the approval certification).

3.2.1 Informed Consent

Ensuring informed consent, i.e. that all participants were aware they were part of a research project and were given sufficient information to understand implications of the research, is generally considered a requirement for research on human subjects (Robson 2011). This becomes complicated when studying large participatory websites, as getting informed consent from thousands of users can be problematic. Also users who are prepared to give consent may be particularly open or confident in their internet usage, which can produce systematic bias (Andrews, Nonnecke, and Preece 2003). Academic researchers must be careful not to leave detailed understanding of the internet entirely to other forms of investigations, such as market research, which do not always have as strong requirements for ethical approval (Savage and Burrows 2007). However going to the other extreme – arguing that ‘the data is already public’ so consent need only play a minimal role – can be risky as many users are unaware of the full implications of the data they post publicly (Zimmer 2010).

My approach to these problems was to be guided, as much as possible, by users of my case-study sites. Firstly, I contacted site moderators: users with higher privileges, used to enforce rules (e.g. by banning members or closing discussions). Moderators are usually long-standing members of the site, and often considered to be socially exemplary figures of the community (Baym 2000; Wright 2007). When trialling case-study sites I privately contacted the moderators to get permission for including the site in my study. In doing so suggested I make a public post on the sub-forum. I also asked the moderators for advice on how to ensure my posts could get maximum visibility without resorting to making the posts multiple times, which can be annoying for the community (Eynon, Fry, and Schroeder 2008). When contacting the moderators I included the proposed post, but made it clear that I would be open to changes.

The post text read:¹⁷

Hello,

¹⁷ This is the post made on XKCDScience, though variations for other case studies were very minor.

I am a current PhD student doing research into online conversations about science. I was hoping to use this forum as one of my case-studies - this would involve using only publically available information, and I shall never be reporting any personal information of users (even user-chosen pseudonyms). I wanted to check this would be ok with you as a group; and also as an individual user, if you would be more comfortable with me not using your posts or comments please do let me know (preferably ASAP to minimise back-searching). More information can be found at ucl.ac.uk/sts/students/marsh, in particular the 'what I am doing' and 'get involved' sections.

Also, I was wondering if any of you would be willing to talk about your experiences of using this forum? I am interested in hearing about all sorts of use, from lurking to regular posting. This could be carried out through any medium you would prefer.

Finally if any of you have experience using any other form of publicly available science-focussed online discussion group - barring blogs, they're not included in my research for various reasons - I'd be very interested to hear about that.

I am happy to chat further or answer questions, so please do comment below, I'm at oliver.marsh.13[at]ucl.ac.uk, or try to PM me (though I'm not sure that feature of my account is authorised yet).

Oliver

As well as allowing participants to make suggestions on how to proceed ethically and/or opt out, this post was designed to recruit interviewees. Providing a link to my departmental research profile, which I had customised to provide information about how data would be collected, stored, and reported, was a step I took following previous good practice in this area (Flicker, Haans, and Skinner 2004; Taylor 1999).¹⁸ In the post I aimed for a friendly tone in order to appeal to participants who treated the forum as a place for light-hearted leisure-time activity, and might have been put off by a more formal approach (James 2006). The results of discussions with moderators, and the effects of the public posts, varied between subfora and shall therefore be discussed in chapter 4.

3.2.2 Protecting Identity of Participants

Despite my efforts to make myself known, it is likely that only a small minority of my research participants were aware they were part of a research project. I argue that I made

¹⁸ A copy of the text from this page is provided in Appendix 1, sec. 2.

considerable efforts to absolve myself of the charge of deliberately hiding my presence (Eynon, Fry, and Schroeder 2008; Garcia et al. 2009) and also become informed of ethical issues that I had not previously considered (Zimmer 2010). However, in the absence of full informed consent it was important to ensure I was using data in a responsible fashion. Following UCL STS ethical requirements, all data was stored in an encrypted and password-protected offline hard drive. Offline copies were made of all interviews (Taylor 1999), and in view of possible breaches of security interviewees were asked if they wanted me to delete the online versions (Eynon, Fry, and Schroeder 2008).

A more complicated issue was how to *report* the data in an ethical fashion. Analysis involved close engagement with specific linguistic choices, which would have been difficult to report without direct quotation. While many people may use pseudonyms online, these should be considered as ‘real’ as offline names as users may still wish to maintain an online reputation (Hine 2012) or may be identifiable from other information (Zimmer 2010). Quotations of online material can be traced to a username via search engines, thus counteracting anonymisation; this can be particularly problematic in situations where participants delete the original material to protect privacy, unaware that reproductions could be found in other locations (Eynon, Fry, and Schroeder 2008). Some participants expressed concerns at losing control over data which appeared in this thesis (discussed in the next chapter, sec. 4.5.2). To minimise risk of post-hoc reconstructions of any discussions which appear in this thesis (through, for example, use of online archives), I identify quoted threads²⁰ in the form (Forum, Thread Title, date(s) material was posted) rather than a URL.

Due to the lack of moderator approval from IFLScience (discussed in chapter 4) I did not quote directly from IFLScience. For the other subfora I contacted any participants who I wished to quote, informing them of the thread and offering to provide further context if wanted. If I did not receive permission I either found a suitable replacement from a participant who had allowed me to quote them, or reported the interaction in a generalised and/or paraphrased fashion which would not allow the original to be located through search tools (or reconstructed if it had been deleted).²¹ The full breakdown of permissions requested and given is given in Table 3.4.

²⁰ A thread is a full list of comments and replies below a post.

²¹ For these reasons, I adopt a stylistic convention of using double quote marks for direct quotations, and single quote marks for paraphrasing.

Table 3.4: Number of participants granting and not granting permission to be quoted, across subfora.

	r/EverythingScience	SkepticsSTM	XKCD
Granted below introductory post	0	5	10
Granted on contacting	37	18	17
Contacted but didn't reply	9	6	19
Contacted and refused	1	0	0
Opted out below introductory post	0	0	2
Total Granted	37	23	27

It should be noted that I made an active decision not to contact some of the participants in threads analysed for this thesis. As the research progressed, a recurring theme which emerged was that some participants received extremely negative responses when they appeared in the subfora. Below my introductory post on the Skeptics Forum, participants debated as to whether this should be seen as 'bullying' or 'debating' (*SkepticsSTM More on PhD Research*, May 2016). Participants from across subfora made me aware that some behaviour which attracted negative responses – in particular, unclear writing and strong aggression – has sometimes turned out to be related to problematic personal factors (such as heavy drug use or extreme personal aggression). One member even reported being personally threatened over the phone by a fellow participant who they had criticised.

This is a recognised problem of studying online subfora. With minimised contextual cues, it is possible for researchers to unintentionally encounter distressing situations, and risk causing psychological or physical harm to both themselves and/or participants (Stern 2003). In order to minimise these risks, I did not initiate contact with participants who experienced regular negative reactions from other participants; they are therefore not quoted. This is potentially problematic, as such antagonistic discussions form a substantial part of many discussions within this thesis. Though I endeavoured to remain personally neutral on all conflicts, I acknowledge that I engaged with one side in more detail than the other. However, I argue the potential ethical risks outweigh these concerns.

3.3 Data Collection

I gathered data from discussion threads using techniques of *web scraping*, which converts online data into a more easily stored and analysed form. I discuss how I approached web scraping in section 3.3.1. In order to deepen my understanding of the subfora, I also carried out semi-structured interviews with participants. This is discussed in section 3.3.2.

3.3.1 Web Scraping

Web scraping is the use of software to extract selected information from websites and reproduce it in a structured form which can be stored offline (Marres and Weltevrede 2013). There are existing web scrapers which could have been used to extract data from my case study sites.²² However researchers have noted a risk of using such devices, that algorithms can often be 'black-boxed' such that researchers have little understanding of how the data was produced (Boyd and Crawford 2011; Marres and Weltevrede 2013). Therefore as part of this project I built my own web scrapers using the open-source programming code Python. As well as avoiding black-boxing of collection processes, this also allowed me to customise the tools as required for this project. It should be noted that I am not an experienced programmer, and learned Python specifically for this project. I therefore encountered minor technical errors, and refined the tools appropriately, over the course of the project. Potential impacts of these errors will be raised when relevant, and fuller details can be found in Appendix 2. However it is unlikely that errors in scraping tools impacted upon the qualitative analyses in this thesis: all threads used were checked against the original web pages, to ensure no contextual details had been omitted or captured incorrectly.

Pilot tests of the scrapers established that roughly a month's worth of threads provided a balance between ensuring a sufficient variety of threads from the smaller case study sites, while avoiding an overload of data from the larger case study sites. I selected three separate month-long periods, to ensure my data would not be dominated by any major topical occurrences. These periods – henceforth 'scraped windows' – were March 2015, August 2015, and February 2016.²³ Note that, for reasons outlined in Appendix 2 sec.1,

²² See, for example, the Digital Methods Initiative (2013).

²³ Due to issues discussed further in chapter 4, I only have two scraped windows for EverythingScience.

some responses captured by the scrapers were posted outside of these month-long windows.²⁴ A quantitative summary of the scraped data is given in Table 3.5.

Table 3.5: Quantitative summary of data in each scraped window. Full details of how values were calculated are provided in Appendix 2, sec. 1.

Time Period	Subforum	Number of posts	Number of responses	Total words responded
March 2015	IFLScience	159	647,766	4.8m
	r/EverythingScience	290	1,729	74,887
	XKCDScience	44	837	106,344
	SkepticsSTM	30	389	28,119
August 2015	IFLScience	504	1.14m	10. 4m
	XKCDScience	36	950	157,047
	SkepticsSTM	21	670	54,243
February 2016	IFLScience	548	1.35m	11. 5m
	r/EverythingScience	345	1,645	59,426
	XKCDScience	58	4,669	622,444
	SkepticsSTM	28	1244	192,487

As this research was exploratory, in addition to textual data I also scraped a series of other variables that could provide relevant contextual information. These included the number of ‘likes’ a comment received (Facebook), how long a participant had been a member of the forum (Skeptics, XKCD) or other subfora they have posted on recently (reddit). I kept the range of variables extremely broad, within ethical limits – for example, due to privacy requirements, I did not scrape Facebook profile details for IFLScience participants beyond their name. A full list of variables is provided in Appendix 2.

²⁴ This was particularly the case on XKCDScience and SkepticsSTM, where participants occasionally commented on posts which had been started years before. The scraper downloaded full threads where any comment appeared within the scraped window. To ensure full engagement with context, I analysed full threads rather than just the material which appeared within the scraped windows.

3.3.2 Interviews

There were some potential problems arising from the multiple case study approach and limited scraped windows. The multiple case study approach is in contrast to much FS work, which tends to carry out ethnographic studies of single cases (Evans and Stasi 2014). FS scholars often study cases with which they have longstanding personal familiarity (Stein 2011). Some FS scholars advocate this method as it allows researchers to develop a tacit familiarity with subtle norms and community dynamics. As Baym noted of her ethnographic approach, “my understandings and intuitions as a member guided this project at many stages” (Baym 2000, 22).

I was not strongly familiar with any of my case studies prior to the research. I also did not follow discussions which were outside my scraped data; and I made the decision to avoid personally participating in subfora (except for below my introductory messages). These decisions were made on both pragmatic and methodological grounds. Pragmatically, while participation allows a researcher to gain a greater sense of what it means to be a community member and develop familiarity with the community, if done badly it can risk annoying the community (Eynon, Fry, and Schroeder 2008). Learning to participate properly can be time-consuming for a single case study, let alone multiple. Methodologically, in this project I argue that the need for comparisons – to address the criticisms of Stilgoe et. al. (2014) regarding lack of wider view across cases – outweighed a need for detailed ethnographic understanding.

However there were risks of drawing conclusions from sampled threads that might not be representative of the forum as a whole, or were affected by ignorance of longer-term history. The online setting also added an additional concern: while this project was based on investigating online discourse, offline factors may have played a role in informing how people participate online (Miller 2011). I therefore used interviews to gain access to insider accounts.

Once case-studies were selected and moderator approval gained I made a public post inviting users to participate in my research (see section 3.2.1). When users contacted me I replied with a message providing a link to my research profile website, and gave a summary of information regarding use of data. I also asked them which medium they would prefer for interviews (Bampton and Cowton 2002). I suggested the site’s own private messaging facility as a default, but also supplied my email address. Most chose private messaging, a

minority opted for email.²⁵ While I was open to other methods of contact, such as telephone or Skype, I did not suggest these and no participants requested them.

The use of messaging and email led to *asynchronous* communication – each participant replied when convenient, rather than immediately. This approach had multiple advantages for this project. In addition to being more convenient across differing time zones than synchronous communication, asynchronous communication allowed participants time for reflection (James 2006). As my aim with the interviews was to provide a richer understanding of participation I often asked broad questions, for example ‘why is science important to you?’. It is likely that participants benefitted from time to reflect, as suggested by their often lengthy answers (sometimes including hyperlinked material).

Interviews were semi-structured, in order to draw on my developing analyses (Silverman 2001). In the early stages of interviews, I relied more heavily on structured questions as these provided useful start points, and comparisons between answers helped me develop a broad familiarity with the case studies. I developed the structured questions using three approaches. Firstly, drawing on the specifics of my research questions:

1. How would you define science?
2. Why is science important to you?
3. What role does science play in your life?
4. What sort of characteristics come to mind when you think of a ‘scientific person’?

Secondly, to provide complementary data which was not apparent from the scraped threads:

5. How did you end up using the forum?
6. What do you look for in an online community and how well does [forum] satisfy them? (based on Nonnecke, Andrews, and Preece 2006; Nonnecke and Preece 2001).
7. Do you use other online forums? If yes, do you participate differently in different forums & if so, why? (based on Nonnecke, Andrews, and Preece 2006; Nonnecke and Preece 2001).

²⁵ Four r/EverythingScience, three SkepticsSTM, and eight XKCDScience interviewees opted for private messaging; one SkepticsSTM and one XKCDScience interviewee used email.

8. Do you seek out scientific information from the forums in general, or do you look for specific topics? (Based on early data analysis suggesting that different topics produce different discussions).

9. Do you engage with science through other means/media?

Thirdly, to build up my understanding of communal dynamics outside of the scraped windows:

10. Do you see individuals assuming certain roles or reputations within the group? (based on Baym 2000).

11. Do you feel able to usefully contribute information? (Based on Jenkins 1995).

12. Do you form particular relationships e.g. friendships with other users? (Based on Baym 2000).

13. (For long-time members). Have there been any important changes or shifts in the community over time? (Based on Baym 2000, 184-196).

These questions were adapted as appropriate, and in many interviews were not used at all if other topics seemed more fruitful. At later stages in the interviews, particularly with participants who stayed in contact over an extensive period of time, I asked more personalised questions based on my knowledge of the interviewee. I also discussed ideas related to my ongoing analyses, which proved valuable for situations where my interpretations were potentially underdetermined by available data.

Disadvantages with long-term asynchronous communication include the low rate of uptake and high rate of dropout (Bampton and Cowton 2002; Denissen, Neumann, and van Zalk 2010). Therefore initial messages were kept as short as feasible, leaving longer messages only for interviewees who had shown consistent interest. All questions were optional, so as to avoid one sensitive question stopping a whole interview, and I tried to move away from topics if interviewees seemed to be showing disinterest (Seymore 2001).

I shall discuss further details of interviews I carried out for each subforum in chapter 4. However, it should be noted that many of the interviewees were active and/or longstanding contributors. This is a common problem in online interviewing (Andrews, Nonnecke, and Preece 2003). I was therefore careful not to treat my interview data as representative of any case study as a whole. Instead interview data was used to corroborate other data on the

background, membership, and general expectations of the case studies (chapter 4) and to test and build upon emerging findings (chapters 5-8).

3.4 Analysis of Themes and Discourse

In this section I shall outline how I used data to develop findings about meaning-making. I begin by introducing *constructivism*, the methodological tradition underlying this research. I illustrate why constructivism was an appropriate methodology for this research, though it also raised issues which any constructivist researcher should address. With these issues in mind, I move onto discussing the specific methods used in developing and analysing key themes in the discourse. These methods were computer aided text analysis, thematic analysis, and discourse analysis. Throughout these discussions I shall illustrate how I addressed the potential issues with constructivist research, as well as problems raised by the large quantity of data produced by the scrapers.

3.4.1 The Constructivist Approach to Analysis

In asking how meanings of science were constructed, I drew upon the methodological tradition of *constructivism*. Constructivist researchers ask how social phenomena emerge from – or, are ‘constructed by’ – interactions between participants in specific situations (Berger and Luckmann 1966). This approach is a contrast to other traditions such as positivism or realism, which look for phenomena which exist prior to or outside of social interaction (Robson 2011). Constructivism problematises some well-established traditions in scientific research. These include *reliability*, the idea that research findings should remain consistent across different researchers and different research methods; and *validity*, the idea that research findings should converge towards describing the world as it authentically ‘is’ (Thomas, 2011). Instead, constructivist methodologies emphasise features such as: being sensitive to context; acknowledging the partial nature of all knowledge claims; and understanding (rather than challenging) diversity and inconsistency in accounts (Charmaz 2000). When constructivist research aims to produce generalisable findings, it is through developing detailed accounts of particular interactions which may help to deepen understanding of other similar interactions (Thomas, 2011b).

Carrying out credible constructivist research therefore requires addressing some potential criticisms. By downplaying reliability and validity, constructivist researchers can be accused

of producing purely subjective accounts – at worst, writing accounts which simply confirm the researcher's own preconceptions rather than engaging with the empirical phenomena (Thomas, 2011b). A related criticism is that constructivist research is unsystematic (Robson 2011). By employing flexible and adaptive research methods, constructivist researchers run the risk of 1) selecting material that is of subjective interest to the researcher, and never engaging with data that does not suit their emerging narrative and 2) reporting findings in a manner that does not permit a reader to assess the credibility of the research process. Finally, in acknowledging the interpretative flexibility of terms used by actors, constructivist researchers can also run the risk of themselves employing key terms in an inconsistent fashion (Charmaz 2000; Sokal 2008). I summarise these three potential risks as *bias*, *non-systematicity*, and *clarity*. The following subsections address how I minimised these risks.

3.4.2 Computer Aided Text Analysis

A useful method for minimising potential bias, as well as addressing the large quantity of textual data collected by the scraping programmes, was computer aided text analysis (CATA). CATA has been used for analysing extremely large amounts of textual data in both a quantitative and qualitative fashion (Hashimi, Hafez, and Mathkour 2015). Large textual corpora are put through a series of computer programmes which algorithmically derive patterns in the text, and display these patterns in ways which guide further analysis (Baker et al. 2008; Younis 2015).

For this project, the aim of CATA was to draw out themes in word choice throughout scraped text from all the subfora. This pointed to the use of an *unsupervised topic modelling* programme (Törnberg and Törnberg 2016). 'Topic modelling' means that the programme examines the corpus for words which frequently appear close together. 'Unsupervised' means that the programme does not require the researcher to specify key terms in advance.²⁶ This combination is extremely valuable for exploratory qualitative research, as it can produce a textual output (rather than purely quantitative data), and also minimises effects of researcher preconceptions (Bara, Weale, and Biquelet 2007). This was particularly valuable in this project, as I aimed to derive topics which were of interest to participants and minimise the effects of framing by the researcher (as discussed in the literature review, sec. 2.2.3).

²⁶ Some programmes require the analyst to pre-specify key terms, and the patterns are derived by considering the relationship of these key words to the rest of the text.

An alternative approach to topic modelling, which could have been used in this project, was sentiment analysis. This uses computerised techniques to classify emotions and/or opinions within text (Serrano-Guerrero et al. 2015). However, features of existing sentiment analysis tools conflicted with other requirements of this project. Some tools classify 'sentiment polarity', i.e. whether a text expresses an overly positive or negative sentiment (Cambria 2016). This would have been inappropriate as this project aimed to provide a contextually sensitive description of roles played by emotion in discourse, rather than a classification of positive and negative emotions. Other sentiment analysis tools are closer to topic modelling, in that they locate recurring expressions of emotion and/or opinions (Serrano-Guerrero et al. 2015). However some rely on explicit expressions of emotion, drawing on a pre-designed lexicon (Cambria 2016; Younis 2015). More sophisticated methods draw on Natural Language Processing, however these usually require labelled training documents (Medhat, Hassan, and Korashy 2014); at the outset of this exploratory project it was not clear what features I would have labelled in a training document. In a more extended project, the results of discourse analysis (3.4.4) could have been used to train a sentiment classifier or develop a lexicon. However given limitations of time and resource, an unsupervised topic modelling was the most suitable approach for providing a broad overview of the whole dataset without relying on too much prior framing of the data.

There are many available unsupervised topic modelling programmes. An increasingly popular tool in digital humanities is the Machine Learning for Language Toolkit, or Mallet (Graham and Milligan 2012). However in initial trials I found that outputs emphasised language which was common across all the subfora. As one of the key uses of CATA in this project was familiarisation with the different subfora (outlined further in section 3.4.3), this was a severe limitation. MALLET also provides data on the proportion of text taken up by different topics, but is less clear on how different topics relate to one another. This conflicted with another key use of CATA for this project, which was to suggest ways in which different forms of discourse might interact (for further investigation by discourse analysis). Another commonly used unsupervised topic modelling programme is Alceste, specifically designed for social scientific investigations which involve deriving meaning across multiple texts (Kronberger and Wagner 2000; Lahlou 2012). However Alceste is paid-for software, and struggles with large quantities of textual data (Schonhardt-Bailey, Yager, and Lahlou 2012). I therefore used an open-source alternative developed from Alceste by Pierre Ratinaud, Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires (IRAMUTEQ).²⁷ Unlike Alceste it is open-source; it also allows for processing of larger

²⁷ Freely available at <http://www.iramuteq.org/>.

corpora than Alceste (Loubère and Ratinaud 2014; Terämä et al. 2016). Most importantly for this project, it presents a range of information around how topics are related to one another and to different subfora. This guided my manual discourse analysis (sec. 3.4.4) of how different forms of language interacted within discussions.

Any use of CATA comes with risks, particularly if outputs are uncritically treated as 'results'. Unsupervised topic modelling has particular risks for a project concerned with meaning-making. The design of topic modelling software proceeds from the assumption that meaning can be derived from the location, co-occurrence, and interchangeability of words (Chartier and Meunier 2011). I did not treat topics derived from the text as 'meaningful' in this manner; this project proceeded on the basis that meaning should be understood with respect to features such as social norms, participants' recognition of one another, and other aspects of community interactions. I instead followed other analysts in using computer-aided text analysis as part of an *iterative* process, and results were ultimately produced by close manual inspection of data (Lahlou 2012). I used Iramuteq only to indicate recurrent patterns of word choice which I may not have been able to derive from reading samples of the data. These guided discourse analysis (sec. 3.4.4), but were not treated as 'results' in their own right.

Full details of Iramuteq's approach to topic modelling are given in Loubère and Ratinaud (2014), but I provide a brief summary of relevant information here and in other appropriate sections of the thesis. Iramuteq forms word 'classes' based on process called Descending Hierarchical Clustering (Kronberger and Wagner 2000). This works as follows:

- The programme creates a list of all words which appear in the original text, and lemmatizes them (so 'loving', 'loved', and 'love' would all appear as 'love'). 'Function words' (such as conjunctions and pronouns) are separated from 'content words' (nouns, verbs, adjectives, and adverbs) and the analysis is carried out separately on each list.
- Each text segment (a certain number of words, chosen by the analyst) is tested for the presence or absence of each word. This is plotted in a matrix, with text segments as rows and words as columns. Each cell contains a 1 or 0 depending on the presence or absence of a word in a text fragment.
- Based on this matrix, the words are split into two classes depending on how frequently they co-occur in text fragments. The programme looks for maximally different classes,

i.e. it aims for an ideal state of putting words which never occur within the same text fragments into separate classes.

- This process is repeated, creating further subdivisions of classes, until the programme can carry out a certain number of iterations (chosen by the analyst) without finding further subdivisions.
- Each word is given a numerical value, calculated by comparing how frequently it would appear in a particular class if the words were distributed at random against how frequently it *actually* appears in that class. This acts as a measure of which words are most strongly associated with particular classes.

The combination of classes, numerical values, and texts allow for a range of graphical outputs. Details of the outputs used in this thesis will be outlined in relevant sections.

Aside from choosing the text for Iramuteq to analyse, there are two inputs the researcher must set for the programme. The first is the length of the text segments, and the second is the number of iterations of text clustering which the programme must carry out before completion.²⁹ By experimenting with these inputs I found that higher values for either (or both) text segment length and number of iterations tended to produce more sub-divisions, as both of these make the programme work harder to find maximally different classes. This means a single word class could be subdivided further if higher values were used for these inputs, which proved useful for finding patterns *within* classes. For example, one of the classes produced by Iramuteq analysis of XKCDScience text contained words related to physics; the same analysis with higher input values split this into two classes, one related to theoretical physics, and another related to engineering.

However this increase in the number of classes can also make the output more complicated to interpret. I therefore used a variety of settings on all text inputs to produce a range of outputs. For reasons of space and clarity I do not present *all* these outputs in this thesis, instead selecting those which illustrated the relevant patterns most clearly. However I only report on a pattern if it appeared consistently across multiple outputs, as this demonstrates the stability of classes (Kronberger and Wagner 2000; Smallman 2015).

²⁹ As a default these are set at 10 and 12 words and 10 iterations – the text segment is input as a pair of lengths, as the programme carries out the analysis with two different length segments and compares them to ensure classes do not vary considerably with different segment lengths.

3.4.3 Thematic Analysis

Thematic analysis is a broad term referring to the identification of themes across collected data. Thematic analysis shares many features with other qualitative methodologies, in particular content analysis, by aiming to locate and explore relationships between recurring features (Vaismoradi, Turunen, and Bondas 2013). Both thematic analysis and content analysis see meaning as emerging from a combination of *what* is said and the *context* within which a text is produced and consumed (Krippendorff 2005). The distinguishing mark of thematic analysis is locating themes which extend across many texts, whereas content analysis uses inductive approaches to categorise recurrent features which occur within a given text (Marks, Yardley, and Joffe 2005; Vaismoradi, Turunen, and Bondas 2013). Thematic analysis was therefore appropriate for my aim of drawing out how emotional and descriptive meaning-making around science appeared across a variety of online contexts.

In this thesis I follow Boyatzis in seeing thematic analysis not as a specific method in itself but as “a process that can be used with most, if not all, qualitative methods...” (1998, 4). Once I had collected data, I identified themes across the data; then, rather than treat the themes as findings, these themes were then used to develop sampling procedures and code-books used for discourse analysis (as discussed further in sec. 3.4.4).

Braun and Clarke (2006) suggest a series of distinct stages for thematic analysis, with movement between these stages a back-and-forth iterative process. The large volume of data (shown earlier in Table 3.5) necessitated a modification of their stages, for multiple reasons. Braun and Clarke suggest the researcher should start by *familiarising* themselves with the entirety of collected data – by which they mean “reading and re-reading the data, noting down initial ideas” (2006, 87). This familiarisation is then used to create *codes*: “the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon” (Boyatzis 1998, 63). Codes are then used to develop themes. It would have been unfeasible for me to read and/or code even a substantial proportion of my entire corpus. However coding only a sample of the data prior to any familiarisation risked creating unforeseen biases.³⁰ Also the exploratory approach of this research, in conjunction with the extremely varied nature of discussions in the case studies, made creating initial codes difficult. Should “information that can be assessed in a

³⁰ For example, an initial sample of only the longest threads suggested that the majority of discussion took an extremely polarised, argumentative form; however reading shorter threads showed that this was a feature inherent to longer threads.

meaningful way” be limited to explicit discussions about science, or encompass all forms of social interaction?

These issues meant I had to find systematic ways of narrowing down the volume of data and range of potential codes, based on familiarisation with the data, *before* beginning in-depth reading. In other words, I established broad features to focus on (such as ‘drawing contrasts between science and non-science’) before I began in-depth coding of threads. The role of the coding was to focus on the detail of ways in which these features appeared within threads.

A summary of the stages is presented in Fig. 3.1. Having established reasons for the ordering, I shall now outline stages 1-3 in more detail. Each theme informed the choice of a sampling procedure (stage 4) and the development of a theme-specific set of codes (stage 5); details of these stages will be outlined in the relevant chapters. Stages 6 and 7 present some overarching methodological issues, which will be discussed in sections 3.4.4 (discourse analysis) and 3.5 (reportage) of this chapter.

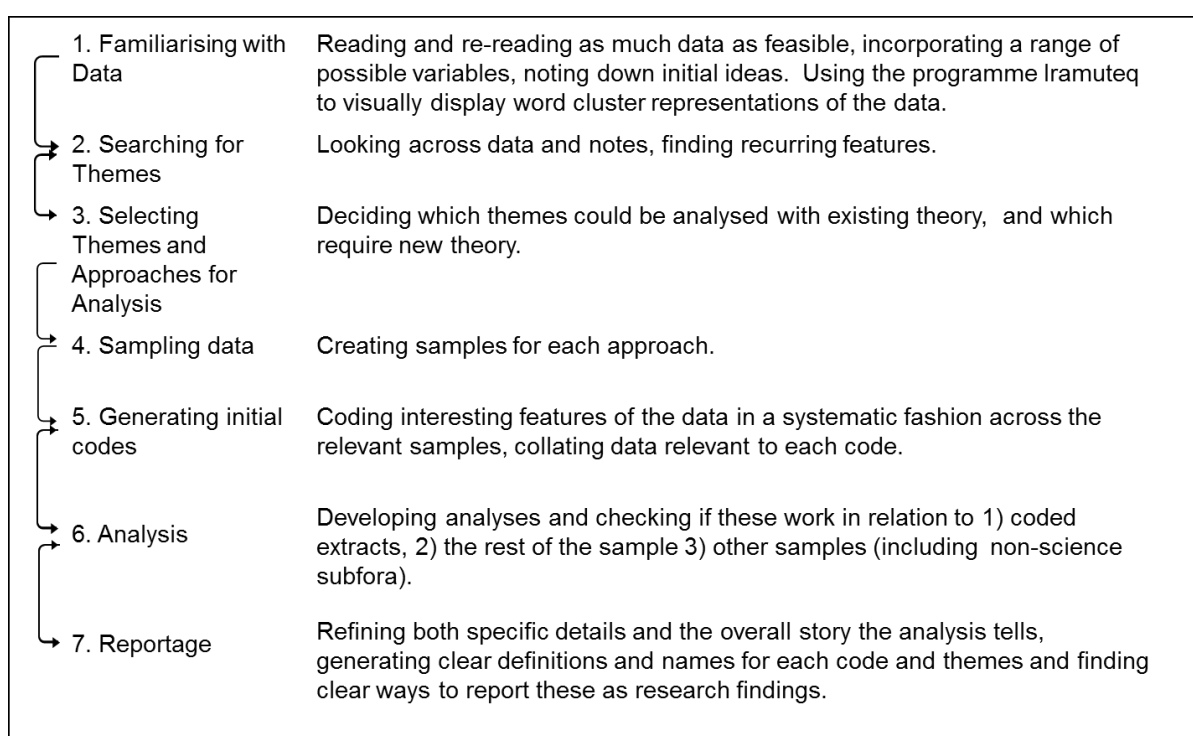


Fig. 3.1: The stages of analysis followed for this thesis. As indicated by the double-headed arrows, there was iterative back-and-forth movement between many stages. Adapted from Braun and Clarke (2006).

Stage 1: Familiarisation

This stage involved two approaches. Firstly I read threads which covered a wide range of variables: these included academic discipline, thread length, number of mentions of the word 'science', and styles of post (e.g. questions, news stories, jokes). At this stage I did not read in detail, but simply made notes on broad features which seemed relevant to either meaning-making around science (such as 'participant claims to be scientific') or to community behaviour ('recognition of other participant'). Secondly, I carried out Iramuteq analyses across all the text, and also on text from each sub-forum in turn, in order to see topics which recurred within discussions. These analyses will be presented in chapter 4 when I introduce the case studies in more detail.

Stage 2: Searching for Themes

As I carried out the above stage I noted any features which occurred repeatedly across notes, Iramuteq analyses, and/or the structured stages of interviews. I began developing labels for themes, i.e. broad headings which subsumed many particular instances (Boyatzis 1998). For example, 'participant claims religion is not science' and 'participant distinguishes popularisation from science' were subsumed under 'contrasts between science and not-science'. At this stage I considered themes that were specific to particular case studies and also those that recurred across multiple case studies.

Stage 3: Selecting Themes and Approaches for Analysis

Stage 2 produced more themes than would be feasible to analyse. In stage 3 I therefore selected themes which a) were prevalent in *all* the subfora and b) related to the issues raised by my research questions and literature review. In some cases this involved collecting original themes together under broader headings; for example, separate themes relating to performing identity and to phatic communication were gathered together under 'emotional relations in community behaviour and norms'. The selected themes, and the approaches taken for studying them, are presented in Table 3.6.

Table 3.6: Summary of themes and associated procedures for analysis.

Theme	Theory or Data Driven?	Type of meaning?	Manifest or Latent?	Sampling Procedure	Discussed in Chapter
Emotional relations in social behaviour and norms.	Theory (Online community formation, Baym 2000; Norms, Bennett 2009).	Emotional.	Latent.	Purposive (post topics which were shared across multiple case studies).	5
Division of 'science' from other practices.	Theory ('Boundary-Work', Gieryn 1999).	Descriptive.	Manifest.	Purposive (posts which discussed the concept of 'science' plus any comment including the string 'scien*').	6
Creation of two types of scientific conversation, technical and meta-technical discussion.	Data.	Descriptive.	Latent.	Stratified (on length) then random.	7
Relations between topics and specific expressions of emotion.	Data.	Emotional.	Manifest.	All other samples combined.	8

I ensured the themes covered both *manifest* and *latent* forms of meaning (Boyatzis 1998). Manifest refers to meanings which can be directly observed in language use. Manifest descriptive meaning-making involves explicitly defining or describing; for example, saying 'science is' or 'being scientific means'. Manifest emotional meaning-making uses explicitly emotional language to show the significance of an object, such as 'I love scientific people' or 'unscientific people make me angry'.

Meanings can also be constructed in a latent form³¹ – through recurrent allusions, implications, or imagery rather than through explicit description (Charmaz 2000). Latent *descriptive* meaning-making involves building up an idea of what something is or does through recurrent implications, comparisons, and references. For example Gilbert and Mulkay (1984) have shown how scientists emphasise ideas such as truth, objectivity, and experimentation in order to create a distinctive identity for 'science'. Latent *emotional* meaning-making refers to the ways in which particular emotional attachments shape interactions around an object. For example, the friendliness often seen in soap opera fandoms suggests an association of these spaces with emotionally secure, supportive interactions. If enough participants desire such interactions (and sanction any unfriendly behaviour) they normalise a distinctive 'ethic of friendliness' amongst the community (Baym 1993).

These labels are heuristics for directing an analyst's attention, rather than mutually exclusive categories. For example aggression could be analysed for any manifestly emotional language shown, and/or for how it relates to particular underlying emotional attachments. Focussing on manifest meaning-making provides useful clarity for the analyst, but explicit descriptive/emotional language can be rare in discussions. Latent meaning-making encompasses a greater variety of phenomena, but has a greater risk of mis-interpretation by the researcher (Boyatzis 1998). In this project I therefore studied both forms of meaning, using each to inform one another (Vaismoradi, Turunen, and Bondas 2013).

Two of the themes in Table 3.6 could be addressed with reference to existing work in STS and/or FS. Specifically, the division of 'science' from other practices has been described by numerous STS scholars using Gieryn's boundary-work (1999), while approaches for analysing emotion in online communities have been developed through the work of Baym (1993, 1995, 1996, 2000) and Bennett (2009, 2011, 2013). To address these themes I used a theory-driven approach, developing coding frames from these existing works. However

³¹ Latent is also referred to as 'tacit' (Charmaz 2000).

other themes presented novel questions for STS and FS scholarship, so could not be clearly addressed by reference to existing literature. For these themes I took a data-driven approach, inductively developing themes through close engagement with the collected data (Boyatzis 1998).

Finally, it is worth commenting on the ordering of the chapters. Despite the different approaches taken, the chapters produced two pairs of related findings. To briefly foreshadow, the analyses for chapters 5 and 6 both demonstrated an important role for mainstream scientific consensus in shaping discourse; the analyses for chapters 7 and 8 both found a separation between language which focussed on objects and language which focussed on people. As I carried out analysis for each chapter independently, and did not consciously draw on findings from other chapters, the appearance of these patterns acts as corroboratory evidence for the findings. The chapter ordering reflects these pairs of related findings.

3.4.4 Discourse Analysis

Coding and analysis of my textual data followed the method of discourse analysis. Broadly conceived, discourse analysis involves “studying discourse as texts and talk in social practices”, examining how social contexts both shape and are shaped by discourse (Potter 1997, 146). Discourse analysis is well suited to studying meaning-making. Constructivism proceeds from the premise that words do not have inherent meaning, but instead acquire meaning through the ways they are used (Charmaz 2000). Discourse analysts study how the relationship between words and their surrounding context makes meaning (van Dijk 1990). Within STS, discourse analysts have noted that descriptive meanings of ‘science’ can be discerned from both the *content* of discourse and in the *context* shaping discourse (Gilbert and Mulkay 1984). Similarly FS scholars have used discourse analysis to show how forms of emotional meaning-making – such as expressions of shared experiences or the creation of social bonds – are shaped by communal expectations of a fandom, but also create and demonstrate those communal expectations (Baym 2000). As discourse analysis has been used to address both descriptive and emotional forms of meaning-making, it was an appropriate method for analysing the interactions between them.

The range of contexts which discourse analysts have considered is extremely broad, leading to a proliferation of approaches (Wetherell, Taylor, and Yates 2001). In this project I followed the approach of seeing discourse as a form of social interaction (Yates 2001).

Specifically, when undertaking close reading I focussed on how participants used particular words, and how this related to the preceding interactions and/or other discussions within the same subforum. Following Bazeley (2009) and Antaki et. al. (2003), I ensured that any links I drew between word choice and context occurred on multiple occasions, and also did not rely on factors which were not conveyed by word choice I had collected (such as internal mental states of participants).

This decision, to focus on word choice in the context of surrounding interactions, was partly made due to the nature of the collected data. Purely textual discourse minimises roles for physical speech cues (Sacks 2001) and makes the impact of national and/or local factors (Fitch 2001) harder to determine. Nonetheless, textual communication is rich in patterns of turn-taking, styles of address, and references drawn from a variety of settings, so still requires the analyst to narrow their focus (Herring 2004b). Other approaches could have been applied to the same data. For instance Foucauldian critical discourse analysis would have drawn attention to social factors occurring beyond interactions, such as unequal distributions of power amongst participants and the historical and/or ideological roles of science (Hall 2001). Alternatively a socio-psychological approach would have asked how individual participants use discourse to create coherent narratives about themselves and events around them (Potter and Wetherell 1987). Factors such as power and narrative were certainly at play within the discourse I analysed for this thesis. However in order to best consider the role of science as a concept related to informal behaviour and communal norms, I focussed attention on the context of the immediate interactions surrounding word choices.

3.4.5 Emotion in Discourse

In this section I lay out how I approached the concept of emotion, and reasons for taking this approach. This is important for multiple reasons. Focussing on emotion as revealed through discourse is a recognised approach in discourse analysis (Edwards 2001) but it does commit me to a certain view of emotion – as a phenomenon expressed through language – which is not shared by all analysts. The distinctions between the discursive approach to emotion taken in this thesis and other approaches to studying emotion are worth expanding on, as this clarifies some of the key aims and limits of this project. Moreover, studying emotional experiences can involve touching on important aspects of people's lives, and demands care and clarity.

Firstly, I am studying *emotion* rather than *affect*. These two concepts are often not clearly distinguished (Hills 2002; Massumi 2002). For clarity, I use emotion to refer to “the *sociolinguistic* fixing of the quality of an experience” (Massumi 2002, 28), while affect refers to the “visceral forces beneath, alongside, or generally other than conscious knowing, vital forces insisting beyond emotion” (Gregg and Seigworth 2010, 1). To somewhat oversimplify, emotion is socially expressed while affect is personal and pre-linguistic. Affective experiences could have been examined using my case studies, to understand the formation of pro-science groups and attraction of participants (Papacharissi 2014). However my aim was to locate features of discourse which could potentially be generalised to other settings, rather than the affective experiences of being in particular settings.

A second distinction is between my approach and *psychoanalytic* approaches to emotion. Many FS scholars have employed psychoanalysis to relate fan behaviours to unconscious states. There is not room here to fully address the uses of and debates around psychoanalysis in FS (Evans and Stasi 2014; Hills 2005). However in not engaging with psychoanalytic methods I need to address potential criticisms, and in doing so clarify some features of my own approach. Hills (2002) has contrasted psychoanalysis with constructivist approaches to emotion, arguing that constructivism focusses on ways in which emotions are shaped to fit into existing cultural categories (for example, in Grossberg 1992). Hills argues these constructivist approaches downplay subjectivity, in that an individual’s feelings may not be adequately described by communal or academic labels (2002, 2005). A similar criticism has been made by Evans and Stasi about solely text-based approaches, which they suggest can risk “assuming and enacting the fan response, and so silenc[ing] the actual living fan” (Evans and Stasi 2014, 12). While acknowledging these criticisms, I suggest they are directed at a different form of project. Hills employs psychoanalysis as part of a larger argument against the imposition of academic narratives onto individuals’ stories (Hills 2005). This fits into a longer debate within Fan Studies about the risks of academics attempting to ‘explain’ fan lives; a practice fans have argued they can undertake themselves (Green, Jenkins, and Jenkins 1998).

As noted above, my aim was to study features of discourse rather than explain the behaviour of people. A psychoanalytic approach risks emphasising what is *distinctive* about my participants rather than what is potentially *generalisable* about their discourse. Moreover, my aim was to extend the academic language of STS, rather than escape academic language. I make no claims that academic language more accurately represents the lived experience of engagement with science. Rather, I proceed from the premise that academic language provides generalisability across various settings. However, this project was

informed by engagement with affect and psychoanalysis in two ways. The first was in maintaining a reflexive acknowledgment of my own personal engagement with the research object – this shall be addressed in section 3.5.2. The second was in maintaining extreme caution around why-questions. Hills notes that attempts at psychoanalysis which do not engage fully with its methodologies risk making claims about participants' inner states which are simply reflections of the analyst's interests (2002, 2005). More pragmatically, my collection of 'natural' data (and limited number of interviewees) only gave me a partial window into individuals' motivations. I therefore avoided diagnosing individual motivations, or extrapolating into how participants felt during participation. While I suggest likely emotional benefits (for the subfora communities) of normalising certain behaviour – drawing on interviews and previous research into community behaviours, as discussed in chapters 4 and 5 – I do not claim to represent the complex motivations of any particular individual or action.

For a final clarification, it is useful to draw a comparison with Gieryn's studies of John Tyndall (Gieryn 1999). Gieryn analyses Tyndall's writings from a constructivist perspective, fitting his contrasts into culturally recognised categories such as 'empiricist' and 'metaphysical'. The motives Gieryn ascribes to Tyndall, to elevate the cultural and practical authority of science, are read directly off his writings rather than related to the distinctive life story of Tyndall (Gieryn 1999). We develop little new understanding of Tyndall as a person, nor a detailed account of his psychological motivations. However, Gieryn makes no such claims to be understanding Tyndall. Instead we are presented with the generalisable idea of 'boundary-work' which can be used across other settings. I based my approach to emotion on this work. In other words, I aimed to a) give STS a more explicit language with which to talk about emotional impacts that are already implicit in much STS research (such as fear of unwanted life impacts, or desire for professional authority) and b) to extend STS engagement with emotions beyond those specifically relevant to high-stakes and/or organised settings (see literature review, sec. 2.1).

Summary of Section 3.4

The combination of discourse analysis with thematic analysis was useful in addressing criticisms of bias and unsystematicity. Each chapter had a clear sampling procedure, chosen to maximise relevance of the sampled material without relying entirely on subjective criteria. I drew on Iramuteq and initial familiarisation with a range of threads to avoid extrapolating from selective data. Using both manifest and latent themes ensured that I

went beyond reportage and into analysis, while also allowing corroboration to ensure my analysis was empirically grounded. The selection of theory/data-driven approaches ensured discourse analysis had clear aims, and was informed by both existing research and available data. In the final section I address the final potential issue, that of clarity.

3.5 Reporting Findings

In section 3.4 I argued that the combination of discourse analysis and thematic analysis addressed issues of bias and unsystematicity. However qualitative research, including discourse analysis, also runs the risk of lack of clarity in reportage (Antaki et al. 2003). For this project, a particular problem was balancing interpretative flexibility against clarity of key terms. Specifically, how was I to maintain some consistency in reporting on ‘meanings of science’ while acknowledging the interpretive flexibility inherent in the concept?

The use of discourse analysis risks worsening this problem, as it becomes easy to slip between ideas of a) meanings being shaped by surrounding discourse and of b) discourse being shaped by surrounding meanings. While this collapse between content and context may be an inescapable feature of social life (Latour 1996), it can cause issues in reporting findings in a clear fashion. In this section I discuss how I used Wittgenstein’s concept of ‘hinges’ to ensure a balance of consistency and flexibility, and also reflexively acknowledged my own commitments as a researcher.

3.5.1 ‘Hinges’ in Chapter Structuring

To simplify Wittgenstein’s original formulation somewhat, a ‘hinge’ concept is one that has interpretative flexibility but is held fixed by a researcher in order to clarify thinking (Wittgenstein 1969).³² The label of ‘hinge’ is drawn from comparison with a door. Hinges could be fixed in different places on a door, and maybe taken out and re-fixed in a different location, but they must be fixed somewhere for the door to function. Similarly, addressing a question requires fixing the meaning of some concepts beforehand. To maintain clarity while also opening up a breadth of analysis, I used different hinges in different chapters. In chapters 6 and 7, which analyse descriptive meaning-making (see Table 3.6), I held closed

³² I am grateful to Meritxell Ramírez-i-Ollé for providing me with a clear introduction to this concept.

questions of how discussion was related to notions of shared emotional meaning. While I noted that certain behaviours were preferred or discouraged, I did not focus on questions around constructing community values, desirable behaviour, or threats to group identity. In chapters 5 and 8 I analysed emotional meaning-making, examining the subfora as places of community and shared emotional experiences. At points where I related these to 'science', I relied on a broad notion of science as a collection of research disciplines and/or professional practices and institutions related to these disciplines. Wynne and Irwin (1996) note that such a view of science is widely shared in Anglophone contexts, though assuming it is universal is problematic; however, for the purposes of these chapters it provided a view which participants would be likely to recognise.

In my final discussion chapter (9) I allowed all questions of emotion, description, and science to be open, using the terminology developed in previous chapters to maintain clarity.

3.5.2 Reflexive Note

In arguing for the context-sensitivity of *any* claims, constructivist researchers must acknowledge that our own claims to knowledge are produced within particular contexts. Reflexivity refers to the process of critically reflecting, as a researcher, upon the contexts of one's own knowledge-producing practices (Charmaz 2000). Psychoanalytically informed scholars argue that reflexivity is particularly important when interpreting emotional attachments to particular objects. This is because one's engagement with the emotional experiences of others is inevitably shaped by one's own affective and emotional states, in a subconscious manner which can be hard to locate (Hills 2005). I shall reserve specific reflexive comments for relevant points in the analysis, in particular when reflecting on the overall findings of this thesis (chapter 9). However, following scholars from within FS (Baym 2000; Bennett 2009) and STS (Dawson 2012; Smallman 2015), I present some brief autobiographical details which may be relevant when considering my analysis.

Demographically, I am a white British male, born in 1991, raised from within the class '1' in the UK's National Statistics Socio-Economic Classification (ONS 2011) or the 'elite' in the more recent Great British Survey (Savage et al. 2013). In terms of *axiology* – the social values which inform research (Heron and Reason 1997) – I take the view that academic research should engage with life beyond the academy, but that specific problem-based research can focus on extreme cases at the expense of everyday life. My own relationship with science is based largely on my undergraduate degree which combined Physical

Sciences with History and Philosophy of Science. I would regard myself as someone who derives emotional pleasure from talking about science, and also has a high degree of trust in mainstream scientific consensus – though, following the STS principle of symmetry (Bloor 1976), in this thesis I do not use my own views on whether claims are ‘scientifically correct’ as a factor in analysis. I also do not see myself as a member of any online and/or fan community. I have generally been a reluctant adopter of social networking technologies, and prior to this project had rarely participated in online discussions with people I was unfamiliar with offline. I therefore viewed all the discussions in this thesis from the stance of a confident engager with science, but an outsider to the online form of the interactions.

Conclusion

This chapter outlined the methodologies and methods I used to address my research question. I drew on qualitative and constructivist methodologies, which focussed my attention on how social interactions are shaped by specific contexts.

I collected natural discussion data from four case studies of online fora. The case studies were chosen to provide a high likelihood of science-related discussions, while still providing variability for comparison. Using multiple case studies, and only reading a sample of threads, meant I did not develop a full ethnographic familiarity with any one case study. However I employed computer-aided text analysis and interviews to familiarise myself with data which went beyond my samples, and locate recurring themes across the threads. I used discourse analysis to examine how these themes were conveyed through word choice, with reference to how this was shaped by surrounding interactions. Analyses were divided up into four chapters, each focussing on a different form of meaning-making – latent emotional, manifest descriptive, latent descriptive, and manifest emotional.

Risks of bias, unsystematicity, and lack of clarity were addressed by clearly outlining the basis for the theme and sample in each empirical chapter; by clarifying the aims and limits of my approach to emotion and meaning-making, in each chapter and in the thesis as a whole; and by a reflexive understanding of my own engagement with the data. Finally, the tension between informed consent and reliable research findings was addressed by engagement with moderators and (where possible) the community prior to analysis, and by caution in data storage and reportage.

“I don’t think you will find much that actually distinguishes the more sciency areas of this site”³³

4: Case Studies

In this chapter I introduce my case study subfora, outlining key contextual factors which feature throughout this thesis. I begin with a brief outline of concepts used during the process of familiarisation with the case studies (sec. 4.1). I then introduce each subforum in a separate section. For each, I discuss five key factors. Firstly, the *background* of each subforum: its history and general relevance to this thesis. Secondly, how I adapted *ethical procedures and data collection* for each subforum. Thirdly, the *affordances* – technical features which enable or constrain certain forms of participation – of each subfora. Fourthly, available information on the *membership* of each subforum. Finally, brief quantitative and Iramuteq analyses of *data on participation*. This is intended to provide a general overview, leaving detailed questions for relevant chapters.

4.1 Key Concepts and Questions

This section has two aims. Firstly, to introduce specific concepts that are used within this chapter. Secondly, to demonstrate broader issues and questions I focussed on during familiarisation with the case studies. Case study research is a holistic approach, which aims to engage with a setting in its full lived complexity (Yin 2014). However, such an approach presents a potentially infinite array of contextual factors to consider. The descriptions I give in sections 4.2 - 4.5 are necessarily partial accounts. This section outlines how the features I focussed on were informed by past scholarship, my methodological approaches, and methods used.

³³ Interviewee Skeptics-C.

4.1.1 Affordances

When examining how people interact with technologies, scholars must engage with technologies' impacts on behaviour without resorting to problematic ideas of technological determinism – i.e. that particular technologies will *necessarily* produce certain forms of behaviour (criticised by, for example, Winner 1986). Recent media scholarship has used the concept of *affordances* to describe “how a medium or a tool affords uses to individuals” in ways which “become part of the users’ perceptions of what actions are available to them” (Nagy and Neff 2015, 2, 5). In other words, users can choose how to use tools, but the presence of certain tools pushes users towards particular forms of behaviour. Studies of online media have shown that website creators can employ digital affordances – for example tools for moderators to sanction other users, or options for users to react to one another’s contributions – in ways which are directed towards particular practical and/or ideological outcomes (Boyd and Ellison 2008; Tkacz 2014). Users may potentially act in line with designers’ expectations, or they may act subversively; however, all these routes are nonetheless shaped by the surrounding medium (Bennett 2011). I shall therefore outline the different affordances available within each of the case study websites.

4.1.2 Membership

The websites used in this thesis did not provide visible demographic data; the exception was Facebook, but for ethical reasons outlined in chapter 3 (sec. 3.2) I have not used data from user’s profiles. However affordances such as profile customisation, quantitative records of posting/commenting behaviour, and interviews allowed me to build up some information about the membership of each case study. In doing so I particularly considered the question ‘why do users, in general, choose to participate?’. This draws on Nonnecke and Preece’s gratification-based model of online participation, in which the choice of whether to participate depends upon what a user requires to satisfy their needs (2001; 2004). This project aimed to explore how factors related to science interact with more everyday social behaviour and concerns. I therefore considered to what extent members’ needs might have revolved around looking specifically for scientific information; and to what extent they came to the forum with other needs, and joined science-related discussions as part of gratifying these.

4.1.3 Iramuteq

To get a broad picture of participation I analysed text from each subforum using the unsupervised topic modelling programme Iramuteq. An explanation of how Iramuteq works is given in chapter 3 (sec. 3.4.3). Here I summarise the key details of how to read graphical outputs from the analyses, to prepare the reader for subsequent content throughout this chapter. In this chapter I use outputs produced by Iramuteq using Correspondence Factor Analysis, a statistical technique which a) converts relationships between variables (in this case, words) into positions on a multi-dimensional plot and b) projects this multi-dimensional plot onto a two-dimensional display (Teil 1975). Fig. 4.1 shows an example, used for illustrative purposes only, of an output created from analysing text from all the case studies.

The key points of the outputs are:

Word Cluster

Iramuteq sorts words into ‘classes’, i.e. lists of words which frequently co-occur with other words from the same class, but do not frequently co-occur with words in other classes. Clusters are graphical representations of classes. These are shown on the figures by a sample of words from the same class all being given the same colour. The size of a word illustrates how ‘characteristic’ a word is of a class – large words occur very frequently alongside other words in the class, and rarely alongside words from other classes. For example, from Fig. 4.1 we can tell that ‘write’ and ‘error’³⁴ frequently occurred close together in the original text, but rarely appeared close to ‘vaccine’.

To aid visibility I have added callouts showing the ten ‘most characteristic words’ for each cluster, and any subfora labels associated with the cluster. The headings for each callout were chosen by me, after consideration of the words within the cluster; the justification for each choice of heading will be outlined in my discussion of each output.

³⁴ This combination was due to a feature of the scraper which replaced any non-Latin script with ‘write error’. They appeared in this cluster alongside names as many IFLScience participants wrote comments which included the name of a friend and an ‘emoji’; this will be discussed further in sec. 4.2.5.

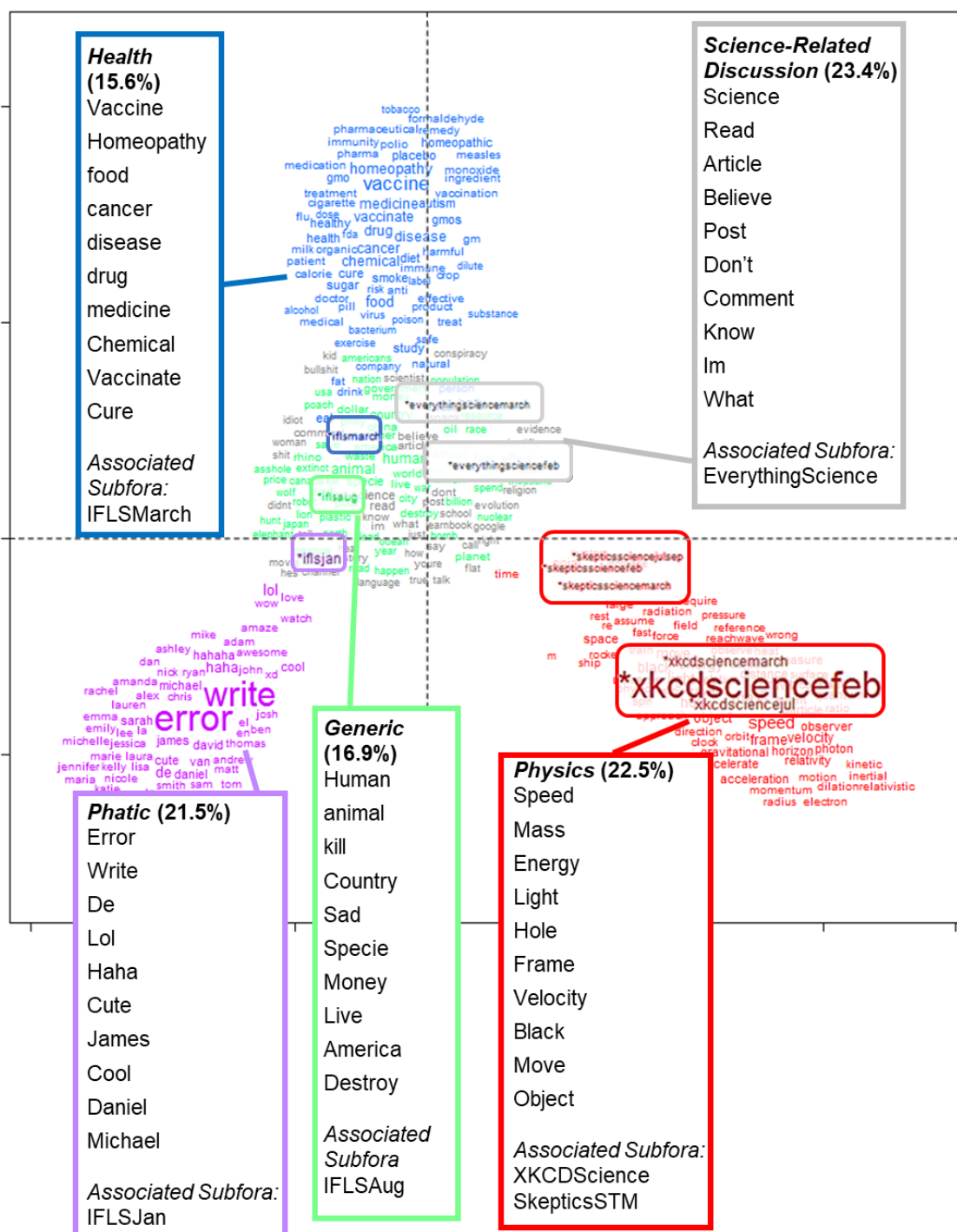


Fig 4.1: Example of an output from an Iramuteq analysis, displaying topic clusters derived from scraped post and comment text from all subfora.

Colours indicate separate topic clusters, with call-outs displaying: a heading selected by me to summarise the words in the cluster; the percentage of the analysed text classified as belonging to each cluster; the top ten 'most characteristic' words for each cluster; and the subfora associated with each cluster. Relative positions of clusters illustrate how frequently words from the clusters occur together in original text. So, for example, words in the red 'Physics' cluster were more likely to appear alongside one another than with words from other clusters, and much more likely to appear in the text scraped from XKCDScience during February than in other scraped text. Words in the green 'Generic' cluster were likely to appear close to words from the grey 'Science-Related Discussion' cluster, and were slightly more likely to occur in the scraped text from IFLScience in August but also fairly likely to appear in other subfora text. For full explanation see pp.90-93.

Clusters which are positioned close together contain words which occurred together relatively frequently, though not frequently enough to be put together into the same cluster. The position of words *within* clusters is determined by requirements of representing a multi-dimensional space in a readable two-dimensional format, so precise word positioning should not be read as indicating a relationship between individual words.

Subfora Labels

Iramuteq also calculates how strongly a word class is associated with different 'source document' – as in, how likely a word from a class is to appear in a particular source document but not in other source documents. For this project, each 'source document' was a scraped window from an individual subforum.

Iramuteq can produce an output showing the names of source documents instead of word clusters. In Fig. 4.1 I have overlaid these outputs over the word clusters to make relationships between word clusters and subfora clearer.

The sizing and positioning of the labels follows the same rules as for word clusters. For example the large red 'xkcdsciencefeb' label indicates that words from the red cluster appeared very frequently within the February scrape of XKCDScience, and not very frequently in other subfora. The small blue 'iflsmarch' label indicates that words in the blue cluster appeared frequently in the March scrape of IFLScience, but also appeared in many other subfora.

The positions of these labels show how the different scraped windows relate to one another; so we see that all scraped windows from IFLScience contained roughly similar language to r/EverythingScience but very different language to XKCDScience. The precise positions of labels are not related to the precise positioning of clusters or any words within them. Subfora labels did not appear in all outputs, and absence indicates that clusters could not be easily associated with particular subfora or scraped windows.

Text from each subforum was put through two different forms of analysis, which I refer to using the following labels:

- *Solo Analyses*: Analyses conducted using *only* text from the subforum under investigation, e.g. only text from XKCDScience.
- *Within-Forum*: Analyses conducted using text from both a case study subforum *and* comparison groups from within the same platform, e.g. text from XKCDScience and

non-science XKCD subfora – details of these comparison groups are discussed in relevant sections of this chapter.

For solo analyses I divided up the text by the three approximately month-long ‘scraped windows’ (March 2015, August 2015, February 2016 – see sec. 3.3.1) to see if any clusters were associated with particular time periods, which might indicate an influence of particular time-sensitive events.

The text used for the Iramuteq analyses usually consisted of all scraped text across all the science subfora. The exception was IFLScience; using all scraped text required more computing memory than was available, so I took a systematic sample of every 10th item (post, comment, or reply) in the dataset; items were ordered such that each post was immediately followed by all comments to that post (and similarly all replies immediately followed the comment they were replying to), ordered chronologically. This sampling procedure was chosen so that the sample would, as much as possible, reflect the original length and ordering of each thread (Patton 2002). These are important features to maintain as Iramuteq results are influenced by both the frequency of certain words and how they are positioned relative to other words (Loubère and Ratinaud 2014).

Though Fig. 4.1 is presented for illustrative purposes, there is one substantive point we should take away – there were differences between the subfora, but similarity amongst the scraped windows from each subforum.³⁶ This illustrates that the subfora did have distinct patterns of language use, but that these patterns were not strongly shaped by time-sensitive factors. In the below sections I therefore draw out differences between subfora, but not differences between scraped windows unless specifically relevant.

4.2 IFLScience

4.2.1 Background

I Fucking Love Science (IFLScience) is a page on the major social network site Facebook.³⁷ It was founded in March 2012 by a then-undergraduate student of biology, Elise Andrew. Although it “was never supposed to be more than me posting to a few dozen of my friends” the page achieved 1000 subscriptions (or ‘likes’, in Facebook’s terms) in its first day, a

³⁶ Though IFLS has three different coloured labels, these are extremely small and close together which indicates a substantial degree of overlap of words used.

³⁷ www.facebook.com/IFeekingLoveScience.

million by September, and two million by December (Lunau 2013). At time of writing it had slightly over 25 million likes³⁸ – for comparison, the Facebook pages for *New Scientist* and *Scientific American* both had around 3 million, and Fox News had 12 million.³⁹ Around 2013 the page broadened into a successful professional enterprise with a website, an online store, and (as of 2015) offices in London's fashionable Covent Garden (IFLScience 2015b). The IFLScience website's Media Kit claimed that during 2014 it was the 3rd most engaged-with of all Facebook pages, based on proportion of posts which are commented on or 'shared' by Facebook users (IFLScience 2014).

The page's motto is 'the lighter side of science' and the 'About' description states:

We're here for the science - the funny side of science. Quotes, jokes, memes and anything your admin finds awesome and strange.

If you take yourself seriously, you're on the wrong page.

We're dedicated to bringing the amazing world of science straight to your newsfeed in an amusing and accessible way. (IFLScience 2015a)

In practice, this means the page mixes posts about recent science news, images, and science-related jokes. Originally the page re-posted content from across the internet. As the IFLScience brand became increasingly professionalised, posts increasingly linked to news stories on the IFLScience website; though this still mixed stories on new research, amusing material, 'cool' material, and politically-themed science stories. Commentators have noted that features of Andrew's personal social media profiles – in particular her irreverent and sometimes confrontational tone, and her support of causes such as feminism, environmentalism, and general left-wing politics – have been reflected in the output of IFLScience (Fitts 2014). This has continued despite IFLScience hiring an increasing number of writers and moderators, as I shall illustrate in the qualitative participation section (4.3.5).

IFLScience has attracted numerous criticisms. These include claims that posted material uses sensationalised headlines (Thomas 2015); that the level of scientific information is low or incorrect (Senapathy and D'Entremont 2015); and that some material is used without due credit to the original source (Wild 2013). Posts from the page oppose climate change scepticism from right-wing politicians, and also support feminism and other socially

³⁸ Value retrieved from www.facebook.com/IFeakingLoveScience/, 18 June 2017. This value was maintained, with fluctuations of less than ± 1 million (4%), over the course of data collection.

³⁹ Values retrieved from www.facebook.com/newscientist/, www.facebook.com/ScientificAmerican/, and www.facebook.com/FoxNews/, 18 June 2017.

progressive causes; these have provoked accusations of ideological bias (Maddox 2012). Others have objected to the profanity in the page's name (Hudson 2012), or criticised Andrew for an aggressive communication style (Fitts 2014). However both Andrew and the page have received endorsement from significant figures in the North American science communication landscape, including Neil DeGrasse Tyson and Bill Nye (IFLScience 2016). Supporters claim the informal, internet-savvy and often scatological style of the page attracts a vast online audience, many of whom might otherwise see science as boring and inaccessible (Lunau 2013; Wills 2013).

In this thesis I do not aim to confirm or deny any of these perspectives. IFLScience was a useful inclusion in this study for two main reasons. The first was that the large membership, Facebook affordances, and appeal to audiences with relatively low levels of scientific expertise (all illustrated throughout this section) provided a useful comparison to the other subfora. Moreover, the size and public profile of IFLScience made it worth exploring for developing knowledge of how public engagement with science can occur online.

Secondly, criticisms of IFLScience have raised questions around the roles of personal identity, enthusiasm, and boundaries between 'genuine' and 'not-genuine' science. The name of the page can be read as a visible expression of personal enthusiasm towards science. However another recurring criticism is that the page allows people to gain social capital by demonstrating an apparent interest in material which 'looks scientific' without putting in effort to engage with 'real' science. One online writer has described engagement with the page as "incredibly shallow... a social media badge that allows the person sharing it to associate themselves with intellectual rigor without putting in the effort to understand anything in a meaningful way" (Veix 2014). Another has accused the page of "cultural fraud", arguing that users are "tak[ing] a passing interest just long enough to glom onto these labels [of 'loving science'] and call themselves 'geeks' or 'nerds' ... Until or unless you've paid your dues, you haven't earned the right—or reason—to call yourself a nerd..." (Maddox 2012). This suggested IFLScience as a valuable source for addressing questions around descriptive and emotional meanings of science.

4.2.2 Ethical Procedures and Data Collection

In order to gain moderator permission, for reasons discussed in chapter 3, (sec. 3.2), I sent a series of messages to Elise Andrew's email address, her Twitter account, and the IFLScience 'contact us' page. None received any responses. As IFLScience was a

potentially very valuable addition to this study, for the reasons outlined in the previous section, I decided to proceed with studying the site. In the absence of moderator permission I never used direct quotations from IFLScience nor made any posts or contacted any users, to avoid upsetting users without moderator support.

As outlined in chapter 3 (sec. 3.1.2), I collected data from non-science groups to compare with each of the science subfora. For IFLScience, I found pages which had a comparable size of membership but talked about topics other than science. Facebook did not provide a straightforward option for systematically producing lists of Facebook pages. I therefore manually searched for prominent organisations and figures on Facebook, noting those with between 20 and 30 million likes. I originally aimed for a range of topics, however it transpired that pages with over 20 million likes were largely limited to popular culture. I therefore looked for popular culture pages from across different forms of media, which would potentially appeal to different audiences – though in practice the requirements of large page size and English language meant the selection was dominated by American media outputs. The selected comparison groups were the official Facebook pages for:

- CNN (American broadcaster).
- TV series *Game of Thrones* (TV series).
- Madonna (musician).
- Disneyland (theme park).

Fuller details are given in Appendix 3, sec. 1.

I did not contact moderators of these comparison groups, as they did not provide a means of Facebook contact. However as I only used these pages to provide quantitative data and text for Iramuteq topic modelling, rather than drawing on specific participants' comments, I considered that risk to participants was sufficiently minimal to proceed without moderator permission.

4.2.3 Affordances

There are various ways to see material from a Facebook page. Anyone with a registered Facebook account can 'like' the page (equivalent to subscribing), and posts from the page will appear in their personalised homepage alongside activity from friends. Alternatively users can go to the web address for the page itself, and see the page's posts as displayed in Fig. 4.2.

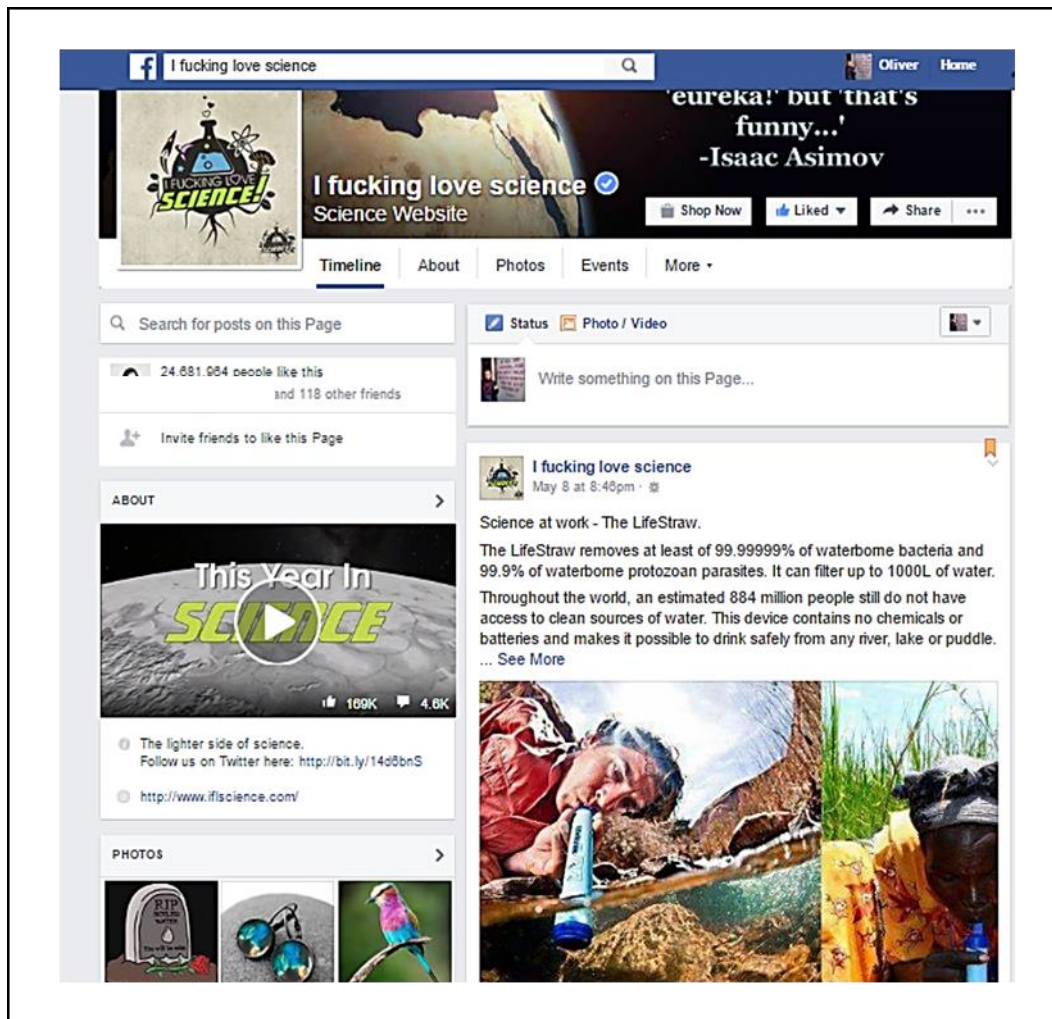


Fig. 4.2: IFLScience Facebook page. The right hand side is taken up by a recent 'post', made by administrators posting under the page's name 'I fucking love science'. Clicking below the post would open up a public comments thread. People who subscribe to the page would also see this post appear in their own personal newsfeed. All posts display the number of likes and comments, as displayed on the bottom of the 'This Year In Science' post under the 'About' heading – this shows the post has 169k likes, and 4.6k comments. Adapted from www.facebook.com/IFeakingLoveScience, 8 May 2016.

Participants have options in how they respond to posts:

- They can 'like' the post, which is usually taken to indicate approval.⁴⁰
- 'Share' the post, which means any of the user's friends might also see the post on their homepages.
- 'Tag' a friend by writing their name in the comments, which will notify them of the existence of the post.

⁴⁰ In February 2016 Facebook broadened likes into a choice of six 'reactions', however this occurred after data collection was complete.

- 'Comment' in the thread below the post.
- 'Reply' in a thread below a specific comment (note that one cannot reply to a reply).

For the purposes of clarity I use *responses* as an umbrella term to refer to both comments and replies. I apply this label across all the case studies.

It should be noted that there are two kinds of posts. Firstly, those made by the page administrators; as in Fig. 4.2, these appear to be posted by 'I Fucking Love Science'. Secondly, those written by participants on the wall of the page. This second variety of post in theory gives users the ability to start discussions, rather than being bound by the topics posted by the page's administrators. However in practice these posts are considerably less visible than those made by the page, appearing in a small box below the 'photos' section shown in the lower left corner in Fig. 4.2. Also, unlike posts by the page's administrators, they do not appear on subscribers' Facebook home page. Numerically, these posts received considerably less engagement: in my dataset, posts made to the wall achieved an average of 0.48 comments and replies, while posts made by the page received thousands (discussed further in sec. 4.3.5). Participation on the site therefore overwhelmingly took the form of responses to posts made by IFLScience administrators.

IFLScience has a team of moderators, with the power to delete responses and/or 'block' participants from the page; however there is no clear set of rules on the IFLScience page, so it is unclear exactly what rules they enforce. Facebook itself has a series of expectations around keeping illegal and hateful content off pages, which moderators of all pages are expected to enforce (Facebook 2015). Due to the high volume of comments this is a challenging task,⁴¹ and there were numerous examples of hostile – and a small number of extremely derogatory – responses in my dataset. The influence of moderation in shaping participation on IFLScience should therefore be seen as minor.

⁴¹ Numerous participants posted complaints about automatic 'bot' accounts that were posting pornographic videos in comments; responses by page administrators suggested that fully moderating comments threads on IFLScience is a challenging task.

4.2.4 Membership

Although Facebook profiles can provide an extremely detailed range of personal data, it should be recalled that for ethical reasons I did not scrape any profile data apart from names (chapter 3, sec 2.2). Quantitative data on participants' activity is provided in Table 4.1.⁴²

Table 4.1: Quantitative breakdown of participants' activity on IFLScience across the three data collection periods.

Dataset	# Distinct Participants	Mean responses / participant
March 2015	358,322	1.81
August 2016	693,719	1.57
December 2016	814,030	1.67

It should also be noted that the mean number of responses per participant was likely to be increased by repeated back-and-forths on a single thread, either in the form of discussions with friends or extended arguments. This suggests that the majority of participants only contributed on one thread, meaning participants were unlikely to build up sustained recognition of one another. Such factors will be considered further in chapter 5.

Though I was not able to scrape demographic data from participants' profiles, IFLScience provides demographic data on visitors to its website (IFLScience 2016). There are three points worth noting. Firstly, website readership in 2015-2016 was dominated by Western audiences: 50% from the USA, 11% from the UK, and 20% from the rest of Europe. Secondly, the audience was relatively young: 67% reported their age as between 18 and 34, though it is possible many users below 18 years reported their age as higher. Thirdly, a substantial proportion of the readership (45%) did not hold a Bachelors' degree.⁴³ Though the website is not precisely equivalent to the Facebook page, these values indicate the sorts of audience the page aims to cater for: a relatively young, largely American group who do

⁴² For reasons related to the scraper tools, it was not possible to reliably compare quantitative data across scraped windows; also the values listed here are likely to be underestimates of true values. This applies to all quantitative data in this chapter. See Appendix 2 for full details.

⁴³ Given the age distribution, it is likely that many of these were not old enough to have completed a degree. Other demographic values were that the audience was split roughly 50:50 in terms of gender, and had an average household income of \$74,100.

not all have college level education.⁴⁴ These are useful contextual details to consider when we look at post topics in the next section.

4.2.5 Data on Participation

Quantitative Summary

Looking at the various reactions across my scraped data produced the following quantitative data.⁴⁵

Table 4.2: Quantitative breakdown of IFLScience posts and responses. Details of how values were calculated are provided in Appendix 2, sec. 1.

Dataset	No. Of Posts	Mean Likes	Mean Shares	Mean Responses	Mean Response Length (words)	% responses with Tags
March2015	159	91,453	25,232	4,074	8.77	28.7%
Aug2015	504	40,324	10,466	2,269	8.11	33.9%
Dec2016	548	35,058	10,813	2,460	8.48	36.7%

From Table 4.2 we can see that IFLScience posts were engaged with by an extremely large number of participants. However, much of this engagement was of an extremely brief nature. The low average word count was skewed by a large number of responses with fewer than three words; this reflects the fact that many responses consisted of a hyperlinked ‘meme’ picture (possibly with a short caption, maybe without), and/or a tagged friend’s name with a short message, and/or an emoticon such as 😊. We also see a substantial proportion of responses with ‘tags’, which usually indicate a participant wished to alert a Facebook friend to the existence of the post. Taken together these suggest that IFLScience participants did not usually engage in sustained discussion, but regularly used IFLScience threads as a place to engage in forms of social behaviour – such as tagging friends or

⁴⁴ It should be noted, however, that a few threads did suggest there were some professional scientists present. For example, *#FieldworkFail Reveals The Hilarious Perils Of Science* (Aug 2015) involved many participants sharing anecdotes of technical fieldwork.

⁴⁵ Note that these values do not accurately capture *all* IFLScience activity over the scraped windows, for reasons outlined more fully in Appendix 2 (sec. 2). In particular, the average number of responses is likely to be an underestimate due to the exclusion of posts with extremely high numbers of comments.

posting amusing pictorial responses – common to Facebook more generally (Wilson, Gosling, and Graham 2012).

Post Topics

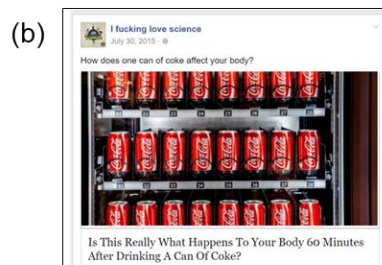
Post topics on the IFLScience page were decided by the administrators. In the past the page welcomed direct engagement from its audience, using Facebook's 'poll' function, responding to comments, and direct questions in posts; however these became less common as the page expanded and professionalised. The visibility of a post on Facebook (and thereby potential advertising revenue for IFLScience) is shaped by the likes, shares, and responses it receives, so the membership *en masse* may have had a role in shaping the sorts of material posted by the page in a broad sense. However, in contrast to the other subfora in this thesis, IFLScience participants had little power to create threads based on specific questions or topics of interest to them.

Fig. 4.3 shows the most responded-to post from each scraped window, in addition to three randomly selected posts; one with a high number of responses, one with a mid-range number, and one with a low number of responses.⁴⁶ This is intended to illustrate a range of posts, while also indicating the material which received most engagement from participants.

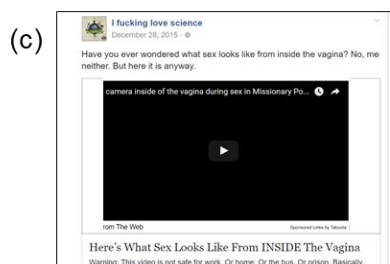
⁴⁶ Where 'high number' is defined as in the top third of all scraped posts by total number of responses, 'low' is the bottom third, and 'mid-range' the third in between. Random sampling was carried out by assigning each post a random number using Excel's RAND function and selecting posts with the lowest number.



Highest #of responses in March2015
Caption: [none]
#Responses: 21818
Words Responded: 168781
Likes: 96007



Highest #of responses in Aug2015
Caption: "How does one can of coke affect your body?"
Responses: 13071
Words Responded: 81464
Likes: 71606



Highest #of responses in Feb2016
Caption: "Have you ever wondered what sex looks like from inside the vagina? No, me neither. But here it is anyway."
Responses: 18788
Words Responded: 123,618
Likes: 62701



Large #of responses, from Aug2015
Caption: "Surgeons Successfully Graft Hand Onto Patient's Leg And Keep It Alive For A Month"
Responses: 17287
Words Responded: 84976
Likes: 215568



Mid-Range #of responses, from Feb2016
Caption: "Whoa. Meet The Futuristic, Electric, Self-Driving 'Batmobile'"
Responses: 903
Words Responded: 5910
Likes: 21523



Low #of responses, from Feb2016
Caption: "The most dangerous pathogens in the world, according to the WHO"
Responses: 280
Words Responded: 2837
Likes: 9834

Fig 4.3: Example IFLScience posts, including reasons for inclusion, data collection period, caption, and quantitative data.

Sources:

- www.facebook.com/IFeakingLoveScience/posts/1055635431124134, retrieved 23 March 2015.
- www.facebook.com/IFeakingLoveScience/posts/1171569639530712, retrieved 20 August 2015.
- www.facebook.com/IFeakingLoveScience/posts/1289207677766907, retrieved 25 Feb 2016.
- www.facebook.com/IFeakingLoveScience/posts/1166744540013222, retrieved 23 March 2015.
- www.facebook.com/IFeakingLoveScience/posts/1294131563941185, retrieved 25 Feb 2016.
- www.facebook.com/IFeakingLoveScience/posts/1282655841755424, retrieved 25 Feb 2016.

As shown by these examples, much of the page's output was topical. Many of the stories reported on new scientific, medical, and/or technological developments, as in (d) and (e). Example (a) was also topical; it parodied an ongoing dispute between the Subway sandwich chain and the 'Food Babe' blogger, a health writer who frequently disputed the claims of mainstream nutrition scientists (Hamblin 2015). Such usage of posts to attack perceived 'anti-science' claims and movements, such as climate change skeptics, creationists, and 'anti-vaxxers' (people who avoid vaccinating themselves or their children), was common on IFLScience. Such posts often achieved the highest number of words per comment, suggesting that these polarised positions generated more engaged discussion (Marsh 2016). There were occasional terms which suggested an expectation of scientific knowledge, such as "pathogen" (f). However the relative scarcity of such terms in Fig. 4.3 reflects the dataset as a whole, where terms which suggested knowledge of specific scientific concepts appeared less frequently than in posts for the other subfora. The exception was that terms such as 'anti-vaxxer' and 'homeopathy', which suggest specific knowledge but also related to debates familiar within American mass media, appeared frequently – and, as mentioned, often achieved a high level of engagement.

Another important theme was the use of material which was likely to have a broad popular appeal. As illustrated by references to Coca-Cola (b) and the Batmobile (e), posts often drew on concepts from popular culture which were likely to be widely familiar to a Western audience. The high number of responses on (c) is indicative of the frequent appearance, and popularity, of sex-related material. It should also be noted that, for reasons outlined fully in Appendix 2 sec. 2, the scraper did not capture posts with over 20,000 comments. These were very rare, but when they did occur they a) could achieve considerably over 20,000 comments and b) were often videos of cute animals. Examples include videos of a newborn Leopard cub (March 2015) and baby sloths being bathed and hung out to dry, both of which achieved upwards of 90,000 responses (though a post about 'pi day'⁴⁷ in March 2015 also achieved 28,000). All the above corroborate the impression of both proponents and critics of IFLScience: posts covered a range of topical, humorous, and controversial material, drawing on both popular culture references and scientific terminology. It also introduces an important suggestion that much participation on IFLScience was driven by contentious topics, often related to conflicts between 'science' and 'pseudoscientific' movements such as anti-vaccination groups and climate change sceptics.

⁴⁷ The 14th March 2015 – when written as 3/14/15 this lists the first digits of pi.

Iramuteq

Quantitative data on participation does not indicate *what* participants are saying in their comments. For this we can look to Iramuteq, as explained fully in section 4.1.3. Solo analysis of responses on IFLScience produced four clusters, as displayed in Fig. 4.4.

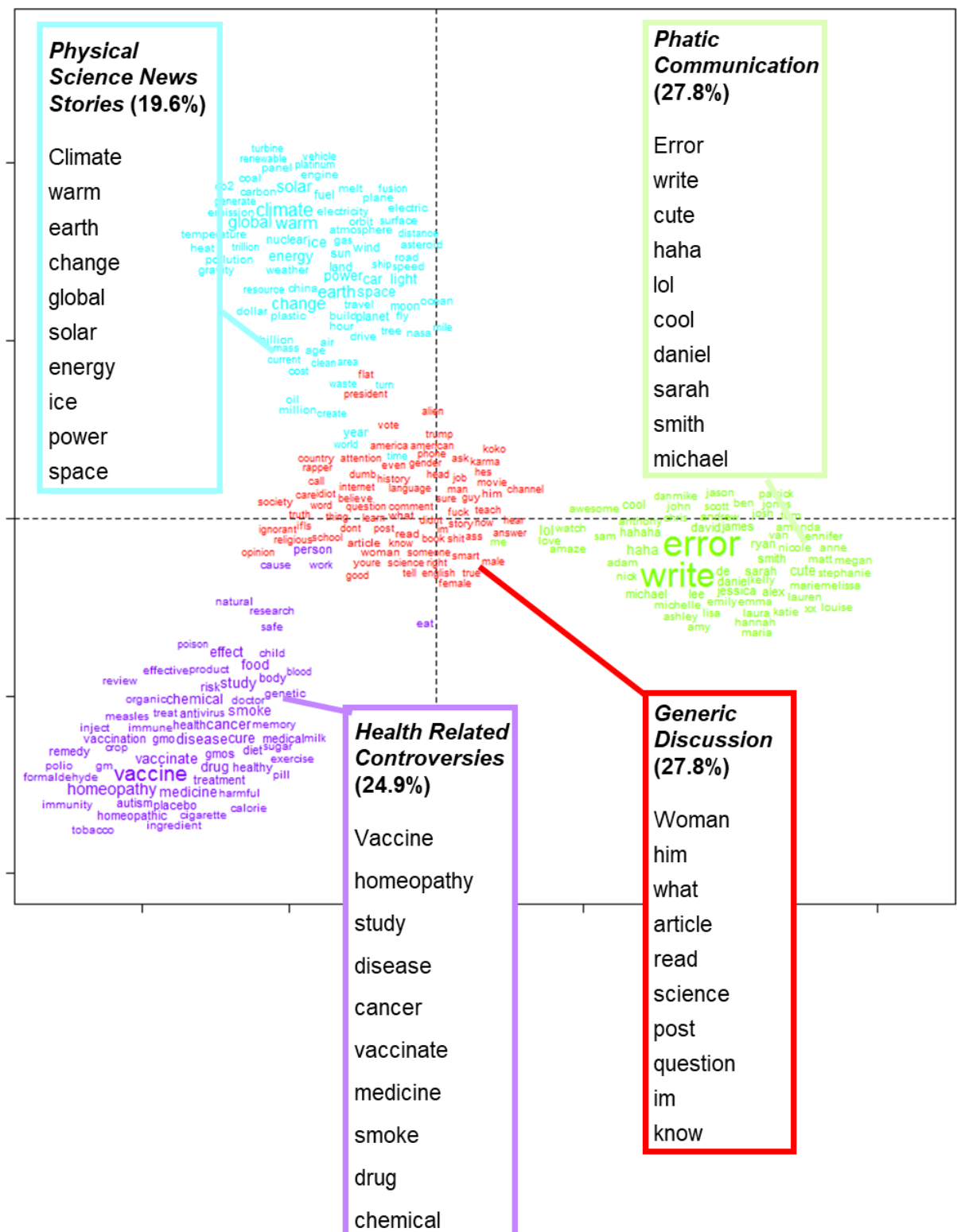


Fig 4.4. IFLScience Solo Iramuteq Analysis.

Output of Iramuteq analysis of a 10% stratified sample of scraped text from IFLScience. Displays the derived topic clusters along with headings (selected by me) and proportion of scraped text which was classified under each topic. Note the separation of clusters related to specific science-related domains (physical science and health) from those related to broader aspects of discussion.

The first cluster shows terms which suggest specific *health-related controversies*, most notably 'vaccine', 'homeopathy', and 'GMO'. The second is a cluster based on *physical science news stories*, with terms related to climate change ('climate', 'global', 'co2') and space travel ('space', 'moon', 'nasa'). All these topics have been noted by scholars of science communication as having high 'news values', features such as wide social familiarity or controversy which drive widespread media reportage (Gregory and Miller 1998). This corroborates the impression given by post topics and quantitative data, that much discussion on IFLScience was driven by news stories and controversial topics.

The third cluster consists mostly of names, with some brief emotional expressions such as 'lol', 'amaze', or 'cute', and 'write error' indicating use of text which cannot be read by the scraper. The names suggest that participants were tagging friends, while the 'write error' is likely to indicate use of emojis – small images such as 😊 or 🤖 – which are integrated within text, usually to represent a person's mood or to make jokes. These all suggest *phatic communication*, forms of communication which strengthen social bonds (Malinowski 1923; Miller 2008). The final cluster contains various *generic discussion* terms. These include: references to online discussion ('post', 'article', 'comment'); other forms of media ('channel', 'media', 'movie'); suggestions of hostility ('ignorant', 'ass', 'idiot'); and terms related to people ('man', 'guy', 'woman', 'someone').

While it is unsurprising that such generic words appeared within IFLScience discussions, it is notable that they formed a separate cluster – implying they were often used separately from words in the physical science and/or health clusters. The generic cluster also contains terms referencing the controversial 2015/16 United States election ('president', 'trump', 'america', and 'vote'), a topic which IFLScience did not post about in any of the scraped windows. Together, these last two clusters together took up over 50% of the data. Taken together these suggest that discussions on IFLScience were not *entirely* shaped by the post topics, but also incorporated a wide variety of other topics and generic everyday discussion.

This latter suggestion was corroborated by within-forum analysis with the comparison Facebook pages (Fig. 4.5).

We see a phatic cluster which overlaps with multiple subfora pages, suggesting that this was a form of interaction common across multiple Facebook pages. Many of the discussion-related terms (e.g. 'write', 'woman') and explicit language which appeared in the 'generic discussion' cluster of the solo analysis in Fig. 4.4, appear throughout different clusters in the within-forum analysis. This again suggests that such language was shared across the Facebook pages. There is a distinctive IFLScience cluster which largely features terms relating to newsworthy science topics such as 'vaccine' or 'climate', and terms such as 'article' and 'study' which suggest references to published research. However the subfora labels are small, indicating that many words from other clusters featured in IFLScience. All this suggests that much discussion on IFLScience related to science topics with high news values, but also to a large extent reflected more general participation on large Facebook pages.

4.2.6 Summary

Post topics of IFLScience were dictated by a small body of administrators; these topics reflected its origins as a site for spreading scientific information in an entertaining fashion. Posts shared scientific news stories, pro-science viewpoints, and/or informal material. More outspoken, humorous, and/or cute material generally received more engagement from participants. Responses across all topics suggested a high rate of short phatic interactions, rather than extended discussion of post material.

Participation on IFLScience can therefore be characterised as that of a general large Facebook page which happened to talk about science. While IFLScience has been widely criticised as a form of science communication, this characterisation raises an alternative use of IFLScience by participants: as a space for social bonding around scientific material.

4.3 r/EverythingScience

4.3.1 Background

r/EverythingScience is a sub-section – or 'subreddit' – of the website reddit.⁴⁸ Reddit describes itself as "a type of online community where users vote on content" (Reddit 2015). All content on reddit is hosted on one of the 9000+ themed subreddits. Subreddits have a

⁴⁸ Reddit: <https://www.reddit.com>; r/EverythingScience: <https://www.reddit.com/r/EverythingScience>.

variety of purposes: simplifying complicated concepts for other users, (r/explainlikeimfive); asking other users for advice or opinions (r/askreddit); or more niche pursuits, such as posting photos of objects fitting satisfyingly well into spaces (r/perfectfit). Unsurprisingly, amongst these 9000+ subreddits can be found some devoted to scientific discussion. The largest of these, r/science, is used for posting peer-reviewed content. The second largest, r/AskScience, provides a space to ask scientific questions for more expert users to answer. Smaller science-themed subreddits range from r/labrats, for sharing stories of laboratory work, to r/shittyaskscience, a parody site in which participants ask 'scientific' questions such as "why hasn't Ryan Gosling become Ryan Goose yet?" (r/shittyaskscience 2017).⁴⁹

r/EverythingScience was created in 2014 as a place for posts which would not pass the strict 'peer reviewed content' rule of r/science but could nonetheless be considered both 'cool' and 'scientific' (r/science meta 2014). The subreddit rules state that posts must have "scientific integrity", by which they mean "posts that that are unrelated to science, promoting pseudoscience or are unscientific in nature will be removed" (r/EverythingScience 2015). As r/EverythingScience is the official 'sister subreddit' of r/science, its existence is advertised on the r/science page and shares many of the same moderators. These moderators have expressed an interest in making subreddits a useful site of science communication, particularly through encouraging professional scientists to share their research in regular 'Ask Me Anything' threads (Owens 2014). However it should be noted that – unlike on Facebook – the vast majority of posts on r/EverythingScience were made by participants and not in an 'official' capacity by moderators. r/EverythingScience therefore provided this project with a second large participatory website, but one which took a different approach to discussing 'science' than IFLScience.

In March 2015 r/EverythingScience had ~43,000 subscribers. At the close of data collection in February 2016 it had ~57,000.

4.3.2 Data Collection and Ethical Procedures

The selection of r/EverythingScience was a more complicated process than the other case studies. When exploring potential case studies I scraped data from a range of science-related subreddits. Of these I originally selected r/AskScienceDiscussion, a subreddit where participants post questions about science-related topics, on the grounds that such questions were likely to prompt participatory discussions. However though I originally received

⁴⁹ For other examples, see <https://www.reddit.com/r/shittyaskscience/top/>.

permission from one of the r/AskScienceDiscussion moderating team, this was withdrawn by another moderator six months later. I therefore selected r/EverythingScience as a similarly sized alternative which, like r/AskScienceDiscussion, was not limited to discussing peer-reviewed publications. However this did mean data from r/EverythingScience only came from two scraped windows; the March scrape I carried out while trialling case studies, and the February scrape after I had received permission to use r/EverythingScience. Reddit places limits on how far back in time scraping tools can access posts from, so I was unable to replace the missing August scrape.

To find comparison subreddits I used reddit's random subreddit search tool; for comparability with r/EverythingScience, which at the point of searching had ~55,000 subscribers, I selected subreddits which had between 40,000 and 70,000 subscribers. I originally selected nine subreddits covering a range of topics. Of these, four did not provide moderator permission for study. As random selection and waiting for moderator approval was a time-consuming process, and as the remaining subreddits already encompassed a variety of topics and styles of discussion, I decided against replacing these. The five comparison subreddits were:

- r/thingsforants: For posting picture of objects which resemble miniature versions of much larger objects.⁵⁰
- r/vxjunkies: For discussing a 'VX', a type of (fictional) technology, using extremely complicated specialised terminology.
- r/futureporn: For posting "high quality images that depict a believable view of the future" created by participants.
- r/asksciencefiction: For asking questions about fictional universes. Despite the name, fictional universes are not limited to the science fiction genre.
- r/unexpectedcena: For posting videos featuring (or edited to feature) unexpected appearances of wrestler John Cena.

Further details are given in Appendix 3, sec. 2. It should be noted that some of these could be classed as broadly science-related; however I retained these as they provided useful comparisons between different forms of reddit participation. For instance r/futureporn was based around discussions of images, which was not the case on r/EverythingScience. I also added r/science to the comparison groups; despite being much larger than

⁵⁰ The title refers to a joke in the film *Zoolander*, in which a character mistakes a model school for a real school and queries whether it is "a school for ants".

r/EverythingScience, this allowed me to examine how different expectations around levels of expertise might be reflected in Iramuteq analyses.

As part of discussions with r/AskScienceDiscussion and r/EverythingScience moderators, I was asked to contact moderators of the overall reddit platform to receive permission from them. This was granted on grounds that I contacted any participants who I was intending to directly quote. As discussed in chapter 3 (sec. 3.2.1) I also made a publicly visible post on r/EverythingScience. This aimed to make participants aware of my research and ask if any would be willing to communicate with me via email or reddit's private messaging facility. This post received no responses. However when I contacted participants asking them for permission to use quotations, a small number volunteered extra information. Though this occurred too late in the thesis to develop extended semi-structured interviews (sec. 3.3.2), it did provide me with some useful participant perspectives. I also received background information from moderators when I initially contacted them for permission, and from one XKCDScience interviewee (XKCD-E) who was also an r/science and r/EverythingScience moderator. Numbers of participants approached, quoted, and interviewed are provided in Table 4.3.

Table 4.3: Permissions to quote requested and given on r/EverythingScience.

Total Granted	Granted below introductory post	Granted on contacting	Contacted but didn't reply	Contacted and refused	Opted out below introductory post	Interviewees
37	0	37	9	1	0	4

4.3.3 Affordances

Similarly to Facebook pages, reddit users (known as redditors) can see posts on particular subreddits by a) subscribing to the subreddit, and thereby see posts from the subreddit in their home page or b) going directly to the subreddit page. Unlike Facebook pages, all posts are made by users – the idea of a post being ‘made by the subreddit’ is nonsensical.⁵¹ This

⁵¹ Unlike IFLScience moderators, r/EverythingScience moderators must post using their personal reddit accounts.

means the topics of discussion on r/EverythingScience are dictated to a greater extent by the user base.

Clicking on a 'comments' link below a post opens up a display of the form illustrated in Fig. 4.6.

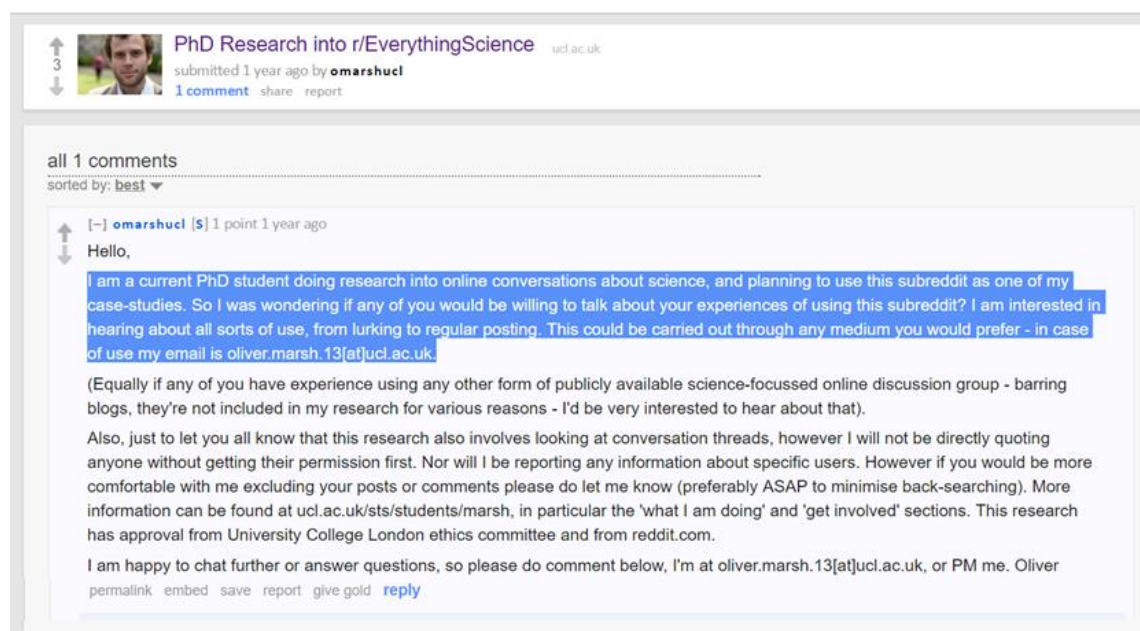


Fig. 4.6: Sample r/EverythingScience post and comment, made by the author. Note the point score of 3 on the post (to the left of the photo), and score of 1 on the comment (to the right of my username). The photograph was copied automatically by reddit from the web page linked to by the post; it is not a personal profile picture, as this is not possible in the reddit infrastructure. Retrieved from www.reddit.com/r/EverythingScience/comments/40tcx1/phd_research_into_reverthingscience/ 26 August 2016.

This shows a post, with a single comment underneath. Users can reply to specific comments, as on Facebook; however on reddit users can also reply to replies (and to replies to replies, and so on), leading to multiple miniature threads occurring underneath comments. In Fig. 4.6 I have also highlighted a portion of the comment, which means if I was to write a reply the highlighted text would appear as a 'quotation'. This allows for close engagement and point-by-point responses.

Users can also 'upvote' or 'downvote' posts and responses. This shows approval or disapproval (much like Facebook likes). This is displayed visibly as a net points score; so for example in Fig. 4.6, the post achieved a total of 3 points and the comment achieved 1 point. Higher scoring posts/responses appear further up a thread, which increases likelihood of being read. This gives the membership additional power to shape discussions through aggregated upvoting and downvoting.

r/EverythingScience has rules listed visibly on the front page. These are reproduced in Fig. 4.7.

Rules	
Submissions <ol style="list-style-type: none"> 1. All posts must be scientific in nature and maintain some level of scientific integrity. Posts that are unrelated to science, promoting pseudoscience or are unscientific in nature will be removed. 2. Posts may be any link format including videos, blogs, audio lectures, editorials etc. as long as the post is grounded in scientific literature or scientific discovery. If the source of the link is unreliable, the submission is subject to removal. 3. Headlines should not be editorialised, sensationalised or biased. While the posting restrictions are less severe than /r/science, this is still a subreddit about science and posts promoting an agenda will be removed. 4. Submissions about the politics of science are permitted as long as they <i>primarily</i> relate to science. 5. Educational videos are encouraged as long as they are from a reputable source. 	Comments <ol style="list-style-type: none"> 1. Comments must be on topic and not a meme or joke. Comments must strive to add to the understanding of a topic or be an attempt to learn more. 2. Abusive, offensive or spam comments will be removal and repeated or malicious offenders may be banned. 3. While anecdotal evidence will not necessarily be removed, comments that are unscientific or promote pseudoscience without proper evidence will be removed. References to peer-reviewed papers in your comments will always be better received so always try to reference your comments. 4. Arguments that run counter to well established scientific theories (e.g., evolution, gravity, global warming) require a higher standard of evidence. Comments that are overtly fringe and/or unsubstantiated will be removed, since these claims cannot be verified in published papers.

Fig. 4.7: r/EverythingScience rules. Adapted from r/EverythingScience front page, www.reddit.com/r/EverythingScience, 10 March 2015.

Though the rules were explicitly “less severe than r/science”, they still restrict participants to material which has some “scientific integrity”. This means removing material which is deemed to be “pseudoscience”, “promoting an agenda”, or “unsubstantiated”. There are also broader expectations that participants will stay on-topic and not be offensive to others. Moderators have the power to delete posts and comments which violate rules. Participants can also click a ‘report’ button on comments, bringing them to the attention of moderators. Responses marked “[deleted]” were fairly frequent across threads – a total of 174 in the March2015 dataset (5.9% of responses), and 24 in the Feb2016 dataset (1.5%). The combination of visible rules, user reporting, and a team of moderators made r/EverythingScience the most heavily moderated of all the case studies in this thesis.

4.3.4 Membership

On reddit, user profiles consist solely of a pseudonymous username and, optionally, 'flair'. Flair is a subreddit-specific label which appears below a participant's name when they post or respond on that subreddit. For r/EverythingScience these flair labels indicate level of qualification and any specialism, for example:

PhD | Environmental Science |

The proportion of flaired users in my dataset was less than 1%; as of December 2015 there were approximately 900 flaired users on the subreddit in total, out of over 40,000 subscribers overall.⁵³ This relatively small proportion may be due to scientifically qualified users not taking the steps required to get a flair label, which requires sending visual proof of qualifications (including real name) to moderators. Two of my r/EverythingScience interviewees suggested that participants may have been nervous of sending such details to strangers. The XKCD interviewee who also used reddit made the distinction between r/EverythingScience as a place for “getting people excited about and chatting about science” and “to talk to laypeople about science”, and r/science as a place where people “make use of input from people with a pretty high amount of knowledge”. Taken together these suggest that there were participants with professional level expertise, but they were in the minority. This to be expected given that the purpose of r/EverythingScience is to act as a less technical version of r/science, which could attract both non-expert participants and more expert participants with an interest in science communication.

Table 4.4 gives a quantitative breakdown of participation within the scraped data.

Table 4.4: Quantitative breakdown of participants' activity on r/EverythingScience.

Dataset	Total # Participants	Mean # Appearances / Participant	Mean # Threads Participated in	Mean # Posts / Participant	Mean # Responses / Participant	# who only posted	# who only responded
March2015	2164	1.98	1.63	0.70	1.27	502	1510
Feb2016	1487	1.92	1.63	0.85	1.07	446	954

⁵³ This information was provided to me by a moderator.

As with IFLScience, there were few regular posters or responders.⁵⁴ However participants had generally written a post or comment on a wide variety of other subreddits – on average, roughly twenty – and looking at the list of subreddits showed a huge variety of topics without any obvious bias towards science. For example r/physics appeared 201 times (out of a total 149,799 items), roughly equivalent to the 204 appearances of r/sports. This suggests that participants on r/EverythingScience were generally using the page as part of broader reddit participation, rather than specifically as a source of science-related discussions.

As mentioned in section 4.3.2, four participants provided me with additional information when I asked permission to use quotations. Two redditors, u/Gonzo_Rick and Martin Kuttner, held Bachelors' degrees (in Neuroscience and Applied Sciences, respectively).⁵⁵ u/Gonzo_Rick described themselves as an infrequent participant in r/EverythingScience, along with other science-related subreddits. Martin Kuttner used r/EverythingScience, alongside other subreddits, as a place to learn by discussing material (related to science or otherwise). A third interviewee focussed on their use of r/EverythingScience as part of a broader range of online discussion about climate change, while a fourth described themselves as mostly learning by reading. These participants indicated the range of possible uses of r/EverythingScience, related to other forms of reddit participation.

4.3.5 Data on Participation

Quantitative Summary

Table 4.5 shows a breakdown of responses by post and word length.

⁵⁴ This may, however, be due to the smaller scraped windows. This was related to technical features of reddit – see Appendix 2, sec. 2.

⁵⁵ Named participants requested to be named; in future all names are altered, except u/Gonzo_Rick who requested to be connected to their interview material.

Table 4.5: Quantitative breakdown of r/EverythingScience posts and responses. Details of how values were calculated are provided in Appendix 2, sec. 1.

Dataset	No. Of Posts	Mean Net Votes / Post	Number of Responses	Mean # Responses / Post	Mean words responded / post	Total Words Responded	Mean Response Length (words)
March2015	290	51.8	1,729	6.0	258	74,887	43.3
Feb2016	345	60.9	1,645	4.8	172	59,426	36.1

This demonstrates a very different pattern of participation to IFLScience. Posts in general achieved a small number of responses. Only 12 posts across the two datasets achieved over 1,000 words of response. However individual responses were on average longer than on IFLScience, suggesting there were fewer short phatic interactions. The mean vote count on posts was also approximately ten times higher than the number of responses, suggesting more users read than responded. Overall these results suggest that r/EverythingScience posts achieved more engaged responses than IFLScience, but little extended back-and-forth discussion.

Post Topics

Table 4.6 lists the posts with highest number of replies for each of the two scraped windows, as well as three randomly selected posts with a high number, mid-range number, and low number of responses (as in sec. 4.2.5). As posts did not rely on visual attachments in the same manner as IFLScience, I present these as scraped data rather than as images.

Table 4.6: Example r/EverythingScience posts, with associated data on responses.

Post Text	Reason for Inclusion	Responses (# / words)	Net votes
Neurologist Analyzes Why Cruz's Strange Smile 'Disturbs' and 'Unsettles'.	Most responses, March2015	123 / 3975	+475
The "Food Babe" Blogger Is Full of S***	Most Responses, Feb2016	121 / 5853	+766
Does LSD permanently change the Brain?	High # of responses, Feb2016	5 / 115	+13
Scott Kelly is launching today. I interviewed him in a Soyuz capsule a month ago. Here's that interview.	Mid-range # of responses, March2015	2 / 37	+44
Stephen Hawking's Lectures on Black Holes Now Fully Animated with Chalkboard Illustrations	Small # of responses, Feb2016	2 / 9	+33

As with IFLScience, post topics included references to current events, attacks on perceived 'unscientific' people, and more miscellaneous topics. The post *Does LSD permanently change the Brain* exemplifies another common type of post on r/EverythingScience, where participants posted questions for other participants to address. This is a common use of reddit more broadly; many of the most popular subreddits are intended purely for this purpose (see sec. 4.3.1). Many r/EverythingScience posts suggested an expectation of more specialised knowledge than on IFLScience, such as awareness of 'Scott Kelly' and 'Soyuz capsules'. However other posts did not rely on such knowledge, though demonstrated awareness of other cultural references such as the 'Food Babe blogger'. As indicated by the reference to Republican senator Ted Cruz, posts related to political and/or social issues often achieved a high level of engagement. The same was true of posts related to perceived pseudosciences, as shown by the popularity of the post criticising the Food Babe.⁵⁷ This suggests a similar interest in contentious matters as IFLScience. In the words of interviewee r/ES-A, "conflict generates interest".

⁵⁷ It should be noted that the 'Food Babe' was not mentioned as frequently as her two appearances in this chapter might suggest; the post in Table 4.6 was the only post which explicitly mentioned her. However more general distrust of anti-mainstream nutrition advice was common.

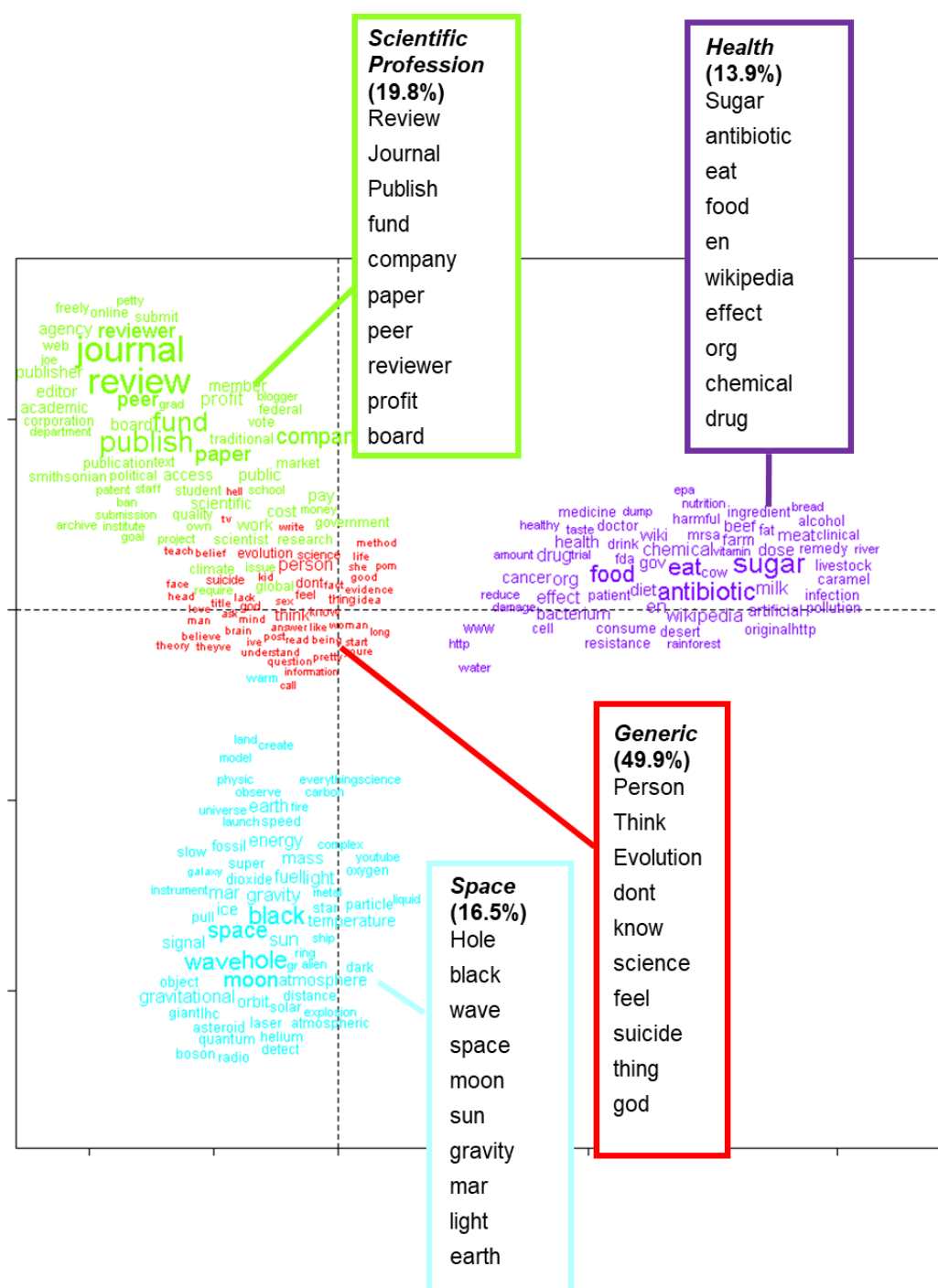


Fig. 4.8. r/EverythingScience Solo Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from r/EverythingScience. Displays the derived topic clusters along with headings (selected by me), and proportion of scraped text which was classified under each topic. Note again the appearance of discipline-specific topics (health and space) separate from clusters related to broader processes of research and more generic discussion. Note also that almost 50% of the scraped text was classified under the 'generic' cluster.

As with IFLScience, Iramuteq solo analysis of r/EverythingScience (Fig. 4.8) produced two clusters driven by scientific topics with high news values (*space* and *health*), and one *generic* cluster. However the language in these clusters suggests less focus on controversial topics than on IFLScience. Where the IFLScience clusters refer to ‘vaccines’ and ‘climate change’, the r/EverythingScience clusters are composed of more neutral language such as ‘antibiotic’ and ‘gravity’. Similarly the generic cluster features much of the same language as the IFLScience generic cluster, including references to people (‘person’), thinking processes (‘think’, ‘know’, ‘feel’), religion (‘god’), and some science-related terms (‘science’ and ‘evolution’).⁵⁸ However the hostile language we saw in the IFLScience generic cluster is absent. This generic cluster takes up 49.9% of the original text, implying that there were many threads which were not associated with a single recurrent topic.

Finally there is a cluster featuring words related to the scientific profession, such as ‘journal’ and ‘fund’. This reflects the fact that many posts with a high number of responses on r/EverythingScience were about stories related to professional science in general – examples include *Researcher illegally shares millions of science papers free online to spread knowledge* (Feb 2016 - 52 responses, 3835 words) and *Reproducibility should be at science’s heart. It isn’t. But that may soon change* (Feb 2016 - 20 responses, 1286 words). Altogether these clusters suggest that r/EverythingScience discussions were driven by a similar combination of news reportage and generic language to IFLScience, though focussed more on the details of scientific research and less on controversial positions.

Within-forum analysis are displayed in Fig. 4.9.

⁵⁸ The appearance of ‘suicide’ is likely due to one post – *Suicide kills more people worldwide per year than homicide and all wars combined* (March 2015 - 36 responses, 2405 words) – which resulted in the word ‘suicide’ being used multiple times in close proximity to other words, and rarely elsewhere in the dataset.

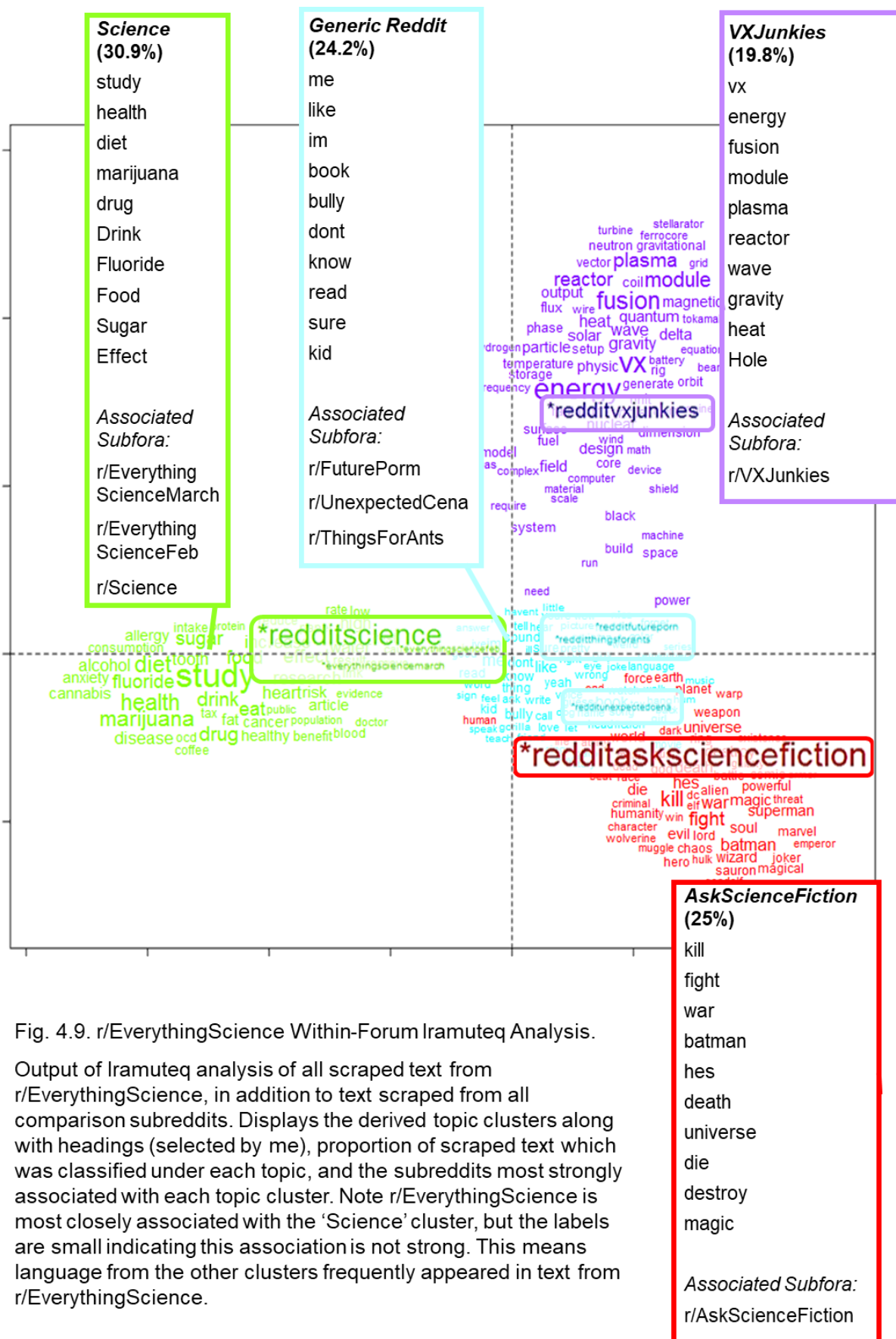


Fig. 4.9. r/EverythingScience Within-Forum Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from r/EverythingScience, in addition to text scraped from all comparison subreddits. Displays the derived topic clusters along with headings (selected by me), proportion of scraped text which was classified under each topic, and the subreddits most strongly associated with each topic cluster. Note r/EverythingScience is most closely associated with the 'Science' cluster, but the labels are small indicating this association is not strong. This means language from the other clusters frequently appeared in text from r/EverythingScience.

There is a central cluster which mixes references to reddit affordances – ‘sub’, ‘post’, ‘video’ – with emotional and phatic terms such as ‘love’ and ‘lol’. As this is associated with three different subreddits on unrelated topics, this cluster can be seen as a generic ‘reddit’ cluster. r/EverythingScience is associated with the same cluster as r/science, however the r/EverythingScience label is extremely small which indicates this association is not strong. Indeed, in analyses with different input parameters (as outlined in sec. 3.4.2) the r/EverythingScience label changed to the colour of the generic reddit cluster. Taken together, these observations suggest that language on r/EverythingScience occupied a middle-ground between the technical language of r/Science and a more general reddit discourse. This was perhaps to be expected given r/EverythingScience’s intended role as an r/Science with less strict moderator enforcement around discussing technical, peer-reviewed literature. However it does raise questions about whether discussions did stay as “on-topic” as suggested by moderation rules (sec. 4.3.3), or whether they digressed into more general discussions of a sort which feature across reddit.

4.3.6 Summary

r/EverythingScience is intended as a place for discussions which do not require high expectations of technical expertise and/or support from peer reviewed source material, but still maintain some ‘scientific integrity’. In practice this means the rules prohibit claims which go against mainstream scientific consensus, and encourage on-topic contributions. Post topics on r/EverythingScience are decided by the participants; all posts are contributed by participants, and how visible posts are depends on how many votes they achieve. In the dataset there was a wide variety of posted material, from news stories to questions for more expert participants. Those which achieved most engagement were those which discussed contentious matters, particularly related to social/political matters or pseudoscience. Iramuteq analyses suggested that many threads on r/EverythingScience discussed scientific work with high news values and/or features of professional scientific culture.

Participants in general did not post or comment on r/EverythingScience very frequently, but when they did they provided more extended responses than on IFLScience. There was also evidence that many participants were reading r/EverythingScience material without responding, and also contributing on a wide range of other subreddits. Iramuteq analyses also showed similarities in language use with a variety of other subreddits. This raised a question as to whether many discussions *did* involve the sorts of everyday, phatic socialising that were discouraged by the rules.

Taken together, these features suggest that participants used r/EverythingScience as a place for engaging with science-related material which did not necessarily require high levels of expertise, in amongst other forms of participation on reddit more broadly.

4.4 SkepticsSTM

4.4.1 Background

SkepticsSTM (or ‘Skeptics Science Technology and Mathematics’ in full) is a subforum of the Skeptics Society Forum, the associated forum of The Skeptics Society and *Skeptic Magazine*.⁵⁹ The Skeptics Society is one of many ‘skeptical’ societies across the world, which aim to encourage independent, critical, and evidenced-based thinking.⁶⁰ The Skeptics Society Forum was created in 2005 and the first ‘Welcome to the Forum’ post included the following:

Like The Skeptics Society, this forum is dedicated to the promotion of science and critical thinking, and to the investigation of extraordinary claims and revolutionary ideas. [...] The Skeptics Society, including its officers and members, and The Skeptics Society Forum, including its administrators and moderators, cannot be held responsible or liable for content.

(Skeptics Society Forum 2005)

This post suggests an informal relationship between the Society and the Forum, but also distinctions between the two. The overall moderator of the Skeptics Forum explained to me that the Forum operates independently of the Skeptics’ Society, though they are allowed to use the name.

With respect to this thesis, we should note the first sentence of the above post: “like The Skeptics Society, this forum is dedicated to the *promotion of science*” (emphasis added). The Skeptic Society explicitly aligns scepticism with science, claiming in their ‘About Us’ page claims that “modern skepticism is embodied in the scientific method”. The subtitle of the Skeptics Forum reads “Promoting SCIENCE and CRITICAL THINKING”. Discussions involving ‘science’ appear throughout the forum, not simply on SkepticsSTM. In the words of one of the SkepticsSTM interviewees:

⁵⁹ Skeptic Society Forum: <http://www.skepticforum.com/>; SkepticsSTM: <http://www.skepticforum.com/viewforum.php?f=18>.

⁶⁰ See Committee for Skeptical Inquiry (2017) for a list.

I don't think you will find much that actually distinguishes the more sciency areas of this site from other sections, but will find much that brings them together [...] On a skeptic site like this, there are frequent and regular appeals to science and especially scientific epistemologies, empiricism, and calls for "evidence," with, at times, some reference to scholarly communities, etc., but these discourses seem to be pretty ubiquitous across areas of the site.

- Skeptics-C.

This idea of 'science' – as a broadly applicable method of making and assessing claims – was a theme which emerged multiple times during my familiarisation with the SkepticsSTM subforum, as shall be discussed across the following sections. Such an approach to 'science' offered a useful comparison to the more topic-driven approaches of IFLScience and r/EverythingScience.

4.4.2 Data Collection and Ethics

On the request of the Forum moderator, I posted on both the SkepticsSTM page (12 April 2015) and the Skeptics Forum front page (20 Dec 2015). As with the r/EverythingScience post (sec. 4.3.2), this aimed to alert participants to my presence and ask if any would be willing to be interviewed by me. These posts received considerably more attention than on r/EverythingScience. My first post on SkepticsSTM received 11 responses, and the one on the general forum received 75. Some responses simply consisted of participants giving permission to be quoted (summarised in Table 4.7). Others involved reflections on forum culture, reminiscences of past threads, and a brief foray into discussions of the *Beach Party* film franchise (SkepticsSTM *More on PhD Research*, Dec 2015 - May 2016). This tendency to change topics, and to move between serious and less serious discussion, was common on SkepticsSTM, and shall be discussed further when I consider subforum norms in chapter 5.

Table 4.7: Permissions to quote and/or interview requested and given on SkepticsSTM.

Interviewees	Opted out below introductory thread	Contacted and refused	Contacted but didn't reply	Granted on contacting	Granted below introductory post	Total Granted
4	0	0	6	18	5	23

All four interviews involved at least three full questions and responses; two of the interviewees continued communicating with me for over a year. This allowed for in-depth explorations of both their Skeptics participation and their personal views around science and scepticism.

The appearance of SkepticsSTM as one subforum in the wider Skeptics Forum made finding comparison groups a straightforward task. The Skeptics Society Forum is composed of 36 subfora. The topics of these subfora range from distinctively 'sceptical' (for example, 'UFOs, Cryptozoology, and The Paranormal' and 'Letting Go of God') to more general 'Book Reviews' and 'The Funny Pages'. I received permission from the forum moderator to scrape all of these as comparison groups, though for technical reasons I only used 29 of these. More details can be found in Appendix 3, sec.3.

4.4.3 Affordances

The Skeptics Forum is built using the php Bulletin Board (phpBB) package.⁶¹ 'Bulletin Board' refers to a traditional forum structure in which users can post and/or respond to publicly viewable messages. This is a structure common to many pre-social media participatory websites, such as the UseNet pages studied by Baym (2000). Each subforum page has a rolling list of ongoing threads, with some threads 'stickied' by moderators to the top of the page to increase their visibility – for example, my introductory post was temporarily stickied to minimise chances of being ignored. Each post includes the current number of replies, the name of the original poster, and the name of the last person to reply. As I shall discuss further in chapter 5, these visible details may have encouraged participants to join in certain threads depending on who else was participating.

Threads are started by users making a post, which other users can comment on – there are no replies, likes, or upvotes. An illustrative comment is displayed in Fig. 4.10. As shown, users can quote a portion of a previous post or comment to appear in their own comment. In the absence of replies, the quotation function allows participants to illustrate that they are responding to a specific previous comment or portion thereof (Baym 2000). The comment in Fig. 4.10 alternates between quoted and not-quoted material; in extended debates, this was used extensively to create point-by-point responses to previous comments.

⁶¹ For history see (phpBB.com 2010).

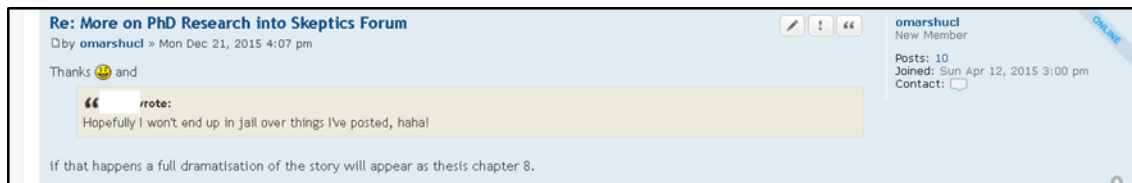


Fig. 4.10: Example phpBB comment, made by the author on SkepticsSTM. Note the alternation between original and quoted text. Retrieved 26 August 2017. URL not provided to avoid commenters being identified.

The right hand of Fig. 4.10 depicts my profile. Mine was entirely uncustomised, however most participants' profiles featured a picture and a personal caption. Participants could also have 'signature' text automatically appended to the bottom of all their comments. In theory captions and signatures could be used to inform other users of a particular expertise, in a similar manner to reddit flair. However no participants in my dataset took this approach. Instead these normally consisted of motivational or humorous slogans, more commonly referencing politics, religion, or general intellectualism than clearly science-specific material.

There is a rules page for the overall SkepticsSTM forum (Skeptics Society Forum 2010). These rules are designed to "provide an intellectually challenging environment for rational, polite discussion". They forbid participants from any legally problematic behaviour; personal attacks on other participants, and posting material repeatedly or across multiple subfora (behaviour known as 'spamming'). These rules are enforced by a moderator for the overall Skeptics Forum, with the power to ban participants, 'lock' threads (stopping further comments), and/or merge multiple threads to minimise spamming. The moderator also participates in the Skeptics Forum as a 'normal' participant. However they rarely appeared in the threads analysed for this thesis, whether as a moderator or as a normal participant.

4.4.4 Membership

Unlike on IFLScience and r/EverythingScience, participants in my SkepticsSTM dataset engaged frequently and across many threads.

Table 4.8: Quantitative breakdown of participants' activity on SkepticsSTM.

	Total # Participants	Mean Appearances / Participant	Mean Threads Participated in	Mean Posts / Participant	Mean Responses / Participant	# who only posted	# who only responded
March2015	38	10.2	4.5	0.79	9.45	1	24
August2015	43	16.9	3.7	0.51	16.4	1	28
Feb2016	51	24.4	4.7	0.55	23.8	3	32

22 of the 71 total participants appeared across all three scraped windows. Participants on SkepticsSTM also participated in an average of ten other Skeptics Society subfora. No participant displayed a clear numerical preference for SkepticsSTM over other subfora.⁶² This suggests that very few participants came to the site specifically to discuss narrowly science-related topics.

The interview data from SkepticsSTM gave me some further understanding of participation in the forum. One question I asked the four SkepticsSTM interviewees was “how did you end up being part of the forum, in particular the Science section?”. Answers are given in Box 4.1.

⁶² Only 7 of the 71 participants posted and/or commented in SkepticsSTM more than other subfora. Five of these only participated on one or two occasions in total, one had commented 50 times on a single post, and one was me.

Box 4.1. Reasons for joining SkepticsSTM

[I]t seemed to me that [intellectual] laziness was becoming fashionable. I've watched, for instance, as qualified dieticians have given way to unqualified nutritionists (pet subject of mine), the Illuminati have taken centre stage [...] I began to wonder a few years ago if there was a resistance movement [...] came across this forum, joined, and have enjoyed the banter ever since. Why the science side? I'm a retired technical author - which other side would I choose?

- Skeptics-B

Many years ago I started wanting to become a little more involved in the Skeptic community... and probably more by pure happenstance I fell onto this particular skeptic forum as opposed to any of the other skeptic forums that exist. It's a place where I can talk about skeptical issues, debate topics, and otherwise exchange ideas in a forum that's generally more appropriate for my particular value system.

- Skeptics-C

I started posting on the Skeptics' Forum several years ago mainly from a somewhat impish interest in testing the members scepticism, sense of humour, and general level of culture... I found it curious that most people there had a proper scepticism about the traditional bugbears of a scientific worldview (religion, parapsychology, etc.), yet they seemed surprisingly gullible about politics, economics.... As far as the science threads went, there was a considerable amount of denial of anthropogenic global warming -- which is fine as far as it goes, from the standpoint of encouraging scepticism, but based on very questionable (to put it mildly) "scientific" ideas.

- Skeptics-D

for years [I] bought the *Skeptical Inquirer* in airports, along with *Discovery*, *Scientific American*, etc. as a way of keeping abreast of science in general. Only recently did I discover this forum - and at the same time that another forum I used went away. So the Skeptics Society forum became my forum of choice quite by accident. As for the science section... the topics there just seemed to fit naturally with my interests [...] I use the Skeptics forum to stay connected, beyond just consuming the Internet News – with give and take dialogue, opinions exchanged, a need for clarity of thought.

- Skeptics-A

All saw the forum as a space for discussing a broad range of topics that interested them, science included. No interviewee spoke at length specifically about their interest in 'science'. When they raised specific topics, they spoke of stereotypically pseudoscientific such as "unqualified nutritionists", "parapsychology", and "denial of anthropogenic global warming",

alongside other non-mainstream views such as belief in “the Illuminati” (1,3). Through further interviewing I found that all except Skeptics-A had an educational background in science, though none presented themselves as a professional researcher.⁶³ Skeptics-A also suggested that in two years of (very active) participation they had only ever encountered one participant who claimed to be a professional scientist. They also suggested that participants generally avoided peer-reviewed or similar material which would suggest a high level of scientific expertise. This impression, that many SkepticsSTM members had studied science in the past but very few professed professional-level expertise, was corroborated throughout threads on the subforum.

Instead of focussing on specific topics, interviewees portrayed SkepticsSTM as a space where they could discuss broad topics with fellow self-identified ‘skeptics’, and for community interaction with like-minded people; whether through enjoying “banter” (1) and sharing a “particular value system” (2), or through testing the thinking of fellow self-identified skeptics (3). This supports the impression that participants aligned interest in science with a broader sceptical mindset applied to a range of topics.

4.4.5 Data on Participation

Quantitative Summary

Table 4.9: Quantitative breakdown of SkepticsSTM posts and responses. Full details of how values were calculated are provided in Appendix 2, sec. 1.

Dataset	No. of Posts	Number of Responses	Mean # Responses / Post	Mean words responded / post	Total Words Responded	Mean Response Length (words)
March2015	30	389	13	937	28,119	72
August2015	21	670	31	2583	54,243	81
Feb2016	28	1244	44	6,874	192,487 ⁶⁴	155

Table 4.9 suggests that responses on SkepticsSTM were more engaged than on IFLScience or r/EverythingScience. There was a higher average number of responses and average length of response than on r/EverythingScience. In conjunction with the data on participation

⁶³ I do not report these, as this could result in interviewees being identified.

⁶⁴ Note that 102,961 of these words (340 responses) were on one thread, *Monty Hall Redux*.

in Table 4.8, we can see that SkepticsSTM participants engaged with posts regularly and at some length.

Post Topics

Table 4.10 shows both the most popular posts and posts with high, mid-level, and small numbers of responses. On SkepticsSTM posts include text in addition to the post title. These clarify the purpose of the post, but were often lengthy; I therefore provide a summary.

Table 4.10: Example SkepticsSTM posts, with associated data on responses.

Post Title	Summary of Post Text	Dataset	# Responses / Words Responded
Question for physicists	Asks if light actually moves or simply gives illusion of movement (based on a YouTube video)	March2015	26 / 1190
Are the Earth moon and Mars moon Phobos hollow and fake?	Poster supplies alleged quotations from scientists which support a theory that the Earth and Mars moons are hollow satellites.	August2015	184 / 11273
Monty Hall redux	Poster supplies a computer programme which reproduces mainstream mathematicians' solution to the "Monty Hall" problem. A commenter disputes the mainstream answer.	Feb2016	340 / 102961
The axioms of science	Asks what fellow members think of the statement "science is not based on any assumptions (axioms) that cannot be falsified with empirical evidence".	Feb 2016	95 / 13960
Population III stars	Asks for help in debunking a claim, made by a website, that the current lack of observed Population III stars disproves the Big Bang Theory.	March2015	10 / 629
Perpetual Motion Debunking	Asks for help debunking a proposed design (from a website) for a perpetual motion machine	Feb2016	3 / 166

Table 4.10 illustrates a broad pattern on SkepticsSTM, that many posts combined relatively specific science-related topics (such as the mathematical Monty Hall problem, or perpetual motion) with broader philosophical/methodological questions around the assessment and/or 'debunking' of claims. However some topics, for example 'Axioms of Science', simply discussed broader questions without relating them to specific topics. There were some posts which simply reported recent news stories – for example, the *New Horizons* flyby of Pluto or the discovery of gravitational waves – but these were in the minority.

It should also be noted that a high rate of engagement did not necessarily indicate widespread interest in the topic. The extremely large word count below *Monty Hall Redux* largely emerged from only two participants; both produced very long arguments, which were met by even longer point-by-point counterarguments (often involving extensive quotation). The high number of replies to 'Are the Earth moon and Mars moon Phobos hollow and fake' resulted from a high number of participants posting comments which criticised or ridiculed the question. As with r/EverythingScience, conflict generated interest. However on SkepticsSTM the 'conflict' did not necessarily emerge from controversial topics, but rather from extended polarisation between or against specific participants. Discussing this important theme requires engaging with communal norms, and shall therefore be discussed in chapter 5.

Iramuteq

The solo analysis of SkepticsSTM is presented in Fig. 4.11. Whitespace in clusters indicate a username has been redacted.

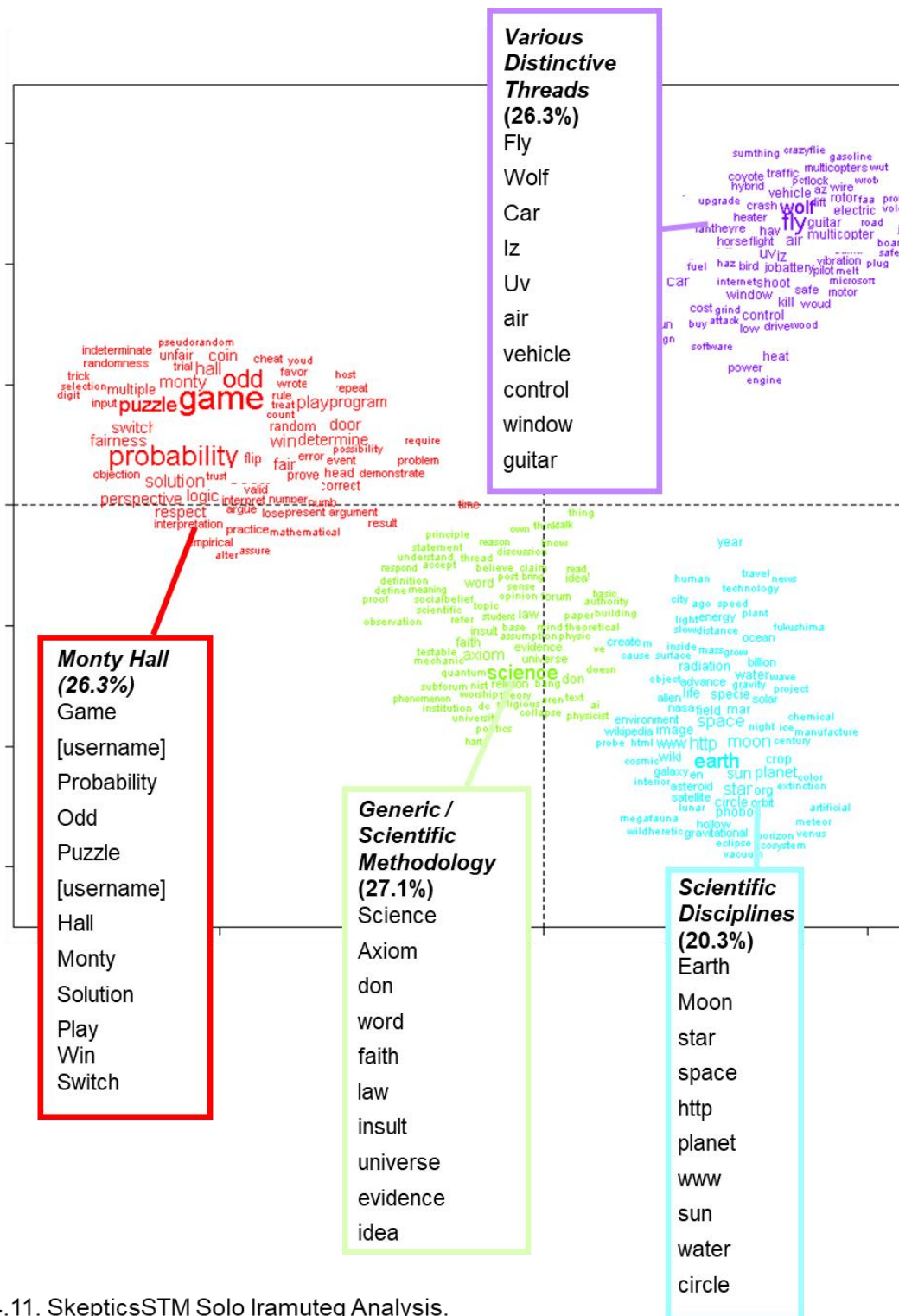


Fig 4.11. SkepticsSTM Solo Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from SkepticsSTM. Displays the derived topic clusters along with headings (selected by me), and proportion of scraped text which was classified under each topic. Note again the separation of discipline-specific terms from more general discussion-related terms, though the latter had a more philosophical/methodological emphasis than in other subfora. The 'Monty Hall' and 'Various Distinctive Threads' clusters appear due to extremely lengthy threads on particular topics; the lower overall volume of text on SkepticsSTM means these threads took up a substantial proportion of scraped text.

Two of the clusters clearly relate to particularly long and/or distinctive⁶⁵ threads within the dataset – *Monty Hall Redux*, *Can a Scaled Up Multicopter Become the Flying Car*, and *Shamelessly Pimping For a Good Cause*.⁶⁶ The third cluster relates to more specific science-related topics, largely drawing on terms from physics such as ‘moon’, ‘gravity’, and ‘radiation’ but also including terms from other disciplines such as ‘species’ and ‘chemical’. The fourth cluster is similar to the generic clusters from IFLScience and r/EverythingScience, in that it combines words related to argumentation in general (‘word’, ‘insult’, ‘idea’), with religion (‘religious’, ‘faith’) and ‘science’. However it also includes terms relating to scientific philosophy and/or methodology (‘science’, ‘axiom’, ‘law’). This corroborates the impression given by the post topics, that many threads on SkepticsSTM involved broadly intellectual discussions of ‘science’. However the separation of this cluster from the cluster of discipline-specific terminology raises questions as to the extent to which discipline-specific topics were discussed *alongside* broader philosophical questions. This distinction shall be investigated further in chapter 7, when I analyse latent descriptive meaning-making.

As noted in sec. 4.4.2, I used 29 comparison subfora for SkepticsSTM. Attempting to include all these in a single Iramuteq analysis resulted in the programme breaking down due to the computing memory required. Instead I randomly sorted the subfora into three groups, and compared SkepticsSTM to each group separately. These analyses produced very similar patterns, so for reasons of space I only display one of the outputs (Fig. 4.12).

⁶⁵ In the sense of repeatedly using specific words – such as ‘Monty’ or ‘wolf’ – which did not appear elsewhere in the data. The appearance of ‘iz’ and ‘uv’ relates to the participant JO 753 (this user requested to be named in the thesis) who consistently used non-standard spelling of words.

⁶⁶ The ‘good cause’ in the latter thread was a wolf sanctuary, hence the appearance of ‘wolf’ in the cluster.

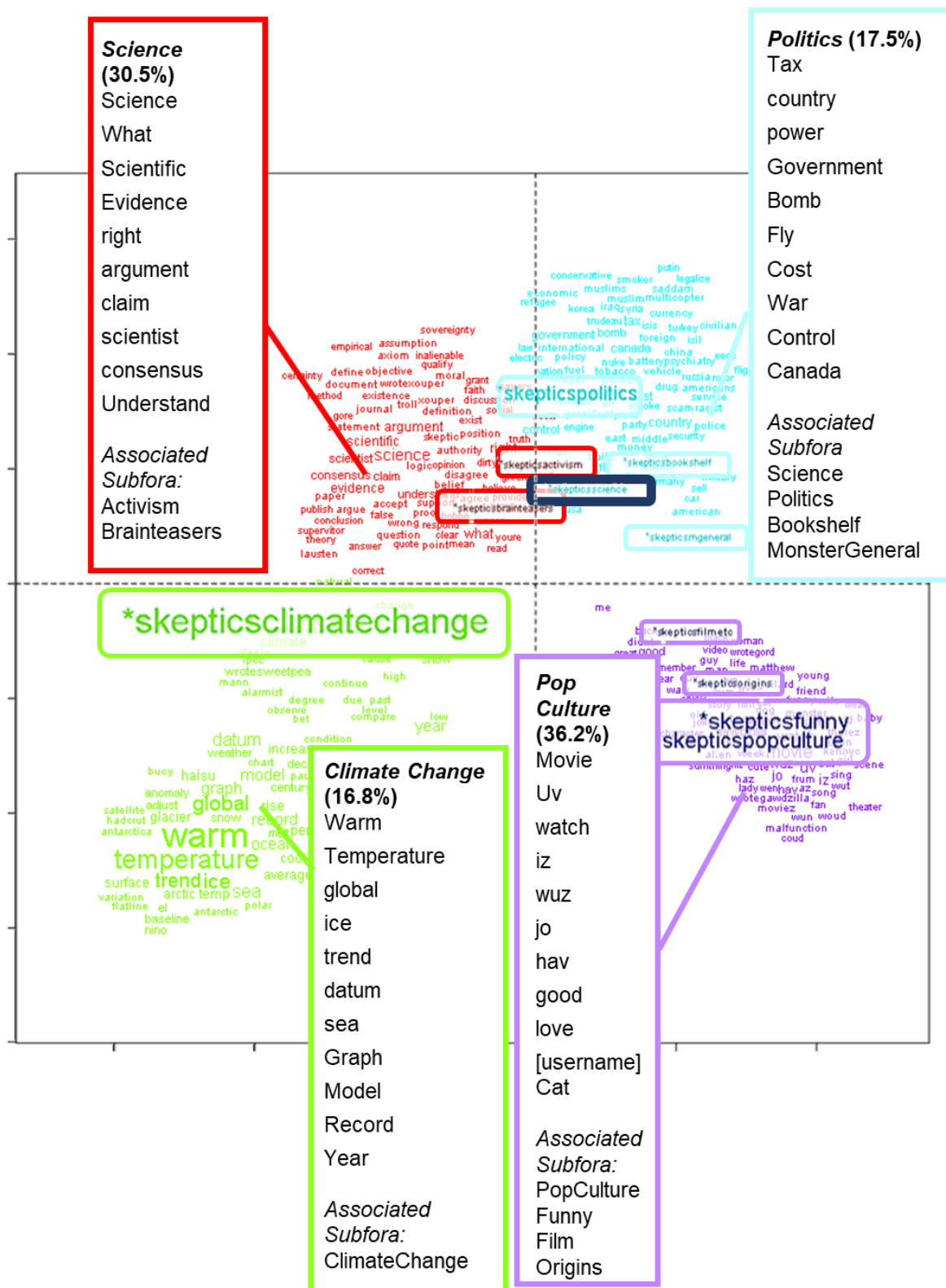


Fig. 4.12 SkepticsSTM Within-Forum Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from SkepticsSTM, in addition to text scraped from comparison subfora. Displays the derived topic clusters along with headings (selected by me), proportion of scraped text which was classified under each topic, and the subfora most strongly associated with each topic cluster. Note that SkepticsSTM (circled in dark blue) was very slightly more associated with the 'Politics' cluster than the 'Science' cluster.

I have picked out the (very small) SkepticsSTM label in dark blue. The positioning of the label indicates similar language use to a range of other subfora – ‘Brainteasers’, ‘Activism’, ‘Bookshelf’, and ‘Monster General’.⁶⁷ Each of these subfora is associated with either the red or the blue word clusters. The red cluster is reminiscent of the ‘generic / scientific methodology’ cluster from the SkepticsSTM solo analysis, featuring words such as ‘scientific’, ‘evidence’, and ‘argument’. The blue cluster is largely dominated by politics-related terms such as ‘Tax’ and ‘Government’.

It is notable that SkepticsSTM is associated more strongly with the blue cluster than the red. This was a distinctive feature of this output; in the other two within-forum analyses SkepticsSTM was most strongly associated with a ‘generic/scientific methodology’ cluster, though with a very small label (illustrating that the association was not strong). However the output in Fig. 4.12 clearly illustrates that language associated with scientific methodology was not the sole preserve of the SkepticsSTM subforum. Moreover, there was not a distinct SkepticsSTM discourse which marked it out from the other Skeptics subfora. Instead discussions on SkepticsSTM closely resembled those occurring elsewhere in the forum, and terms such as ‘scientific’, ‘empirical’, and ‘theory’ appeared as part of general Skeptic Forum discourse.

4.4.6 Summary

The Skeptics Society Forum brings together people attracted to the ‘skeptic’ identity. This is aligned with a view of ‘science’ as an intellectual approach to assessing claims and evidence, and terms such as ‘scientific’ and ‘hypothesis’ appeared in discussions across multiple subfora. While discussions on Science Technology and Mathematics (STM) subforum did often involve material related to specific scientific disciplines, the broader topics of discussions were often related to broader philosophical/methodological questions around empirical evidence and credible claims. Some participants had educational backgrounds in specific scientific disciplines, however very few presented themselves as possessing professional-level expertise. A large proportion of participants contributed across multiple threads, and often wrote extremely lengthy responses. The discussion below my introductory posts suggested a community atmosphere, in which participants joked and developed informal tangential discussions with one another. Overall I characterise discussions on SkepticsSTM as demonstrating formation and maintenance of a skeptic

⁶⁷ The latter is a subforum for generic discussion.

community, which discussed ‘science’ – including specific topics, but more often as a broad ‘scientific’ mindset – as part of this broader community activity.

4.5 XKCD

4.5.1 Background

XKCD is a popular webcomic created by physics graduate, former NASA roboticist, and science communicator Randall Munroe. Styled as “a webcomic of romance, sarcasm, math, and language” (Munroe 2017b) the strip frequently features themes related to specific scientific knowledge, often involving relatively high levels of expertise – see the references to “centripetal force” and “coordinate substitution” in Fig. 4.13, for example. The forum was started in 2006 and was originally co-moderated by Munroe, though he has since distanced himself and rarely (if ever) participates or takes a role in moderating.⁶⁸ However the webcomic’s ‘About’ page still maintains a link to the forum (Munroe 2017a). Two of the subfora are related to the XKCD comics,⁶⁹ but the majority discuss more general topics, such as news, books, and logic puzzles. Much like the Skeptics Forum, the XKCD Forum therefore operates as a general online forum with some unofficial links to the comic – most importantly, as I shall discuss further in section 4.5.4, it seems that many participants arrived at the forum through an interest in the comic. As noted by one of my interviewees, the comic “tends to attract science minded folks per it’s topics” (XKCD-E). Therefore although discussion on the forum occurs largely independently of the comic, it is likely that the forum’s membership reflects the comic’s generally high level of interest in science-related topics.

⁶⁸ This information was supplied by interviewee XKCD-D, a long time participant. XKCD Forum: <http://forums.xkcd.com/>; XKCDScience: <http://forums.xkcd.com/viewforum.php?f=18>.

⁶⁹ These are ‘Individual XKCD Comic Threads’ and ‘What If?’.

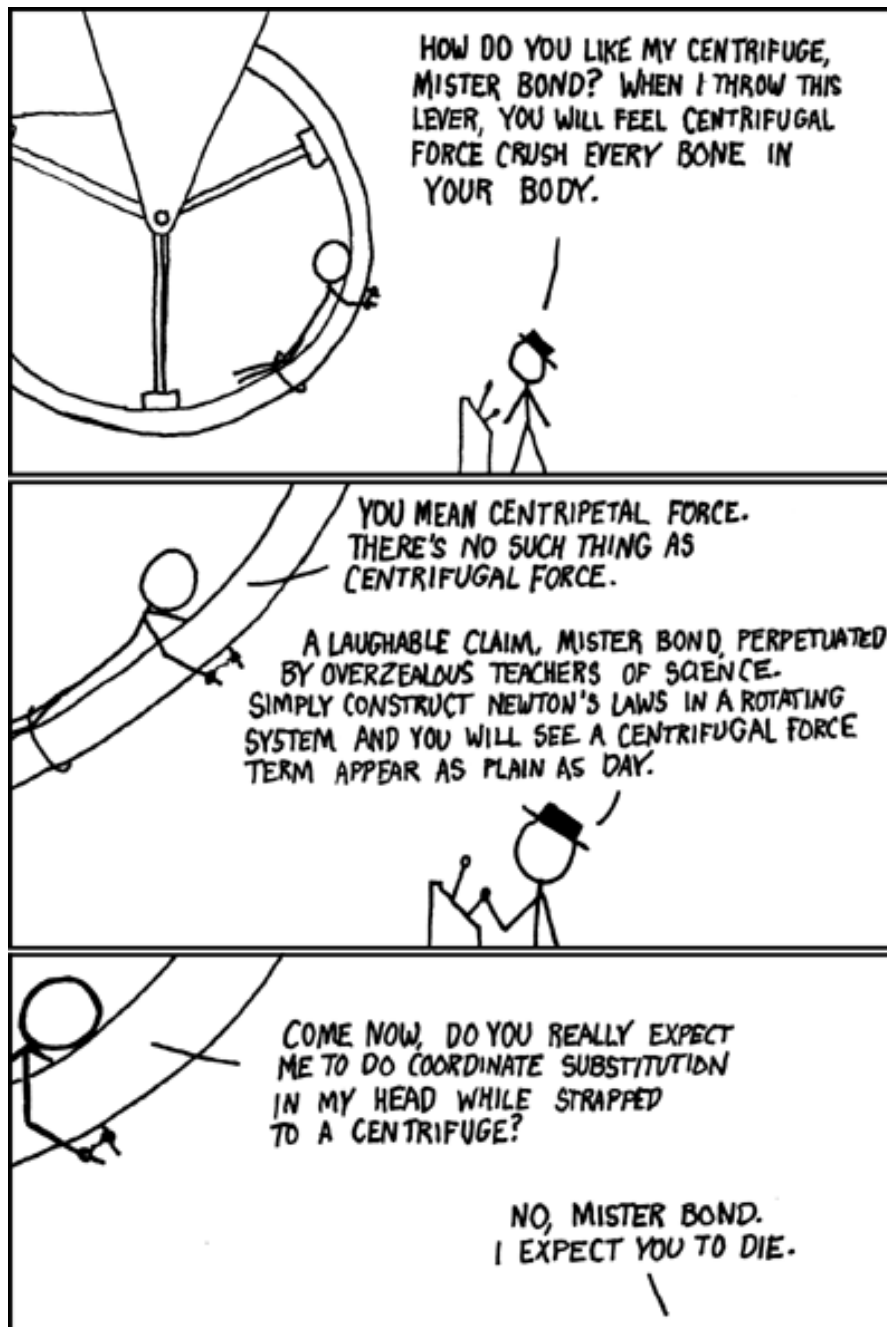


Fig. 4.13: XKCD comic #123 'Centrifugal Force', retrieved from www.xkcd.com/123, 26 August 2017.

4.5.2 Data Collection and Ethical Procedures

Ethical procedures followed the same pattern as for SkepticsSTM: after receiving moderator permission I made a post on the XKCDScience subforum (24 May 2015) and the forum as a whole (20 Dec 2015). These posts received fewer comments than on SkepticsSTM, but from a greater number of participants. Most of these simply gave permission to use quotations and/or offered to be contacted for interview. Two participants objected to my use

of an ‘opt-out’ approach (*XKCDScience PhD Study of this forum*, May 2015). This led to a debate over the ethical procedures adopted in this thesis. Many participants argued that opt-in would lead to a very biased sample, though expressed concerns around quotations being traceable. I responded to these with assurances that I would contact participants before quoting them. The full breakdown of participants interviewed and quoted is listed in Table 4.11. Of the nine interviewees, four stayed in contact for over a year.

Table 4.11: Permissions to quote and/or interview requested and given on XKCDScience

Total Granted	Granted below introductory post	Granted on contacting	Contacted but didn't reply	Contacted and refused	Opted out below introductory post	Interviewees
27	10	17	19	0	2	9

Like SkepticsSTM, the comparison groups consisted of other subfora on the XKCD Forum. The XKCD Forum has a total of 27 subfora, with topics ranging from science and multiple subfora for computing to food, popular culture, and the XKCD comics. Some were excluded for technical reasons, and others at a moderator’s request that I avoid subfora labelled as safe spaces. This led to a total of 20 comparison groups. Further details are given in Appendix 3, sec. 4.

4.5.3 Affordances

The XKCD Forum is built using the same phpBB platform as the Skeptics Society Forum, and therefore shares the same affordances. The only clear distinctions in their usage relate to moderation. Firstly, a link to the XKCD Forum rules page is displayed on every subforum; on SkepticsSTM this only appears on the front page of the overall forum. The XKCD Forum rules forbid hostility, and encourage participants to avoid potentially annoying material and/or quantities of responses (XKCD Forum 2008). Secondly, there is a specific XKCD Science rules page; this re-iterates the expectation of civility, encourages participants to keep responses relevant to post topics, and states that “only a small amount of pseudo-science is permitted, mostly to debunk it” (XKCD Forum 2009). Thirdly, the XKCD Forum has multiple moderators including one who appeared regularly within my dataset (as both a moderator

and normal participant). In addition to enforcing rules through banning or locking threads, they also often reprimanded participants for poor behaviour in a less official capacity. This will be discussed further in chapter 5. The key point here is that moderation played a much more active and visible role on XKCDScience than SkepticsSTM.

4.5.4 Membership

As with SkepticsSTM, participants on XKCDScience contributed frequently and across multiple topics. Few participants only posted and the majority only responded, again suggesting active participation in topics raised by others. See Table 4.12 for the full breakdown.

Table 4.12: Quantitative breakdown of participants' activity on XKCDScience.

Dataset	Total # Participants	Mean Appearances / Participant	Mean Threads Participated in	Mean Posts / Participant	Mean Responses / Participant	# who only posted	# who only responded
March2015	171	10.3	5.7	0.25	4.9	5	134
August2015	187	5.5	3.0	0.2	5.3	9	158
Feb2016 ⁷⁰	756	6.2	1.6	0.08	6.0	10	711

68 participants participated across all three scraped windows, out of 899 total. Participants in my XKCDScience dataset also participated in an average of only three other subfora. Excluding participants who only appeared in the anomalously high Feb2016 scrape, 133 (of 283 total) participants posted and/or commented in the Science subforum more than all other subfora combined. All these suggest a distinct hard core of participants who brought a specific interest in science-related topics to their XKCD Forum participation.

When asked the question “how did you end up being part of the forum, in particular the Science section?” six (of the nine) interviewees referenced the XKCD comics. With respect to the Science subforum, all referred to being interested in ‘science’. However where the

⁷⁰ The discrepancies between this scraped window and the previous two is due to the inclusion of two extremely long-running ‘stickied’ threads – *RELATIVITY QUESTIONS* and *Favourite Home Experiments* – in this dataset. Though these threads were participated in during the other scraped windows, they were not scraped in other windows so as to avoid double-counting.

SkepticsSTM interviewees aligned this with a certain way of thinking, XKCDScience interviewees associated ‘science’ with particular knowledge/expertise. Four were involved in professional scientific research, two were software engineers, and the others presented themselves as interested in learning about science. However all participants spoke of being interested in a breadth of science topics, whether or not they were specialists in a particular discipline; five also spoke of using XKCD to learn about topics outside of science. Though all emphasised *learning* about science, four of the interviewees also saw *providing* information as an important part of their XKCDScience usage. Multiple interviewees also made positive references to fellow XKCD forum participants, who they described as a source of interesting and/or intelligent views (five interviewees); polite (three); and funny or generally enjoyable online company (three).

4.5.5 Data on Participation

Quantitative Summary

Table 4.13: Quantitative breakdown of XKCDScience posts and responses.

Dataset	No. Of Posts	Number of Responses	Mean # Responses / Post	Mean words responded / post	Total Words Responded	Mean Response Length (words)
March 2015	44	837	19	2,416	106,344	127
Aug 2015	36	950	26	4,362	157,047	165
Feb 2016	58	4669 ⁷¹	81	10,731	622,444	133

Quantitative data for XKCDScience showed similar values as SkepticsSTM (Table 4.9) – indeed, even longer average length of responses. Again this suggests relatively high levels of engagement within threads.

Post Topics

Table 4.14 shows the three most responded to posts and posts of a range of other sizes, as in previous sections; note that ‘most responded to’ posts exclude stickied threads, as the

⁷¹ Note that 2610 of these responses (341,222 words) were from *RELATIVITY QUESTIONS*, and 578 (60437 words) were from *Favourite Home Experiments*.

high number of responses can be ascribed to the longevity of these threads and their heightened visibility.

Table 4.14: Example XKCDScience posts, with associated data on responses.

Post	Context	Dataset	# Responses / Words
Living in an earth-like moon orbiting a planet	Asks for suggested implications of the scenario proposed in the post topic.	March 2015	39 / 8410
Flying cars and jet-powered batwing	Asks for thoughts on a personal engineering design for a flying car	August 2015	105 / 33524
Is 'control' a common property of all life?	Proposes a personal theory that biological stimulus-response processes can all be modelled as feedback control processes	Feb 2016	168 / 42623
Landing rockets upright is unnecessary?	Asks question in post title	Feb 2016	62 / 11349
Spectrum of antimatter excursion	Proposes theory that a large annihilation of antimatter in open air would appear blue to an observer	March 2015	11 / 1194
A solution to the black hole information paradox?	Posts recent article on professional research into black holes	March 2015	2 / 243

Similarly to SkepticsSTM, posts on XKCDScience largely sought answers and/or ideas from other participants. Topics tended to be less philosophically or methodologically inclined than SkepticsSTM, and instead asked for input on specific technical points. The appearance of terms such as 'antimatter excursion' and 'black hole information paradox' suggest a generally high level of technical expertise was expected of participants (neither of the posts explained these terms). All of these posts presented topics related to physical sciences and/or engineering except *Is Control A Common Property of All Life* (which discussed

biology) and *Living in an Earth-Like Moon Orbiting a Planet* (which covered numerous disciplines). This was representative of a general disciplinary bias within the XKCDScience data, which reflects the largely physics/mathematics focus of the comics.

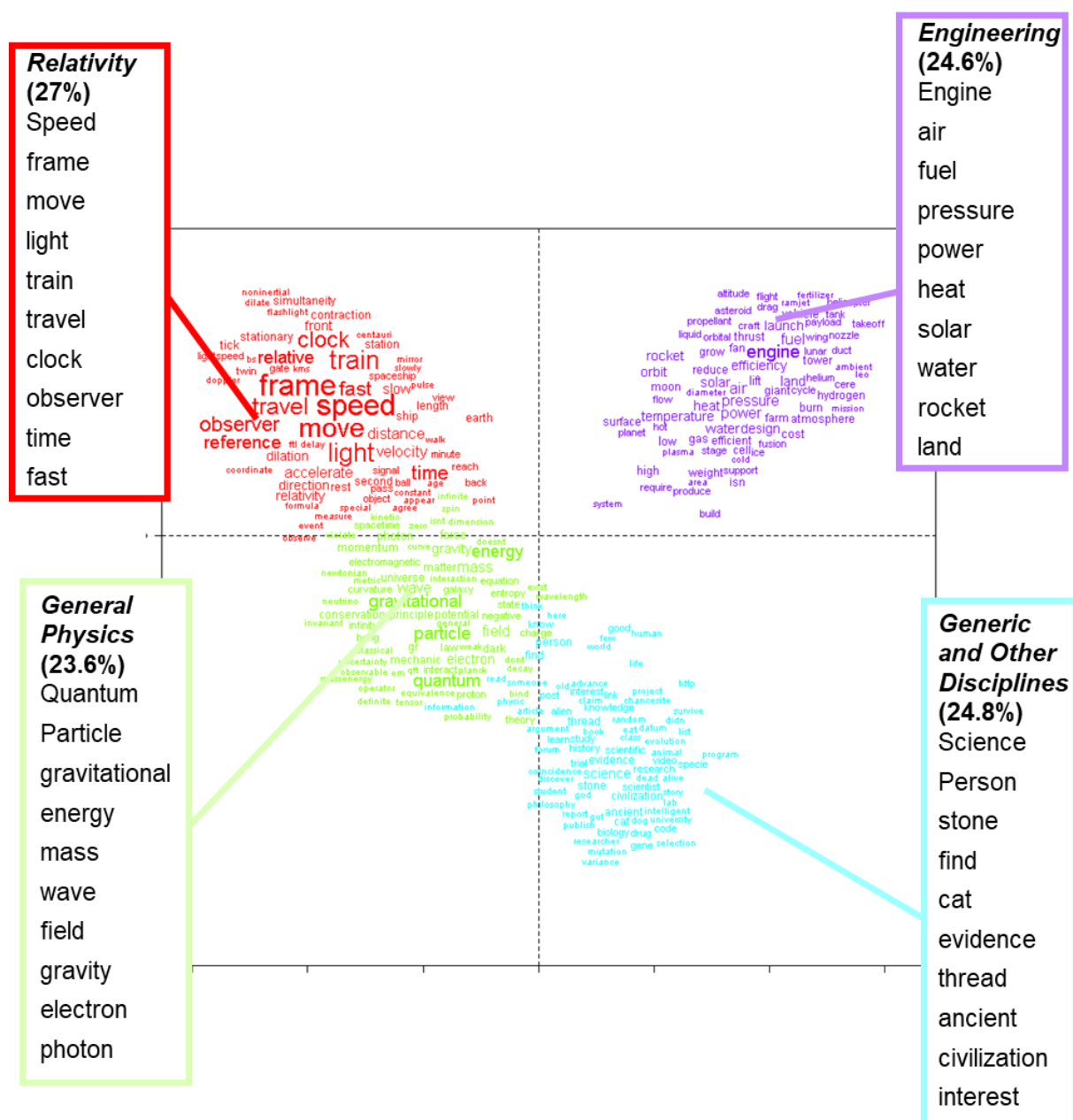


Fig. 4.14. XKCDScience Solo Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from XKCDScience. Displays the derived topic clusters along with headings (selected by me), and proportion of scraped text which was classified under each topic. Note the dominance of physics-related terms, many suggesting high levels of expertise.

The solo Iramuteq analysis of XKCDScience (Fig. 4.14) produced three clusters dominated by terms from physical sciences and engineering. One of these is related to special relativity, including terms such as ‘frame’, ‘speed’, and ‘clock; one featuring engineering terms such as ‘engine’, ‘air’, and ‘pressure’; and a third composed of terms from a variety of physics-related disciplines, such as ‘quantum’, ‘gravitational’, and ‘energy’. Some word choices suggest high levels of specific knowledge; for example the appearance of terms such as ‘frame’ and ‘observer’ suggests familiarity with the details of special relativity. This corroborates the impression given by post topics and interviews, that XKCDScience participants had a generally high level of technical knowledge.

As with the other subfora, there is a ‘generic’ cluster featuring both broad science-related terms (‘science’, ‘evidence’) and terms such as ‘person’ and ‘interest’. The appearance of ‘stone’, ‘ancient’, and ‘civilisation’ in the top ten most characteristic words relates to the distinctive and lengthy thread *Puzzling Artefacts and Reasonable Reasoning* (July 2015 – 78 replies, 17,000 words) which discussed a hypothetical discovery of ancient stone artefacts. Also prominent within the cluster, though outside the top ten most characteristic terms, are terms related to biology (‘gene’, ‘species’, ‘evolution’). This reflects the fact that, although XKCDScience was largely dominated by discussions of physical sciences, a significant minority of lengthier threads focus on biological topics – as well as *Is Control a Common Property* (Dec 2015) in Table 4.14, other examples included *Homo Naledi: Another Link* (Sep 2015 - 22 responses, 2332 words) and *BIOLOGY: EVOLUTION* (March 2015 - 33 responses, 5424 words).

As with SkepticsSTM (sec. 4.4.5), for within-subforum analysis I randomly allocated the XKCDScience comparison subfora into three separate groups and carried out a separate Iramuteq analysis on each of these groups. Each of these produced very similar patterns, so I only present one output in Fig. 4.15.

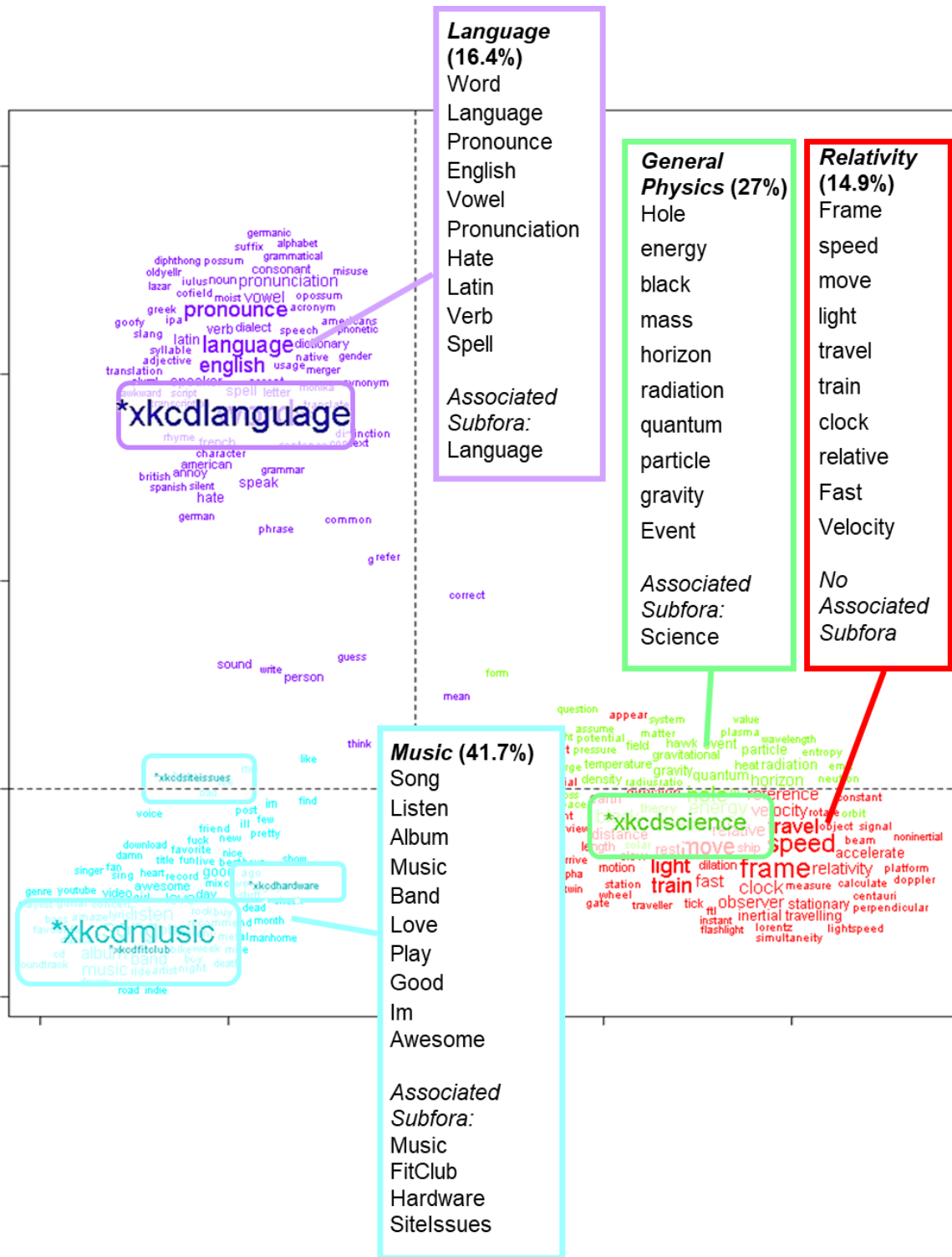


Fig. 4.15 XKCDScience Within-Forum Iramuteq Analysis.

Output of Iramuteq analysis of all scraped text from XKCDScience, in addition to text scraped from comparison subfora. Displays the derived topic clusters along with headings (selected by me), proportion of scraped text which was classified under each topic, and the subfora most strongly associated with each topic cluster. Note that XKCDScience forms two clusters which were very separate from all other subfora, indicating that XKCDScience language was very distinctive.

A large XKCDScience label appears extremely far away from all other subfora labels, and is strongly associated with a pair of clusters; one related to relativity, the other to more general physics-related terms. In within-forum analyses carried out with the other two groups of comparison subfora this pair of clusters appeared as a single 'general physics' cluster, though still strongly and distinctly associated with XKCDScience. This means that the language in the clusters was likely to appear in XKCDScience, but unlikely to appear in other subfora. These corroborate the impression of the post topics that XKCDScience discussions were heavily shaped by focussing on specific topics, often dominated by physical science.

4.5.6 Summary

Discussions on XKCDScience displayed a high level of interest and expertise in specific science-related topics. Posts largely took the form of asking questions and/or suggesting personal theories, though many also shared news stories or articles. Physics and engineering were the most prevalent disciplines, though a range of disciplines featured across and within threads. Many participants contributed frequently, and often wrote lengthy responses. While responses to my introductory posts did not produce the same sorts of informal socialising as on SkepticsSTM, interviewees suggested they did recognise and appreciate the social aspect of the group. I therefore characterise XKCDScience as an online community for discussion of specific high-level scientific topics.

Conclusion

Case study selection encompassed subfora with a variety of membership sizes, general levels of expertise, and affordances. Familiarisation with the backgrounds, membership, post topics, and data on responses suggested that the subfora could be contrasted in two main ways.

The first contrast related to how the participants used the subfora as online participatory websites. IFLScience and r/EverythingScience both featured a large number of participants engaging with science-related material as part of broader Facebook/reddit usage. On both of these subfora, participants contributed relatively infrequently. The most engaged-with threads tended to involve contentious and/or news-related material, often including references to perceived pseudoscientists or political figures. Patterns of language use, derived through Iramuteq, suggested that both these subfora used similar language – often

revolving around everyday phatic communication – as other pages on Facebook or reddit. By contrast, SkepticsSTM and XKCDScience appeared to be more clearly bounded communities, in which participants contributed many times across multiple threads. Posts welcomed perspectives from other participants, whether through questions or by presenting personal theories for discussions.

The second contrast related to participants' approaches to discussing science. From the data presented here, XKCDScience and r/EverythingScience seemed to focus on 'science' in the sense of professional, disciplinary research. Post topics and Iramuteq clusters for these subfora featured discipline-specific terms; r/EverythingScience also featured a cluster comprising many references to professional scientific culture, such as 'journal' or 'trial'. Both subfora also featured members with professional levels of expertise in specific topics, though they seemed to be in the minority on r/EverythingScience. The r/EverythingScience and XKCDScience rules also encouraged participants to stay on-topic, though whether this was followed requires further exploration in future chapters. By contrast, the data for SkepticsSTM and IFLScience did not suggest a significant role for participants with professional levels of expertise, nor did discussions feature much specific technical terminology. Moreover, both of these subfora seemed to discuss 'science' in a manner which related to other concerns – the promotion of a broadly 'skeptical' mindset on SkepticsSTM, and phatic socialising on IFLScience.

These contrasts made the subfora valuable spaces for investigating how various approaches to discussing to 'science' interacted with a range of communal behaviour. In the next chapter I shall build on these findings through discourse analysis.

“Who is this ‘we’ you refer to? You are a solo ‘woo’ troll”⁷²

5: Latent Emotional Meaning-Making

In this chapter I consider emotional meaning-making, by which I mean the ways in which an ‘object’ – in this case, science – is engaged with in a manner that implies certain emotional commitments. More specifically, I examine *latent* emotional meaning-making. This means I am looking for forms of emotional meaning-making which were shown implicitly, expressed through recurrent patterns of behaviour (discussed further in chapter 3, sec. 3.4.3). I consider the subfora as social spaces in which participants built on and shaped one another’s contributions in line with particular emotional commitments. As well as presenting a series of findings related to emotional meaning-making on the subfora, this chapter also provides a deeper understanding of communal norms on the subfora; this will be of relevance to the rest of the thesis.

This chapter is divided into two main sections, each focussing on a specific form of social behaviour which FS scholars have highlighted as important for drawing out underlying emotions. The first section examines how participants in the subfora recognised one another as real people, as opposed to generic sources of information. I draw out three types of recognition: recognising specific other participants, recognising oneself as part of a community, and recognising types of people. I then examine how these forms of recognition were indicative of shared emotional commitments within the subfora, and how they shaped participation. In the second section I consider three forms of phatic interaction: off-topic tangents, humour, and hostility/politeness. I compare the subfora studied here to various fandoms studied within FS. This allows me to contextualise the social behaviour of these subfora with respect to existing studies, and begin to discern distinctive features of science-related online discourse for further analysis in future chapters.

Background and Methodology

Under the framework outlined in the methodology chapter (3.4.3), analysing latent emotional meaning-making involves examining how social interactions around a particular object a)

⁷² Comment on thread SkepticsSTM *More on PhD Research Into This Forum* (Dec 2015).

convey underlying emotional attachments and b) encourage particular forms of emotional behaviour from others. For instance, following Baym (1996), language which conveys politeness can be seen as reflecting a desire for friendly, non-combative interactions. If others desire similar interactions, they can respond in kind and create an 'ethic of friendliness'. In such a context any participant who uses hostile language is a threat to the emotional expectations of the community and is likely to prompt disapproval. Other groups may fulfil participants' desires for proving oneself in competition, and normalise combative language and intolerance of 'off-topic' friendliness (Bennett 2013, Jenkins 1995). The challenge is that *any* form of social interaction can be related to emotional factors. I therefore took a theory-driven approach, drawing on FS literature. FS scholars have drawn out recurrent patterns of behaviour which suggest certain forms of emotional commitments. The sections of this chapter draw on patterns described in FS literature, which I found could be usefully applied to understand interactions within the subfora.

For section 5.1 of this chapter I looked for instances of participants displaying *recognition* of one another. FS scholars have shown how recognition of other people is an important medium through which emotional commitments are conveyed, for example acts of in-group bonding (Baym 1993) or through feelings demonstrated towards unwelcome 'others' (Bennett 2013). I therefore looked for instances of participants showing recognition of specific other people and/or types of people, and drew on FS literature to examine how these showed emotional commitments to the subfora and/or 'science' more broadly.

For section 2 I focussed on *phatic interactions*. Vincent Miller defines these as "communications which have purely social (networking) and not informational or dialogic intents" (Miller 2008, 387). However during analysis it became apparent that, on these subfora, separating 'social' from 'informational' was a problematic task – a finding in itself, but also a challenge to using this definition. I therefore looked for specific types of phatic interaction which FS scholars have shown as important ways in which emotional attachments are demonstrated within fandoms; these were off-topic tangents, humour, and politeness/hostility (Baym 2000; Bennett 2009).

Sampling and coding for this chapter were carried out in two separate stages. Coding in the first stage was carried out immediately following the familiarisation stage (sec. 3.4.3). To highlight how social behaviour varied or remained consistent across subfora, I initially took a purposive sample (Silverman 2001, 250) of posts related to topics which appeared across multiple subfora. During the course of data collection two major events occurred which were discussed across all four of the subfora: the NASA *New Horizon* flyby of Pluto in July 2015, and the discovery of gravitational waves in February 2016. Apart from these no topic was

discussed at length in all four case studies, so I also selected topics which appeared in three of the four: flying and/or self-driving cars, primitive humans, disputes over evolution, and effects of climate change. Full details of threads are given in Appendix 4, sec. 1. All threads were coded in their entirety, except for IFLScience threads where coding was carried out until theoretical saturation – the point at which phenomena repeatedly fitted existing patterns, rather than producing new insights – was reached (Charmaz 2000). In developing codes I drew on the approach of discourse analysis outlined in chapter 3 (sec. 3.4.4); I located recurrent features of discourse and asked how they related to the surrounding thread, and to interactions in other threads on the same subforum.

The second stage of coding took place when analyses for all other chapters had been carried out. In this stage I applied the code-book developed in the first stage to the samples used in other chapters.⁷³ This second stage was carried out for two reasons. Firstly, to contextualise the results of other chapters with respect to the features identified in this chapter. Secondly, to see if the code-book for this chapter should be refined on a larger sample and in light of analyses from the other chapters. In practice some of the coding categories from the original code-book were discounted as not relevant to the emerging arguments of the thesis, however the remaining categories did not require further refining. Further details of the final code-book are given in Appendix 5, sec.1.

5.1. Recognition

I begin this section by comparing different forms of recognition – recognising specific real people, community, and types of people – across the subfora. In 5.1.2 I then examine how forms of recognition indicated communal values and norms of the subfora; drawing on FS literature, I consider how these reflected and constructed emotional attachments. Finally, I consider how these forms of recognition acted to shape individual and communal participation within the subfora.

⁷³ Full details of these samples will be given in the relevant chapters. To briefly summarise, these samples consisted of: responses which contained explicit references to ‘science’ (including words such as ‘scientific’ and ‘scientist’), and threads which included such references in their original post; and random cluster samples of 5 each of short, mid-length, and long threads from each subforum.

5.1.1 Types of Recognition

Recognition of Specific Fellow Participants.

As discussed in chapter 4 (sec. 4.4.4 and 4.5.4), on XKCDScience and SkepticsSTM a substantial proportion of participants contributed multiple times across many topics. Participants recognised specific other members of the community from previous interactions. Illustrative examples are shown in Box 5.1.

Box 5.1 Illustrative Examples of Recognising Past Interactions

- (1) Vandal is far too emotive a term. We KNOW what we're doing, yet there are still people hunting whales (sorry, [username]).

SkepticsSTM *Ancient peoples were ecological vandals*, Jan 2016

- (2) [Your]misunderstanding [was] shared by the last person who came here asking about GR and then getting frustrated with people misunderstanding questions. I apologize for initially reacting as if your level of knowledge was closer to hers than to, say, [username]'s.

XKCDScience *Acceleration Near A Black Hole*, Apr 2013

- (3) User1: I think he means the [username1] thread that [username2] deleted in full...

User2: Oh, I thought that had been one of [username3]'s threads but don't recall all the intricacies anymore... I only remember it was *freaking crazy!*

User3: Oh, *that* kind of attacked...

SkepticsSTM *More on PhD Research*, May 2016

- (4) Interesting quote from the article:... "is the first gravitational wave to be detected directly by human scientists..." Maybe [username] is right. The reptiles are here and they detected gravitational waves already!

SkepticsSTM *Gravitational Waves Detected*, Feb 2016

In extracts (1) and (2) participants referred to others who were present in the thread, and drew on recollections of past interactions with them. In (1), the participant recalled that a fellow user lived in a country which allowed whaling – a detail not mentioned in this thread, so recalled from previous interactions. In (2) the participant referred to a user who was present in the thread and widely recognised on XKCDScience as an expert in relativity. By drawing a contrast with an unnamed (and less expert) participant, the author of (2) created a reference point to explain their mis-characterisation of the person they were addressing. Both extracts 1-2 also featured direct naming of another participant. As noted by Baym,

there is no practical reason for users to identify one another by names as the quotation function (4.4.3) is more effective at directing speech towards a specific participant. Instead, naming has the function of “enhanc[ing] public recognition of the other... a way of personalizing the group as a whole, populating it with identified individuals”, which Baym regards as crucial to creating an “ethic of friendliness” amongst participants (1996, 333). The author of (1) even used a shortened nickname-style version of their fellow member’s username, further heightening the show of familiarity. Although these extracts had an informational purpose – both were assessing claims within ongoing debates – participants wrote in a manner which suggested a desire to show friendliness.

Extracts (3) and (4) showed participants referring to fellow members who were *not* present within the thread. In (3) participants referenced three other members, and shared recollections of a particularly ‘freaking crazy’ thread. In (4) “the reptiles are here” referenced a particularly extreme conspiracy theory that the world is secretly run by lizard-people; this relates to the referenced user’s holding of fringe views about alien visitations and spiritual influences (*Crop Circle Formations*, Jul-Sep 2015; *Question for Physicists*, March 2015). These examples exhibit less of an ethic of friendliness than the previous examples, being criticisms of fellow members. Such behaviour was particularly common on SkepticsSTM. Extract (3) is just one example from the thread below my introductory post (chapter 4, sec 4.2) in which participants showed themselves adept at naming a range of users who they regarded as dislikeable. Moreover, participants agreed with one another’s recollections of unpopular participants, sometimes adding their own recollections. The joke in (4) relied on an expectation that participants would share a recognition of the referenced user, and find humour in the characterisation. Despite the manifest unfriendliness, such forms of recognition still facilitated social bonding amongst participants by providing a shared reference point for reminiscence and/or humour.

Instances of participants recalling one another from previous threads were extremely rare on IFLScience and r/EverythingScience. This was most likely due to the size and rate of interaction on these sites (4.2.5, 4.3.5). However on IFLScience users frequently used Facebook’s tagging function, i.e. wrote a friend’s name to automatically send them a notification and thereby attract them to the thread. This sometimes resulted in miniature dialogues between the tagger and the tagged, which involved drawing links between the discussion topic and some shared facet of their lives. For instance there were multiple examples of people tagging their partner to discuss buying a flying car (*Who Wants a Flying Car*, March 2015), or comparing a cartoon of Pluto looking sad as the *New Horizons* spacecraft flies past to ‘that feeling when you don’t reply to my texts’ (*How Pluto Felt This*

Week, July 2015). Some tagging even turned into arranging of social plans (*IFLScience In Science We Trust*, March 2015). These reflect the most common primary motivation cited for using Facebook, to keep in touch with friends (Wilson, Gosling, and Graham 2012). Without participants recognising other members of IFLScience, it is hard to see the page as providing the same sort of distinctive community as SkepticsSTM and XKCDScience. Nonetheless, the topics of IFLScience's posts were used for a different form of social bonding.

On reddit, the recognition of specific real people was even less apparent than on IFLScience. I only found one example of a participant drawing on another participant's past behaviour, and this came from searching their post history rather than recognising them from previous discussions (*r/EverythingScience The Food Babe Blogger*, Apr 2015). Reddit does not have a tagging function, and the pseudonymous nature of reddit means a user's network does not draw on offline relationships in the same way as Facebook. However despite these features the designers and moderators of reddit encourage participants to see themselves as members of "community", and follow "rediquette" which encourages them to "always remember the human" (Reddit 2015). This brings us on to our second form of recognition: recognising oneself as a member of a community, even if one is not familiar with many (or any) specific fellow members.

Recognising Community.

The label of 'community' is often applied to groups which provide members withal benefits; most particularly a sense of belonging, incorporating elements of shared social identity⁷⁴ and/or lasting interpersonal relationships (Gibbs 2011). To considerably simplify a complicated debate, this sense of belonging can be recognised in two different ways. Firstly, instances of people identifying themselves as belonging to a specific group; for instance sports fans explicitly identifying as fans of a certain team, rather than as fans of football more generally (Theodoropoulou 2007). Secondly, through participants expressing a sense of similarity with those around them. This similarity may appear as shared "work or intellectual attitude" in traditional theories of community (Tönnies 1957), or shared approaches to engaging with a particular object in fandoms (Baym 1993).

⁷⁴ Social identity is "the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of group membership" (Henri Tajfel, quoted Hogg and Abrams. 1988, 7). See 2.5.2 for further discussion.

Some of my interviewees explicitly identified themselves as belonging to the ‘community’ of the subforum. For example XKCD-E told me that “I’ve been a member of this community for about 7 years now... and have met a few of them in meatspace” (i.e. the offline world). Skeptics-C referred to the Skeptic Forum as “a community space somewhat analogous to a church – online forums are about as close as an atheistic skeptic like myself is going to get, mostly”. However my interviewees were relatively long-term participants, and similar expressions did not appear within threads; unlike Baym’s examples, where participants did occasionally refer to themselves as part of a community within threads (Baym 2000). Some participants even *distanced* themselves from the subfora in which they were participating. This was particularly the case in IFLScience, where participants frequently referred to the page in very critical terms. Examples included regular accusations that the page shared ‘clickbait’ (*What TV Channels Really Show*, March 2015) or promoted an overly celebratory and insufficiently critical idea of ‘science’ (*In Science We Trust*, March 2015). Similarly, some r/EverythingScience participants accused the subreddit of political polarisation (*Ted Cruz’s Strange Smile*, Feb 2016), and some SkepticsSTM participants argued that the community did not encourage truly sceptical discussion (*More on PhD Research*, Dec 2015; *Are the Earth Moon*, Apr 2015). In sum, the idea of the specific subfora providing a sense of ‘belonging’ to participants did not appear clearly or consistently.

More prominent was the suggestion of ‘community’ through expressing an expectation of shared characteristics and values amongst participants. Examples are shown in Box 5.2.

Box 5.2 Recognition of Expected Characteristics

(1) Pretty sure you don't need to explain G or the \wedge symbol to anyone who might be reading this thread.

XKCDScience Acceleration Near A Black Hole, Dec 2015

(2) I promise you that a solid majority of us would be very interested to see evidence that recommended consumption levels of caramel coloring or standard table sugar have a causal relationship with cancer or acute toxicity.

r/EverythingScience The Food Babe Blogger, April 2015

(3) I realize facts are hard, and reading is hard, but I'd expect people posting in a sub about science to be more dedicated to ... you know, .. facts and stuff.

r/EverythingScience House Passes Bill Saying Yes to Industry Lobbyists, March 2015

(4) Who is this "we" you refer to? [...] You are neither a critical thinker, nor a skeptic. You are the exact opposite.

SkepticsSTM More on PhD Research, Dec 2015

These examples referred to expectations that participants would be knowledgeable of specific scientific information (1,2), and/or that they would show individual engagement with details rather than uncritical acceptance (3,4). Also note that when participants labelled themselves and others they did not use the name of the subfora but instead broader labels such as "people posting in a sub about science" or (3) "a critical thinker [or] a skeptic" (4) – or even, on one occasion, "science dudes and dudettes" (*XKCDScience The Science of Autumn*). This suggests that if participants saw themselves as part of a community, it was often a broader 'science' or 'skeptic' community which extended beyond the boundaries of the subfora.

This was reflected in broader online behaviour. Multiple participants revealed, in both interviews (*XKCD-E*, *XKCD-D*, *Skeptics-C*) and threads (*SkepticsSTM Gravitational Waves*, Feb 2016; *SkepticsSTM Some Reasoned Argument*, Aug 2015; *XKCD PhD Research into this Forum*, May 2015), that they frequented other forums or groups for scientific and/or skeptical discussion. Indeed, on the thread *XKCDScience LIGO Gravity Waves* (Feb 2016) one participant expressed recognition of another participant from a different webforum, presumably by noticing their username.

To summarise, I argue that seeing oneself as part of a broader community of 'scientific' or 'skeptical' people played a clearer and more consistent role in discourse than recognition of

oneself as a member of a specific subforum community. This was tied to expectations of engaging with claims in a knowledgeable and/or independently critical fashion. These are both important themes I shall return to throughout this thesis when considering understandings of 'science'.

Recognising Types of People

A final form of recognition, common to all the subfora, was recognising *types* of people. Examples, from both interviews and threads, are shown in Box 5.3.

Box 5.3 Recognising Types of People

(1) I absolutely recognize some users for their expertise in certain things [username] has a strong background in math, physics, and linguistics, for example [username] is an MD. Going beyond science, [username] is a (le surprise) chef,⁷⁵ and a number of people are pretty experienced programmers. Etc, etc. As for there being other things to recognize them for, again, of course - I've been a member of this community for about 7 years now, and even scientists are people.

Interview, XKCD-E

(2) There are definitely other particular users I have extended relationships with, either as a sort of hat-tipping acknowledgement of brightness and insightfulness on the technical topics, or socially more generally. It's also fun to have rando[m] new blood come in, ask some questions, give a little help or fresh perspective.

Interview, XKCD-D

(3) Some of the really big-time commenters have a rep, like [username], and maybe individually some relationships (positive or negative) build up over time if people respond to one another on similar topics constantly and over a long period of time.

Interview, Skeptics-C

(4) It might help you to know that the xkcd forums are regularly bombarded by people who, while they don't actually have a degree in the subject they're talking about, nevertheless think they've found something awesome that they want others to be excited about, too. The thing is, there are many regulars here who do, in fact, have relevant degrees [...] you're really unlikely to have found something that no one else knows about. You're much, much more likely to have found something that has been already disproven and are being fed your ideas from a crackpot's rambling.

⁷⁵ The username in question was cookery-related.

(5) I totally despise what I see as an increasing tendency to ignore evidence in favour of feeling, fact in favour of bullshit, and research in favour of thought experiment by people without the necessary equipment [...] On the SSF [Skeptics Society Forum], those people come to us (god knows why) so I don't have to go out and look for them.

Interview, Skeptics-B

In extracts (1, 2, 4) participants categorised fellow members as experts in particular subjects. Similar recognition could also be seen in the r/EverythingScience use of 'flair', labels which indicate scientific expertise (sec. 4.3.3). However, participants also recognised others for characteristics besides expertise. Having described the expertise of fellow participants, the interviewee in (1) noted that there are "other things to recognize them for"; their statement "even scientists are people" implies that they recognised them for more general interpersonal characteristics. The interviewee in (2) recognised people both for technical ability and "socially more generally", as well as for "fresh perspectives" which were not clearly either technical or non-technical. The "big time poster" mentioned in (3) was recognisable for their frequent humorous posts (as they themselves noted in *SkepticsSTM More on PhD Research*, May 2016). Participants valued expertise, but also other characteristics which enlivened the social life of the subfora.

In (4) and (5), participants expressed dislike of people who made claims without evidence, and instead relied on "crackpot's ramblings" or "bullshit". Hostility towards participants who believed in perceived 'fringe' theories over mainstream science was also extremely common on IFLScience. For example in *Pluto Continues To Blow Away All Expectations* (July 2015) any participants who claimed that NASA fakes photographs of Pluto were labelled as conspiracy theorists (or more unfriendly terms). Anyone doubting the safety of vaccines in threads such as *How To Argue with Anti-Vaxxers* (Aug 2015) was criticised as dangerous and ill-informed. Similarly, on r/EverythingScience *The Food Babe Blogger* (Apr 2015) the appearance of a participant who disagreed with mainstream views of nutrition prompted another participant to search through their previous posts, to find other occasions where they had argued non-mainstream positions. In these examples participants were recognising *people they had not previously encountered* as a certain type of person; such recognition

⁷⁶ As discussed in sec. 4.4.3 a small proportion of threads on received continual replies across many years, including the scraped windows (hence appearing in the dataset). Comments made outside of scraped windows were still analysed to maximise understanding of context.

shaped the emotional background of discussions, introducing elements of anger and/or ridicule.

The question of how these forms of recognition shape participation will be the subject of section 5.1.3, once I have discussed the communal values indicated by these forms of recognition in section 5.1.2. The overall takeaway from these various types of recognition is that all the subfora operated as places for creating social bonds and social identities (rather than solely as places to find information and expertise), though the manner in which this was expressed varied.

5.1.2 Recognition and Values

FS has highlighted that recognition of other participants plays a role in understanding communal values of the fandom. For instance, Baym notes that welcoming new members is an important factor in creating the ethic of friendliness in soap opera fandoms (Baym 2000). In a more hostile example, the label 'drooler' – used on the R.E.M fan forum *Murmurs* to label participants who focus on physical attributes of the band – is used to highlight (by contrast) the forum's valuing of 'intellectual' debate (Bennett 2013). I therefore examine how forms of recognition discussed in the previous section reveal values distinctive to, and shared across, the different subfora.

In general the relationship between recognition and communal behaviour across the subfora was closer to the 'droolers' example – certain types of behaviour were deemed unwelcome, and are responded to with criticism. Box 5.4 shows illustrative examples.

Box 5.4 Recognising Participants in Criticisms

(1) User1: [username1] will always stick to their speculation as if it was proven fact [...] [he/she] ignores data when it does not support the argument he/she is putting forward. Of course, since [username1] does not argue for the joy of academic discussion, but just to create mischief, he/she does not care if he/she is correct or not.

User2: That's why I used to think [username1] was a sock puppet of [username2].

SkepticsSTM *Primitive humans caused widespread animal extinctions*, Aug 2015

(2) Your previous explanation was beyond handwavy and spurious. It's also frustrating that your last thread was about how control loops were the best way to model evolution, and now you're saying that you can/should only apply control loops towards modeling individual organisms behaviors, of a very specific sort. One has to wonder where the goalposts will be shifted to next.

XKCDScience *Is Control a Common Property of All Life*, Dec 2015

(3) [Your] misunderstanding [was] shared by the last person who came here asking about GR [General Relativity] and then getting frustrated with people misunderstanding questions I apologize for initially reacting as if your level of knowledge was closer to hers than to, say, [username]'s.

XKCDScience *Acceleration Near A Black Hole*, Apr 2013

Extracts (1) and (2) negatively referenced behaviour that other members had exhibited over previous discussions. In (1) recognition of another participant was used to criticise their approach to debating. The first accusation – a refusal to change views in the face of evidence – was a recurring criticism across many of the most antagonistic discussions on the subfora, including SkepticsSTM *Monty Hall Redux* (Oct-Nov 2015) and IFLScience *How To Argue With Anti-Vaxxers* (Aug 2015). “Sock puppet” in (1) is online jargon for multiple accounts secretly run by one user. This implies that both of the referred-to users behaved in a similar manner and were probably run by one person to “create mischief”. In (2) the participant criticised the poster for unclear argumentation, using a previous thread to highlight the poster’s lack of consistency. Failure to argue clearly – in particular using technical terminology in a confusing fashion – often provoked frustration from other participants. The SkepticsSTM threads *Show Me Scientism* (Sep 2015), *Monty Hall Redux* (Oct-Nov 2015), and *Axioms of Science* (Dec 2015), as well as XKCDScience *Is Control a Common Property* (Dec 2015) consisted largely of participants criticising unclear argumentation. Extract (3) shows one of the less common occasions in which a participant – an expert on General Relativity – was recognised in a manner which highlighted rather than

attacked credibility. Nonetheless, this reference was still used in conjunction with criticising “the last person who came here” for their lack of knowledge and patience, and in a wider context of questioning the credibility of another participant. While, as noted from Box 5.3, interviewees recognised others for more positive aspects such as expertise or skill, in threads such positive recognition was not expressed as explicitly as criticisms. Such criticisms indicate that the communal values of the subfora revolved around encouraging well-argued points, based on evidence rather than stubborn commitments or desire to antagonise.

Across all the subfora it was extremely common to see these values expressed in relation to the idea of scientific consensus. I use ‘scientific consensus’ to refer to views seen to be held by a majority of mainstream scientists. We have already seen, in section 5.1.1, how participants expressed hostility towards non-mainstream views, such as beliefs that vaccines are dangerous. For further examples see Box 5.5.

Box 5.5 Values and Scientific Consensus

- (1) You are being downvoted because you are making extraordinary claims and not backing it up with even a hint of evidence [...] Oh, shit I just saw your sentence "We don't need sugar to live". That pretty much invalidates any insight you might think you have into modern human nutrition.

r/EverythingScience *The Food Babe Blogger*, Apr 2015

- (2) I'm not so much angry as frustrated. You seem to be putting a lot more energy into proposing this whatever this is, and not so much on learning [...] I don't feel inclined to copy-paste wikipedia's biology articles and so on. A certain degree of basic learning sort of falls on ya before questioning the basic underpinnings of any field.

XKCDScience *Is Control a Common Property*, Dec 2015

- (3) You reject strictly empirical science and, for that reason alone, you're rejecting the Big Bang Theory without properly characterizing it. It's not that the steady state theory is particularly plausible; it's that you have some great need to reject the big bang theory and empirical science itself.

SkepticsSTM *IMAP*, Apr 2015

- (4) Who is this "we" you refer to? You are a solo "woo" troll, promoting "Ra" the fake alien, invented by three people on LSD, through seances, using incense sticks, candles and a bible. You are neither a critical thinker, nor a skeptic. You are the exact opposite.

SkepticsSTM *More on PhD Research*, Dec 2015

Extract 1 criticised the fellow participant for making “extraordinary claims” (which run counter to scientific consensus about nutrition) without evidence. A particularly extreme example of a counter-consensus view – “we don’t need sugar to live” – was used as reason to “invalidate” any further contribution from the participant. Similarly in (2) the participant was criticised for ignorance of consensus knowledge in biology, emphasised by the repetition in “*basic learning... of basic underpinnings*”, and the argument that they could acquire the knowledge from Wikipedia articles. Note that the expressed source of frustration was not simply ignorance, but rather the lack of personal effort to engage with relevant scientific consensus. In extract (3) the participant was accused of being committed to Steady State theory – an alternative to the much more widely accepted Big Bang theory – for reasons of personal bias. Extract (4) associates “woo” – a label for non-mainstream views⁷⁷ – with references to a “fake alien”, the spiritualist practice of “seances”, the countercultural paraphernalia of incense and drugs, and the religious image of a bible. These are images which often connote pseudo-scientific or anti-scientific movements (Kaiser 2011), and were used here in a hostile fashion. The participant was also referred to as a “troll”, suggesting that their non-mainstream beliefs were proposed purely to antagonise; the opening “who is this ‘we’ you refer to” framed these criticisms as excluding the participant from the community.

These examples were not criticising others for being straightforwardly wrong about scientific consensus. When participants simply corrected perceived misunderstandings, they generally did so with little relatively little hostility. On XKCDScience there were repeated threads by the same participant, which expressed lengthy and extremely non-standard understandings of physics – for example, that energy can possess its own energy ([username] *Talks About Trains*, June 2014 - Feb 2016; *Gravity Wave Musings by [username]*, Nov 2015 - March 2016). However this participant also displayed gratitude to fellow participants and a willingness to change their mind. They were met with strong disagreement and some jokes at their expense, but not subject to the same levels of anger and/or ridicule as participants who were seen as entrenched in non-consensus views (*Is Control a Common Property*, Dec 2015; *Biology: Evolution*, March 2015; *The Battery That Isn’t A Battery*, Jan 2011). Anger was provoked by a combination of going against perceived scientific consensus *and* doing so in manner which suggested an unwillingness to change one’s mind, or to engage with evidence which might develop understanding.

⁷⁷ This label also appeared in references to a “Woo-ster” on *SkepticsSTM* Gravitational Waves Discovered (Feb 2016), and on IFLScience How To Make An Impact on Anti-Vaxxers (Aug 2015).

I shall henceforth refer to the *Respect Scientific Consensus (RSC) Norm* to describe this behaviour of sanctioning participants who were seen as not respecting scientific consensus. I shall also use 'non-RSC' to refer to views or behaviours which were perceived to contravene this norm. The term 'norm' has been used in various ways across different social scientific disciplines, including STS (Merton 1942; Mitroff 1974). Here I refer to norms in the sense used by Fan Studies scholars: behaviours that are common and expected within a particular group (Bennett 2011). Unlike rules, which are explicitly codified and enforced by authority figures, norms are implicit and encouraged by the collective behaviour of fellow participants.

Scientific consensus is often seen within STS as playing an informational role, ensuring people agree on empirically well-evidenced claims (Evans and Durant 1995). However the anger and ridicule expressed in the above examples suggests that disagreement was not simply informational. Rather, emotional responses played a role in creating an unwelcome environment for such claims (and perceived characteristics of the claimants). This should not be seen simply as a process of excluding certain views, but also the construction of a 'scientific' type of person. FS scholars have argued that "emotional investment in anti-fandom"⁷⁸ is significant to the construction of fan identity" (Theodoropoulou 2007, 317). In other words, responses to 'anti-fans' or 'non-normative participants' construct (through contrast) the expected norms, values, and characteristics of a fandom. This shall be explored further in the next section.

5.1.3 Recognition and Participation

FS scholars have highlighted how recognising types of people plays an important role in encouraging members of the fandom to communally respond in similar ways to particular contributions (Bennett 2013). In this section I shall consider how the phenomena examined in the previous section shaped communal participation.

Criticisms of the sort we saw in Box 5.5 often appeared alongside a collection of negative comments directed at any participant who seemed to contravene the RSC norm. On SkepticsSTM any comment promoting non-RSC views frequently provoked new participants to join in the discussion, often simply to make jokes or insults at the expense of the non-RSC participant (*Crop Circle Formations* Jul-Sep 2015; *CERN The End of the World*, Sep 2015).

⁷⁸ Anti-Fandom is a term referring to people who participate in fandoms to display disagreement with expected behaviours (Gray 2003).

XKCDScience featured similar behaviour, though usually featuring reprimands rather than jokes. For example, the participants who proposed non-RSC theories in *The Battery that Isn't a Battery* (Jan 2011), *Biology: Evolution* (March 2015), and *Is Control A Common Property* (Dec 2015) had their views criticised (often accompanied by accusations of ignorance or disrespect) by multiple other participants. These criticisms often referred to characteristics discussed in 5.1.1, such as stubbornness or lack of 'basic' understanding. The important point here is the involvement of multiple participants. FS scholars have noted that communal joking and shared expressions of values can act to create social cohesion (Baym 1995), while attacking unwelcome participants helps to solidify the boundaries between 'us' and 'them' (Theodoropoulou 2007).

The affordances of Facebook and reddit were also used to bolster the display of communal dislike. Any response on IFLScience which was seen as non-RSC – most usually, supporting creationism or opposing vaccination – often received a barrage of negative replies, which in turn received many likes (*How To Argue with Anti-Vaxxers*, Aug 2015; *Teaching Stork Theory*, March 2015). The number of likes often exceeded the number of people replying to the comment; as seeing replies requires clicking a link below the comment, this suggests participants were actively making an effort to show appreciation for exclusion of non-RSC views. Despite the r/EverythingScience rule that "comments that are unscientific or promote pseudoscience without proper evidence will be removed" there were responses which got through moderation but were then accused of being 'unscientific'. These were often downvoted to the bottom of a thread. Despite being less visible they still often received many critical replies, suggesting that downvotes were not considered sufficient sanctioning (*The Food Babe Blogger*, Apr 2015; *Exhibit Paid for by Kochs*, Apr 2015). As numbers of likes or votes are publicly visible, these behaviours displayed the unpopularity of non-RSC behaviour.

Sanctioning did not straightforwardly act to drive non-RSC participants away from the subfora. Bennett has noted the existence of 'non-normative' participants in fandoms, who continue to participate despite sanctioning (Bennett 2009). The idea of non-normative participants was particularly applicable to SkepticsSTM. Over the course of analysis I encountered multiple such participants who, despite attacks, continued to participate (without changing their behaviour) across multiple threads. XKCDScience participants also showed recognition of non-normative participants, though concentrated in a small number of threads which became defined by the presence of the non-normative participant. For example, when I asked for examples of bad discussions the interviewee XKCD-E pointed me to threads started by a specific participant (of which only *Is Control A Common Property*,

Dec 2015, fell within my sample). Another cluster of threads started by a non-normative participant (with non-standard approaches to physics, as discussed in sec. 5.1.2) were re-titled by the moderator to 'gravity wave musings by [username]' and '[username] talks about Trains'. This flagged up an expectation of a certain kind of discussion; as the moderator suggested in a note above *[username] talks about Trains*, they had an "anticipation of further such threads" (June 2014). This was akin to the way in which moderators created a separate section for 'droolers' in Bennett's study, which allowed non-normative participation while still demonstrating its unwelcome nature (Bennett 2013).

Bennett notes that non-normative participants can be aware of their status, and sometimes justify their behaviour by arguing they display the values of the fandom more strongly than other members (2009). Both of these phenomena appeared within the subfora. Many of the non-normative participants wrote in extremely distinctive ways, such as stream-of-consciousness (*SkepticsSTM Crop Circle Formations* Jul-Sep 2015; *Question for Physicists*, March 2015) or using multiple exclamation points and emoticons (*[username] Talks About Trains*, June 2014 - Feb 2016; *Gravity Wave Musings by [username]*, Nov 2015 - March 2016). Some also criticised normative participants for uncritically adopting scientific consensus, and presented their non-consensus views as more 'scientific' or 'skeptical' (*SkepticsSTM More on PhD Research*, Dec 2015; *XKCDScience Biology: Evolution*, March 2015). They also frequently highlighted the intellectual work they put into their ideas (*XKCDScience The Battery That Isn't A Battery*, Jan 2011; *XKCDScience Biology: Evolution*, March 2015; *SkepticsSTM Monty Hall Redux*, Oct 2015; *SkepticsSTM Axioms of Science*, Dec 2015). As we saw in section 5.1.2, these characteristics – intellectual work, thinking critically, and presenting independent perspectives – were usually valued within the subfora. However when combined with non-RSC behaviour, these characteristics prompted anger and hostility. This again suggests that the RSC norm was a central expectation of participation within the subfora, and one which has both informational and emotional significance.

An important feature distinguishing the subfora from similar cases within FS is that the RSC norm entangles identities with assessments of claims to fact. We have seen across previous examples how dislike was prompted by claims which were contrary to scientific consensus. Some participants who made claims which could be perceived as non-RSC attempted to mitigate potential dislike by separating their personal identity from 'the sort of person who would normally make these claims' (*SkepticsSTM Some Reasoned Argument*, Aug 2015; *r/EverythingScience The Food Babe Blogger* Apr 2015; *IFLScience How To Argue with Anti-Vaxxers*, Aug 2015). The success of such tactics was often determined by recognition (or

not) of the claimant. On *SkepticsSTM Some Reasoned Argument* (Aug - Sep 2015) a claimant who participated frequently in SkepticsSTM (usually in a normative fashion) had their non-RSC query addressed with relatively little hostility from many of the other participants. However in cases where the claimant was less familiar, their claims were taken as evidence for broader non-RSC views. In the words of one respondent on *r/EverythingScience The Food Babe Blogger* (Apr 2015), “your anti artificial, anti industrial arguments sound a lot more like anti science to me”. Making and responding to informational claims on the subfora was tied, in multiple ways, to recognition of welcome/unwelcome types of people.

Summary of Section 5.1

Across all the subfora, participants displayed general positive recognition of people who were seen as bringing intelligent and novel perspectives to discussions, whether through specific expertise or more general insight. Participants also appreciated the socialising aspect of the subfora, and characteristics (such as humour) which facilitated such aspects. They also recognised people – whether specific real participants or types of people – who made claims which went against perceived scientific consensus, and expressed this recognition in a manner which made participating harder for such people. This was not only an informational concern of ensuring all participants interacted on a basis of shared facts. Negative recognition was expressed through emotional expressions of anger and hostility, or through communal humour or displays of solidarity, which suggested a united in-group against an unwelcome type of person.

The exact manner in which recognition shaped participation varied across the subfora. IFLScience and r/EverythingScience participants used affordances such as ‘liking’ and ‘downvoting’ to demonstrate (un)welcomeness of comments; while SkepticsSTM and XKCDScience participants drew on recollections of past discussions with certain people or types of people. But across the subfora enforced a communal expectation which I have referred to as the respect scientific consensus (RSC) norm. This norm reflects familiar emotional responses to (un)welcome forms of participation seen in FS, and also relates these to questions of how informational claims were made and assessed on the subfora.

5.2 Phatic Interactions

Community and sociability can also be demonstrated through phatic communication: “a type of speech in which ties of union are created by a mere exchange of words... They fulfil a social function and that is their principal aim” (Malinowski 1923, 316). FS scholars have noted that different forms of phatic interactions, and attitudes towards them, vary across fandoms. In this section I shall focus on three forms of phatic interaction which have been identified by Baym as key defining features of online communities: off-topic tangential discussions (1993), humour (1995), and politeness/hostility (1996).

5.2.1 TANS

Borrowing a label from Usenet participants, Baym employs the term ‘TANs’ (short for tangentials) to refer to extended off-topic discussions. In TANs participants turn a discussion topic into sharing jokes, personal experiences, and general small talk (Baym 1993). FS scholars argue that the prevalence or lack of TANs provides further insight into the communal values underlying a fandom; whether an ‘ethic of friendliness’ which encourages participants to share their personal lives with others (Baym 2000) or a belief that TANs detract from ‘intelligent’ or ‘useful’ discourse (Bennett 2013; Jenkins 1995). In this section I consider the prevalence of TANs across the subfora, and attitudes displayed towards them.

TANS were common on three of the subfora: *SkepticsSTM*, *r/EverythingScience*, and *IFLScience*. Many TANs were humorous, such as discussions of whether Republicans are secretly robots (*r/EverythingScience Ted Cruz’s Strange Smile*, Feb 2016) or finding amusing patterns in photos of Pluto (*SkepticsSTM Pluto Flyby*, July - Sep 2015). In others participants revealed personal stories or experiences, for example around university life (*r/EverythingScience My University’s Marketing Team*, Feb 2016; *Ted Cruz’s Strange Smile*, Feb 2016), countries of upbringing (*SkepticsSTM Pluto Flyby*, Dec 2015), or certain diseases (*IFLScience Scientists Grow Miniature Brains*, July 2015). Some TANs involved a great many participants, and/or made up a substantial proportion of the thread. This suggests that, on these three subfora, TANs were a welcome part of participation for many members. As one participant remarked of a discussion about the *Beach Party* film franchise on my introductory thread *SkepticsSTM More on PhD Research*, “the thesis will be about how quickly discussionz get derailed and turned into larfs” (Jan 2016).⁸⁰

⁸⁰ This comment was from JO 753, who – as noted in chapter 4 (sec. 4.4.5) – habitually employed this style of spelling.

TANs can be considered with respect to the affordances of different subfora. The ‘reply’ function of Facebook and reddit mitigated the risk that TANs might take over a thread – a criticism of TANs in some fandoms (Bennett 2013) – as they could be carried out in a miniature thread of their own. The r/EverythingScience rules specified that “comments must be on topic and not a meme or joke” (sec. 4.3.3). However there were many undeleted TANs, suggesting that participants often do not report them. SkepticsSTM has no ‘reply’ function, nonetheless participants did not express annoyance at threads being taken over by TANs. Participants rarely even remarked upon the presence of TANs. One of the few examples, the reference to how ‘discussionz get derailed’ in the previous paragraph, did not halt the TAN and was made by a participant who themselves participated in TANs,⁸¹ so should not be read as an expression of dislike. On another example (*Monty Hall Redux*, Oct 2015) one participant criticised an extended comment about the action film *Taken*; however they were quickly described as “humourless”, and the original poster suggested that it was “no biggie” that others have lost interest in the topic. Evidence suggests that on these subfora TANs were a welcome, even enjoyed, part of participation.

The popularity of TANs on these subfora is worth noting with respect to FS accounts. Baym argues that the prominence of TANs on the soap opera fandom in her study partly emerges from the subject matter. Discussions around soap operas often involve participants drawing parallels with personal issues in their own lives, which requires a guarantee of friendly responses (Baym 1993). However the subfora presented themselves as spaces for sharing scientific expertise and discussing factual claims. In FS such spaces are generally seen as eschewing TANs to push away personal/emotional experience in favour of ‘intelligent’ contributions (Bennett 2013; Jenkins 1995). However while some TANs discussed deeply personal issues, and received friendly responses, these were uncommon.⁸² As noted in section 5.1.2 the language on the subfora was often hostile, rather than conveying the sort of safe space seen in Baym’s study. Instead, I argue the prevalence and variety of TANs across these three subfora illustrate that participants on these subfora welcomed a wide variety of contributions, without an expectation of on-topic input.

TANs were much rarer on XKCDScience. Features which could lead to TANs – in particular, jokes and personal stories – appeared on XKCDScience, but were usually not developed into TANs. For example during the thread *Flying Cars* (Nov 2014) one participant shared an announcement of their job interview at a company which builds flying cars. This led to one

⁸¹ For example their contributions on *SkepticsSTM Are the Earth Moon* (Apr 2015) and *CERN The End of the World* (Sep 2015).

⁸² As these involve potentially sensitive material, I do not provide examples – see chapter 3 (sec. 3.2).

congratulatory comment, and one question about the company, but apart from these the discussion continued as before. However it should be noted that the ‘topics’ of XKCDScience discussions were often extremely fluid. While many started with a specific question, this would often change mid-way through the thread (*Flying Cars*, Oct 2014; *Puzzling Artefacts*, Aug 2015). There were also occasions where the moderator had ‘merged’ different threads into one, on the grounds that they dealt with broadly similar topics (*LIGO, Relativity Questions*, Feb 2016).

The ways in which initial topics lead to a wide array of ideas, suggestions, and shared expertise was reminiscent of the *Twin Peaks* fandom studied by Jenkins (1995). However he also argues that while “the netters pooled their knowledge, shared their mastery” they also “held this process at a distance from their emotional lives and personal experiences” (p.61). This distancing of emotional/personal experiences did not seem to apply in the case of XKCDScience. As noted above, participants did share personal experiences, even if they were not developed into TANS. Interviewees also suggested that TANS were an important aspect of other subfora on the XKCD Forum, many of which shared some participants with XKCDScience.⁸³ I therefore argue the absence of TANS on XKCDScience does not show dislike of sharing emotional/personal experience. Rather, it suggests interest in a range of contributions participants could add within the topics provided.

TANS also further demonstrated dislike of people who do not respect scientific consensus, and in-group bonding around that dislike. TANS rarely, if ever, included non-RSC participants; one non-RSC participant on *SkepticsSTM* occasionally tried to open new topics within discussions, but they were not taken up by other participants. Indeed, on one occasion they were met with the blunt response “I look forward to your groundbreaking journal paper on that” (*SkepticsSTM Axioms of Science*, Dec 2015). Moreover some TANS involved stories of dealing with people who did not respect scientific consensus. Examples included family members who were skeptical of man-made climate change (*r/EverythingScience My Father Sent Me This Article*, March 2015) and debating non-RSC views on other forums (*SkepticsSTM Gravitational Waves Discovered, Perpetual Motion Debunking*). In such TANS, participants talked about failure to respect scientific consensus even when no-one was proposing non-consensus arguments within the thread. As in

⁸³ Both XKCD-A and XKCD-H pointed me to the ‘Free As in Destitute’ subforum which has no specific topic, many in-jokes (XKCD-A), and “the best chit-chat” (XKCD-H).

section 5.1, failures to respect scientific consensus became a reference point for humour, expressions of shared dislikes, and the construction of a desired in-group identity.

5.2.2 Humour

The role of humour at creating community has been the subject of much social scientific literature; for wide-ranging accounts see (Billig 2005; Mulkay 1988). I shall focus on two specific themes, which have been noted in both FS (Baym 1995; Jenkins 1995) and STS (Riesch 2015). The first is the sort of knowledge(s) participants expect others to possess to 'get' the joke. The second is how humour can create enjoyment and social bonds amongst an in-group, while simultaneously indicating the unwelcomeness and perceived inferiority of an out-group. I shall begin by describing how humour appeared in the subfora, with reference to the first theme. I shall then consider the second theme with reference to the RSC norm.

Interviewees across subfora described humour as an enjoyable feature of discussions (XKCD-D, Skeptics-A, Skeptics-B). Similar attitudes featured on r/EverythingScience meta⁸⁴ threads. Humour was more prevalent on SkepticsSTM and IFLScience threads than on XKCDScience, with r/EverythingScience occupying a middle ground. On SkepticsSTM and IFLScience the threads on Pluto, Gravitational Waves, and Climate Change consisted almost entirely of jokes, and many participants joined discussions purely to contribute jokes.⁸⁵ At the other extreme, XKCDScience threads were less dominated by humour and featured fewer participants who joined discussions purely to make jokes. The only example of an extended joke in the XKCDScience samples was the thread *I Trust Science, So I Let It Make Decisions For Me* (Jan 2016). This began from a humorous premise – that phylogeny can be used to distinguish between meals and pets – and prompted entirely humorous comments. We have seen that XKCDScience discussions tended to stay on-topic; in this case, being humorous was the topic. This thread mostly featured participants who posted non-humorously elsewhere, and in other discussions participants weaved humour into informational contributions in a manner which fitted with the topic.

Examples of jokes are given in Box 5.6.

⁸⁴ 'Meta' threads on reddit are those in which participants and moderators discuss the role and functioning of subreddits.

⁸⁵ A full list of these threads can be found in Appendix 4, sec.1.

Box 5.6 Examples of Jokes

(1) I didn't evolve from no Homo naledi! My great^10000 grand-pappy was a Homo heidelbergensis!

XKCDScience *Homo Naledi: Another Link*, Sep 2015

(2) User1: A red dwarf has a lifespan much longer than the current age of the universe, so any first generation red dwarfs will still be chugging along [...]

User2: It's cold outside, there's no kind of atmosphere I'm all alone, more or less Let me fly, far away from here Fun, fun, fun, In the sun, sun, sun.

SkepticsSTM *Population III Stars*, Apr 2015

(3) User1: Could someone ELI5?

User2: It's 8:30 and your bed time.

User1: Can you tell me tomorrow?

r/EverythingScience *Einstein's theory about gravitational waves*, Feb 2016

In extracts (1) and (2) technical terminology – “Homo Heidelbergensis” and “red dwarf” – were turned into humorous references: stereotypes of rural Americans (1) and the theme song of the TV series *Red Dwarf* (2). Extract (3) involved wilful misunderstanding of a common reddit acronym ‘ELI5’ (Explain Like I’m 5 years old), and in doing so achieved an extremely high upvote score of +20. These examples display how a range of knowledges were involved in jokes: technical scientific knowledge (1), America-centric stereotypes (1), cultural references to media outputs (2), and platform-specific in-jokes (3). Baym (1995) has argued that the shared knowledge involved in jokes demonstrates communal interpretations of certain material – part of a socialisation process that Jenkins calls ‘learning to read the ‘right’ way’ (Jenkins 1992). Relating this idea specifically to science, Riesch has expressed concerns that science-related humour may exclude participants without the expected technical knowledge required to get jokes (2015). However non-technical knowledge also requires learning (I had to use search engines to get cultural references in many jokes) and as such may be similarly exclusionary. These examples suggest that creative participation on subfora drew on a very wide range of knowledge, much of which bore no self-evident relation to ‘science’.

The high proportion of humour on SkepticsSTM was largely due to extended jokes which built on previous contributions. For example, the thread *Gravitational Waves Detected* (Feb 2016) involved multiple comments about how the article was from the future (due to a

misprinted date), followed by another about gravitational waves detecting “the farts of God”. Much of the thread alternated between informational discussion and these humorous TANs, with many participants joining in both. Similar examples of collaborative joke-making appeared across various r/EverythingScience threads – for example on *Ted Cruz’s Strange Smile* (Feb 2016) and *Why is Homeopathy* (Feb 2016) – though the reply function meant these did not take over the thread in the same manner as on SkepticsSTM. Collaborative jokes provided opportunities to combine personal creativity with communal socialising, using ideas drawn from science and from elsewhere to create humour.

The high proportion of humour on IFLScience did not come from the sorts of collaborations seen on SkepticsSTM. Instead there was periodic repetition of similar, even identical, jokes. Many of these involved cultural references which were humorously related to the post topic. Examples included the claim that the Pluto New Horizons missions cost ‘about tree fiddy’, a catchphrase from the TV series South Park (*How Much Did It Cost To Send A Spacecraft to Pluto*, July 2015) or mistaking the gravitational wave detector ‘LIGO’ for the popular toy ‘LEGO’ (*Rumor Claims Gravitational Waves Have Been Detected At LIGO*, Jan 2016). Such jokes often took the form of ‘meme’ images – combinations of pictures and captions which gain recognition through repeated use across the internet. Examples are displayed in Fig. 5.1.



Fig. 5.1. Examples of 'meme' images which appeared as responses, often multiple times, on IFLScience threads across data collection periods. Full explanations for each are given in the text below. I do not provide URLs as these would identify individual commenters.

Fig. 5.1(a) depicts two characters from the 1970's American sitcom *Sanford and Son*, and is designed to look as if the characters are remarking on the above comments – a device which can be employed in any Facebook thread, whatever the topic. Other memes were associated with scientific themes. Fig. 5.1(b) compares the flyby of Pluto by the *New Horizons* spacecraft to a recognisable phenomenon from human relationships. Fig. 5.1(c) depicts the science communicator Bill Nye, alongside a caption in which 'dropping' science can be seen as a reference to 'dropping the mic' (a dramatic and crowd-pleasing way to conclude a speech) or 'dropping an album' or 'the beat' (which are used to suggest musical skill). Fig. 5.1(d) depicts another science communicator, Neil DeGrasse Tyson; the phrasing of 'y'all motherfuckers' can be read as a racialised reference to language used by characters such as Jules in the film *Pulp Fiction*, a common comparison made with Tyson on science-

related Facebook pages.⁸⁶ Such jokes again indicate the range of knowledge participants drew upon for creative participation. Parallels can also be drawn between these memes and the fan videos and music studied by Jenkins (1992) – both involved group-specific re-use of existing material, which brought participants together in shared appreciation of creative skill. In the case of IFLScience, this appreciation was shown through the relatively high number of likes these images often received.

In sum all the subfora exhibited uses and appreciation of humour. These were shaped by distinctive features of each subforum. XKCDScience participants integrated jokes with on-topic discussion; in SkepticsSTM and r/EverythingScience participants developed lengthy collaborative jokes; IFLScience participants used references and meme images that were likely to be recognisable from wider social media usage. However there were general patterns, which corroborate the arguments of section 5.1 that the subfora acted as places to discuss ‘science’ in a social as well as information-seeking fashion, and where ideas drawn from science were combined with a range of other topics and references.

Humour and the RSC Norm.

Humour was often used in response to participants who violated the RSC norm. Examples are given in Box 5.7.

⁸⁶ See in particular the Facebook page ‘Black Science Man’. It should be noted that such humour does not feature within posts by administrators of IFLScience.

Box 5.7 Examples of humour and non-RSC participants

(1) User1: I haven't read your reference in full. I scanned quickly through it but had to stop when I got to the glass in the sky bit - I could no longer see through the tears of laughter.

User2: :facepalm: It's bafflingly bizarre.

SkepticsSTM *Tropic of Cancer*, Apr 2015

(2) However, in your description, I need only run faster and I will start to mysteriously cool down, yet sweat will continue to evaporate as if I were warm. That is certainly a change in physics.

XKCDScience *Gravity-Temperature Musings* by [username], Feb 2016

(3) It would cost more [to use non-homeopathic treatments], yes. Because you would not be treating them with literal water.

r/EverythingScience *Why Is Homeopathy*, Feb 2016

(4) "Because apparently there are still some people who argue against the correct solution." There's the first couple of lines of your opening post, [username] And they say precognition isn't real!

SkepticsSTM *Monty Hall Redux*, Oct 2015

(5) Yeah but they'd [scientists] lie about something else, like "I have dolphins with lasers on their heads" or "let's go get some ice cream".

SkepticsSTM *CERN The End of the World*, Sep 2015

Some of these, such as (1-3), used humour to emphasise the purported incorrectness of claims. Exaggeration was created through such rhetorical devices as describing physical responses (1); or in (2) and (3), through incongruously contrasting an understated tone ("that is certainly", "it would cost more, yes") with a dramatic statement highlighting the non-consensus nature of the claim ("change in physics", "treating with literal water"). Others, such as (4) and (5), used humour to ridicule more general non-RSC behaviours. Extract (4) derived humour from the inevitability that "some people" will argue against a "correct solution" – the reference to "precognition" can be read as sarcastic, given the frequency with which participants on SkepticsSTM did argue against perceived 'correct solutions'. Extract (5) offered a general response to a common claim on SkepticsSTM: that scientists, and therefore scientific consensus, are biased and/or deliberately concealing information. The humorous images presented in this extract contrast with the seriousness with which non-RSC participants presented this claim (*SkepticsSTM IMAP*, Apr 2015; *Are the Earth Moon*,

Apr 2015). All of these served to make non-RSC views look not simply incorrect but also ridiculous.

While I have discussed examples of individual jokes, humour frequently featured as part of a phenomenon described in section 5.1.3 – the instant, communal sanctioning of participants who were recognised as proposing non-RSC stances. For example, extract 1 was one of many contributions in this thread which made jokes against claims that crop circles are produced by aliens (*SkepticsSTM Crop Circle Formations* Jul-Sep 2015). Examples included offering exclusive opportunities to purchase alien memorabilia, and discussing if hay bales are three-dimensional crop circles. The recognition of non-RSC views therefore gave opportunities for communal humour, creativity, and social bonding amongst those who followed the RSC norm, while also strengthening barriers against non-RSC claims. Again we see the entanglement of shared in-group enjoyment with the assessment of informational claims.

Uses of humour went beyond directly attacking non-RSC participants within discussions, and can also be seen as presenting RSC attitudes as generally superior. Many jokes implied poor or deluded thinking on the part of people who held non-RSC views; from phrases such as ‘tin foil hat’ and ‘illuminati’ which connoted extreme conspiracy theorists (*IFLScience How to Argue with Anti-Vaxxers*, Aug 2015; *In Science We Trust*, March 2015) to humorous descriptions of people failing to understand scientific information (*XKCDScience Favourite Home Experiments*, Oct 2007). In Fig. 5.1, the people in (c) and (d) – Bill Nye and Neil DeGrasse Tyson – are both relatively well-recognised amongst American audiences as popular science communicators and opponents of perceived anti-science movements.⁸⁷ The superiority implied by Nye’s “dropping the science” and Tyson addressing “y’all motherfuckers” can therefore be read as representing the superiority of their RSC views. The social role of such jokes goes beyond the immediate interaction. Analysts following a ‘superiority’ approach to humour (Billig 2005) argue that the combination of shared knowledge and ridicule acts to continually reinforce a general sense of superiority amongst an in-group. Humour can therefore be seen as serving social purposes beyond simply responding to unwelcome participation, but also in presenting pro-RSC views as indicative of a superior social identity.

⁸⁷ For example Bill Nye has publicly debated the anti-evolutionist Ken Ham, an experience which informed his book *Undeniable: Evolution and the Science of Creation* (Nye 2014), and in the *Washington Times* stated he was open to the idea of jailing climate change deniers (Richardson 2016). DeGrasse Tyson has argued in favour of scientific thinking against religion, climate change denial, and non-empiricist philosophy in numerous interviews, broadcasts, and popular writings (for example Pigliucci 2014; Tyson 2016).

5.2.3 Politeness/Hostility

Though some of the examples discussed above could certainly be interpreted as hostile, none of the subfora showed clear evidence of respecting or expecting hostility.⁸⁹ In the discussion below my introductory post on SkepticsSTM (*More on PhD Research*, May 2016) participants raised “bullying” and “personal attacks and insults” as examples of poor behaviour. When I asked interviewees for characteristics of bad discussions, responses included “people hurling insults at each other” (XKCD-H) “too much animosity” (Skeptics-A); and “ad hominem” instead of “civility” and “discuss[ing] the issue even-handedly” (Skeptics-C). As discussed in section 5.1.1, r/EverythingScience reflected a wider ‘redditiquette’ expectation of politeness; there was a high proportion of thanking and/or showing respect for answers, and multiple users joined discussions simply to provide brief expressions of appreciation. It was harder to discern general attitudes to hostility in IFLScience. There were comments which objected to perceived ‘nastiness’ or ‘rudeness’ (e.g. on *IFLScience Scientists Grow Miniature Brains*, July 2015; *How To Argue with Anti-Vaxxers*, Aug 2015) but this may simply have arisen from the extremely large number (and variety) of responses on IFLScience. However, I did not encounter any suggestions that hostility was *expected* on IFLScience. Overall, where evidence existed of participants’ attitudes towards hostility, it showed a preference towards politeness.

However, whatever participants’ intentions or preferences, online groups based around discussing factual claims can struggle to maintain a non-hostile environment. Suggesting that a fellow participant is factually incorrect while staying polite can be difficult, particularly given that the written medium has a tendency to be more aggressive than face-to-face interaction (Mulkay 1985). Fandoms which aim for an ‘ethic of friendliness’ often use rhetorical modifiers to soften disagreement (Baym 1996). Such devices were sometimes used across the subfora. However in other cases strength of disagreement was rhetorically strengthened. Examples of both are shown in Box 5.8.

Box 5.8. Modifying Disagreement

- (1) I'm sorry if I come off as a little rude, but the combination of making claims without providing any supporting evidence and unscientific tone of your comment made me a little impatient when trying to decipher it.

r/EverythingScience *The Food Babe Blogger*, Apr 2015

⁸⁹ Some social media sites do have an explicit expectation of hostility – for example see Bartlett’s (2014) account of 4chan.

- (2) The claim was made that science is not based on any assumptions (axioms) that cannot be falsified with empirical evidence". Not your statement, I know, [username], but it's a horrible double negative to sort out.

SkepticsSTM *Axioms of Science*, Dec 2015

- (3) User1: 10,000? Can you offer a source for that figure? That would be a devastatingly low breeding population.

User2: I have no idea where that number is coming from. Seems pretty handwavy to me

XKCDScience *How Long Can We Survive Global Warming*, Feb 2015

- (4) User1: Yes but that doesn't mean they propagate the gravitational force.

User2: It quite literally does, unless gravity itself is an emergent property of some other as yet undiscovered force.

XKCDScience *LIGO Likely to Announce*, Feb 2016

Extracts (1,2) used modifiers such as "I'm sorry", and "not your phrase I know" to downplay the strength of disagreement. By contrast, extracts (3,4) used phrases such as "devastatingly low", "I have no idea", and "it quite literally does", to strengthen disagreement. A key point to is that even when disagreement was strengthened, it was often to attack ideas and not personal characteristics of people. However, as we have seen in many of the examples in this chapter (particularly in Box 5.5) there *were* instances of personal attacks, many of which come from participants who generally respected norms. Further examples are shown in Box 5.9.

Box 5.9 Hostility and Strong Disagreement

- (1) If, instead of becoming totally goggle-brained about the pretty images you claim can be produced only by a computer, you thought about it for a moment (OK - in your case a year) you would realise that ANY Mandelbrot image, computer-generated or not, is incomplete.

SkepticsSTM *Crop Circle Formations*, Jul 2015

- (2) When you say stupid things like that including misusing the word "valid" you are just embarrassing yourself. It reveals to all here that you truly do not have a clue what you are talking about.

SkepticsSTM *Monty Hall Redux*, Oct 2015

- (3) Whatever resources you have been using to learn about the topic have led you severely astray and have clouded your mind to the point where you will accept any "fact" so long as it sounds scary or evil enough.

r/EverythingScience *The Food Babe Blogger*, Apr 2015

- (4) Who. Cares. What makes sense to you is actually factually irrelevant, because what you don't know about this field, and the field of biology at large, is so vast that 'what makes sense to [username]' is as irrelevant as my opinions on how black holes work. I've got ideas, some that even make sense to me, but do you know who doesn't give a fuck about them? If you guessed 'any physicist' you would be correct.

XKCDScience *Is Control a Common Property of All Life*, Dec 2015

All these examples, as in hostility more generally, were addressed towards non-RSC behaviour. These did not simply attack claims, but also the claimants themselves. They focussed largely on the claimants' intelligence and scepticism, with phrases like "totally goggle-brained" (1), "stupid things" (2), "you will accept any "fact" (3), and "what you don't know... is so vast" (4). These characterisations were particularly hostile given, as argued in section 5.1.3, non-RSC participants often presented themselves as intelligent and sceptical thinkers. When directed against non-RSC participants such hostility was generally permitted by fellow participants. On some occasions, for instance on *r/EverythingScience The Food Babe Blogger* (Apr 2015) and *SkepticsSTM Monty Hall Redux* (Oct 2015) participants criticised others (or even themselves) for the hostility; however other participants then supported the hostility. Therefore the general pattern of not personally attacking participants did not apply when the RSC norm was flouted.

This relationship between hostility and the RSC norm was illustrated particularly clearly by the moderator of XKCDScience. This participant was active at reprimanding participants who they saw as being disrespectful towards others (*Landing Rockets Upright*, Feb 2016; *Is Control A Common Property*, Dec 2015). However on one occasion (on *Acceleration Near a Black Hole*, Apr 2013) their reprimand was responded to by a participant generally accepted as an expert in relativity. The exchange went as follows:

Mod: the thrust calculation isn't any different from the value you [the original poster] claim to be asking for. You should probably learn more about the physics we're discussing before you decide to be condescending about our answers [...] You were being condescending when, upon having your question answered, you supposed I was probably compensating for something Freudian.

[...]

User: nah nah, the infaller has a ruler and a clock, and if she uses her own ruler and clock to measure $d^2 x / dt^2$ she isn't gonna get infinity use the infalling metric and take some derivatives. I gotta catch a bus but [Mod] you jumped the gun on calling our comrade here out.

[...]

Mod: [The original poster's] misunderstanding [was] shared by the last person who came here asking about GR and then getting frustrated with people misunderstanding questions. I apologize for initially reacting as if your level of knowledge was closer to hers than to, say, [user]'s

We should note that the moderator apologised for misunderstanding the poster's "level of knowledge", even though the initial reprimands were about referring to answers as "Freudian" (and, elsewhere in the thread, for describing a suggested Wikipedia article as "gibberish"). This "condescending" choice of language is a fault which need not, in theory, be justified by higher levels of knowledge. However the moderator tied their reaction, and their apology, to their perception of the poster's level of knowledge. This brings us back to a running argument of this chapter, first raised in section 5.1.3. There, I argued participants' interpersonal behaviour followed from an assessment of whether a claimant was respecting scientific consensus. Here, participants assessed their behaviour in light of the levels of expertise exhibited by those they were addressing. These were two facets of a broader argument: what was considered an appropriate social response was tied to perceptions of how participants used scientific knowledge within discussions.

In concluding, we should also note how the second user in the above extract referred to "calling out" the participant. This could be read as suggesting non-RSC participation cannot just be ignored, but should be made visible and reprimanded. In isolation, we cannot say much about this particular choice of words. However it foreshadows a key question of the next two chapters: what did normative participants of the subfora find so problematic about disrespect of scientific consensus? Such a question requires closer engagement with how participants interpreted 'science', and its roles in both the subfora and wider society.

Conclusion

In this chapter I have examined latent emotional meaning-making – the ways in which patterns of social behaviour around a particular object (science) can be related to underlying emotional attachments. In section 5.1 I focussed on how participants showed recognition for

one another, and how this related to values and participation within the subfora. I found variations between the subfora, resulting from both technical affordances and features of the membership. The way in which participants appeared multiple times on SkepticsSTM and XKCDScience allowed members to build up recollections of specific people and types of people. IFLScience and r/EverythingScience participants' affordances used such as 'liking' and 'downvoting' in response to particular forms of recognised behaviour. Participants on all the subfora recognised people – whether specific real participants or more general types of people – who made claims contrary to mainstream scientific consensus. Recognition was expressed in a manner which made participating harder for such people. This was not purely an informational concern of ensuring all participants interacted on a basis of shared facts. Rather, participants responded emotively to people who refused to accept perceived scientific consensus as correct or to engage with the details of consensus. I referred to this recurrent behaviour as the respect scientific consensus (RSC) norm.

In section 5.2 I examined phatic interactions. Across all subfora participants appreciated phatic interactions, corroborating my argument that the subfora were not simply places for sharing information. All except XKCDScience featured regular TANs, involving jokes and sharing of personal details, in a manner which turned 'informational' posts into sites of social bonding. On XKCDScience participants focussed more on the post topics; though there were still jokes and anecdotes, and interviewees claimed they enjoyed this social aspect of participating. However, this range of participation did not equate to an 'anything goes' attitude on the subfora. Across all subfora, phatic communication encouraged the RSC norm. Humour and TANs were often used to denigrate people, both in the subfora and wider society, who seemed to misunderstand and/or contradict consensus scientific knowledge. However when participants aligned with the RSC norm they were able to engage in a wide range of social behaviour.

Phenomena which have been noted in studies of other online settings featured throughout this chapter. In particular, the enforcement of behaviour through community co-ordination is a common theme within studies of online fandoms (Baym 1993; Bennett 2013) and other participatory websites (Bruns 2008; Tkacz 2014). The use of linguistic modifiers and online affordances to imbue textual communication with emotional force has also been noted across various studies of online fora (Herring 1996; Papacharissi 2004). Such ideas are less familiar within STS. These findings therefore provide novel perspectives on how participation in science-related discussion can be shaped by underlying emotional motivations, such as desire for socialising or to develop a certain kind of social identity. I have also highlighted mechanisms – socially enforced norms – through which emotional

factors shape participation. However, as there are still open questions as to how these emotional factors relate specifically to *science*; this will be the task of the next chapter, when I consider how participants demarcated science from other concepts.

A final important theme throughout this chapter was the way in which these everyday online behaviours drew heavily on references to consensus knowledge developed by professional scientific institutions. These findings begin show how two major uses of participatory websites – socialising and seeking/debating of authoritative knowledge – can be entangled. Moreover, they also demonstrate ways in which forms of expertise developed within professional, high-stakes settings can play roles within informal, lower-stakes settings. This finding will be developed over the following chapters.

“I would prefer that we don’t go looking for alternatives for what Science means”⁹¹

6: Manifest Descriptions of Science

In this chapter I examine *manifest descriptive meanings of science*: instances in which participants explicitly ascribed certain characteristics, descriptions, and/or definitions to ‘science’. In section 6.1 I draw out recurrent examples of ‘non-sciences’ which were distinguished from ‘science’. In section 6.2 I develop on a finding from 6.1, that across the subfora distinguishing ‘science’ and ‘non-science’ often involved references to group and personal identities. In section 6.3 I move away from a focus on people and consider how ‘science’ was presented as a concept – one associated with higher epistemological, ethical, and social values than other practices.

As outlined in my literature review (2.1.1), within STS scholarship one of the most widely used approaches for analysing descriptive meanings is Gieryn’s ‘boundary-work’ (Gieryn 1983, 1999). This approach focusses on how distinctions between ‘science’ and ‘not-science’ shape and are shaped by social interactions, particularly in relation to excluding ‘non-scientific’ viewpoints. Throughout this chapter I shall consider how boundary-work on the subfora was like, and unlike, settings studied in previous STS work. By drawing these comparisons I consider how traditional STS ideas of scientific authority were (or were not) reproduced in online non-professional discussion.

Methodology

The data for this chapter was taken from two purposive samples of scraped threads. The first sample was designed to capture a breadth of instances in which ‘science’ was explicitly discussed. I created, separately for each subforum, a randomly ordered list of responses which contained the string ‘scien’ (so as to capture ‘science’, ‘scientific’, ‘scientist’, etc.).⁹² I coded each of the four lists until I reached *theoretical saturation*: the point at which material repeatedly fitted recognised patterns, rather than producing new insights (Charmaz 2000).

⁹¹ Interviewee Skeptics-A.

⁹² String searching was carried out using the Excel query “=IF(ISNUMBER(SEARCH(“scien*”, [text])), “True”, “False”)”. Each response was given a random number using Excel’s RAND function and then sorted lowest to highest.

The random ordering of each list ensured that theoretical saturation was not influenced by the original chronology of posts, but rather drew from a range of threads.

The second sample was aimed at developing a fuller understanding of the contexts around references to 'science' and 'not-science'. I began by selecting all post titles which suggested discussions of 'science' as a concept were likely to occur in the thread. These decisions were made based on findings from prior STS literature and my prior familiarisation with the data, as discussed in chapter 3 (sec. 3.4.3). The selected posts are listed in Appendix 4, sec. 2. The data in the second sample was made up of all responses below these posts. Any thread over 10,000 words in length was only coded until theoretical saturation was reached.

The coding for this chapter took a theory-driven approach (sec. 3.4.3). Drawing on the concept of boundary-work I coded instances of participants distinguishing 'science' from other practices, describing certain characteristics as 'scientific' or 'unscientific', or presenting certain activities as limited to 'scientists' (Gieryn 1983, 1995, 1999). Fuller details of the code-book are given in Appendix 5, sec. 2.

The recurrent forms of these instances are presented and discussed in section 6.1. Following the approach of discourse analysis outlined in chapter 3 (sec. 3.4.4), I then focussed on how these presentations of 'science' work in conjunction with other linguistic features to shape participation within the subfora. These analyses are presented in sections 6.2 and 6.3.

6.1 What boundaries were drawn?

I begin by describing three forms of boundary which repeatedly appeared across the subfora. These boundaries were: contrasts between 'science' and 'unscientific' or 'pseudoscientific' practices; distinguishing 'popularisation' from 'real' science; and restricting science to professional practitioners. I compare the ways these boundaries were presented on the subfora with other settings studied in STS.

6.1.1 Non-Sciences and Pseudosciences

Across all the subfora, a common form of contrast involved referring to various forms of organised practices as 'not science' or 'pseudoscience'. Examples are given in Box 6.1.

Box 6.1 Illustrative Examples of Organised Practices which are 'Not Science'

- (1) Faith is enough to verify something for the believer - he/she does not need other sources of confirmation... believing in a scientific theory is not enough, believing in religious principles is. So no, Faith is not a characteristic of science.

Skeptics *Axioms of Science*, Dec 2015

- (2) I am starting to see a reason why we should doubt whether string theory is science. Maybe it is more like math?

XKCD *Science Should We Consider String Theory To Be A Science?*, Feb 2016

- (3) The problem is millions of people pretending to be scientists who are in reality subjective opinion philosophers, e.g. so-called "economists." But actual science has always been about accuracy/repeatability.

r/EverythingScience *Reproducibility Should be at Science's Heart*, Feb 2016

- (4) You accuse proponents of the Big Bang theory of holding it purely for political reasons, and then defend the Steady State theory using purely politically-motivated reasoning... essentially rejecting the scientific method.

SkepticsSTM *IMAP*, Apr 2015

Perceived non-sciences included religion (1), other academic disciplines (2, 3), and politics (4). Another commonly mentioned form of non-science was organised movements against mainstream scientific consensus, such as 'anti-vaxxers'⁹³ (*IFLScience How To Argue With Anti-Vaxxers*, Aug 2015), advocates for teaching creationism (*IFLScience Teaching Stork Theory*, March 2015), and climate change deniers (*r/EverythingScience My Father Sent Me This Article*, March 2015). All these contrasts have been observed across numerous studies of boundary-work in different settings – to give just a few examples, religion in Gieryn (2008), politics in Jasanoff (1987), other academic disciplines in Burri (2008), and pseudoscientific movements in Gieryn (1983).

This variety of contrasts occurred within all of the subfora, and did not point to any consistent or shared representation of 'science' within any particular subforum. Indeed, boundaries

⁹³ People who argue that vaccines are harmful, and oppose mandatory vaccination.

were sometimes drawn in seemingly inconsistent ways within subfora. For example, in IFLScience *How to Argue with Anti-Vaxxers* (Aug 2015), anti-vaxxers were described as unscientific for doubting scientists' claims about the safety of vaccines. However in another IFLScience post, *In Science We Trust* (March 2015), uncritically trusting claims (even those made by scientists) was labelled as unscientific. These alternative contrasts reflected surrounding context; on *How to Argue with Anti-Vaxxers* the thread was dominated by people using 'science' to criticise anti-vaccine stances, while on *In Science We Trust* 'science' was used to demonstrate personal characteristics (including presenting oneself as a 'real skeptic'). In line with findings from STS scholarship, boundaries around 'science' were drawn and re-drawn depending on surrounding context (Gieryn 1983).

Looking more closely at the language used in Box 6.1, we can note a distinction between whether boundaries were drawn between types of *ideas* or types of *people*. Examples of boundaries between ideas included the question of whether string theory (2), accuracy/repeatability (3), or faith (1) are 'science' (and/or "characteristics of science"). Examples of 'unscientific' types of people included "the believer" (1) and "subjective opinion philosophers" (3). Such references to types of people, with connotations of certain kinds of views, appeared in much boundary-work across the subfora. For example, discussions of politics often referenced specific political figures or movements. The use of Darwinism for political purposes was criticised on *XKCDScience Homo Naledi: Another Link* (Sep 2015) specifically in relation to politicians with racist agendas. IFLScience and r/EverythingScience participants commonly referred to prominent Republicans such as Ted Cruz; in the words of one participant "the idea that *someone like this* can lead the Senate science committee scares the hell out me" (*r/EverythingScience Ted Cruz Goes Full Orwell*, March 2015, emphases added). Such references reflected the generally progressivist political stances and the emphasis on topical events⁹⁴ of these subfora (4.2.5, 4.3.5). In these cases, boundary-work related less to the idea that politics and science should be separated to ensure a general "prevention of the control of science by outside powers" (Gieryn 1995, 434; see also Jasanoff 1987). Instead, the concern seemed to be about separating science from particular *types* of people and their views.

⁹⁴ We should recall that the data collection period co-incided with campaigning for the Republican presidential candidacy.

6.1.2 Popularisation

Studies of public engagement with science have shown that popularised accounts of science, such as those which appear in popular media or books/programmes intended for non-expert consumption, are often presented as distinct from ‘real science’ (Cassidy 2006; Hilgartner 1990; Mellor 2003). Suggestions that popular and/or mass media presentations of science are not ‘real science’ appeared across the subfora. Sometimes popularisations of science were related to the ‘anti-science’ positions outlined in section 6.1.1. Participants across subfora referred to specific media outlets, in particular *Natural News* and *Conservapedia*, as mouthpieces for positions such as anti-vaccination or climate change denial (*IFLScience How To Actually Argue with Anti-Vaxxers*, Aug 2015; *IFLScience Ted Cruz recently compared himself to Galileo*, March 2015; *SkepticsSTM ‘Libertarian’ ‘Science’*, Apr 2015). However on other occasions popularisation *in general* was presented as a contrast to science. Examples are given in Box 6.2.

Box 6.2 Popularisation as Not-Science

- (1) User1: Numerous recent blogs and web postings are erroneously claiming that an asteroid will impact Earth, sometime between Sept. 15 and 28, 2015... That's the rumor that has gone viral - now here are the facts ...

User2: This kind'a highlights what, unfortunately, many people have with their relationship with science. They think that science is so awesome that it can do things like predict an asteroid impact not only on the exact date but exactly where (Which obviously they can't) but not awesome enough to discover something much more plausible like climate change.

SkepticsSTM *WAKE UP SHEEPL*E, Aug 2015

- (2) I think presenting science for the gen pop is great, but there's something missing - like a hook to draw them into learning more about the hard work or theory behind it, not just the EXCITING SCIENCE NEWS EVERYBODY.

r/EverythingScience *‘Woohoo!’ email stokes rumor that gravitational waves*, Feb 2016

- (3) The problem is that the people presenting experiments like that are generally doing so to a broadly lay audience. In this case, they have to try to come up with some explanation people will understand, but these explanations are not the physics.

XKCDScience *RELATIVITY QUESTIONS*, Apr 2012

These extracts suggested that popularisation presents “rumour” rather than “the facts” (1) and “explanations which are not the physics” (3); or that popular accounts incorrectly

represent science as discoveries without “hard work or theory”, or as a practice which can make overly accurate predictions (1). In so doing they followed a pattern noted by Bucchi (1996) and Cassidy (2006), of suggesting that ‘deviations’ from science made in the process of popularisation separate popular science from real science. However it is important to note that these examples did not simply blame the media for presenting an erroneous picture of science. Rather, as in the previous section, they referred to a mixture of the media and “people” (1,3), or the “gen[eral] pop[ulation]” (2), whose media consumption led them to misunderstand ‘science’. Again, much boundary-work on the subfora also involved drawing boundaries between types of people.

STS scholars have argued that using boundary-work to separate types of people is motivated by aims of monopolising authority. Hilgartner has argued that distinguishing popularisation from science separates “scientists (and others who derive their authority from science)” from “the non-expert community” (1990, 534) – by shifting boundaries around what counts as ‘popularisation’, experts are able to defend both professional autonomy and the epistemic authority of scientists. The question of how, if at all, participants on the subfora “derive[d] their authority from science” is worth careful consideration. I selected the subfora precisely because they offered low-stakes interactions, by contrast with (for example) laboratories and public engagement events where professional standing may be at stake. Most participants did not present themselves as professional scientists; even amongst those who did, there was no evidence that activity on the subfora could impact on their professional autonomy. However separating science from popularisation can also serve to defend a more general epistemic authority of science, which goes beyond particular professional stakes (Mellor 2003). This idea that on the subfora non-experts carried out actions which shored up the epistemic authority of experts is a question which I will return to throughout this chapter.

6.1.3 Professional Boundaries

A final important form of boundary-work is claiming that only the work of professional scientists counts as ‘science’ (Yearley 1988). As shown by the examples in Box 6.3, participants did draw rhetorical boundaries around the activities and abilities of professional scientists.

Box 6.3 Science as Professional Expertise

- (1) I want you to reread [your] sentence, reconsider what YOU know vs what actual scientists who study these topics know, and reconsider if you think [you] offering this brilliance to the world is something worth banking on.

XKCDScience *Is Control a Common Property of All Life*, Dec 2015

- (2) If you are not a scientist in the field, and you have read the papers, and you find that you don't believe the papers, the question you should ask first is 'what am *I* not understanding?' Because as with any field for which the apprenticeship is a decade of undergraduate and graduate study, there are *many* little pieces of assumed knowledge and understanding that might not be obvious to the attempted autodidact

r/EverythingScience *My Father Sent Me This Article*, March 2015

- (3) If science has overlooked something, it's pretty much guaranteed that there's a grad student (one with all of the required background and training) who is studying exactly this idea, and equipped with a university laboratory..... So don't take this personally, but you're really unlikely to have found something that no one else knows about.

XKCDScience *The Battery That Isn't A Battery*, Jan 2011

- (4) User1: Scientists, especially great ones, have usually done a tremendous amount of research before arriving at their conclusions, as opposed to cranks and jerks who spew nonsense.

User2: The work of all of those 'priests' [of science] has been subjected to the most rigorous examination possible by large numbers of other scientists.

SkepticsSTM *'Libertarian' 'Science'*, Apr 2015

Reasons given for inaccessibility included lack of the knowledge acquired by scientists through “study” (1) or “apprenticeship” (2); the technical resources of a “university laboratory” (3); and the “tremendous amount of research” and “the most rigorous examination possible” which characterises professional scientific work (4). It should be noted that 1) all of these accounts were criticising arguments made by other participants and 2) that none of the authors of these extracts referred to any personal scientific credentials. References to boundaries around professional science were used as attempts to control discussion, without requiring professional scientists to be present.

In STS accounts professional scientists are often depicted as constructing boundaries around professional practices in order to protect their autonomy (Gieryn 1995; Jasanoff 1987). It was therefore notable that participants in the subfora who presented themselves as

professional scientists – either in reddit flair,⁹⁵ interviews, or threads – did not clearly show a stronger tendency towards drawing professional|non-professional boundaries. Indeed in some cases scientific experts went *against* a form of professional boundary-work noted by Gieryn, that scientists sometimes distance ‘science’ from technological and/or moral failings by placing blame on politicians, engineers, or the media (1995). For example, on r/EverythingScience *Professor Who Helped Expose Crisis* (Feb 2016) a contributor flaired with a ‘PhD in Environmental Science’ was more critical of internal practices of academic science than other (non-flaired) participants, who attempted to blame industrial funding instead. Similarly, on XKCDScience *Problems in Medical Research* (Feb 2016) a professional biologist made repeated claims that science has huge problems with selective reporting of positive results, without moving blame for this behaviour out of the realm of science. As in section 6.1.2, these findings raise questions of how professional stakes apply in the subfora. In particular, they suggest that attempts to shore up the epistemic authority of science may be motivated by interests which are not related to securing professional or personal authority.

Summary of Section 6.1

From the contrasts drawn between sciences and non-sciences I suggest two main themes which are worth further analysis. Firstly that recurrent forms of boundaries drawn on the subfora were very similar to those in other settings studied by STS scholars. There were some distinctive features in how these boundaries appeared, which can be related to features of the subfora. For example the way that boundary-work on IFLScience and r/EverythingScience drew on references from other online media (6.11) might reflect the fact that participants on these sites were likely to be consuming science-related material alongside a range of news stories, a feature of social media Jenkins refers to as ‘convergence culture’ (Jenkins 2006a). However, overall the ways in which ‘science’ was distinguished from ‘non-science’ on the subfora fell largely within patterns familiar from STS studies of other settings.

The second theme was that boundary-work was often tied to questions of identity. This is again familiar within STS work in other settings. The work of Gieryn and Jasanoff has illustrated how groups such as scientists, policymakers, or journalists draw boundaries

⁹⁵ Recall from chapter 4 (sec. 4.3.3) that flair is a short label appended to a reddit username to indicate certain levels of education in a subject.

around ‘science’ to increase their professional authority. However it is not clear how the motivations present in these other settings – in particular, issues around maintaining professional autonomy – translate to the subfora. The extensive references to identity in the above examples suggest that the subfora open up ways to further examine relationships between motivations for boundary-work, identity references, and epistemic authority of science. In the following section I shall therefore focus specifically on the role of identity, before moving on to questions of epistemic authority in 6.3.

6.2 *Boundary-Work and Identity*

I begin this section by looking more closely at references to identity; in particular, drawing a distinction between references to people *outside* of the thread, and references to fellow participants *within* the thread. In doing so I relate boundary-work to FS work on community formation. Finally I consider how participants variously moved themselves ‘inside’ and ‘outside’ the space of science, in relation to the role of the sub-fora as spaces for non-specialist discussion.

6.2.1 *Unscientific Imagined Others*

Previous boxes included references to a wide variety of people and groups outside of the thread, from the “believers” (in the religious sense) and “subjective opinion philosophers” in Box 6.1, through “the gen[eral] pop[ulation]” and numerous mentions of “people” in Box 6.2, to “actual scientists” and “the attempted autodidact” in Box 6.3. Participants also used identity labels which negatively characterised groups of people seen as being against ‘science’. We saw in the previous chapter (sec. 5.1.2) that both IFLScience and SkepticsSTM participants used ‘woo’ to refer to beliefs they saw as pseudoscience, and terms such as ‘wooster’ and ‘woo-natic’ to describe people who held those beliefs. Similarly, the label ‘anti-vaxxer’ was commonly used on IFLScience to refer to people who distrusted mainstream scientific consensus about the safety of vaccines (*How to Argue with Anti-Vaxxers*, Aug 2015).

It is important to note that these labels were often based on *imagined* behaviour. Here I am not using ‘imagined’ in the sense of fictional. Rather, I am drawing on Benedict Anderson’s description of nations as ‘imagined communities’, whereby “the members of even the smallest nation will never know most of their fellow members... yet in the minds of each lives

the image of their communion” (Anderson 2006, p.6). In other words, to imagine is to assume certain people or behaviours are representative of a larger community. Anderson focusses on how participants imagine *themselves* as members of a community. However other scholars, particularly those working within postcolonial studies, have noted how similar behaviour results in the assigning of characteristics to imagined *other* communities (Gearon 2001; Hosford and Wojtkowski 2012). For example, the SkepticsSTM thread *Gravitational Waves Detected* (Feb 2016) involved a description of a “Wooster” on another forum who “had just started to present a beautiful, complex, insane alternative hypothesis in psychics, that proved gravity waves would not exist” immediately before the discovery was announced. Another participant replied “since when does reality dissuade a True Genius™ from raving on about his woo?”. The single ‘Wooster’ was seen as being a representative of a larger group of people who could all be expected to behave in a certain way. Certain types of people and beliefs were rhetorically associated with imagined ‘unscientific’ behaviour in the world outside the subfora, and recognition of these types became encoded in identity labels.

6.2.2 Imagined Participation and Real Boundaries

References to fellow participants in the previous boxes showed specific claims being attacked by presenting the claimant as ‘unscientific’. In Box 6.3 (extracts 1-3), the claimants’ lack of professional scientific credentials were presented as reasons to disbelieve their arguments. In Box 6.1 (extract 4) the participant who was accused of “rejecting the scientific method” was also, over the course of the longer discussion, accused of disbelieving the Big Bang theory due to a collection of political and philosophical beliefs which led to them ignore “math and logic” and “reject empirical science” (*SkepticsSTM IMAP*, Apr 2015). Participants characterised their opponents as ‘unscientific’ in order to discredit them, and in doing so referenced those recognisable ‘unscientific’ characteristics discussed in section 6.1. This is a device which has been noted across STS accounts of boundary-work conflicts (Cassidy 2006; Gieryn 1999).

However I argue that on the subfora boundary-work was not simply about constructing credibility, but also constructing community. This argument involves relating general ideas of ‘unscientific’ characteristics to specific interactions. On *XKCDScience The Battery Which Isn't a Battery* (Jan 2011), a participant informed the original poster that they were probably “being fed your ideas from a crackpot’s rambling”; a participant on *r/EverythingScience The Food Babe Blogger* (Apr 2015) was told that “your anti artificial, anti industrial arguments sound a lot more like anti science to me”. These examples drew links between the specific

claims of real participants, and characterisations of more general “crackpot” or “anti-science” beliefs. On one occasion this behaviour was openly commented upon: in another debate on *r/EverythingScience The Food Babe Blogger* (Apr 2015), a downvoted participant was told that “some around here may not listen to you no matter what researching body you cite (probably from being tagged as a scientific charlatan of sorts)”. These examples are in line with observations from FS, that imagined characteristics of the ‘other’ community become rhetorical resources for encounters with *real* people (Theodoropoulou 2007).

The ways in which descriptions of ‘science’ and ‘non-science’ shaped behaviour towards other participants suggests that community-forming behaviour⁹⁷ took a role STS scholarship usually ascribes to professional or political authority. STS studies of boundary-work have shown that there are many ways of drawing boundaries around science. Rhetorical descriptions of ‘science’ can have substantial non-rhetorical effects, such as shaping the allocation of resources (Gieryn 1999) or deciding who influences decision-making in problems with political ramifications (Jasanoff 1987). In other words, descriptions of ‘science’ and ‘non-science’ feed into forms of boundary which impede flows of resources, people, and power. In the subfora, by imagining communities of people inside and outside of ‘science’ participants impeded the ability of ‘unscientific’ people to participate in threads. As in previous STS studies, descriptions of science became other forms of boundary. Unlike previous STS studies, community behaviour replaced accredited authority.

6.2.3 Non-Professionals, Popularisation, and Permeable Boundaries

In STS literature, the relationship between identity and boundary-work is often described as people being ‘insiders’ to the space of science (Gieryn 1999; Riesch 2010). My above analysis showed that participants used ideas of ‘science’ and ‘anti-science’ to build boundaries against out-groups. In this way, the boundaries of science mapped onto the boundaries of the subfora: holding ‘unscientific’ or ‘pseudoscientific’ views also made one unwelcome within the subfora community. However, looking at the other two forms of contrast discussed in section 6.1 – popularisation and professional boundaries – we see more complicated behaviour, in which the boundaries of in- and out-groups did not map cleanly onto boundaries drawn around ‘science’.

We saw in section 6.1.3 that participants drew boundaries around professional science in order to inhibit certain forms of participation. However participants also regularly made

⁹⁷ Notions of ‘community’ were discussed further in sec. 5.1.1.

statements along the lines of ‘I am not a scientist, but...’ (*XKCDScience What Is The Smallest Object*, Nov 2013). In some cases participants presented themselves as experts, but in a different field; for example on r/EverythingScience *Brian Greene Breaks Down How Gravitational Waves* (Feb 2016) a participant described themselves as “a medic”, so “I’m sure I’ve missed a lot [...] because I know relatively nothing about this area of science”. Some participants also spoke of having forgotten their past knowledge (*SkepticsSTM IMAP*, April 2015), or flagged up their expertise as limited (*SkepticsSTM Question for Physicists*, March 2015). On XKCDScience participants even used the acronym ‘IANA’, standing for ‘I Am Not A’, followed by a letter denoting a discipline – so, for example, IANAP for ‘I Am Not A Physicist’ (*XKCDScience LIGO Gravity Waves*, Feb 2016). The fact that this acronym was used without introduction implies that participants expected others to either recognise it or be able to work out its meaning. In all these forms of self-description, participants were acknowledging that being a non-expert might *impede* their ability to contribute. Such participants nonetheless attempted to contribute, and were rarely sanctioned for doing so. In other words, constructing boundaries around professional science did not produce hard boundaries to participation.

In a similar fashion, we saw in section 6.1.2 that boundaries were drawn between ‘real’ and ‘popular’ science. Such boundary-work often incorporated the sorts of out-grouping behaviour discussed previously in this section – note how “people” and “the gen pop” were referred to as “they” and “them” throughout Box 6.2. However discussions within the subfora also frequently drew on information from popular science articles.⁹⁸ Such behaviour did not prompt sanctioning in the same way as ‘pseudoscientific’ or ‘anti-science’ behaviour (as discussed in section 6.2.2), unless the popular source was from a recognised ‘pseudoscientific’ site such as *Natural News*.

Participants rarely reflected on whether *their own* use of popular sources was ‘unscientific’ or not. More broadly, any ‘unscientific’ attributes of popular sources were presented in more complicated terms than those of pseudoscience. The examples in Box 6.4 show a mixture of attitudes towards popular sources.

⁹⁸ Even the more expert XKCDScience participants drew on popular science articles and/or blogs in their discussions, potentially to escape issues of paywalling.

Box 6.4 Popularisation and Avoidable Unscientificity

- (1) The absolutely smallest object would have to be a higgs boson, wouldn't it?

[Is corrected by another user]

Ah, so I fell into the popular science journalism trap.

XKCDScience *What Is The Smallest Object*, Nov 2013

- (2) Do you really believe people would stop saying stupid things about science if they stopped hearing explanations of it in lay terms? People **still** believe ridiculous nonsense about magnets, despite the fact that a bright child who isn't very good at math could quite easily learn enough about magnetism to understand why such nonsense doesn't work.

XKCDScience *RELATIVITY QUESTIONS*, Apr 2012

- (3) I can't wait to watch [DeGrasse Tyson's new TV show]. I fear that with how easily information is to obtain on the internet that the younger generations may become complacent and the 'just Google it' mentality will replace critical thinking and experience. There are not enough quality educational programs like this on tv.

r/EverythingScience *Neil DeGrasse Tyson's Genius Plan*, Apr 2015

- (4) How many new museums have opened near you in the last decade? The more a kid can be exposed, the more likely they'll be interested in science, and the more likely they'll be interested in facts when making decisions in the future.

r/EverythingScience *Science Museums Urged to Cut Ties With Kochs*, March 2015

Across all these any 'unscientificity' of popular sources was tied to the approaches of people using them. In (1) popular science was presented as laying a "trap" that one could avoid with care. In (2), the participant shifted the blame for "people saying stupid things" away from "lay explanations", arguing that learning more would allow people to avoid misunderstandings. Here participants suggested that being 'scientific' or 'unscientific' was a property of (avoidable) behaviour. In (3) and (4) the participants suggested that popular sources *could* inculcate the kinds of 'scientific' values – such as critical thinking or being "interested in facts when it comes to making decisions" – that we saw in chapter 5 (5.1.2). As with professional science, boundaries related to popularisation were sometimes presented as reasons for othering and at other times were treated as acceptable forms of participation in 'science'.

The contrasts between these different forms of boundary-work – the treatment of 'pseudoscience' versus the use of boundaries related to professionalisation/popularisation – reflected the role of the subfora as a space for non-specialists to discuss science. Hilgartner

(1990) and Gieryn (1988) have argued that all these forms of boundary-work can serve the same interest for professional scientists: monopolising authority within the space of professional science. However on the subfora straightforwardly equating ‘science’ with ‘professional science’, or excluding ‘popularisation’ from ‘science’, carried a potential risk. Hard boundaries against non-professional contributions and/or popular sources could have seriously limited the ability of non-specialists to contribute. As diverse perspectives were cited by participants as motivations for participating in the subfora (secs. 4.3.4; 4.4.4; 4.5.4), overly restrictive boundaries could damage participants’ enjoyment of the subfora. However excluding ‘pseudoscience’ carried no such risk – and indeed could support motivations explored in chapter 5, such as being humorous or creating a social identity as a ‘scientific person’.

There was one complication regarding the picture presented in 6.2.2, of boundaries around ‘science’ mapping onto boundaries around the subfora. Participants sometimes used discussions of professional science and/or popular sources to draw boundaries between themselves and the surrounding subforum. For example, on the IFLScience thread *What TV Channels Really Show* (March 2015) participants made humorous comments which took the original post (shown in Fig. 6.1) and replaced ‘Discovery’ with ‘IFLScience’ and ‘people in the jungle’ with ‘memes’ and/or ‘clickbait’. In doing so they presented IFLScience as appealing to popularity over science; note particularly that ‘clickbait’ refers to material which uses sensational headlines to attract audiences, but then provides little substantive material in the article.

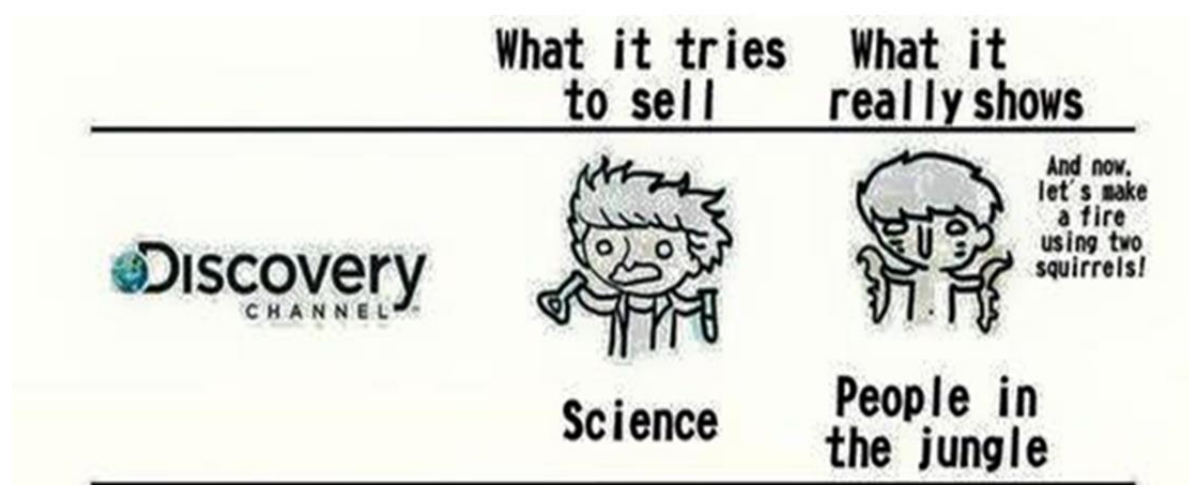


Fig. 6.1 Image from IFLScience post ‘What TV Channels Really Show’, posted 11 March 2015. Multiple commenters turned the presented contrast into a joke mocking IFLScience for showing ‘memes and clickbait’ instead of ‘science’. Retrieved from www.facebook.com/IFeakingLoveScience/posts/1060028687351475, 23 March 2015.

Across subfora, some participants also criticised others for trusting in professional scientists rather than ‘scientifically’ assessing claims for themselves (*SkepticsSTM More on PhD Research*, Dec 2015; *XKCDScience Biology: Evolution*, March 2015; *r/EverythingScience My Father Sent Me This Article*, March 2015; *IFLScience In Science We Trust*, March 2015). Such behaviour builds on a suggestion from chapter 5 (sec. 5.1.1) that participants portrayed themselves as part of a broader imagined community of ‘scientific’ or ‘skeptical’ people. For these participants, creating a distinctive individual identity as a ‘scientific’ person involved arguing that others around them were using popular sources and/or accepting professional science in an ‘unscientific’ way. In doing so, they placed themselves inside the space of science and put the rest of the community outside.

As shown in the examples above, such boundary-work also provided opportunities for humour and/or the construction of a desirable personal identity (of someone ‘more scientific’ than others in the thread). However the relative scarcity – and frequent unpopularity⁹⁹ – of such behaviour suggested that most participants generally aligned the identity of a ‘scientific’ person with being part of the surrounding community. In concluding we should also note that, whether or not participants placed themselves and/or the surrounding community within the space of ‘science’, characteristics of science were always held to be superior to other practices. This will be explored further in the next section.

Summary of Section 6.2

In this section I have shown that boundary-work can act as a form of ‘othering’, both towards real others within a thread and imagined others in society at large. I noted how characterisations of imagined others provided rhetorical resources for sanctioning real participants who seemed to be bringing ‘unscientific’ or ‘pseudoscientific’ views into discussions. However, these behaviours were not so clear in relation to boundaries related to popularisation and professionalisation. In these cases participants rhetorically moved themselves in and out of the space of ‘science’, and also aligned and dis-aligned themselves with the surrounding community.

I have suggested all these behaviours related to the non-professional nature of the subfora, and also to motivations discussed in chapter 5: that participants used the subfora as spaces to create community, humour, and/or a social identity as a ‘scientific’ person. However, this behaviour should also be considered in relation to arguments from STS that ‘science’ is

⁹⁹ As noted in sec. 5.1.3, this behaviour was particularly common amongst non-normative participants.

often seen as an authoritative, intellectually superior practice. In the next section I shall focus on the epistemic authority of science, and in doing so consider benefits boundary-work provided for subfora participants.

6.3 Science as a Way of Knowing

In this section I move away from focussing on people and consider 'science' as an idea – to borrow Felicity Mellor's phrase, a "way of knowing" about the world (2003, 521). I note two recurring themes. Firstly, that 'science' was frequently presented as superior – in the sense of having higher epistemological, ethical, and/or cultural values – than other ways of knowing (6.3.1). Secondly, that 'science' was presented in a *monist* fashion, i.e. as a term with a single referent (6.3.2). In both these sections I saw similar contrasts between the subfora; I draw out this finding further in section (6.3.3).

6.3.1 'Science' as Superior

A key theme across STS literature on boundary-work is that science is widely presented as superior to other cultural practices (Gieryn 1999; Riesch 2010). We have seen this behaviour throughout the previous sections. Participants presented science as ethically superior to self-serving political and/or business interests (6.1.1); popularisation was seen as a simplified and misrepresented form of 'real science' (6.1.2); and 'unscientific' people were presented as inferior to 'scientific' people, both within the subfora and/or society at large (6.2.1, 6.2.2). Further examples are given in Box 6.5. I present the scores for r/EverythingScience comments to illustrate contrasts in popularity.

Box 6.5 Elevating Science

(1) User1: Goodness, I hope this lasts. This [increasing successful replications of experiments] is one of the biggest needs our world has today. [+6]

User2: I think this is a bit of an overstatement. [0]

User1: I encourage you to read the article. Note the failure rate of reproduction. [+2]

r/EverythingScience *Reproducibility should be at science's heart*, Feb 2016

(2) User1: [Comment about engineering applications of string theory].

User2: Oh no no no... It is the thinking of Tools. Tools! But this is the haven of the Sweet. We ought not abide Tools.

XKCDScience *Should we consider string theory to be a science?*, Feb 2016

(3) I wanted to point out what I saw [username] doing, which is essentially rejecting the scientific method, or at least attempting to displace it somewhat from its modern throne.

SkepticsSTM *IMAP*, April 2015

(4) [Scientific Racism] was an attempt by politically motivated individuals to use scientific concepts in their rhetoric than anything else, but it did happen [...] Several other things obviously do make it obvious that science doesn't help justify racism [...] There's no point in pursuing that line of thinking, period.

XKCDScience *Homo Naledi: Another Link*, Sep 2015

User1 in extract (1) presented scientific research in terms which strongly emphasised its practical importance, as “one of the biggest needs our world has today”. Though they were seen as hyperbolic by User2, the distribution of votes showed greater support for User1’s position. The other extracts focussed less on the practical benefits of science, and more on science as having high cultural, epistemological, and ethical values. Science was described as “the haven of the Sweet” (2) above the practical endeavours of tools; as being on a “modern throne” (3); and “obviously” not aligned with racist ideology such that “there’s no point in pursuing that line of thinking, period” (4). These examples again reflect findings from professional scientific discourse. While Gieryn largely focusses on the professional resources that are hoarded in protecting ‘science’ he also suggests that boundary-work relates to a range of symbolic resources, with scientists appealing to “higher values to justify their practices” (Gieryn 1995, 434). However discussions in the subfora did not show scientists justifying any practices. This builds on a recurring theme of this chapter, that familiar representations of ‘science’ from professional discourse were reproduced in the subfora despite the lack of clear professional stakes or motivations.

However the specifics of how science was presented gives some indication as to motivations which were present in the subfora. To begin, we should note that there were variations in how the elevation of science was presented in different subfora. These contrasts were particularly clear between SkepticsSTM and XKCDScience. Box 6.6 compares extracts from these two subfora on the same topics.

Box 6.6 Hostile and Non-Hostile Elevation of Science

- (1) Certain people who call themselves scientists work in areas where empirical evidence is totally lacking, like string theory, quantum loop gravity, brane theory etc. I do not call that science. It is mathematical speculation. I hope one day we can bring it into the field of science by generating testable predictions.

SkepticsSTM *Axioms of Science*, Dec 2015

- (2) I am starting to see a reason why we should doubt whether string theory is science. Maybe it is more like math? Maybe what you're trying to say is that string theory is to some nice theory of nature as vector calculus is to electromagnetism... and if that is the case then I would call string theory math, or mathematical physics. And then there's the question of is mathematical physics a science?

XKCDScience *Should We Consider String Theory To Be A Science?*, Feb 2016

- (3) I am hostile, because this line of argument has been used a lot to claim that science is just a form of religion. And that is BS. So if you have no agenda with this question, I don't know why you bring it up.

SkepticsSTM *Axioms of Science*, Dec 2015

- (4) All we can really do is admit that we don't know. Philosophy and religion seems to have a real problem with question marks, but science, well, science is pretty okay with acknowledging the unknown.

XKCDScience *The Argument from Contingency*, Jan 2016

The SkepticsSTM extracts presented more emphatic contrasts. The non-sciences were referred to with extremely negative language. Extract (1) talked of “totally lacking” evidence from “people who call themselves scientists”, while extract (3) referred to claims that science “is just a form of religion” as “BS” (bullshit). Extract (1) also suggested that being brought into science is something to “hope” for; they also referred to the non-science as “mathematical speculation” rather than ‘mathematics’, suggesting lack of rigour. By contrast the XKCDScience extracts were more neutral in both tone and about the perceived non-science. Extract (2) presented questions rather than arguments, and made no statements

about the relative values of science and mathematics. Extract (4) described religion (and philosophy) as struggling with a problem that science is “pretty okay with acknowledging” – presenting science as superior, but in less emphatic language than on SkepticsSTM. Extract (4) appeared as part of a longer thread in which most participants were largely dismissive of religion as a form of intellectual endeavour, but do highlight its historical importance. One participant was explicitly hostile to religious arguments, but this prompted jokes about their levels of anger. By contrast, (3) presented any attempt to align science with religion as part of a suspect “agenda”, an argument which they claimed “is used a lot.” By contrast with the mixture of dismissal and acceptance of religion shown in extract (4), the language in extract (3) suggested that keeping science elevated above religion as a serious concern.

IFLSscience was similar to SkepticsSTM in how participants presented ‘science’ as superior. For example, descriptions of religious people and homeopaths were consistently hostile on IFLScience (*Teaching Stork Theory*, March 2015; *Homeopathy Does Not Effectively Treat Any Health Condition*, March 2015). Groups such as anti-vaxxers and climate change deniers were presented as dangerous, and defending scientific consensus was put forward as a weapon against them (*How to Argue with Anti-Vaxxers*, Aug 2015; *Ted Cruz Recently Compared Himself To Galileo*, March 2015). Such depictions occurred on posts which were not directly related to any specific ‘anti-science’ movement. On *In Science We Trust* (March 2015) various perceived anti-science views were referenced as part of contrast with ‘pro-science’ people; responses to *Dozens Of Scientific Papers Withdrawn After Peer-Review Fraud Uncovered* (March 2015) expressed concerns that the story would be seized on by anti-science movements, though many other participants also took the story as evidence for the ‘self-correcting’ powers of science as a process.

r/EverythingScience participants displayed both SkepticsSTM-esque and XKCDScience-esque approaches to presenting science as superior. There were numerous instances of science being elevated above perceived non-sciences, in a manner which was hostile to the non-sciences. Some participants argued that keeping science elevated above politics/pseudoscience protects against dangers to society and/or individuals (*Ted Cruz’s Strange Smile*, Feb 2016; *The Food Babe Blogger*, Apr 2015). However, in the face of real participants who queried why mainstream science should be seen as superior to religious beliefs or alternative medicine, the tone was often less hostile. Participants engaged with ideas of religion and science as alternative intellectual pursuits (*Defending Darwin*, March 2015) and on the potential benefits of homeopathy as a cheap placebo (*Why Is Homeopathy*, Feb 2016).

Such contrasts can be partly explained by reference to the communal norms discussed throughout chapter 5 (see particularly 5.2.3). Sanctioning on SkepticsSTM often involved hostility, while on XKCDScience sanctioning more often took the form of criticising arguments. Hostility was generally minimised on r/EverythingScience by moderation and expectations of ‘reddiquette’ from other participants, but a reasonably common feature of IFLScience discussions. However these contrasts also relate to features associated with ‘science’ as a distinctive concept. To see this, we should consider one final theme in how science was presented on the subfora.

6.3.2 ‘Science’ as Singular

A common theme across all the examples of boundary-work presented in this chapter is that participants presented ‘science’ in a *monist* fashion. Monism is the idea that ‘science’, despite various complications, does ultimately have a single referent; this is a contrast to pluralism, the idea that ‘science’ refers to multiple distinctive practices (Chang 2012). In discourse across the subfora, most references to science were monist. This was true even in the uncommon cases where definitions of science were opened up for extended discussion. Examples of such discussions are given in Box 6.7.

Box 6.7 Debating Definitions of Science

- (1) And then there's the question of is mathematical physics a science? Well it's clearly kind of part of science but you're obviously going to run into trouble drawing a demarcation line at that point and you're also getting to the point where it doesn't matter (unless you're trying to convince funding agencies of something or something) ... So ok. I think I'm going to walk away with this as my final answer for now and just decide that all of the debate people are having is just because they're confused about what string theory/science does?

[Responses ignore question and turn to discussing Bayesian confirmation].

XKCDScience *Should We Consider String Theory To Be A Science?*, Feb 2016

- (2) User1: We cannot ‘define’ science. But we can point out the core principles ...

User2:¹⁰⁰ [Argues science can be defined by scientific method, though notes parts of scientific practice don’t follow this straightforwardly]

User1: Sounds to me as if you fundamentally agree with what I was saying ... I would suspect that a comprehensive definition of the scientific method would take several encyclopedias to contain it... Science is teamwork these days and if one person or team

¹⁰⁰ As I did not receive permission for all parts of the discussion in extract (2) I have summarised User2’s statement.

does the theoretical work, and another person or team does the experimental work, that is fine and is still science. [Thread ends]

SkepticsSTM *Axioms of Science*, Dec 2015

Despite presenting various ways in which science could be understood, these ultimately closed on the idea that there is a singular 'science' which people can misunderstand (1) or that 'science' *could* be defined given sufficient space (2). More commonly, monist presentations featured in a much more straightforward fashion. For example, a common refrain on IFLScience was the question 'how is this science?' – or even just 'science?' – frequently used without any elaboration or justification. Such statements worked on the premise that science is a singular concept, and also suggested that self-evident boundaries around 'science' had been breached. In other words, there was an expectation that others would recognise science as singular. From a discourse analytic perspective, monist presentations of science were almost universally accepted rather than challenged or developed into further discussion.

Gieryn argues that rhetorically limiting 'science' to a singular space, and then drawing hard boundaries around this space, allows for monopolisation of the authority and resources associated with science (1995). However Box 6.8 shows examples in which participants pushed against attempts to impose tight boundaries on what counts as 'science'. For the r/EverythingScience examples I have included the score for each response, as this indicated the communal popularity or unpopularity of certain views.

Box 6.8 Attempts at Strict Boundaries

(1) User1: [Distinguishes environmental work from science]. [-8]

User2: There isn't some clear separation between environmental work and science: notice the 'Environment' field in the sidebar of this subreddit, as well as in the sidebar of /r/science. [+7]

User1: [Argues article talks about environmentalism not environmental science]. [-5]

r/EverythingScience *A Wisconsin State Board has prohibited*, Apr 2015

(2) User1: The problem is millions of people pretending to be scientists who are in reality subjective opinion philosophers, eg so-called 'economists.' But actual science has always been about accuracy / repeatability. [-1]

User2: [Disagrees]. [0]

User1: That is not an argument for your assertion that philosophers who study the economy are scientists. Actual science has physical repeatable experiments (ie physical units of measurement) & thus accuracy/repeatability e.g. chemistry and physics. [-3]

User2: [Disagrees, defines science as building knowledge]. [+1]

User3: Well [...] The method of science is to generate testable hypotheses (possibly by gathering data, or by other means), then to test them, and form explanations, call theories. 'Building knowledge' is too nebulous. (That's what historians do). [+1]

r/EverythingScience Reproducibility Should Be At Science's Heart, Feb 2016

- (3) Nah, musing is fine. You don't have to be 'doing science.' But musing doesn't prevent you from being incorrect about interesting inanimate objects.

XKCDScience Gravity-Temperature Musings by [username], Nov 2015

In extracts 1-2 participants who attempted to draw strong boundaries around science achieved negative votes (indicating that other participants disagreed with or disliked their contributions). By contrast, in extract (1) a participant who blurred the “separations between environmental work and science” achieved a positive score. The participant in extract (3) was responding to a (non-normative) participant, who had tried to clarify the boundaries of the discussion by asking whether talking about “inanimate objects” counted as “doing science”. The quotation marks around “doing science” can also be read as showing scepticism about the phrase. These examples push against the idea that participants aimed for a tightly-controlled notion of ‘science’.

This is not to argue that there was general disapproval of people who drew boundaries around science. As we have seen throughout this chapter, participants certainly did use labels of ‘science’ and ‘not-science’ to try and shape participation. Also note that the attempt to define science in extract (2), which involved drawing boundaries between science and “historians”, was upvoted. The argument here is that instances of boundary-work within the subfora showed various relations between communal norms and attitudes towards controlling the space of science. Extract (2) showed familiar behaviour for *r/EverythingScience*. The downvoted participant was criticised (in the redacted comments) for their aggressive tone. User 3’s response presented a detailed argument, drawing on evidential sources – behaviour which often achieved upvotes. In the *XKCDScience* example, the participant being addressed was told they did not need to be “doing science”, but – in a refrain common in *XKCDScience* (see sec. 5.1.2) – were told throughout the thread that they should be listening to more expert participants. On these subfora,

controlling the space of science appeared as a lesser concern than other communal expectations.

On SkepticsSTM and IFLScience, many participants *did* attempt to control the space of science, and in doing so promoted certain communal behaviours (sec. 6.3.1). For example, the SkepticsSTM participant in Box 6.6 (3) explained their “hostile” tone by claiming “this line of argument has been used a lot to claim that science is just a form of religion.” In all these cases, attitudes towards controlling the space of science were tied up in a series of other attitudes towards desirable and undesirable behaviour. In some cases monopolising ‘science’ encouraged certain behaviour; in others, norms pushed against attempts to tightly control ‘science’.

We should also note that the contrast between two pairs of subfora – r/EverythingScience and XKCDScience on the one hand, and IFLScience and SkepticsSTM on the other – is the same as that which emerged when considering how science was presented as superior (6.3.2). Exploring this pattern further suggests two alternative sets of general motivations underlying the presentation of science as singular, and boundary-work more broadly, across the subfora. This will be the topic of the next, and final, section.

6.3.3 *Two Reasons for Boundary-Work*

The relation between attitudes to science as superior (6.3.1) and to science as singular (6.3.2) was reflected in interview data. Box 6.9 shows responses to questions which encouraged interviewees to reflect on demarcating features of ‘science’. Unless otherwise noted, the question took the form ‘I was wondering if you have a strict definition of science that you go by, and if so do you ever see it shared or disputed by others?’.

Box 6.9 Attitudes to Defining 'Science' in Interviews

- (1) I don't find it worth arguing about. If someone disagrees in conversation I'll probably just accept whatever definition they wish to use.

XKCD-A

- (2) Hmm a personal definition of science... that's a hard one. I guess I do not have a hard and fast definition, but things are clearly science or not. Not-science being perhaps personal belief, or conjecture without validation, or ignorance and/or resistance to facts.

XKCD-I

- (3) *Q: Would you regard the xkcd science subforum as a science community, or a page where a larger community goes to discuss science matters? [...]*

Can I ask why you're trying to define 'what is a science community'? It seems a little bit like a semantics issue - any community of people doing a thing are a 'community' of that thing, right?

XKCD-E

- (4) It's like porn – you'll know it when you see it.

XKCD-E & XKCD-H¹⁰¹

- (5) The scientific method – set a hypothesis, observe, measure, experiment, repeat the cycle... and of course see where any findings/conclusions support or contradict other areas of related science, etc. [...]

Q: How would you feel about an alternative description of science which doesn't rely on the scientific method, like 'science is the job qualified scientists do'?

I would prefer that we don't go looking for alternatives for what Science means – especially 'the scientific method', given that there are a whole lot of people who would just love to be able to describe it in any old way [...] giving way for faith, astrology, etc., to automatically be described as being based upon science.

Skeptics-A

- (6) Science is one of the most important methods of probing what is external to our hallucinatory inner perceptions... The scientific method, peer criticism, induction, etc. all may have their failings, but over time, and approached honestly, they provide more trustworthy information than our evolutionary legacy of accepting the immediate phantasms of our brains.

Skeptics-D

¹⁰¹ As in, both users independently made this reference in separate interviews; the reference is originally from a 1964 obscenity case, though is now a meme (FindLaw 2017).

(7) *Q: Would you regard yourself as someone who's a fairly active user of internet forums in general, or is there something particular about your use of science forums?*

There is certainly something particular about my use of science forums... I totally despise what I see as an increasing tendency to ignore evidence in favour of feeling, fact in favour of bullshit, and research in favour of thought experiment by people without the necessary equipment [...] It should be opposed and attacked at every opportunity. On the SSF [Skeptics Society Forum], those people come to us (god knows why) so I don't have to go out and look for them.

Skeptics-B

XKCDScience interviewees suggested that they had little interest in defining 'science', claiming that "I don't find it worth arguing about" (1), querying why it was of interest beyond "semantics" (2), or arguing it was clear in context even if hard to define in the abstract (3,4). They also tended to focus on issues related to XKCDScience as a place of discussion, such as accepting definitions (1), being a "community of people doing a thing" (2) or people showing "resistance to facts" (3).

By contrast the SkepticsSTM interviewees provided more detail in their demarcations of science, using less context-dependent reference points such as "the scientific method" (5, 6). They also made frequent references to issues beyond the subfora – talking of 'science' as a professional research method (5), the evolutionary tendencies of humanity (6), and behaviour in wider society (7). These references related the intellectual superiority of science to concerns that it provides a defence against poor – even dangerous – thinking on the part of individuals (6) and wider society (5, 7). The SkepticsSTM quotations reflect Gieryn's idea of monopolisation, in that they attempted to define a singular space of science – to push against "looking for alternatives for what Science means" (5) – in ways that aimed to limit the perceived misuse of 'science' as a label. This was not done to protect personal autonomy or secure resources, but rather maintain the authority of science as an idea.

However the responses from XKCDScience interviewees were similar to the XKCDScience and r/EverythingScience extracts in Box 6.8, in that they focussed on subforum-related behaviour to a greater extent than monopolising the authority of science. An alternative explanation provided by Gieryn for presentations of science as singular is that it shows science having "settled boundaries" which "[need] little or no manifest attention from the people who live inside them" and "exist in a tacit but durable and imposing state" (Gieryn 2008, 91). This can be applied to the XKCDScience instances more clearly than ideas of monopolisation. Suggestions that boundaries are "tacit" and have "little or no manifest

attention” can be seen in interview responses such as “you’ll know it when you see it” and “hmmm [...] that’s a hard one. I guess I do not have a hard and fast definition” (2). Nonetheless, boundaries were “durable and imposing” – as we have seen throughout this chapter XKCDScience participants did use references to ‘science’ to sanction unwelcome participation, and there was little open dispute around where these boundaries should be drawn. Indeed interviewee responses such as “I don’t find it worth arguing about” (1) and “it seems a little bit like a semantics issue” (3) suggested disinterest in where boundaries around science ‘should’ lie.

These attitudes should be considered in relation to the communal expectations of XKCDScience discussed in chapter 5 (sec 5.2.1), that threads should be on-topic, clear, and not require participants to explain ‘basic’ scientific consensus to others. If boundaries around science were not tacit and durable, but instead subject to constant re-negotiation, then this could result in arguments over ‘basic’ definitions; diversions from specific topics of threads, and a cause of frustration for many XKCDScience participants. However, a tacit and general idea of being ‘scientific’ could be used to exclude any (also frustrating) claims which ran counter to scientific consensus. In this sense, we can see the singular presentation of science as a form of ‘ironic commitment’ (Lyotard 1984) or ‘language game’ (Wittgenstein 1953), in which questioning the precise definition of a term is a lesser concern than being able to carry out shared discussion. Gieryn argues that the existence of settled boundaries emerges from certain features of spaces, institutions, and working practices (2008). Based on the above arguments, I would add informal community norms and preferences for certain forms of discussion.

In sum, I suggest there were two general forms of motivation which shaped boundary work on the subfora. Firstly, concerns that the label of ‘science’ should be associated only with people who were perceived to use its authority for good purposes. Secondly, to direct participants towards contributing novel perspectives rather than distracting with ‘unscientific’ claims. Both of these were served by presenting science as singular and epistemically superior, though the exact form of these presentations varied. Participation on SkepticsSTM and IFLScience was strongly shaped by the first motivation, XKCDScience by the second. r/EverythingScience was somewhat more complicated. In section 6.3.1 I discussed how r/EverythingScience participants were generally hostile to ‘unscientific’ behaviour in society, but often engaged with such claims within threads. Instances in this chapter – the idea that ‘environmentalism’ should not be excluded from r/EverythingScience threads (Box 6.8, 1) or the concern that certain definitions of science are “too nebulous” (Box 6.8, 2) – suggested concerns around how to effectively discuss ‘science’, but not as clearly as the XKCDScience

examples. Overall it seems r/EverythingScience did not normalise any one approach towards boundary-work.

It should be noted that these contrasts map onto proportion of professional scientists within the subfora. This could suggest a phenomenon Collins has referred to as “distance lends enchantment”: the closer one is to professional science, the more one sees it as a practical human endeavour rather than an authoritative ideal (Collins 1997, 131). The largely non-professional groups of SkepticsSTM and IFLScience may have seen the ‘distant’ science as worth protecting, while the (more prevalent) professionals in XKCDScience may see science as a practical, communal activity. However, this is a point which the data was not able to clearly address.

This chapter has focussed on explicit demarcations of ‘science’, and ways in which they were used to control discussions. However there were other forms of behaviour which involved monism, related to views of science as either superior or settled. For example, numerous jokes across subfora used monist presentations of science to create humour. The monism shown in the IFLScience memes in chapter 5 (Fig. 5.1) can be seen as reflecting attitudes that ‘science’ should be used to attack poor thinking in wider society, an approach taken by Tyson and Nye (chapter 5 sec. 5.2.2). They can also be read as deriving humour from presenting ‘science’ as incongruous with crudity (‘y’all motherfuckers’) or popular culture (dropping the mic). Humorous uses of contrasts between ‘science’ and informality have been noted in various forms of scientific talk, from professional publications (Gilbert and Mulkay 1984) to the #overlyhonestmethods hashtag (Riesch 2015). As Bell has argued through her concept of the ‘irreverent deferent’, presenting science as incongruous with informality can imply deeper underlying attitudes that science is distinct from, and ultimately superior to, features of everyday life (Bell 2011).

For comparison, we can look to the XKCDScience thread *I Trust Science, So I Let It Make Decisions For Me* (Jan 2016). This post derived humour from the idea that the technological achievements of science could justify using ‘science’ to make any decision (such as what pet to buy, or meal to eat). The monist presentation of ‘science’ united two separate ideas – technological achievement and personal preferences – in an incongruous fashion; in doing so, the post also humorously re-presented a familiar argument that technological advances self-evidently show science’s superiority in other areas (critiqued by Higgitt 2012; Stilgoe 2012). Throughout the thread the monist presentation was also used to create anthropomorphic depictions of ‘science’, such as “science says: Lose some weight” and “science has ruined your fun”. This post reflected the more ambivalent attitude shown within

XKCDScience towards 'science' as superior, but used the monist presentation of 'science' to create a shared reference point in discussion.

Such questions of how communal norms and values shape presentations of 'science' more broadly, beyond manifest description, will be the topic of the next chapter. For now, the overall point is that various motivations which led people to participate in the subfora – hoping for novel perspectives rather than familiar debates, desire to create a social identity as a 'scientific person', or enjoyment of communal bonding experiences – could all be served by presenting a singular, superior idea of 'science', with associated boundaries to entry.

Conclusion

In this chapter I have examined how participants constructed manifest descriptive meanings of science, i.e. explicitly defined, demarcated, and/or characterised 'science'. Drawing on Gieryn's concept of boundary-work, I showed how these manifest descriptive meanings emerged from, and shaped, surrounding discourse. This also allowed for comparison with STS studies of boundary-work in other settings, thereby highlighting any distinctive factors associated with non-professional online discourse.

I began by examining the various forms of boundary-work which appeared on the subfora. I found that participants in the subfora drew boundaries around science which were recognisable from STS studies of other settings; in particular religion, politics, popularisation, and various non-professional or non-mainstream versions of doing 'science'. Gieryn, and many other STS scholars, argue that boundary-work is closely tied to questions of professional authority. However I found that, even in the absence of the professional authorities and structures present in many other settings, the subfora reproduced many descriptions of science which appear in offline settings – enforcing them through social norms rather than through accredited authority.

In section 6.2 I considered the relationship between boundary-work and identity in more detail, and the effects on participation within the forum. I examined how boundary-work acted as a form of 'othering,' referring to both real others within a thread and imagined others in society at large. I also noted how treatments of imagined and real others built on one another; attitudes towards imagined others were used as resources in sanctioning real others, while the presence of real others provides evidence for the existence of imagined

others. However, I also showed that the boundaries of welcome and unwelcome people did not map cleanly onto the boundaries between science and non-science. In particular, I showed how references to science|popularisation and professional|unprofessional boundaries had to navigate a risk that boundary-work around 'science' might exclude certain forms of welcome non-professional participation. In doing so, I related boundary-work to forms of emotional motivations and commitments outlined in chapter 5: the seeking of diverse perspectives, the creation of social identities, and/or enjoyment of in-group bonding.

In section 6.3 I examined the presentation of 'science' as an abstract concept. Across all subfora there was a consistent monist presentation of science, i.e. participants talked of 'science' as a singular thing rather than as having multiple and/or variable definitions. On the infrequent occasions where people explicitly raised questions about definitions of science, the discussion usually closed down relatively quickly. I also noted that, again in line with previous STS literature, participants in the subfora often presented 'science' as having higher ethical, epistemological, and social values than non-sciences. Though these presentations of 'science' as singular and superior appeared across all subfora, the manner in which they were expressed varied somewhat across subfora. In particular XKCDScience and (to a lesser extent) r/EverythingScience participants were less aggressive in their presentations of science as superior, though still used depictions of science as singular to sanction perceived 'unscientific' perspectives.

I concluded that excluding types of people from the space of 'science' was related to two general motivations, associated with different forms of dislike. The first was antipathy towards the existence of people who held perceived 'unscientific' views. Much STS research has explained such behaviour by reference to protecting professional autonomy; in the subfora, I argue this antipathy was instead used to build social identities and opportunities for communal bonding. The second form of dislike was against discussions which involved explaining or debating 'basic' knowledge, rather than exploring novel perspectives on a topic. In both these cases, forms of boundary-work familiar from professional settings also served non-professional motivations.

For STS scholars these findings raise questions of whether boundary-work in professional settings might also be influenced by emotional commitments, in ways which are not easily explained by focussing on professional commitments; and moreover, whether these different motivations might shape how boundaries are presented and responded to. These findings also develop on conclusions from chapter 5, which suggested that forms of expertise developed within professional settings can play roles within informal, lower-stakes settings. They show how forms of scientific authority from professional offline settings can be

reproduced in non-professional online settings. This is worth considering further, given that online settings have been seen as catalysts for new paradigms of expertise (Forrest and Duff 2017; Levy 1997). Such discussions will be deferred to my discussion in chapter. However in the next chapter I shall explore broader issues around expertise and credibility, by considering how 'science' was presented in a latent fashion.

***“Those are actually the fun topics, IMO.
Usually there's room to find unconventional
viewpoints that are still valid”¹⁰³***

7: Latent Meanings of Science

In this chapter I examine descriptive meanings of science which were constructed in a *latent* fashion, i.e. through recurrent patterns in language used to discuss or represent ‘science’. I took a two-stage data-driven approach, using Iramuteq to automatically derive topics which appeared across a large number of threads and then drawing on these topics to guide discourse analysis.

In section 7.1 I re-consider the word classes produced by Iramuteq analyses (chapter 4), comparing *across* subfora to find common and distinctive patterns of language use. These analyses showed that all subfora exhibited a distinction between two forms of language. The first, which I call *object* language, involved specific objects or ideas (such as ‘stars’ or ‘gravity’). The second, which I call *discursive* language, used terms associated with assessing contributions to a discussion (for example, ‘comment’ or ‘evidence’). I analyse how these two forms of language were used in discourse in sections 7.2 and 7.3. These analyses brought out an inconsistency related to *credibility* (by which I mean, questions around whether claims could be believed). The use of object language often downplayed questions of credibility, while discursive language brought credibility to the foreground. In section 7.4 I therefore draw on Gilbert and Mulkay’s (1984) approach, looking at how inconsistencies were resolved to reveal latent meanings.

Background and Methodology

Latent descriptive meanings presented greater methodological challenges than manifest descriptive meanings. Looking for latent meanings requires familiarity with a dataset in both a broad and close fashion, in order to see recurrent patterns *and* engage with the details of contextual factors underlying these patterns (Boyatzis 1998). Previous STS studies of latent meanings have often drawn from relatively small datasets, focussing on select groups such

¹⁰³ Interviewee XKCD-B.

as scientists working in a particular field (Gilbert and Mulkay 1984) or members of a local community (Wynne and Irwin 1996). This allows analysts to become broadly familiar with recurrent patterns across an entire dataset, while also pointing analysts to illustrative instances of these patterns for closer analysis. However the size of the dataset in this study made such an approach unfeasible. STS accounts using larger datasets have framed the data by particular socio-political issues, which helps analysts locate relevant instances for closer analysis (Marres 2015; Nisbet 2009). However, as this research was exploratory it would have been inappropriate to frame the data in advance. I therefore needed a data-driven approach to find broad recurring patterns, which could then provide a framework to guide closer analysis.

Computer-aided text analysis proved a useful tool for addressing these challenges. As discussed in chapter 3 (sec. 3.4.2) the topic modelling programme Iramuteq automatically derives topics from large amounts of textual data without requiring any prior framing by the researcher. However, it must be used in an iterative fashion, as part of a stepwise process involving other forms of analysis, to avoid uncritically treating outputs as ‘results’. I have already illustrated how I used Iramuteq to become broadly familiar with the case studies in chapter 4. For this chapter I examined Iramuteq outputs for patterns in language which appeared *across* subfora. As I shall discuss further in section 7.1, a recurring pattern was that language related to specific science-related topics often appeared separately from language related to more general discussion or argumentation, a distinction I refer to as *object language* and *discursive language*.

The next step in the analysis involved examining how these two forms of language were used in threads. Following the discourse analysis approach laid out in chapter 3 (sec. 3.4.4) I considered the following questions, which could not be easily answered from Iramuteq outputs:

- 1) How and why did the separation of object and discursive language shown by Iramuteq analyses come about?
- 2) How did object and discursive language appear alongside grammatical features – in particular personal pronouns, tone, and any textual devices to increase/decrease strength of agreement/disagreement?
- 3) How, if at all, were distinctions made between ‘scientific’ and ‘unscientific’ objects and discussions? I asked this question in order to compare the findings of this chapter with those emerging from my analysis of manifest meanings of science (chapter 6).

During discourse analysis, distinctions between ‘object’ and ‘discursive’ language were made using a combination of personal judgement and Iramuteq’s ‘corpus en couleur’ feature. This applies the colour of the word classes produced by Iramuteq back onto the original text, to show which text segments are associated with which classes. These corroborated the divisions of object and discursive terms I made in my reading.

Samples

The Iramuteq analyses used in this chapter were the same as those in chapter 4; i.e. all scraped text from all subfora, except for IFLScience where I used a 10% systematic sample (sec. 4.2.2). For sections 7.2-7.4, in which I examine word use in the context of discussions, I constructed a sample of threads using a multi-stage process. As this chapter examines how science is presented in general, rather than within particular settings, I used random sampling of threads in order to minimise potential selection bias.¹⁰⁴ A true random sample risked selecting *entirely* from the (numerous) extremely short threads. However restricting sampling to only longer threads could have over-emphasised controversial topics (see chapter 3, sec. 3.4.3). I therefore first separated threads in each separate subforum into three strata based on number of words; the longest third of threads from each subforum, the shortest third, and the remaining mid-length threads. Random sampling was then carried out using Excel’s RAND function to assign each thread a random number, and then selecting the threads in each stratum with the highest five assigned numbers. This produced 15 threads. Further details are given in Appendix 4 sec.3.

7.1 Iramuteq Analyses

Chapter 4 illustrated how I used Iramuteq to familiarise myself with each individual case study. However throughout chapter 4 I also noted how certain patterns were recurrent across multiple case studies. In this section I investigate these recurrent patterns further, to draw out repeated linguistic features pertaining to discourse across science-related subfora.

¹⁰⁴ It should be noted that another option would have been to use Iramuteq to locate threads which were particularly ‘characteristic’ of a word class, i.e. which had a high concentration of words which were strongly associated with one particular word class. However there was no guarantee that this approach would produce a broadly representative range of threads, and when I trialled this approach it resulted in an extremely narrow selection.

For ease of reference, a simplified version of all solo analyses¹⁰⁵ from chapter 4 is presented in Fig. 7.1. Each subfora produced clusters which related to a single particular topic, for example 'health' or 'space'. Each also produced a cluster which was harder to relate to a single topic, but instead brought in a broader range of more generic terms. I shall consider each type of cluster in turn.

¹⁰⁵ I used the solo analyses as the within-fora analyses only produced one, or at best two, clusters for each of the science subfora; this made detailed comparison difficult.

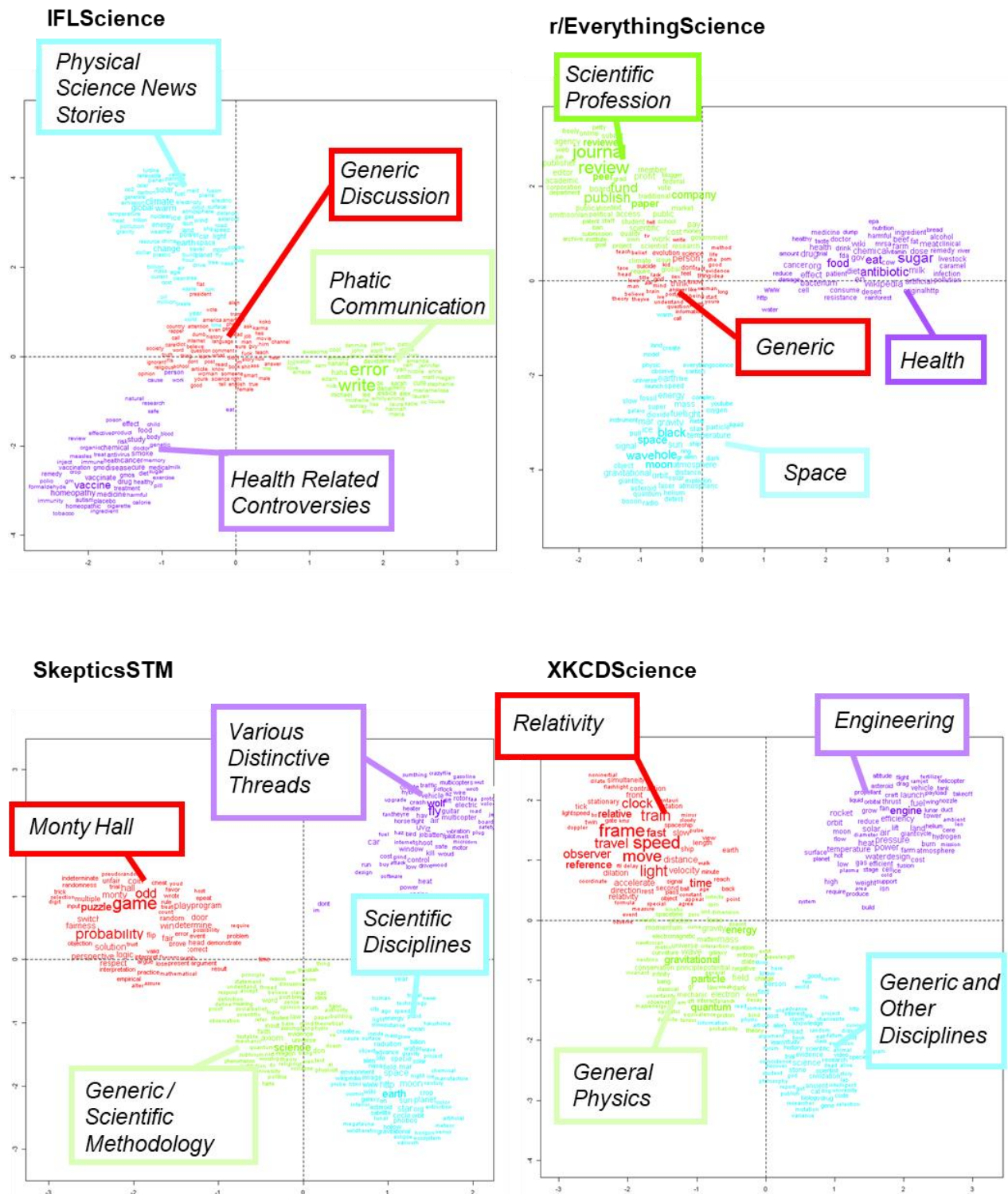


Fig. 7.1: Summary of Iramuteq Solo Analyses.

Simplified versions of the Iramuteq solo analyses for each subforum, depicted in full in Figs.4.4 (IFLScience), 4.8 (r/EverythingScience), 4.11 (SkepticsSTM), and 4.14 (XKCDScience). For simplicity I have provided only the cluster headings, not the list of representative words or the percentage of text classified by each cluster.

Table 7.1. Characteristic words in topic-specific classes from Iramuteq solo analyses.

The top twenty 'most characteristic' words produced by Iramuteq, for clusters selected from those displayed in Fig. 7.1.

IFLScience Physics	IFLScience Health	ES Physics	ES Health	Skeptics Scientific Disciplines	XKCD Relativity	XKCD Other Physics	XKCD Engineering
climate	vaccine	hole	sugar	earth	speed	quantum	engine
warm	homeopathy	black	antibiotic	moon	frame	particle	air
earth	study	wave	eat	star	move	gravitational	fuel
change	disease	space	food	space	light	energy	pressure
global	cancer	moon	en	http	train	mass	power
solar	vaccinate	sun	wikipedia	planet	travel	wave	heat
energy	medicine	gravity	effect	www	clock	field	solar
ice	smoke	mar	org	sun	observer	gravity	water
power	drug	light	chemical	water	time	electron	rocket
space	chemical	earth	drug	circle	fast	photon	land
light	effect	energy	milk	life	relative	gr	launch
car	food	gravitational	wiki	org	reference	force	design
planet	cure	fuel	bacterium	crop	velocity	momentum	orbit
fuel	autism	atmosphere	diet	specie	distance	potential	temperature
sun	placebo	mass	dose	phobos	accelerate	principle	efficiency
land	health	signal	meat	wiki	slow	matter	low
nuclear	healthy	ice	health	year	dilation	universe	thrust
moon	homeopathic	temperature	farm	radiation	direction	dark	lift
wind	gmo	orbit	www	image	front	Conservation	cost
year	gmos	object	cancer	field	relativity	Law	atmosphere

Table 7.1 shows the twenty most characteristic terms from the classes related to a single particular topic.¹⁰⁷ Many of the terms in these classes were discipline-specific terminology, of the sort described by Evans and Durant (1995) as ‘scientific products’: specific phenomena, objects, and theoretical terms of particular scientific disciplines, of the sort that may be listed in a science textbook or dictionary. However other terms, such as ‘diet’, ‘design’, and ‘smoke’ were more ambiguous; they *could* have appeared in discipline-specific discussion, but equally they could suggest discussions which range into other aspects of social life. To accommodate this variety, I refer to these word classes as composed of *object language* – drawing on Star and Griesmer’s (1989) usage of ‘object’ to refer to a wide variety of material and non-material concepts, which have shared (though somewhat mutable) interpretations across many social worlds.

Table 7.2 shows the twenty most characteristic words for the clusters labelled as ‘generic’ in chapter 4.

¹⁰⁷ As outlined in full in (chapter 3, sec. 3.4.2), classes are lists of words which frequently occur close together in the original text; the ‘most distinctive’ words are those which appear most frequently with terms from a particular class and rarely amongst terms from other classes. A cluster is a graphical representation of a class.

Table 7.2. Characteristic words in ‘generic’ classes from Iramuteq solo analyses.

The top twenty ‘most characteristic’ words produced by Iramuteq, for ‘generic’ clusters displayed in Fig. 7.1. Bold formatting indicates word repeated over multiple subfora. Words like ‘don’ and ‘doesn’ are variants of ‘don’t’ and ‘doesn’t’ produced by certain combinations of subforum text formatting and Iramuteq’s ‘stemming’ of words.

XKCDScience	SkepticssSTM	r/Everything Science	IFLScience
science	science	person	woman
person	axiom	think	him
stone	don	evolution	what
find	word	dont	article
cat	faith	know	read
evidence	law	science	science
thread	insult	feel	post
ancient	universe	suicide	question
civilization	evidence	thing	im
interest	idea	god	know
research	religion	belief	comment
gene	[username redacted]	mind	guy
scientist	forum	title	believe
scientific	doesn	religion	idiot
post	scientific	brain	man
drug	definition	write	hes
trial	theory	like	didnt
biology	assumption	answer	language
learn	physic	love	learn
know	worship	evidence	fuck

The most frequently repeated words across subfora were ‘science’ and ‘scientific’, suggesting that these classes were associated with discussions which reflected on ‘science’ broadly. The repeat appearance of words connoting religion, which frequently featured as an example of not-science (chapter 6, sec. 6.1.1), suggests that terms in these classes may have appeared frequently alongside exclusion of perceived non-sciences. We also see a greater focus on the role of people than in the object classes, with words such as ‘people’, ‘man’, ‘woman’, and ‘guy’. There were also multiple terms which suggest acquisition and/or assessment of information, such as ‘learn’, ‘know’, ‘believe’, and ‘evidence’. The term ‘post’ also suggests references to material posted on the subfora. All these point to discussions around evidence, credibility, and scientificity more generally.

Another recurring theme was that these classes suggested polarisation and dispute. There were recurrent terms of denial – ‘dont’, ‘doesnt’, ‘didnt’ – suggesting that words from this class were often used in oppositional contexts. Terms such as ‘insult’ and ‘idiot’ also implied hostility. However, other contextual details suggest caution around associating these classes too strongly with aggression. As noted in chapter 4 (sec 4.2.5, 4.3.5), the appearance of ‘stone’, ‘ancient’, and ‘civilisation’ in the XKCDScience column suggests an association between this class and the thread *Puzzling Artefacts and Reasonable Reasoning* (July-Aug 2015), and the appearance of ‘suicide’ in the r/EverythingScience column was related to the thread *Suicide Kills More People Worldwide* (March 2015). Both of these involved disagreement and reflections on evidence, but were conducted in largely non-hostile language.

Finding a label which encompassed these various themes was a more complex task than for the object clusters. Though I referred to the clusters as ‘generic’ in chapter 4, this does not usefully convey the themes I have presented here. After consideration of both the word classes and their use in discussions – discussed in section 7.3 – I settled on referring to this as *discursive* language, which captures the stance-taking elements in a way which can encompass either hostility and/or more dispassionate reflections on evidence.

In the following sections I use this distinction between object and discursive language as a basis for discourse analysis. In particular I focussed on the *separation* of object and discursive language, as this is notable from an STS perspective. Both normative descriptions of the ‘scientific method’ (Durant 1994; Popper 1963) and empirical studies of science-in-practice (Gilbert and Mulkay 1984; Latour 1987) suggest that object and discursive language should closely co-occur, as the language of ‘evidence’, ‘scientific’ and ‘belief’ is used to address the credibility of topic-specific claims. I therefore used discourse analysis to examine how the separation between topic-related and discussion-related

language came about in the subfora, and analyse different forms of language use across the subfora.

7.2 Object Language

In this section I focus on 'object language': terms which refer to specific material objects, such as 'stars', or non-material ideas, such as 'spacetime'. I illustrate that object language was used in a great variety of ways across the subfora, and contextualize this usage with respect to existing STS literature. In section 7.2.1 I compare uses of object language on the subfora to an STS framing of technical terminology as a method for transferring understanding of scientific consensus. In section 7.2.2 I consider the extent to which object language meant participation required (or did not require) knowledge from specific scientific disciplines. In section 7.2.3 I analyse relations between object language and credibility.

7.2.1 Conversation, Not Didacticism

Object language was used for a great variety of purposes across the subfora. Box 7.1 shows some examples which illustrate – though do not fully capture – this diversity.

Box 7.1 Various uses of object language

- (1) User1: If you accelerate fast enough by using a laser beam sent from earth to reach mars in 3 days... how would you go about slowing down enough to not just shoot right past the planet?

User2: That's what I'm wondering as well. Especially because atmospheric braking is so low on Mars.

r/EverythingScience *To Get To Mars in Days*, Feb 2016

- (2) [I]t's just fundamentally wrong. The Northern Hemisphere rotates Eastward. Just look at the picture where he shows what he believes is what the path of the Sun should be, according to the heliocentric view [...] The reality should be pretty easy to imagine. Try this: Picture a circle representing the Earth, drawn on a piece of paper (to keep it simple, imagine it's during an Equinox [...]).

SkepticsSTM *Tropic of Cancer*, Apr 2015

(3) User1: Not particularly [interesting experiment], it looks like. It's just going to show yet again that, yup, there's no such thing as a collapse threshold, and that you can maintain superposition in an arbitrarily large system [...].

User2: First of all, please use a more descriptive topic title instead of clickbait buzzfeed propaganda. It looks interesting to me. Though, I'm not quite sure how much a microbe is "alive" at less than 100mK.

XKCDScience *Super-Imposed Microbe*, Sep 2015

In (1) a specific technology (lasers) and idea (atmospheric braking) related to space exploration were mentioned as part of providing answers to a technical question. In (2), technical terminology was used to construct a refutation. In (3), technical terminology about the current state of a scientific field was used to express personal views about a new discovery. Some subfora exhibited slight tendencies towards certain kinds of usage. For example r/EverythingScience participants frequently discussed new research, while XKCDScience threads often began with a technical question. A recurring theme on IFLScience was the use of technical terminology to allege omissions, misunderstandings, or exaggerations in posted articles. For example, on *Dutch Architects Create A Habitable Windmill That Could Power A City* (July 2015) participants argued that the article had miscalculated the megawatts a city would require, or misunderstood how windmills work. However, a range of usage of object language appeared within every subforum.

Producing overarching conclusions from this range is challenging. I begin by comparison with STS research. In much of this literature object language is seen in terms of transferring or demonstrating knowledge of settled scientific consensus. Within science communication, laypeople's ability to define certain 'scientific products' – such as 'gene' or 'atom' – has been seen as a way of measuring knowledge of settled scientific 'facts', and teaching the formal meanings of these terms as a way of transferring such knowledge (Durant, Evans, and Thomas 1989; Miller 1983). In contrast to this formal understanding of scientific terms, Collins has argued that individuals share scientific knowledge through 'interactional expertise'; a tacit familiarity acquired not through didactic education but by 'linguistic socialisation' amongst experts (Collins 2004). In Collins' account, understandings of technical terms are learned and conveyed through usage without explanation.

Following this distinction between didactic and tacit understanding of technical terms, we can note that none of the extracts in Box 7.1 explained meanings of the terms in the manner discussed by Durant, Evans, and Thomas (1989). This was representative of object language usage across threads. Discussions may have involved transfer of knowledge, but

rarely in the form of didactically educating other participants in the meanings of terms. Sometimes terms included hyperlinks to other pages, most commonly Wikipedia, which provided an explanation. This suggests an expectation that participants might not have already been familiar with technical terms; however, the use of hyperlinks put the onus on others to acquire knowledge of the term. The lack of explanations for object language made the discussions closer to Collins' account of tacit familiarity than to the Durant *et. al.* transferral of formalised knowledge.

I suggest that this approach to object language reflects an underlying preference across the subfora for *conversation* – in the sense of sharing a range of contributions, viewpoints, and suggestions – rather than didactic transfer of consensus knowledge from experts to non-experts. This contrast can be seen in an interview extract from XKCD-D, who contrasted XKCDScience with StackExchange (a popular webforum for technical queries):

[StackExchange] is intended to be primarily useful to the much greater number of people who arrive there from Google wanting to know the answer to a question that has been asked before. [...] You're not supposed to have long back-and-forth discussions with people and try really hard to help the specific person who asked a question even if they phrased it poorly or have serious fundamental misunderstandings of the topic even though they seem genuinely interested in learning more [...] [On XKCDScience] you can also (and are encouraged to) have in-depth follow on discussions.

This interviewee presented participation on StackExchange as transfer of existing knowledge: answers to “question[s] which have been asked before”, which should be provided as efficiently as possible. This was contrasted with the “long back-and-forth” and “in-depth follow on discussions” which occurred on XKCDScience. This participant still presented both StackExchange and XKCDScience as places where people gained greater understanding from more expert participants. But the form this took was presented differently between the two. Though this interviewee was specifically talking about XKCDScience, I shall illustrate that this picture – of participants sharing expertise through back-and-forth discussion – is applicable across the subfora.

The idea of going beyond “question[s] which have been asked before” can be seen in the ways that opening posts framed threads. Even posts which focussed on specific topics often offered discussions which were unlikely to have a conclusive ‘answer’. For example, post topics such as *what are the implications of living in an earth-like moon orbiting a planet?* (XKCDScience, Jul 2013) or *primitive humans caused widespread animal extinctions* (SkepticsSTM, Aug 2015) required a certain amount of speculation due to fictional scenarios or incomplete archaeological data. Other posts, such as *the bell that has been ringing for*

the last 175 years (SkepticsSTM, Apr 2015) or *why is the scientific world abuzz about an unpublished paper?* (r/EverythingScience, Apr 2015) addressed topics where professional research was known to be inconclusive. And many posts welcomed socio-political viewpoints rather than a single expert answer, for example r/EverythingScience *Australian government to sharply cut back on funding for climate sciences* (Feb 2016) and SkepticsSTM *Not Newsworthy, But...* (Feb 2016).¹⁰⁸ A range of contributions also featured below posts which could, in theory, have been addressed in a didactic form. For example on the thread XKCDScience *Unbihexium Density* (Dec 2015), a post asking how to calculate the density of unbihexium¹⁰⁹ led to discussions of whether there is a theoretical maximum density, and of how to acquire tungsten. A request for thoughts on an anti-Darwinian evolution article on *SkepticsSTM Fun With Casey Lukin* (Apr 2015) produced discussions about how to 'scientifically' analyse an incomplete fossil record. Each new direction, in turn, opened up possibilities for other participants to contribute a new perspective.

The 'back-and-forth' conversations made possible by these broad topics often led to collaborations between multiple participants, in which they reacted to and built on one another's perspectives. I present examples in Box 7.2.

Box 7.2 Object terms in collaborations

- (1) Separate sapient species developing and conquering each other I'm not so sure about - I think you might need more separation than that [...] Good call on the gigantic perpetual full moon. That could well be at least as significant as the daily eclipse [...] It'd be enough to make for some interesting equivalents to Hadley cells, though, like [username] noted.

XKCDScience *Living In An Earth-Like Moon*, July 2013

- (2) User1: I'm sort of wondering about the maximum available protein in an environment and the fact that humans need a lot of protein as omnivores. Let's pretend we have an environment in equilibrium that doesn't have humans [...]

User2: I think some people get the wrong idea when seeing how people figured out/noticed how things work (well) and responded accordingly to achieve maximum yield. That might look like some form of respect as in crop rotation for example, but to me the meaning is essentially no different from research and developments of today [...]

User3: To [nickname for User2]. My own view is that respect for nature is something new, and dates back only about 50 years [...]

¹⁰⁸ This latter post discussed possible cover-up of radiation still being produced by the damaged Fukushima power plant.

¹⁰⁹ A postulated but undiscovered element.

User2: I am not so sure about dating back for only 50 years.

SkepticsSTM *Primitive Humans*, Aug 2015

- (3) User1: The fact that this person did all this tripping during their mid-teens is probably why they are continuing to self-report cognitive issues into adulthood.

User2: I can only agree. As long as the brain is still in development (which it is at this point) permanent "damage" or change to it through the use of drugs is very much possible from any drug really.

r/EverythingScience *Does LSD permanently change the Brain*, Feb 2016

The language used frequently highlighted the personal nature of contributions: "I think you might need more separation than that" (1), "my own view is that" (2), and "I can only agree" (3). This latter example indicates a reaction to another participant's contribution, which can also be seen in "good call" (1) and "I am not so sure about..." (2). There were also direct addresses to other participants, using names (1,2). All these emphasised the sense of a communal setting in which participants built on one another's contributions. In extract (2) User1 employed the phrase "let's pretend we have an environment in equilibrium", language which suggested a group working through a problem together. Such language was particularly common on XKCDScience, where users frequently employed the pronoun 'we' in a manner reminiscent of science/mathematics problem solving – for example "if we keep your orbital velocity that gets us 500 times more energy" (*Energy of a Collision*, Dec 2015) or "how much smaller can we go?" (*What is the Smallest Object*, Nov 2013). Some threads featured 'live' calculations (*SkepticsSTM Primitive Humans*, Aug 2015; *XKCDScience Energy of Collision*, Dec 2015), and even drawings by participants to help address questions (*XKCDScience Living In An Earth Like Moon*, Jul 2013; *XKCDScience Landing Rockets Upright*, Feb 2016). It should also be noted that few of these threads reached a final conclusion. Taken together, these convey a sense of collaborative working around a particular problem rather than an attempt to reach a single consensus, expert answer.

These examples suggest high levels of interactional expertise: participants used object language in a manner which implied familiarity with technical terms and specialist knowledge in particular scientific disciplines. However questions of 'expertise' raise the issue – discussed more fully in sec. 2.3.2 of my literature review – of whether unequal levels of scientific expertise created barriers to participation within threads. It also raised questions around participants' credibility. When object language was used to make personal suggestions and speculations, how was credibility assessed? These will be the key questions of the next section.

7.2.2 Object Language, Expertise, and Credibility

In this section I address two linguistic features which modified uses of object language: hedges and pronouns. ‘Hedges’ are linguistic devices used to illustrate uncertainty in one’s own claim (Baym 1996; Mulkay 1985). We have seen examples in Box 7.2, such as “I think you might need” (1), “I’m sort of wondering about” (2), or “is probably why” (3). However on the subfora hedges did not just illustrate uncertainty in specific claims; participants also used phrases which decreased their broader personal credibility. We have already seen one form of this in the ‘I am not a scientist’ device, in chapter 6 (sec. 6.2.3). There were also examples of participants describing themselves as “ignorant-but-interested” (*r/EverythingScience LIGO likely to announce*, Feb 2016) or having a ‘layperson’ level of knowledge (*XKCDScience What is the Smallest Object*, Nov 2013; *r/EverythingScience Brian Greene Breaks Down*, Feb 2016). Such hedges did not simply illustrate uncertainty in a specific claim, but more broadly raised doubts about the participant’s credibility in the relevant topic. Nonetheless, in these examples, participants still contributed and employed subject-specific object language.

One interpretation of hedges is that they were pre-emptive face-saving devices, in case someone with more expertise disputed the comment. This was a reasonable explanation for hedges on the subfora, given that all except IFLScience regularly featured contributions from people who were knowledgeable in the subject under discussion. In some (though not all) cases professed ‘non-experts’ were corrected (*XKCDScience Landing Rockets Upright*, Feb 2016; *XKCDScience What Is The Smallest Object*, Nov 2013; *r/EverythingScience LIGO Likely To Announce*, Feb 2016). However I did not see any instances of such participants being told that, as self-professed non-experts, they should not have contributed (unless the RSC norm was being violated). This is worth noting, as another interpretation of hedges is that they create an atmosphere which normalises and welcomes less confident contributions (Baym 2000).¹¹⁰ Unequal expertise certainly shaped discussions – hedges were still acts of deferral towards those with more expertise, and directed others to be careful of building on the contribution. However, such concerns did not go as far as stopping contributions from participants who considered themselves non-expert.

In addition to hedges, I have noted how participants often employed pronouns in a manner which made the personal nature of their contributions clear, such as “*I think* you might need

¹¹⁰ There may, of course, be many users who did see the presence of experts as reason to not contribute and therefore did not appear in the data. The key point here is this was not universal, nor clearly encouraged by communal responses.

more separation than that” (Box 7.2, 1) or “*my own view*” (2). However we have also seen many instances in which object language was used without any personal pronouns – for example, “atmospheric braking is so low on Mars” (Box 7.1, 1) or “there’s no such thing as a collapse threshold” (3). Many threads, and even speakers, moved between the two. In the lengthy and highly speculative the XKCDScience threads *Living on an Earth-Like Moon* (Jul 2013 - Feb 2015), and *Landing Rockets Upright* (Jan - Feb 2016), the speculations began with very hedged language, alongside ideas phrased in the subjunctive mood – ‘I would expect’, ‘it would probably’, and so on – which made uncertainty clear. However, over the course of the threads multiple participants used depersonalised language – ‘it will’, ‘it does’ – to describe the fictional astronomical system or new rocket design. In other words, speculative knowledge became rhetorically indistinguishable from fact.

Where hedges present claims as subjective and potentially wrong, depersonalised language is often taken to imply objectivity and speaking ‘for nature’ (Gilbert and Mulkay 1984). Such language is commonly used within professional scientific discourse as a device to bolster credibility, i.e. to imply that one’s claims are to be *believed* rather than treated as opinion or invention (Latour 1987). The use of depersonalised language within these non-professional settings is therefore notable. Without any guarantees of relevant expertise, provided in professional settings through institutional accreditation and processes of publishing, how did participants expect others to accept their credibility? One possibility was through providing evidence or source material, but even this occurred inconsistently. While in some cases depersonalised language was combined with references or hyperlinks, these were mostly used as explanations of particular technical terms (usually via Wikipedia). Such use of depersonalised language, and absence of evidential support, was particularly notable given many of the above examples involved speculating beyond the limits of scientific consensus. While these did build on consensus knowledge (7.2.1), the language used meant it was not always easy to distinguish consensus and personal speculation. The significance of this finding will become apparent after the discussion of discursive language; I shall therefore consider it more extensively in section 4.

Before moving on, it is worth noting that in this section I have focussed on object language which had relatively clear links to specific scientific disciplines. However, this is not representative of all object language. Various terms in the object word clusters – such as ‘china’ (IFLScience) or ‘youtube’(r/EverythingScience) – did not clearly relate to scientific research but nonetheless were topic-specific. Some, such as ‘wildheretic’ (SkepticsSTM), required specific knowledge. We saw in chapter 5 (sec. 5.2.2) how object terms such as ‘Heidelbergensis’ and ‘red dwarf’ featured in jokes; but so did ‘ELI5’ and ‘grand-pappy’.

Similarly a TAN on r/EverythingScience *Science Says Speed Reading Doesn't Work* (Feb 2016) referenced 'tumblr' and 'w.a.s.p.s'. These terms were used in a similar way to object language from specific scientific disciplines: providing specific points of reference, which other participants would either recognise or would need to educate themselves to understand the message. Some threads were dominated by object terms which were not clearly linked to specific scientific disciplines, for example 'adblock' and 'browser' on *SkepticsSTM Google Decay* (Dec 2013 - Dec 2015), or 'Pepsi' and 'Coke Zero' on *IFLScience One Can Of Coke* (July 2015). My argument here is not that these object terms were 'unscientific'; constructivist STS analysts must be careful not to impose our own ideas of 'scientific' onto participants' discourse (Bloor 1976). Rather I argue such combinations of knowledge, which ran throughout many threads, show roles for object language which need not have involved exclusion of participants without discipline-specific expertise.

Summary of Section 7.2

Object language was used for a great variety of purposes – from providing answers to questions and constructing speculative answers, to making jokes and expressing personal viewpoints. Notably absent were explanations of what object terms meant, which reflected a broader absence of didactic explanations. Participants were not visibly limited by requirements of using (or being knowledgeable of) consensus scientific knowledge, nor was there an expectation that object terms should be accompanied by demonstrations of credibility and/or explanations of meanings. Instead participants used object terms to express personal ideas, views, and creativity as part of constructing back-and-forth, multi-perspective conversations.

7.3 Discursive Language

In this section I focus on discursive language: terms connoting commentary on argumentation and/or discussion, often related to scientific methodologies, philosophical notions of evidence, or terms suggesting hostility. In section 7.3.1 I describe how this language was often used to discuss credibility – by which, I mean whether something or someone could be believed – in ways which went beyond the specifics of claims. In section 7.3.2 I focus on the role of language related to professional scientific culture and processes.

7.3.1 Discursive Language, Polarisation, and Credibility

As illustrated by the examples in Box 7.3, discursive language was often used to assess the evidence given for certain claims. In doing so participants also made broader comments about credibility, which were not limited to those specific topics.

Box 7.3 Discursive Language and Argumentation

- (1) That site seems to be rather unreliable. In addition to using clickbait titles (e.g. the one about phone choice being related to cavemen, which cited a ***YouTube video*** and no formal research findings), I can find no peer-reviewed research linked from the article, just an independent institute which doesn't seem to link to anything either.

r/EverythingScience *A Troubled Relationship*, Feb 2016

- (2) User1: I'd say there's enormous evidence to the yes. Fecal transplants being a thing is probably old hat to anyone curious [...] if you want to get hung [up] on the semantics between 'really really useful to have' and 'essential' then fine, but there's a lot humans don't need to survive. Like thumbs. Or eyes. Or a second arm. Etc.

XKCDScience *Human Gut Microbiome*, Feb 2015

- (3) User1: I've read quite a few books and studies on OBEs [out of body experiences] and NDEs [near death experiences]. Interesting stories but very weak on evidence. [...] I am open to suggestions. What have you got? Keep in mind I have a keen sense of what kind of evidence is useful or not in evaluating the claims about these things.

User2: Actually [username's] crap can easily be dismissed. It was debunked by a bloke who wrote a secret message [...] Not one person who claimed they could control their OBEs could read it [...] next time you read about a mediation centre going bankrupt please send them applications to the JREF million dollar challenge¹¹¹ so we can laugh even harder at them.

SkepticsSTM *Question for Physicists*, March 2015

¹¹¹ A challenge made by leading skeptic James Randi to demonstrate "under proper observing conditions, evidence of any paranormal, supernatural, or occult power" with a prize of one million dollars (Carroll 2016).

(4) I do not think [username]¹¹² has much appreciation for either history or archaeology. They will always stick to their speculation as if it was proven fact [...] I am directly experienced with the modern (and through reading, the old) cultures of the Maori, Australian aboriginee, Fiji native, Papuans, and Tongans [...] [username] ignores data when it does not support the argument he/she is putting forward. Of course, since [username] does not argue for the joy of academic discussion, but just to create mischief, he/she does not care.

SkepticsSTM *Primitive Humans*, Aug 2015

Extract (1) used “phone choice being related to caveman” as an example to demonstrate more general factors which cast doubt on the website’s credibility: “clickbait” titles, the use of YouTube, and lack of peer-reviewed research. In (2) the discussion went beyond the specific topic of fecal transplants into broader questions of distinguishing “benefit” from “being essential”, and even whether the basic question was “semantics”. Extract (3) and the latter half of (4) barely made any reference to the specific topics being discussed, and instead focussed entirely on distinguishing credible and not-credible types of people. The way in which discursive language in these extracts was used to *criticise* claims to credibility was representative of the subfora more generally. By contrast with the use of object language¹¹⁴ to collaboratively build upon other participants’ contributions (sec. 7.2.1) discursive language was more often used as part of questioning, disputing, or criticising other participants’ credibility.

In the Iramuteq analyses (section 7.1), I noted that terms in the discursive word classes often suggested dispute through negations (‘don’t’, ‘doesn’t’) and references to hostility (‘idiot’, ‘insult’). In threads, discursive language often involved participants positioning themselves against another participant. Examples in Box 7.3 included “what have *you* got? Keep in mind *I* have a keen sense of what kind of evidence...” (3); “*I’d* say... but if *you* want to get hung [up]”; and “*I* have a personal hypothesis... *I do not think [username]* has much appreciation” (4). This antagonism sometimes took hostile forms – “username’s crap” and “we can laugh even harder” in (3), and “[username] argues... just to create mischief, so

¹¹² A fellow participant, who the author of this extract argued with earlier in this thread.

¹¹⁴ Though the extracts of Box 7.3 do feature object language – such as “Maori”, “OBE”, and “JREF” – Iramuteq word classes emerge from words being used repeatedly in close proximity to one another. The distinctive clusters for discursive language therefore do not suggest that such language is used *entirely* without object language; rather, it means that discussions use words such as ‘evidence’ or ‘people’ repeatedly and in close succession, suggesting these are the key focal points of the discussion. If discussions continually moved between (for example) terms such as ‘rockets’ and ‘evidence’ then these would appear in the same cluster, and there would not be a distinction between object and discursive language.

he/she does not care” (4). In conjunction with the generally critical attitudes expressed through discursive language, this often led to lengthy polarised discussions in which specific topics become extended critiques of other participants. This could be seen in many SkepticsSTM threads such as *Crop Circle Formations* (Jul-Sep 2015) or *Monty Hall Redux* (Oct-Nov 2015), but also such threads as *XKCDScience Is Control a Common Property* (Dec 2015) or *r/EverythingScience Researcher Illegally Shares* (Feb 2016). I suggest the distinction between object and discursive language shown in the Iramuteq analyses emerged from such extended polarised discussions,¹¹⁵ in which assessments of credibility became detached from specific topics.

7.3.2 Discursive and Scientific Culture/Process

A second feature of the discursive word clusters is that they frequently included references to professional scientific research and/or communication. This was particularly true of r/EverythingScience, which produced a pair of clusters with words such as ‘theory’, ‘method’, ‘evidence’ in a separate cluster from ‘journal’, ‘reviewer’, ‘agency’ (Figs. 4.8, 7.1). However terms such as ‘trial’, ‘research’, and ‘article’ appeared across discursive clusters from other subfora. This is worth discussing further in light of a categorisation made by Durant in his work on scientific literacy (1994).

I have already referred to Evans and Durant’s reference to being literate in ‘scientific products’, by which they mean having knowledge of specific facts and technical terms drawn from mainstream scientific consensus (1995). But Durant develops a further distinction between scientific *culture* and scientific *process*. He defines scientific processes as more idealised methodological and intellectual approaches: hypotheses, falsifications, and similar. By contrast, he defines being literate in scientific culture as having knowledge of how science works as a profession, including publications, peer reviews, and funding. The appearance of scientific culture terms amongst discursive language, rather than alongside object language, is worth investigating further: it implies that professional scientific work was more often discussed in relation to broad questions of credibility, than in relation to specific topics. I therefore examine this suggestion in relation to data from threads.

¹¹⁵ These ‘discussions’ could be whole threads, or *sections* of threads – some threads, in particular *SkepticsSTM Primitive Humans* (Aug 2015), moved between discussions dominated by object language and discussions dominated by discursive language. However these were relatively uncommon; once a discussion became polarised, it would generally be dominated by discursive language.

Box 7.4 shows example usages of terms associated with scientific culture.

Box 7.4 References to Scientific Culture

- (1) User1: Have you considered the possibility that it's the blogger who's being misleading and not the museum?

User2: Lol, Dr. Joe Romm isn't just some random internet blogger. He's a physicist and an author. He was also acting Assistant Secretary of Energy back in the 90s. He's also a fellow of both the Center for American Progress and the American Association for the Advancement of Science. His pay has nothing to do with how many people he can get to look at his web pages.

User1: So, you're saying that Joe Romm is smarter and more honest than the all guys who run the Smithsonian?

User2: Nobody made that claim. I'm saying that Dr Joe Romm isn't just some random internet blogger. He is more honest than Dr Soon who pushes a debunked view of climate change and has failed to disclose conflicts of interest. The Smithsonian as an institution rejects Soon's ideas yet still creates exhibits based on those ideas despite the fact that they've been aware of his disclosure problems for some time.

r/EverythingScience Exhibit Paid for by Kochs, Apr 2015

- (2) User1: A few of these gysts were already thrown around, but I guess you want citations? I'm just grabbing stuff from google here; [Links from scientific journals ...]

User2: It'd be a pain to track it down from my phone, but I actually remember reading about research done a couple years ago about differences in gut flora linked to differences in calorie uptake.

User3: The BBC article may be misleading. If you read the original case report [...]

XKCDScience Human Gut Microbiome, Feb 2015

- (3) From Wikipedia [...] "Detection of Population III stars is a goal of NASA's James Webb Space Telescope. New spectroscopic surveys, such as SEGUE or SDSS-II, may also locate Population III stars [...]" So there are several places where researchers are currently looking in order to find evidence of Population III stars.

SkepticsSTM Population III Stars, Apr 2015

In extract (1) references to scientific culture – the professional positions of Joe Romm, the Smithsonian's role as an institution – were still oriented towards supporting an argument over who should be counted as a credible source. This occurred alongside features already noted in Box 7.4: personal stance-taking and references to the wider group in "so you're

saying... *nobody* made that claim. *I'm* saying", as well as slight antagonism in "lol". The responses shown in extract (2) referenced "citations", "case report", and "research" (in the sense of a specific professional project) to response to dissatisfaction with 'evidence' that had previously been provided in the thread. Extract (3) drew on reportage of ongoing professional work as part of a broader aim to debunk an argument opposing the Big Bang theory. In these examples, as across the subfora more broadly, references to professional scientific culture were used to provide broader authority to participants' arguments.

Across subfora, references to scientific culture featured in a variety of ways. On XKCDScience, threads which began with discussions of specific research – such as *Black Hole Information Paradox* (April 2015) and *Super-Imposed Microbe* (Sep 2015) – were turned into personal assessments of the novelty or excitement of the research. Some SkepticsSTM and IFLScience threads involved multiple references to professional research and researchers; such references were used to back up personal positions and/or criticise opposing positions in a debate (SkepticsSTM *CERN: The End of the World*, Sep 2015; IFLScience *Scientists Grow Miniature Brains*, July 2015). On r/EverythingScience there were lengthy threads focussed on the details of professional scientific work, which explained the appearance of a distinct 'scientific culture' cluster in Iramuteq analyses for this subfora. However even these often involved contributions which brought in personal stances and viewpoints. For example there were lengthy threads debating social and ethical issues related to scientific publication (*Researcher Illegally Shares*, Feb 2016; *Reproducibility Should Be*, Feb 2016) or scientists' involvement in socio-political controversies (*Science Museums Urged to Cut Ties*, March 2015; *House Passes Bill Saying Yes to Industry Lobbyists*, March 2015). As we saw with object language, participants showed relatively little interest in straightforwardly transferring information or news. Instead terms from scientific culture were commonly used as a form of discursive language, to develop personal viewpoints, stances, and comments on credibility.

Summary of Section 7.3

Overall, the findings of this section were in line with section 7.2: terms and ideas related to scientific research were one resource amongst many used to construct back-and-forth, multi-perspective conversations. However where looking at object terms showed a variety of knowledges being used for purposes of creativity, the use of discursive language showed a much stronger concern with assessment and criticism. This included assessing the credibility of claims and/or of other participants – or, frequently, a combination thereof. A

frequent result was extended polarised discussions in which the specific topics become enrolled in, or put aside in favour of, more general assessments of credibility.

7.4 ‘Science’, Credibility, and Latent Meaning

In the previous two sections I have shown that the distinctions produced by Iramuteq, between object and discursive language, were reflected in two different forms of discussion. Discussions which involved a high proportion of object language tended to involve creative, collaborative contributions which moved outside of settled scientific consensus and downplayed questions of credibility. Discussions which involved a high proportion of discursive language tended to involve critical, polarised stance-taking which continually foregrounded questions of credibility. In this final section I consider how these two, apparently inconsistent, attitudes to credibility co-existed within the subfora.¹¹⁶ I follow Gilbert and Mulkey’s (1984) approach to apparent inconsistencies between forms of scientific discourse. They point out that, from a constructivist point of view, we should not expect consistency in discourse – all speech is shaped by context, and context is rarely static. However a closer focus on how apparent inconsistencies are resolved by speakers can bring latent meanings of ‘science’ to light.

To investigate credibility further, I presented all interviewees with the following thought experiment:

There's a thread about a fairly niche scientific topic that you don't know that much about. Someone who you don't recognise comes in and contributes a comment. They're using fairly high-level terminology but they don't give any links. How (if at all) would you assess the credibility of that comment?¹¹⁷

I present key themes from responses in sections 7.4.1 and 7.4.2. In 7.4.3 I relate these themes to findings from threads, as discussed in sections 7.2 and 7.3.

¹¹⁶ This inconsistency was not due to differences in language choice between participants – many of the discussions quoted in sections 7.2 and 7.3 involved the same people.

¹¹⁷ In later stages of interviews I asked a similar thought experiment around making claims and demonstrating credibility in a highly speculative topic; however as this occurred in late stages of interviews, and as there was often a delay in between questions and answers, I only received two responses in the time for use in this thesis.

7.4.1 Credibility as Effort

The most common theme in responses to the thought experiment was that assessing the credibility of claims involved effort, and therefore had to be driven by sufficient personal motivation. Specific examples are given in Box 7.5.

Box 7.5 Credibility and Effort

- (1) Honestly, while I probably **should** research the post, I'm not going to unless the topic is particularly interesting [...] I'm likely just going to assume they do unless there's reason to question it. There's a practical bar for verification in terms of hassle.

XKCD-B

- (2) If I don't know anything about it, I'd go with my gut and probably not weigh in conclusively one way or the other [...] I'll take those statements as 'probably reliable' until I have reason to believe otherwise. If they're not giving any data, I'm going to be somewhat skeptical of their claims, but not really have any way of verifying or rejecting them.

XKCD-E

- (3) So, if I'm being honest, it depends. Am I commenting in my free time or am I commenting during a pause at work? Am I pissed off and feeling skeptical of everything, or am I feeling content and trustful? Is the tone of the commentor friendly and genuine or is it smug and *r/iamverysmart*? So [assessing credibility] may or may not matter to me, depending on those (and probably other) factors.

r/ES-u/GonzoRick

- (4) Q: *what would you say are the major ways participants deal with disagreement?*

I have come across the 'put up (evidence), or shut up' stance here too, but not frequently [...] we are (mostly) not scientists and in general may not have access to these articles or are unwilling to pay-per-view; then when we do have access, they generally are difficult to skim-read and thus find the particular quote/evidence necessary to support ones' position, and I suspect that we are just a bit lazy, given that we are here for enjoyment and not professional development or economic best interests.

Skeptics-A

All of these suggested that assessing credibility required some effort, and noted that certain factors would have to prompt them to undertake such activity. Some factors were related to specific details of the claim: whether the topic was "interesting" (1), or whether the participant knew enough about the claim to have "reason to believe otherwise" (2). The interviewee in (3) also noted the effects of offline factors, such as mood and available time. Other factors

related to the claimant's behaviour, such as whether they were "giving data" (2) or writing in a "friendly" or "smug" style (3). This latter theme appeared in other interviews. r/ES-B said they would be more likely to check credibility if "wording came across in a condescending way"; XKCD-E noted that "language used and presentation are going to probably unduly influence my impression"; and Skeptics-C referred to responses with "a lot of high-level words with no real connection or substance behind them". These suggest that assessing credibility was tied to assessments of both information and type of participant.

Though participants suggested that assessing credibility required some effort, they also portrayed *spotting* potentially non-credible contributions as relatively straightforward (Box 7.6).

Box 7.6 Prompts to challenge credibility

- (1) Clues that perhaps a position is not well thought out, and easy to challenge are many. Sure, most of us don't bother with perfect spelling and grammar, and speak pretty informally, but someone who is clearly an outsider in speech is likely to also hold outsider opinions, and poor presentation, while not guaranteeing a low quality post, definitely is a factor.

XKCD-D
- (2) People do have a tendency to not comment in scientific threads unless 1) they are religious/quackery or 2) they actually know a thing or two. It is pretty easy to assess the difference [...] it is easy to pick up on who knows what they are talking about and who is pulling it out of their arse. I don't know if I can point to anything more specific than I have already mentioned. But it does work even with fields I am not intimately familiar with.

XKCD-I
- (3) Generally, if their comment doesn't raise any red flags for me, they're being friendly, and I'm interested in the topic, somewhere in my comment I'll ask if they study X subject. If I'm not in a good mood, or they're being smug, or something admit they're comment raises red flags, I'll start with a Google search, probably end up in Wikipedia.

r/ES-u/GonzoRick

Interviewees in (1) and (2) both described spotting non-credible contributions as "easy". (3) mentioned "red flags" twice, suggesting that prompts to assess credibility were clear and visible. We can also look to XKCD-E's reference to "go[ing] with my gut" in Box 7.5 (2), suggesting that assessments could instinctively. All these examples suggest that

interviewees found distinguishing between credible and non-credible contributions relatively easy.

They also related this to ideas of in-group and out-group, as discussed in chapter 5. XKCD-D (Box 7.6, 1) spoke of people who were “outsider[s]” in both writing style and views. XKCD-I (2) drew a distinction between “people who know what they are talking about” and those who contributed pseudoscientific “religious/quackery”. This corroborates an argument of chapter 6 (sec. 6.2.2), that characteristics of ‘unscientific others’ provided resources for participants to instantly recognise unwelcome behaviour. Again we see that assessing credibility of claims was tied to characteristics of people, encoded in recognisable identity labels.

7.4.2 Credibility as Expectation

Box 7.7 gives examples of how participants went about checking credibility.

Box 7.7 Personal Credibility Checks

- (1) I'm versed enough to usually be able to tell when someone is using high-level terminology appropriately or inappropriately, and if someone piqued my interest I'd start by politely asking them to cite a particular claim so that I could read the source. Something like, "I'm curious about the part where you said X. Do you have a source where I could find more information?" The quality of their source usually helps distill whether they're being genuine or trollish.

r/ES-A

- (2) To assess credibility first of all I would look at the logical consistency (or inconsistency, thereof) of their post. Also, the wonders of the Internet it is easy to quickly validate - as this is a scientific niche topic in our thought experiment, the use of PubMed or google Scholar should pop up papers if there is any part that needs fact-checked.

XKCD-A

- (3) If the topic was interesting to me, I would probably cut & paste, and then use snippets to google the topic in an attempt to find relevant information, and possibly his source. Failing that, I might just ask for links.

Skeptics-A

These participants made references to using personal knowledge (1) and/or broader critical thinking approaches of “look[ing] at logical consistency” (2). But they also brought in the use

of online affordances, whether search engines (2, 3) or the ability to respond with a request for citations (1,3). Some of these methods could require relatively high levels of expertise, such as the use of PubMed (2). However others, in particular asking for sources (1), could be accomplished by any participant with relative simplicity.

Amongst XKCDScience participants, another common theme was the presence of other users who could also assess credibility. Examples are given in Box 7.8.

Box 7.8. Credibility of the Group

(1) The tricky part is the less-common third category of "knows something, but not much, and made the rest up with conjecture" [...] One tends to comment and follow threads of interest, so the readers should (hopefully) have enough background knowledge to tell if it is commenter type three.

XKCD-A

(2) Generally, most frauds tend to out themselves soon enough, or at least get challenged by someone with more specific knowledge, and then I can focus verification efforts easily enough to determine who's correct. I'll cheerfully call out errors/etc that I see, and I figure others will often do the same for issues they care about, so it mostly works on a low-effort basis [...] anything nobody challenges must have at least a decent level of acceptance.

XKCD-B

(3) Generally, I rely on the knowledge of people I trust [...] It's no different on /r/science - someone who has the flair 'BS Biology' has an undergraduate level of knowledge, whereas someone who has the flair 'PhD CRISPR' probably knows more about modern genome editing technologies. I could probably tell if a user was full of shit in a bunch of [user's field] related topics, but probably not so much in something like [an unrelated field].

XKCD-E

The absence of such references amongst non-XKCD interviewees does not mean that such participants on subfora did not use such methods; note that my question asked participants 'how would *you* assess credibility', which may have encouraged them to reflect on their personal methods. As noted by XKCD-E, who also used r/EverythingScience, flair could encourage participants to be aware of the expertise of fellow members (3). However the recurrence of this theme amongst XKCDScience interviewees is worth noting given a) the generally high level of expertise on this subforum and b) the fact that many of the most extended speculative threads occurred on this subforum (*Landing Rockets Upright* Jan - Feb 2016, *Puzzling Artefacts* July - Aug 2015; *Living in an Earth Like Moon*, July 2013 - Feb 2015). This suggests that confidence in surrounding participants' expertise may have

allowed speculations to proceed without continual demonstrations or (visible) assessments of credibility.

Interviewees not only presented assessing credibility as achievable; they also suggested that credibility was an *expectation* on the subfora. There were distinctions between how strictly interviewees applied this expectation, but it was consistent. When asked how they would demonstrate credibility in a very speculative topic, XKCD-A replied “I do not take a side on a topic unless I have evidence to back it up.” By contrast, r/ES-B claimed that “as long as I feel confident that I can't be called out on a falsehood I don't necessarily see a reason to double-check my facts”; however, they still spoke of demonstrating credibility as a “concern”, and that they would often do some research.

Others suggested that adhering strictly to consensus knowledge might impede enjoyment (XKCD-A, Skeptics-A). In particular, when I asked an interviewee (XCKD-B) about a hypothetical “highly underdetermined topic, perhaps some predictions about the future or some scientific field with lots of open questions and little consensus”, they provided the following view:

Those are actually the fun topics, IMO. Usually there's room to find unconventional viewpoints that are still valid, simply due to the speculative nature, so you're more likely to get a stimulating conversation rather than a rehash of already set views.

In contrasting “stimulating conversation” and “unconventional viewpoints” with the “rehash of already set views” which could come from discussing settled consensus knowledge, this participant tied the underdetermined nature of the topic to the enjoyability of the conversation. However such interviewees still expressed concerns with checking credibility, and hoped for “unconventional viewpoints *that are still valid*” (XKCD-B, emphases added). No interviewee objected to the idea of speculations, or argued that participants should aim to *prove* claims. But despite the variations across interviews, one expectation was consistent: on the science subfora, claims should always aim to be credible.

7.4.3 Credibility, Object Language, and Discursive Language

While interviewees cannot be assumed to speak for the subfora as a whole, the above findings indicated factors which may underlie the ways object and discursive language were used in the subfora. In this concluding section I reflect on the data from threads discussed in sections 7.2 and 7.3, in light of key themes from the interview data. To summarise, these key themes were: assessing credibility takes effort, and must be prompted by motivating

factors; motivating factors include being 'interested' in the topic, but also the writing style of the claimant; and that credibility *can* and *should* be assessed, whether through personal methods or through relying on the expertise of the surrounding group.

I begin with the finding that object language was often used in ways which did not reference credibility, either as assessment or as demonstration (sec. 7.2.2). This finding cannot be explained by participants generally not being interested enough to assess credibility. Some particularly speculative threads, which featured extensive uses of object language (*XKCDScience Living in an Earth Like Moon*, July 2013 - Feb 2015; *XKCDScience Puzzling Artefacts*, July 2015; *SkepticsSTM Primitive Humans*, Aug 2015) were extremely long and featured multiple participants. They also featured explicit expressions of enjoyment and/or claims that the discussions were 'cool', which were relatively rare phenomenon (discussed further in chapter 8).

Instead, explanations for the lack of references to credibility in such speculative threads can be found in other factors. As noted in section 7.2.1, such speculative discussions often featured multiple disciplines, questions which were hard to address using settled scientific consensus, and/or slippage between objective statements and hedged suggestions. They often unfolded in real time, and sometimes involved calculation or multiple point-by-point responses to previous contributions. These made individual methods for checking credibility, such as using web resources or assessing logical flow, difficult. However the multi-participant nature of such discussions increased the chance of an expert calling out perceived errors. This was particularly the case on *XKCDScience* and *r/EverythingScience*, which may explain the regular (and often extended) appearance of such speculative discussions on these subfora.

The idea that, ultimately, speculations should stay within the bounds of credibility can also be seen in the threads discussed in section 7.2 and 7.3. We have already seen how hedged language was used to defer to those with greater credibility (sec. 7.2.2). In addition, participants in *XKCDScience Living in an Earth Like Moon* (July 2013 - Feb 2015) repeatedly spoke of trying to keep their ideas within the realms of the 'possible'; the participant with the "personal hypothesis" on *SkepticsSTM Primitive Humans* (Aug 2015) acknowledged that gaps in evidence meant their hypothesis could never be conclusively demonstrated. The general lack of clear demonstrations and/or assessments of credibility in such threads should therefore not be read as a discounting of expectations of credibility.

A comparison can be drawn here with Gilbert and Mulkay's analysis of professional scientists' discourse. They also found a distinction between two forms of language. The first

was the 'contingent repertoire', in which science was presented as a practice carried out by humans, with results emerging from biases, preconceptions, and other social or psychological factors (1984). They contrast this to the 'empiricist repertoire' in which science was presented as an abstract, depersonalised search for truth.

Gilbert and Mulkay note an inconsistency between these two ways of presenting science. How, they ask, can science be both a human practice (with associated biases) and also a depersonalised process of finding the truth? When scientists were presented with this inconsistency they argued that, over time, the processes of science would minimise the effects of biases and produce truth. Gilbert and Mulkay refer to this as the "Truth Will Out" device (p.91). This rhetorical device allowed the scientists to describe their professional lives – filled with stories of mistakes, tribalism, humour, and similar human factors – while still maintaining a conception of science as a truth-finding activity. The resolution of the inconsistency thereby reveals a shared latent meaning of 'science' as an activity based around seeking the truth.

In this chapter I have argued participants sought *credibility* rather than truth. There was little evidence that participants expected claims to be definitely true – as shown in 7.2, there were many threads which could not provide clearly 'true' answers. But they did expect claims to be *potentially* true, and be able to demonstrate this – i.e. to be credible. Nonetheless, a parallel can be drawn with the Truth Will Out device. I argue participants on the subfora drew on ideas that a) credibility *could* be assessed using online tools and b) others in the community, quite possibly with more expertise, were potentially also assessing the credibility of statements. As a result, participants need not continually query and/or demonstrate expertise as, in the end, 'credibility will out'.

However, if a participant was prompted to visibly challenge a claim's credibility, the result was one of two outcomes. Either the dispute could be quickly settled through some method of fending off the challenge to credibility, usually by presenting accepted consensus knowledge and/or the support of another participant who was accepted as credible. We saw an example of this in chapter 5 (sec. 5.2.3), where the XKCDScience moderator acknowledged they had misjudged another participants' knowledge after a relativity expert intervened (*Acceleration Near a Black Hole*, Apr 2013). However, such interventions were relatively uncommon. If the original claimant did not present a defence which was 'acceptable' to the wider community, then "red flags" – of the sort discussed in section 7.4.2 – had been raised. Questions of credibility, which might previously have been in the background, were brought into the foreground. This potentially prompted other participants to also assess and/or attack credibility.

As noted in Collins' concept of the 'experimenters' regress' (1985), disputes to credibility can rarely be settled purely by reference to 'facts'. Instead these disputes were entangled with questions of who counts as a credible person. In addition to such issues, we saw in section 7.4.2 that participants who raised 'red flags' about credibility often exhibited forms of behaviour – such as unclear writing, or impolite tone – which antagonised normative participants (chapter 5, sec 5.1.2). The net result of these processes was that a challenge to credibility could lead to an entire thread being dominated by claims and counter-claims to credibility, often in association with personal antagonism. This was the pattern we saw in section 7.3.

I suggest that these patterns – that credibility could be tacitly guaranteed through the surrounding group, or that personal credibility was challenged and counter-challenged by individuals – underlay the different forms of discussion shown in sections 7.2 and 7.3.

These different attitudes to credibility could lead to either:

- 1) object-dominated discussions which did not address credibility (when users expect that others will point out non-credible material), or
- 2) discursive-dominated discussions in which 'red flags' had been raised about credibility.

While the presence of recognised experts in XKCDScience and r/EverythingScience could make the first type of discussion easier to maintain than in SkepticsSTM and IFLScience, the appearance of participants who did not accept expertise could produce discussion type (2). Similarly, as we saw in sec. 7.3.1 and 7.4.3, 'interesting' topics could lead participants across all subfora to defer a continually critical approach and produce discussion type (1). These two paths illustrate how a latent shared conception of science, as an activity which required credibility, could be mediated through features of different groups to produce the patterns observed in this chapter.

Conclusion

In this chapter I have looked at ways in which participants constructed latent descriptive meanings of science through recurring linguistic patterns. Using Iramuteq I found that all four science subfora showed a distinction between *object* and *discursive* language – in other words, terms relating to specific objects/ideas appeared in separate clusters to terms relating to producing and assessing claims. The relative proportions and particular appearances of

these terms varied between the four science subfora, but all incorporated them in some form. The separation of these forms of language in Iramuteq was a contrast to previous STS examinations of scientific discourse in many other settings, which have noted how topic-specific claims and evidence for those claims are often presented *alongside* one another (Gilbert and Mulkay 1984; Latour 1987). The findings of the next chapter build considerably on these findings, so for now I defer fuller analysis of this distinction.

From discourse analysis of object and discursive language, I presented two key findings. Firstly, that both object and discursive language were used to bring a very wide range of knowledges, viewpoints, and contributions to discussions. Despite the appearance of words suggesting topics or methodologies from professional scientific research in the Iramuteq word clusters, participation was not limited to drawing on discipline-specific knowledge or references from professional research. This allowed participants to bring in a range of personal ideas, views, and contributions.

The second key finding was a general expectation that discussions should stay within the bounds of credibility, i.e. that all claims should be believable even if not provably true. How this appeared varied between threads and subfora. In some cases, particularly in threads which involved collaborative sharing of topic-specific knowledge and ideas, credibility was tacitly assured by the presence of experts who corrected the occasional mis-steps. In other cases, most notably discussions in which participants were disputing one another, credibility was continually critiqued – often in a manner which became detached from any specific topics. These two forms of discussion suggest an explanation for the distinct clusters in the Iramuteq outputs. More importantly for the purpose of this chapter, both these forms of discussion suggest that participants across the subfora respected credibility, whether visibly or tacitly. This became particularly obvious in moments where credibility and creativity came into conflict; in these circumstances, participants deferred towards the maintenance of credibility. Overall, this suggests a shared latent meaning of science as a practice is based on *credibility*.

Comparing the analyses of latent descriptive meanings from this chapter with the analyses of manifest meanings (chapter 6) suggests two common themes. Firstly there was considerable interpretative flexibility in what is presented as ‘science’ on the subfora, which opened a great variety of behaviour – a feature that participants seemed to enjoy. Secondly, this interpretative flexibility did not extend as far as ‘anything goes’. Across all four science subfora, patterns of participation certain expectations related to discussing ‘science’. In the analysis of manifest meanings (chapter 6) we saw how participants were sanctioned for drawing on ‘unscientific’ views and thinking; in this analysis of latent meaning we have seen

that, across the science subfora, participation generally showed respect for credibility. In other words, behaviour across the subfora was shaped by shared expectations of what 'science' is or should do. More broadly, participants' online socialising was heavily shaped by ideas of expertise and credibility. In doing so, they combined traditional processes of guaranteeing expert authority with features of online communal participation. This has implications for thinking about expertise online, which will be explored further in chapter 9.

“A robot driven flying car will be very, very much safer than a flying car driven by an idiot, which means most people.”¹¹⁸

8: Manifest Emotional Meaning-Making

In this chapter I address manifest, explicit expressions of emotion. Using a data-driven approach I derive five common themes in emotional expression and patterns in their usage. The chapter is structured around these five themes: visual expressions, dislike, neutrality, interest, and hope. Sections 8.1 and 8.2 focus on themes which illustrated the role of emotional expressions as responses to objects and/or people. In sections 8.3 to 8.5 I focus on how emotional expressions were seen as shaping social behaviour, both within subfora and society at large. I conclude by considering how these findings add an emotional dimension to the distinction between object and discursive language from the previous chapter.

Background and Methodology

As outlined in chapter 3 (sec. 3.4.3), analysis for this chapter followed a data-driven approach. This involved coding instances in which participants explicitly mentioned emotion. During coding I found that explicit mentions of emotion were relatively rare, an observation also made within Fan Scholarship (Hills 2002). I therefore interpreted ‘explicit mentions of emotion’ broadly, to include expressions which made emotion apparent through modifiers such as profanity, hyperbolic language, and emoticons. For example, the statement ‘please stop talking’ would not be coded, while ‘please stop talking it’s making me angry’ or ‘stop {!#%#@} talking’¹¹⁹ would. Fuller details are given in Appendix 5, sec.4.

As in chapter 5, I examined all the samples from chapters 6 and 7 combined to maximise coverage. Once I had noted expressions of emotion which occurred repeatedly across

¹¹⁸ SkepticsSTM *Can A Scaled Up Multicopter* (Dec 2013).

¹¹⁹ This sequence automatically replaces any profanity in SkepticsSTM. For other subfora I coded a wide variety of profanities.

these threads, I also used NVivo's text search functions to search for these expressions outside of the sampled data. Despite the breadth of the sample used for this chapter, explicit emotional expressions were relatively hard to find. Many were also extremely brief, though there were examples of extended interactions which allowed the sorts of detailed discourse analysis carried out in the previous chapters.

Reporting the derived patterns was more challenging for this chapter. Many examples of explicit emotional expressions came from IFLScience which, for reasons outlined in chapter 4 (sec 4.2.2), I am unable to directly quote. I also did not receive permission to quote many of the extended examples of explicitly emotional interactions I found; due to the relative infrequency of such interactions I was not able to easily replace them with other quotations, as was the case in previous chapters. Therefore this chapter unavoidably includes more paraphrasing and summarisation than elsewhere in the thesis.

8.1 Objects and Visual Language

A common feature of emotional expressions in the subfora was that they frequently drew on references to aesthetics or visual factors, such as 'beautiful' or 'looks cool'. I shall refer to such expressions as *visual language*. I begin by describing recurrent features in how visual language appeared in the subfora. I shall then connect the use of visual language within the subfora to a question raised by both academic and non-academic commentators vis-a-vis the use of visuals in science communication.

8.1.1 Visual Language as Response

Images and videos appeared across the subfora, in both posts and responses. Use of images was shaped by features of the different subfora. On IFLScience, participants could add images with a simple drag-and-drop action. Almost all IFLScience posts from administrators included an image or video, a tactic for increasing the reach of posts on Facebook (IFLScience 2016; Sabate et al. 2014). In line with other social media sites, commenters frequently used images alongside (or as a replacement to) text (Coscia 2013). On the phpBB platform of SkepticsSTM and XKCDScience, adding images was a reasonably straightforward process of copy-pasting a URL. By contrast, on r/EverythingScience posting a link did not produce an automatic preview of an image meaning images did not appear within a thread (users would need to follow a hyperlink out

of the thread to see the image). This means images, and responses to them, were rarer on r/EverythingScience than on other subfora.

Across subfora, images often depicted natural objects such as Pluto or technological objects such as futuristic vehicles. Examples are presented in Fig. 8.1.



Fig. 8.1(a) Image from IFLScience post *Meet the Futuristic, Electric, Self-Driving "Batmobile"*, posted 5 Jan 2016. Retrieved from www.facebook.com/IFeakingLoveScience/posts/1294131563941185, 25 Feb 2016.



Fig. 8.1(b) Image in comment on thread *SkepticsSTM Pluto Flyby*, posted 14 July 2016, retrieved 22 August 2015. URL not provided to avoid identifying commenter.

Responses to such images often featured positive visual language. Natural phenomena such as Pluto were frequently ‘beautiful’ or ‘amazing’ (*IFLScience How Much Did It Cost*, July 2015; *SkepticsSTM Pluto Flyby*, July - Sep 2015), while technological objects were often described as looking ‘cool’ (*IFLScience Self-Driving “Batmobile”*, Jan 2016; *IFLScience This Driverless Mercedes*, March 2015; *SkepticsSTM Can A Scaled Up Multicopter*, Dec 2013 - Jan 2016). Visual language was also used in response to *non-visual* stimuli. Examples of material described as ‘beautiful’ included: relativity (*SkepticsSTM Axioms of Science*, Dec 2015); the ‘complexity of evolution’ (*r/EverythingScience Defending Darwin*, March 2015); information on the density of unbihexium (*XKCDScience Unbihexium Density*, Dec 2015); and a quotation from celebrity physicist Brian Cox that “life is the means by which the universe understands itself” (*IFLScience Brian Cox*, March 2015). There were also examples of negative visual language, such as ‘ugly’, though these were less common. As with positive emotional language, negative visual language was applied to both visual and non-visual material. For example ‘ugly’ was used (infrequently) to describe an image of a driverless car (*IFLScience This Driverless Mercedes*, March 2015), but also the mathematical concepts of ‘singularity’ and ‘renormalisation’ (*XKCDScience Relativity Questions*, Apr 2011). Following the terminology employed in the previous chapter, I shall refer to this combination of concrete and abstract material – natural phenomena, technological artefacts, and ideas – collectively as ‘objects’.

In the above examples participants were responding to a depicted object. However participants rarely referenced the work that went in to producing an image. This was true whether the images were produced by people within or outside of the subforum. When participants expressed admiration for the beauty of Pluto, this was rarely accompanied by expressions of respect for NASA or their technology. Participants on IFLScience discussions about Pluto – for example *How Much Did It Cost* (July 2015) and *Pluto Continues To Blow Away All Expectations* (July 2015) referenced NASA’s imaging technology, but only to attack conspiracy theorists (who claimed images were faked) rather than in references to beauty. Some threads on XKCDScience featured images custom-drawn by participants.¹²¹ On *XKCDScience Living in an Earth Like Moon* (July 2013) one participant produced a detailed diagram of how day/night phases would appear across 17 different points in a planet’s cycle. On *Landing Rockets Upright* (Feb 2016) and *Flying Cars* (Oct 2014) participants drew their own engineering designs, in one case humorously featuring a company name based on another participant’s username. Participants showed

¹²¹ I did not receive permission to reproduce any of these images.

respect for the ideas expressed through the drawings, but not the level of skill or effort involved in drawing them.

This does not necessarily mean the work which went into making images was not respected. Jenkins (1992, 2006c) has noted that creators of fan artwork can achieve widespread admiration; but when their work is the subject of communal discussion, interpretation focusses on features of the image and their relation to a wider body of fan knowledge (Jenkins 1992). Such visual material thereby gives discussants an opportunity to demonstrate, share, and learn responses which bring 'meaning-pleasure' to the surrounding community (Bacon-Smith 1992). In a similar fashion, objects of science can be understood as providing focal points around which individual emotional responses became a shared experience, and the identity of a 'science enthusiast' could be constructed. This question of identity is the topic of the next section.

8.1.2 Visual Language and Engagement

In expressing visual language about a variety of objects, participants reflected a long-standing tradition within professional science of using 'beauty' to refer to both concrete and abstract material (Girod, Rau, and Schepige 2003). However some commentators have argued that an emphasis on visual spectacle amongst non-professional audiences can be symptomatic of shallow engagement with information (for discussions see McCrory 2013; Usher 2015). This argument has been used repeatedly in criticisms of IFLScience, and more broadly of science communication online. For critics, the minimum effort required in responding to visuals helps inexperienced participants to "take a passing interest [in science] just long enough to... call themselves 'geeks' or 'nerds' every chance they get" (Maddox 2012) or for "reinforc[ing] one's aesthetic self-identification as a 'science lover'" (Thomas 2015). In this section I examine these purported relations between visual language, engagement, and identity.

Visual language usually appeared as brief, generic statements (such as 'that's beautiful'). This could, as these critics argue, be evidence of low-effort responses; they did not require engagement with informational content, but still allowed participants to perform an identity as a science-interested person. However, there were no clear distinctions between how visual language was used by expert and non-expert participants. Visual language appeared in response to material which *did* involve high-level information, and in a manner which suggested visual language could be expected from scientific experts. We have already seen

XKCDScience participants using visual language in response to high-level material (such as normalisation or unbihexium) in section 8.1.1. Another example was a technical webpage about using anti-protons to trigger nuclear fission, which was described as ‘nerd porn’ – relating the visual impact of the piece to a recipient’s identity as a ‘nerd’ (*XKCDScience Spectrum of Antimatter Excursion*, Feb 2015).¹²²

I suggest that seeing visual language as genuine expression of emotion is more productive than dismissing it as disingenuous identity performance. Doing so allows us to see how participants engaged with material as a source of both information and emotion simultaneously. As well as uses of visual language to express straightforward aesthetic appreciation, we can see more subtle linkages between visualisation and forms of emotional engagement. Consider Box 8.1.

Box 8.1 Visual Language and Emotional Engagement

(1) At the moment I see it as trying to measure a changing distance with a ruler that is also changing in length by the same amount, no matter how much space distorts [...] but I still can't grasp how spacetime distortions cause a detectable signal at the interferometer [...]

This is really getting me! Let's say we have a ruler, 1km long. [...] say a gravity wave passes by and causes the distance to each mirror to fluctuate between 1% and 1000% of the original distance rapidly... I look at my rulers and both mirrors seem to be static at the 1km mark... Ergo, I don't detect the passing wave... I think that about sums up my understanding :)

[Answers redacted for length].

I'm aaaaaaaaalmost getting it, I feel like there's a connection or a leap I am not making... I read something about rubber sheets and rulers not being great visualisations [...] But it's not coalesced into a solid.....anything, in my head yet...

XKCDScience *LIGO Gravity Waves*, Feb 2016

¹²² Note that some web forums use ‘porn’ to refer to any aesthetically pleasing material, which need not be sexual. The ‘nerd porn’ is accessible at (Kircher 2000a, 2000b).

- (2) Just look at the picture where he shows what he believes is what the path of the Sun should be, according to the heliocentric view [...] Guh! Do you see that dashed line ending in the arrow? Do you want to know what that's supposed to be pointing at? THE SUN!! So clearly, the red line he drew has no relationship to where the Sun should be. The reality should be pretty easy to imagine. Try this: Picture a circle representing the Earth [...]

SkepticsSTM *Tropic of Cancer*, Apr 2015

The participant in (1) used visual language to express a variety of experiences. They expressed their lack of understanding in visual language: the phrase “at the moment I see it as” implied that they expected to ‘see’ differently after receiving explanations, while “rubber sheets and rulers not being great visualisations” were put forward as a possible explanation for their confusion. They also used visual language to clarify their precise “un-understanding” through visual thought experiment, imagining that “I look at my rulers and both mirrors seem to be static” as a gravity wave passes. Visual language also helped verbalise the affective experience – how their confusion was really “getting me” – by expressing that their understanding had “not coalesced into a solid”. Extract (2) showed a participant’s response to a website which was attempting to disprove the heliocentric model of the solar system. The participant used visual language to suggest that a simple inspection of an image on the website should have clearly revealed the error. The purported ridiculousness of the website’s claim was emphasised by concluding the inspection with “guh!” and a capitalised “THE SUN!!”. The criticism was further heightened with another thought experiment, intended to show how “the reality should be pretty easy to imagine” – presenting the website’s claim (by contrast) as poorly thought through. These responses show how visual language expressed a variety of emotional responses, including frustration and scorn, in a manner which also presented informational engagement with the material.

This use of visual language to link emotional and informational responses also appeared in the generally less expert discourse of IFLScience. Examples of images which prompted multiple visual responses are shown in Fig. 8.2.

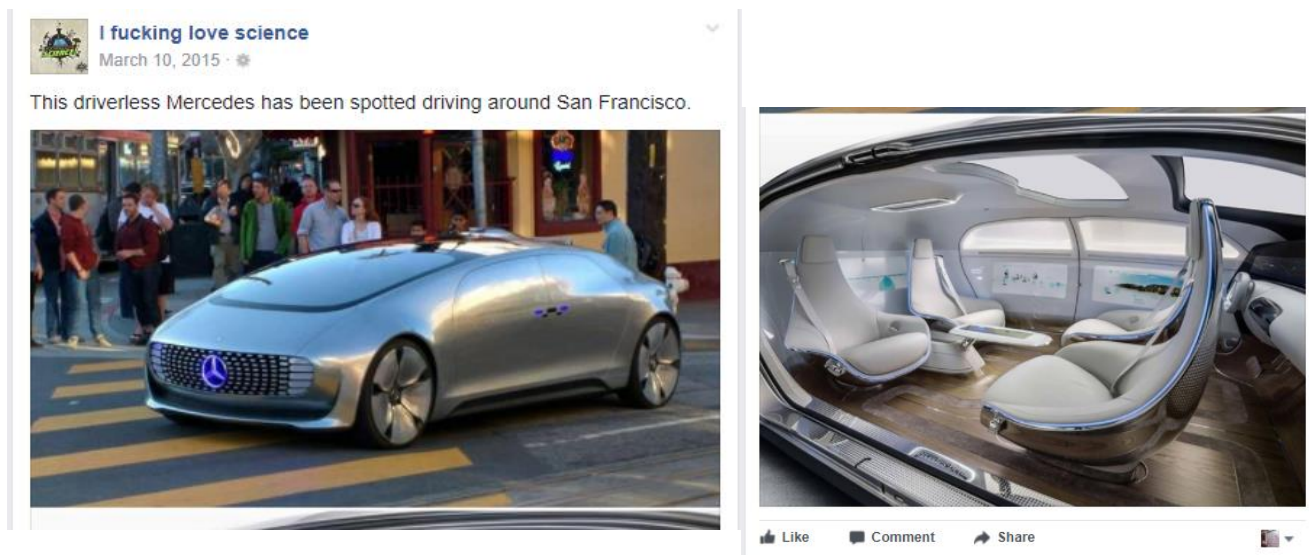


Fig. 8.2(a) Images on IFLScience post *This Driverless Mercedes*, posted March 10 2015. Commenters debated the aesthetic features alongside technological factors, and also noted how no-one in photo (a) was looking at the car. Retrieved from www.facebook.com/IFeakingLoveScience/posts/1059286497425694, 25 March 2015.



Fig. 8.2(b) Image on IFLScience post *In Science We Trust*, posted 12 March 2015. Commenters debated the use of sigma as an E, in a manner which raised aspects of personal/group identity. Retrieved from www.facebook.com/IFeakingLoveScience/posts/1060950617259282, 25 March 2015.

Under the post shown in Fig. 8.2(a), Participants discussed both the technological promise of driverless cars and the aesthetics of the vehicle in the image. Some participants drew contrasts between the technology and aesthetics – expressions such as ‘ugly but cool’ were frequent. However, other responses suggested that aesthetic assessments were integral to assessment of the technology; that realising a hoped-for future involved achieving a certain look, as well as technical achievement. Other participants noted that, in the photograph, people were not looking at the driverless car. This was used to criticise the informational claims of the post; in other cases it provoked aggression and/or amusement at the unlikelihood of people ignoring a driverless car. Multiple comments on *In Science We Trust* in Fig. 8.2(b) objected to the use of the Greek letter sigma¹²³ to stand in for ‘E’, sometimes with expressions of anger. These often prompted replies such as ‘do you not mind that the N is a dinosaur?’. These can be read as negotiations over identity. The initial commenters indicated a personal knowledge of (and attachment to) the ‘correct’ interpretation of the letter Σ , while the replies mocked these as mis-interpretations of how the image is ‘supposed’ to be interpreted. Visual language thereby conveyed a variety of engagement with material, in ways which related emotion to other forms of response.

8.2 Responses to ‘People’: Dislike and Ambivalence

In this section I consider emotional responses to people. This builds on findings from throughout this thesis, that negative emotions – particularly frustration, concern, and scorn – were often used in reference to people. Such emotional expressions were used to sanction non-normative participants (sec. 5.1.3, 7.3) and to describe ‘unscientific’ people in wider society (6.2.1). In this section I expand on these findings in two ways, using the umbrella term ‘dislike’ for negative emotional expressions. Firstly, by examining more closely how dislike was associated with both science-related and not clearly science-related factors. Secondly, by considering different types of people who were rhetorically associated with dislike. I draw out these by examining contrasts between emotions expressed when talking about non-scientists as opposed to when talking about scientists.

¹²³ This is used to indicate ‘sum of’ in mathematical formulae.

8.2.1 Dislike of People

Box 8.2 shows examples of dislike.¹²⁴

Box 8.2. Examples of Dislike

- (1) It's irritating when someone goes to the hospital, receives the most advanced treatments modern medicine can offer, and then claims they were cured by some homeopathic nonsense.

r/EverythingScience *Why is Homeopathy*, Feb 2016

- (2) The minute anyone even mentions the word 'scientism' in any argument, to me that is the end of the argument. It is a word solely used by scientific ignoramuses and is little more than the school yard equivalent of 'your Mom smells' from some dickhead who can't think of anything intelligent to respond with.

SkepticsSTM *Show Me Scientism*, Sep 2015

- (3) I don't really trust the idea [...] most road accidents are caused by people being stupid. I don't even need to leave my house to hear the idiot hoons tearing up the streets. Oh, there goes one now. What do you think would happen if you put a flying car in their hands? Also, they're incredibly noisy. Can you imagine (oh, and another) the deafening cacophony of everyone flying around? You'd never sleep.

SkepticsSTM *Can A Scaled up Multicopter*, Dec 2013

- (4) It is a complicated issue with no clear, easy *answer* to make everyone happy. But trust me on this: twenty years ago when one had to physically go to a university library or a professor's office to access science, people weren't complaining about this (other than actual scientists). Now, however, when we expect (rightly or not) that *all information be immediately and freely available*, companies like Elsevier have the idiocy to try to charge as much as \$40 to access a single article. Makes everyone angry and encourages exactly the behavior we are discussing here.

r/EverythingScience *Researcher Illegally Shares*, Feb 2016

- (5) I am sorely disappointed, [username]. I thought you were better than that. I'll give you one more chance. Please explain which lines of code in my program you feel are 'untrustworthy' or 'unfair'.

SkepticsSTM *Monty Hall Redux*, Oct 2015

¹²⁴ The emphasis on anger/frustration in this box is due to ethical restrictions; while I aimed to include references to sadness and disappointment, extended examples of such references were rare and I did not receive permission to quote many of them.

Extracts (1) and (2) discussed frustration in association with specific science-related issues: belief in a perceived pseudoscience (homeopathy) and accusations of ‘scientism’. Extract (2) rhetorically associated frustration more broadly with “people who can't think of anything intelligent to respond with”. Extract (3) expressed similar frustration at lack of intelligence – “people being stupid” and “idiot hoons” – without making any references to science-specific topics. Extract (4) similarly referred to the “idiocy of Elsevier”. However this latter extract also referenced unhappiness and anger felt by other people; the author associated these emotions with expectations of being able to access information freely, and elsewhere in the thread they were presented as a response to greed. Extract (5) referenced ‘disappointment’ to highlight poor behaviour from a specific other participant. It is likely this extract was sarcastic – in the fuller thread the author did not display very high expectations of the participant they were addressing. However it still illustrates how references to negative emotions were rhetorically associated with particular forms of people and behaviour.

All of these extracts combined negative emotional language with references to people, whether general ‘idiots’ or a specific named other participant. This is a contrast to the extracts in sec. 8.1, in which positive emotional expressions minimised mentions of people. It was *not* the case that objects were uniformly the cause of positive emotional responses, and people always the cause of negative emotional responses. For example, extract (2) expressed concerns about the noise produced by flying cars and extract (1) attacked “homeopathic nonsense” rather than homeopaths. However extract (2) still referred to people in “the deafening cacophony *of everyone* flying” while extract (1) praised the depersonalised “advanced treatments [of] modern medicine”. The argument here is that the negative emotional language often foregrounded mentions of people where the positive expressions in sec. 8.1 used depersonalised language.

References to people can be categorised following Mike Michael’s (2009) analysis of how public groups present themselves and others in one of two ways. The first is ‘publics in particular’ (PiPs) who are held to have particular interests and/or stakes in a discussion. The second is ‘publics in general’ (PiGs), which are not easily characterised by specific interests. Both forms of categorisation can be seen across the subfora. In chapters 5 (sec. 5.1) and 6 (sec. 6.2) I discussed various forms of PiP, in particular groups who supported perceived ‘unscientific’ views and those driven by certain ideological and/or economic interests. However, note that examples in Box 8.2 used extremely general language in referring to people – for example “someone” (1), “anyone” (2), “people being stupid” (3), and “everyone” (4). References to general ‘people’ were extremely common across the subfora, and have been noted in previous chapters. For instance in chapter 6 (sec. 6.1.2) we saw how

science|popularisation boundaries were drawn with reference to ‘people’ who misunderstand science; in chapter 7 (sec. 7.1) references to ‘people’ (and similarly broad terms such as ‘guy’) were more prominent in the discursive word classes than any specific identity labels, apart from ‘scientist’.

This recurrent dislike of PiGs raises some questions with respect to FS accounts of dislike. FS shows how negative references are often directed at *particular types of people* in order to show, by contrast, the types of people who are welcome within the community (Theodoropoulou 2007, see also the literature review sec. 2.4.2). This suggests that distinctions were not only drawn between ‘scientific’ people and *specific* ‘unscientific others’. Instead, participants built up a picture of being science-minded as an alternative to the intellectual, moral, and/or political failings of wider society. In the words of a participant on SkepticsSTM *Can A Scaled Up Multicopter* (Dec 2013), “a robot driven flying car will be very, very much safer than a flying car driven by an idiot, which means most people”. In this, participants were showing a familiar characterisation of PiGs, as “juxtaposed to science-in-general: science as a worthy democratizing, civilizing and epistemic endeavour” (Michael 2009, 621). This raises a question about a specific group of people. How, if at all, was this distinction between ‘science’ and ‘people’ reflected in emotional references to *scientists*?

8.2.2 Ambivalence about ‘Scientists’

It was extremely hard to find instances in the subfora in which scientists provoked explicit emotional responses. Even using NVivo search tools to isolate mentions of ‘scientist’, and examples of characteristics which we might expect to be applied to scientists,¹²⁵ produced very few examples. This absence of emotive references is particularly notable when we compare how scientists and objects were referred to by the same speaker. Box 8.3 shows examples. To highlight contrasts, sections referring to scientists are italicised.

¹²⁵ Having isolated characteristics associated with unscientific people in sec. 8.2, I searched for contrasting characteristics which we can presume participants might apply to scientific people: these included ‘clever’, ‘intelligent’, ‘trust’, ‘respect’, and ‘hardworking’ (allowing for stemmed terms such as ‘trustworthy’). I do not claim this is an exhaustive list of possible characteristics; however, none of these terms produced many results. When searching for ‘scientists’ I also included related terms such as ‘expert’ and ‘academic’, in addition to specific disciplines.

Box 8.3 Neutral Description of Scientists vs. Emotional Descriptions of Objects

(1) I find this [LED farming]¹²⁶ extremely exciting. Farm uses 1% the water used for traditional farming, is 100-fold more productive per square meter (vertical stacking!) and produces higher quality veggies [...] That link is neat [username], I'm glad to see so much effort being put into this sort of technology around the world [...]

[lengthy dispute redacted]

This is in response to me linking an article in which a bunch of scientists talked about it being an issue [...] you're making claims that run contrary to what a bunch of scientists are making.

XKCDScience *LED farm 100-fold more awesomer than farmland*, July 2015

(2) *When the machine was in engineering mode so they [the physicists at LIGO] were still checking their sensitivity, but the signal was so 'loud' that they saw it anyway. It then officially turned on in September, with a factor of 3 increase in sensitivity (and there is a possibility they may have 2 more detections between then and December). This means they saw something much stronger (bigger signal) than expected [...]* Alright, now for even more exciting stuff :). Soon, a third LIGO-like instrument is starting (VIRGO in Italy), and there may be other similar instruments opening in Japan etc. When you have 3 or more detectors, detecting these events, then you can located where they happened on the sky. Which means we can try to look for left-overs of the event with telescopes [...].

r/EverythingScience *LIGO likely to announce*, Feb 2016

(3) *The big thing for me is whether humans can make cement from moon soil [...] [o]nly connecting airlock doors, some windows and frames for pouring would need to be shipped from Earth. 'Astronauts as common builders.'*¹²⁷ [...] The one insane thing I would like to see is an Olympic swimming pool on the moon with a high diving board. Can you imagine the amazing mid air callisthenics a diver could make in such low gravity? It would be fascinating.

SkepticsSTM *Lunar Village*, Jan 2016

Objects were described in positive terms. In (1) LED farming was “extremely exciting” and a link was “neat”. In (2) the development of new astronomical observation tools were the “more exciting stuff :),” while in (3) “mid air callisthenics” were predicted to be “insane” and “fascinating”. By contrast scientists were described in emotionally neutral terms, as simply carrying out actions. In (1) scientists “talked” and made claims; in (2) they checked and fine-

¹²⁶ A form of indoor farming, in which sunlight is replaced by customised artificial lighting.

¹²⁷ Though this is presented as a quotation in the thread, I was unable to locate a source.

tuned instruments; in (3) they built a moon base. If scientists, or their work, were referenced positively it was through implication – for example, “I’m glad to see so much effort being put into this sort of technology” (1). One could also read (2) as implying that astronauts would normally be superior to “common builders”. Even posts which might welcome praise for scientists (or other experts) did not produce many positive emotional responses. For example *IFLScience Dutch Architects Create A Habitable Windmill That Could Power A City* (July 2015) prompted many responses arguing that engineers, not architects, were needed to produce such designs. These generally focussed on the ‘impracticality’ of architects rather than the skills of either profession. *IFLScience Scientists Convert Cancer Cells Into Harmless Immune Cells* (March 2015) prompted some excited responses, but these generally referenced the disease rather than the scientists; mentions of scientists were more often tied to concerns over funding and issues with pharmaceutical industries. Overall, explicit positive emotional expressions were associated with the objects of science rather than the producers.

We have seen evidence throughout previous chapters that scientists *were* respected. For example in chapter 6 (sec. 6.2.3) I discussed how the authority of professional scientists was used to sanction unwanted behaviour, while in chapter 7 (sec. 7.2.2) I noted that participants deferred to people with professional scientific expertise. However such respect was rarely expressed except as part of a contrast with ‘unscientific’ or ‘non-expert’ people, and did not usually involve emotional language. We should also note that when scientists were mentioned in *negative* terms (usually by non-normative participants), any responses were usually critical. However even these responses did not counter emotively negative descriptions of scientists with emotively positive ones. For example, a participant on *r/EverythingScience My Father Sent Me This Article* (March 2015) accused scientists of being led astray by uncritical acceptance of orthodoxy; this was met with a lengthy, emotionally neutral response which presented various ways in which scientists guard against mistakes. On *SkepticsSTM IMAP* (Apr 2015) a description of scientists as ‘unintelligent’ encountered strong hostility, but this was directed at attacking the accuser rather than presenting a counter-view of scientists as intelligent. Again we see contrasting forms of language depending on whether participants were talking about objects or people – when participants spoke about people, they rarely used positive emotional references.

An exception was when participants referred to specific, named scientists. Participants on *r/EverythingScience Neil DeGrasse Tyson’s Genius Plan* (Apr 2015) praised both DeGrasse Tyson, and his fellow science communicator Brian Cox, for their enthusiasm towards

science.¹²⁸ Similar sentiments were expressed below an IFLScience post featuring an image of Cox with a superimposed quotation “life is the means by which the universe understands itself”; though others also criticised the quotation for being vague, or claimed it was stolen from an earlier science communicator Carl Sagan (*IFLScience Brian Cox*, March 2015). Yvette D’Entremont, the ‘Science Babe’ blogger, was praised for her attacks on the non-mainstream views of the ‘Food Babe’ (*r/EverythingScience The Food Babe blogger*, Apr 2015). We have seen how Neil DeGrasse Tyson and Bill Nye were similarly used to symbolise the superiority of scientific thinking in chapter 5 (sec 5.2.2). Similarly, IFLScience featured a series of posts on prominent female scientists with the hashtag #WomenYouShouldHaveHeardOf (March 2015). Some responses to these scientists simply expressed admiration for their research and/or communication work, however others discussed them in relation to sexism in science.

FS scholars have noted how particular figures can become associated with broader social values held by a fandom; examples include the charitable activism of musician Lady Gaga (Bennett 2014a) or the humanist values of Star Trek creator Gene Roddenberry (Jenkins 1988). In a similar fashion, these specific scientists became foci for discussing values held by the subfora, such as clarity of thought, support of social progress, and defence of ‘scientific’ thinking (sec. 5.1.2). However, the praise of scientists being enthusiastic about science raises an important question, given historical contrasts between ‘science’ and ‘emotion’ (sec. 2.1.1) – how were explicit emotional attachments to science responded to more generally?

8.3 Neutrality

This section moves away from considering emotions as responses, and into discussions of how participants referred to the emotions of others. I begin by focussing on how participants referred to the emotions of scientists. This draws on commentaries around norms of science, in particular Merton (1942), which present emotional neutrality as a positive characteristic in professional science. I then consider if this was reflected in references to emotional neutrality applied to fellow participants, and to non-scientists more broadly.

¹²⁸ Though some also debated DeGrasse Tyson’s merits as a presenter, using Cox as a contrast.

8.3.1 Neutrality as Scientific

Continuing the pattern of sec. 8.2.2, there were differences in how participants referred to the emotions of individual scientists versus those of 'scientists' in the abstract. Box 8.4 shows examples of references to individual scientists.

Box 8.4 Emotions of Individual Scientists

- (1) I love Brian Cox's stuff. I'd take him over NDT [Neil DeGrasse Tyson] any day. Cox always comes across with a genuine sense of wonder, while NDT comes across with a sense of smugness.

r/EverythingScience *Neil DeGrasse Tyson's Genius Plan*, Apr 2015

- (2) Lawrence Krauss has been giddy as a schoolgirl on Twitter for the past couple of days. My bet is it's confirmed.

r/EverythingScience *Einstein's theory about gravitational waves*, Feb 2016

- (3) Some of my favourite fly gene names are "decapentaplegic", "shaven baby" and "toll" - which means amazing, or cool in German, because the German scientist, Christiane Nüsslein-Volhard exclaimed "Das ist ja toll!" - "that's amazing" when she was shown it.

XKCDScience *Published Paper on Sonic Hedgehog*, Aug 2015

These examples suggested that being emotional is a welcome quality for a scientist. Brian Cox's "genuine sense of wonder" (1) and the naming of a fly gene after an excited exclamation (3) were described in explicitly positive terms. Emotion was presented as part of a range of scientific practices: research and discovery (3), communication (1), and the interface between the two (2).

However when 'scientists' were described in the abstract they were presented as emotionally neutral. Examples are shown in Box 8.5.

Box 8.5 Unemotional Scientists vs. Emotional 'Others'

- (1) I take as the model for this, Svante Paabo's group and their investigation of Neanderthal DNA. [...] their papers have overly cautious sounding statements like 'in our model for potential homo sapien contamination, we estimate that less than 1% of the DNA examined came from a homo sapien'. That's how you know you are reading a paper by true scientists and professionals [...] But when I see 'we got 1000 people from a couple colleges in a room and they filled out a survey indicating how the stimulus made them feel afterward' I just feel unsatisfied.

r/EverythingScience *Reproducibility should be at science's heart*, Feb 2016

- (2) 'In the 1970's scientists also claimed we were entering another mini ice-age.' Not true, at all. A handful of hyperbolic journalists tried to spin that message, but only a few fringe scientists were even speculating that this was plausible.

r/EverythingScience *How climate change destroyed Britain's 'Atlantis'*, Feb 2016

- (3) Big claim. Strong language. No evidence [...] That [quote from the IPCC report] seems a lot less extreme than Patrick Moore's phrasing of it.

[...]

If you're a scientist, in the field, of course you will look at the evidence closely and skeptically. And they do [...] Caution is advised until the science has been reproduced.

r/EverythingScience *My Father Sent Me This Article*, March 2015

These examples portrayed scientists as “cautious” (1) or avoiding “extreme...phrasing” in favour of “looking at evidence carefully and sceptically” (3). Such characteristics were presented as contrasts to other types of behaviour – college surveys (1), “hyperbolic” journalists (2), and the “strong language” of a climate denier (3). These examples were all from r/EverythingScience, but across other subfora ‘calm’ and ‘rational’ scientists were juxtaposed to ‘excitable’ political figures (*XKCDScience Favourite Home Experiments*, Oct 2007) and ‘irrational’ anti-vaxxers (*IFLScience How To Argue with Anti-Vaxxers*, Aug 2015).

This inconsistency around whether emotion is desirable in science reflects STS debates around Merton's norm of *organised skepticism*, in which the emotional detachment of scientists is held as a distinguishing mark of professional scientific practice (Merton 1942; Mitroff 1974). The norm of organised skepticism does not hold that complete emotional neutrality is a universally good (or even feasible) characteristic. Even proponents of organised skepticism argue that “emotional commitment... is a necessary component of the moral dedication to the scientific values and methods” (Barber 1952, 126; quot. Mitroff 1974,

580). Rather, the claim is that aiming for emotional neutrality gives scientists' claims greater credibility – as we saw in Box 8.5, the emotional neutrality of scientists was held to give them superiority when compared with other parties.

The idea that emotional neutrality suggests credibility also featured in discussions which did not refer to professional scientists. Box 8.6 shows examples in which participants referred to their own emotions and/or those of fellow participants.

Box 8.6 Encouraging Neutrality

(1) You, [username], have been seduced by a romantic view of primitive peoples. It is just plain wrong.

SkepticsSTM *Primitive Humans*, Aug 2015

(2) User1: [...] I'll put you down as a science denier for AGW¹³⁰, and as a science fantasist for anything exo-planet. Yes... all too easily distracted. Reach for the stars, but keep your feet firmly planted in reality.

User2: [...] The fact that progress has been relatively slow so far does not mean there is no progress. I could resent being called an AGW denier. I certainly said nothing to lead to that conclusion, and I am not one. Nor am I a fanatic for exoplanet developments. Interested, certainly, but I am interested in all forms of human progress.

SkepticsSTM *Ancient Peoples Were Ecological Vandals*, Jan 2016

(3) User1: Goodness, I hope this lasts. This is one of the biggest needs our world has today.

User2: I think this is a bit of an overstatement.

User1: I encourage you to read the article. Note the failure rate of reproduction.

r/EverythingScience *Reproducibility should be at Science's Heart*, Feb 2016

(4) User1: Seriously, I get that you find feedback mechanisms cool, but what's abundantly clear at this point is that your grasp of biology is very very tenuous, and you keep trying to reinvent the wheel. Just go learn some Introductory Biology.[...].

User2: [username], something I can't figure out from your posts: do you think you have discovered something new? Some insight that biologists should have realized, but didn't? Or are you just enthusiast about feedback mechanisms in biology?

XKCDScience *Is Control A Common Property Of All Life*, Dec 2015

¹³⁰ Anthropogenic – as in, human-made – Global Warming, in this context used to suggest denial thereof.

Participants in these extracts suggested that others had been led astray by emotion. Some were “seduced” (1) or a “fantacist” (2); a hopeful claim that “this is one of the greatest needs our world has today” was criticised simply as “an overstatement” (3); and a participant was accused of discussing material they find “cool” without understanding it. The participant in extract (1) argued their opponent had committed themselves to an already-existing stance – the “romantic view”, which was “plain wrong” – in an ongoing debate about ancient humans. These extracts all suggested that expressing (or failing to express) appropriate emotions was a reason for doubting credibility, as suggested by Merton’s norms.

However, emotion was not seen as a bad characteristic *in general*. The specificity of the emotion mattered. Some responses showed a more complex relationship in which credibility and emotion impacted upon one another. In extract (2), User1 attempted to downgrade their emotional state from “fanatic for exoplanet development” to “interested in all forms of human progress”, implying that a less extreme (and less specific) emotion should not detract from the credibility of their claims. In extract (3) User1 attempted to bolster their credibility, using the posted article as evidence, in a way which justified the emphatic nature of their original statement. In a reverse process, credibility was also used to justify stances on appropriate levels of emotion. The participant addressed in extract (4) responded by agreeing they were an ‘enthusiast’ and potentially biased by emotion. However, alongside this acknowledgement, they also presented arguments (using a neutral tone) with references to modelling and experimentation; they also accused their critics of frustration and aggression. In these examples participants used references to ‘appropriate’ levels of emotion to discuss credibility of selves/others. However, they also presented claims to credibility in ways which justified particular emotions as appropriate (or not). Construction of credibility and construction of appropriate levels of emotion, and the relationship between them, were in negotiation by various participants throughout discussions.

8.4 'That's Interesting'

Alongside ‘that’s beautiful’, a second recurrent emotional response commonly applied to objects was ‘that’s interesting’.¹³¹ However in this section I shall note how ‘interest’ serves different rhetorical roles to visual language. Where I have previously focussed on emotional expressions as *responses*, in this section I shall discuss how expressions of interest worked to *shape* discussions. In particular I examine two recurrent features: the role of ‘interest’ in

¹³¹ ‘Interest’ in the sense of fascination, intrigue, or desire to learn more – not, as often used in STS literature, in the sense of ‘stake’.

focussing attention onto particular topics, and in forming in-groups and out-groups. I shall also consider a negative form of ‘that’s interesting’ – ‘who cares?’ – which acted as a variant of ‘that’s interesting’ in more polarised situations.

8.4.1 Interest in Objects shapes Behaviour of People

Box 8.7 shows examples of references to ‘interest’.

Box 8.7 Examples of ‘Interesting’

- (1) An interesting piece of data is the simple fact that coal ash from coal burning power plants contains more radioactive waste than the waste from nuclear power plants of the same output over the same time.

SkepticsSTM *Not Newsworthy But...*, Feb 2016

- (2) It's hard enough to get funding for museums as it is. How many new museums have opened near you in the last decade? The more a kid can be exposed, the more likely they'll be interested in science, and the more likely they'll be interested in facts when making decisions in the future.

r/EverythingScience *Science Museums Urged to Cut Ties With Kochs*, March 2015

- (3) It's all about trolling. Don't worry about [username]. The topic is more interesting. I'm sort of wondering about the maximum available protein in an environment and the fact that humans need a lot of protein as omnivores.

SkepticsSTM *Primitive Humans*, Aug 2015

Objects labelled as ‘interesting’ could be as specific as a “piece of data” (1) or as general as “science” (2) or the “topic” of ancient human behaviour (3). All of these featured a theme, of ‘interest’ being referred to as a factor which shaped discussions. In (3) the participant used the interest of the topic as a reason for ignoring another participant’s contribution. (1) and (2) suggested that interest shaped discussions *outside* of the subfora. The argument of extract (1) was that media and political entities show more interest in the dangers of nuclear power than traditional power generation; extract (2) claimed that an interest in science and facts would have an impact on future decision-making. Expressions of interest therefore did not simply convey personal responses to certain topics, but also encoded expectations of how discussions will and/or should proceed.

The second point of note in these extracts was the combination of depersonalised, objective statements (“what’s really interesting”, “the topic is more interesting”) and personal references (“I’m sort of wondering”, “as scientists, we seek to...”). Examples of ‘interest’ being more clearly linked to personal identity are given in Box 8.8.

Box 8.8. Interest and Personal Identity

- (1) It's grown so boring that I can't remember where I read anything anymore. The "No-Moon landing" conspiracy is much more fun. Less mathematics and more bat-shit crazy people. Flat earth is even crazier. Personally I'm only interested in ones that might have elements of truth, or at least where the accepted explanation might be incomplete [...].

SkepticsSTM *Some Reasoned Argument*, Aug 2015

- (2) For those interested in a scholarly discussion of the topic, here is the book and the author's blog.

SkepticsSTM *The Fermi Paradox (Re: Where are the aliens?)*, Aug 2015

- (3) User1: Reading your points, it is clear that you are interested in how to be healthy, but you are clearly misinformed on many points (which the poster above has provided some links to). [...]

User2: I know that some around here may not listen to you [...] but I promise you that a solid majority of us would be very interested to see evidence that recommended consumption levels of caramel coloring or standard table sugar have a causal relationship with cancer or acute toxicity.

r/EverythingScience *The Food Babe Blogger*, Apr 2015

- (4) User1: I think it is just spamming and she should be thrown off the forum, as she was thrown off the JREF forum. She is simply disrupting posts, with off-topic, cut & pastes, to get woo attention [...]

User2: I find it interesting that different topics can irritate people differently. There are certain topics on this forum that push my hot button, and others that don't interest me in the least [...] Don't mind me, [User1], I'm just thinking out loud here. In my book, you've always been one of the good guys on the forum, and I don't want to get you mad at me.



User1: You are obviously right in that I'm expressing my personal view on [username] and what "I" think is spamming. My annoyance is that there are occasional threads that seem to be getting interesting and then [username] throws in his regular, "You are only dreaming this" post, and the thread falls apart.

SkepticsSTM *Are the Earth Moon*, Apr 2015

Some examples referred to individual identities. Extract (1) referenced self-identity – “personally, I’m only interested in”. Extracts (2) and (3) referenced other forum users, both unspecified (“for those interested in scholarly discussion”) and specific other participants (“it is clear that you are interested in how to be healthy”). But they also used ‘interest’ to rhetorically group types of people. In extract (2), for example, users could choose to place themselves in the group of “those interested in scholarly discussion” by following the provided link. In (3), User2 referred to “interest” to claim social cohesion with other participants (“I promise you that a *solid majority of us* would be very interested”), as part of an attempt to present their opponent’s view as aberrant within the subforum. In extract (4) the participants distinguished themselves from one another by the topics they were interested/uninterested in. However both identified with the group of “good guys on the forum” who did not derail threads by “spamming” (excessively posting uninteresting content). Though these participants disagreed on exactly what counts as “interesting” they agreed that failure to provide interesting content – or worse, to derail discussions which “seem to be getting interesting” – was a source of frustration, connecting “interest” to ideas of negative emotion raised in sec. 8.2. References to ‘interest’ thereby conveyed views both about desirability of certain topics, and also about certain types of people.

Associations between topics of ‘interest’ and expectations of identity/behaviour has been noted by Bennett in her studies of an online fan forum for the band R.E.M. (2009). Bennett notes that forum participants associated interest in the physical attributes of the band with certain kinds of ‘feminised’ behaviour, which contradicted the ‘masculine’ expectations of the forum. I argue a similar process was at work within the subfora; attempting to push out certain topics was related to encouraging/inhibiting certain kinds of behaviour and/or people. However, Bennett’s example presents a clearly bounded unwelcome topic (discussion of physical attributes). The interpretative flexibility of science adds a complicating factor, in that the various ideas of what a scientific discussion ‘should’ involve could be used to justify different ideas of ‘interest’ in different circumstances. This is the topic of the following section.

8.4.2 ‘Who cares?’ as Polarising ‘That’s Interesting’

One expression used frequently to indicate lack of interest in a topic was ‘who cares?’ (or variants thereof). Examples are given in Box 8.9.

Box 8.9 Who cares?

- (1) User1: So that's ~9,000 heads of lettuce per day per acre, while this guy is putting out 17,540 heads of lettuce per day per acre.

User2: Who cares? I grew up in farming country. The smallest unit of land discussed for farming is a "forty", which is, of course, forty acres. Plenty of land just wasn't farmed on off years because there was no money in it. Efficiency per acre was not the most important element.

XKCDScience *LED farm 100-fold more awesomer than farmland*, July 2015

- (2) Fortunately, no scientist or mathematician cares what you think about this [...] And mathematicians don't care that you don't care [...] Mathematicians define their terms for specific reasons and it does not matter if you don't like those definitions [...] I don't care how or why you misunderstand the puzzle.

SkepticsSTM *Monty Hall Redux*, Oct 2015

- (3) Who. Cares. What makes sense to you is actually factually irrelevant, because what you don't know about this field, and the field of biology at large, is so vast that 'what makes sense to [you]' is as irrelevant as my opinions on how black holes work. I've got ideas, some that even make sense to me, but do you know who doesn't give a fuck about them? If you guessed 'any physicist' you would be correct.

XKCDScience *Is Control A Common Property of All Life*, Dec 2015

As in sec. 8.4.1, these examples tied 'caring' to questions of identity. In (1) User2 backed up their claim "who cares?" with the statement "I grew up in farming country". This bolstered their claim to be able to assess the (un)importance of the innovation discussed by User1. Extracts (2) and (3) moved between claiming that scientists would not care about the addressed participants' claims, and phrases such as "I don't care" or "Who. Cares" (3). These placed the author together with 'scientists' in one group who did not have any interest in the addressed participants' claims. The rhetorical question 'who cares?' (1,3) also implied belief that the sentiment was likely to be widely shared. All these examples appeared within polarised discussions, and often employed "who cares" alongside other negative language such as "I don't care how or why *you misunderstand the puzzle*" (2) or "you know who doesn't *give a fuck* about them" (3). These examples take a theme discussed in sec. 8.4.1 – how 'interest' was used to encourage/inhibit certain kinds of participation – and adapt it for the more confrontational context. 'Who cares' put the onus on others to justify why the topic was worth discussion; not just 'interesting' or not, but worth caring about at all.

The use of ‘who cares’ can be related to another theme from sec. 8.4.1, the use of ‘interest’ to group certain types of people. A recurrent theme across Box 8.9 was references to scientists. Participants suggested that certain topics were not worth discussing because a “scientist or mathematician” (2) or “any physicist” (3) would not care about them. In doing so, participants often rhetorically blurred boundaries between the interests of the subforum and the interests of professional scientists. In some cases this blurring was explicit, such as in the expression “us scientists... don’t care” in extract (1). Extracts (2) and (3) were less explicit, but in both cases participants used the claim that ‘professional scientists wouldn’t be interested in your argument’ as a way of simultaneously a) expressing their own lack of interest in a topic and b) attempting to inhibit their opponent’s participation. An example in which ‘who cares’ was used as a general statement, rather than as a reply to a specific other user, was the IFLScience post *How much did it cost to send a spacecraft to Pluto* (July 2015). The question in the post title provoked numerous ‘who cares’ responses, often followed up with remarks such as ‘it was worth every penny’ and/or ‘anything for scientific knowledge’. The thread *XKCDScience Puzzling Artefacts* (Aug 2015) also included an extended discussion, involving multiple participants, on why scientists should care about the (hypothetical) discovery posed in the opening post.¹³² This discussion tied questions of interest to keeping ‘science’ separate from media sensationalisation, and also whether excessive interest in one discovery could bias scientific investigations. In these examples, participants implied that discussion topics and behaviour should be guided by how professional scientists act upon their interests.

However, this alignment of participants’ interests with the interests of scientists was not universal. There were examples in which ‘who cares’ was used to *dismiss* scientific authority in favour of other concerns. The IFLScience thread *This is What Drinking One Can of Coke* (July 2015) featured many examples of participants pushing aside health concerns with phrases along the lines of ‘who cares, it tastes delicious’ or ‘who cares, everything is bad for you these days’. In this case other concerns of IFLScience participants – demonstrating a personal attachment to a popular product, or more broadly to enjoyment of unhealthy activities – overrode attachments to scientific authority. Similarly a participant on *SkepticsSTM Some Reasoned Argument* (Sep 2015) responded to the poster’s claim to scientific expertise with the rebuttal “I don’t care what credentials you have, you’re spouting some major BS [...] you’re rambling on about theories that aren’t proven and discussions about atheism.” It is notable that ‘theories which aren’t proven’ and ‘discussions about

¹³² Five hewn stones in an ancient monument which somehow have the exact mass ratio of the particles in the Standard Model of physics.

atheism' were topics that people cared about (often strongly) elsewhere in SkepticsSTM and the Skeptic Society Forum (as shown in sec. 6.3.1, or the 'Atheism' subforum). However in this case the original poster had contravened an expected norm of the Skeptics Society Forum, by querying the cause of collapse of the World Trade Center. In these cases, the authority of scientists was less cared about than other values, such as individuals' dietary preferences or avoidance of conspiracy theories. However 'who cares' was still used as an expression of these values, in a manner which showed expectations of how others would or should behave.

In summary, 'who cares' acted as a more aggressive formulation of 'that's interesting', used to try and shape more polarised discussions. Alignment of one's interests with those of 'scientists', or with other participants, could be used as part of this tactic. Continuing the running contrast noted throughout this chapter, 'who cares' often acted to introduce an element of antagonism by bringing in references to the *people* who did or did not care about the topic. By contrast, 'that's interesting' focussed attention on interesting *objects* and generally appeared within more positive discussions.

8.5 'Hope' and Imagined Futures

A final recurrent form of expressed emotion related to ideas of 'hope'. This was a slightly more complex example of emotion, in that it could have both positive and negative connotations. In section 8.5.1 I examine how references to hope encompassed both positive references to objects and negative references to people. In section 8.5.2 I consider how expressed hopes could encode certain social values. Finally, in section 8.5.3, I look at how expressions of hope acted to shape behaviour.

8.5.1 Negative Present People and Positive Future Objects

'Hope' can have positive and negative connotations; both featured in the examples shown in Box 8.10.

Box 8.10 Hope and Positivity/Negativity

- (1) User1: I honestly hope though that in a few decades outdoor farming won't be a thing. In my future land transportation is all done underground [...] Meat is also grown in factories, without the need to kill animals. Because of this, despite there being many more people than now, there is much more room for nature. The future is awesome.

User2: sounds more like a vision from the naive 50's. I guess we'll all drive in atomic turbine driven cars. but in the real world, people appreciate organically grown food, meat from animals which have actually eaten real grass, etc, and people would go crazy driving in nothing but a tunnel for a 1000km road trip. [...]

User1: What's the point of the future if we can't have those nice things we always wanted as a kid? Sure there'll be a market for 'organic' (or other ill-defined feel-good terms) food [...] As for meat from real animals, I sincerely hope that'll be banned pretty much everywhere in a hundred years. And people won't drive in these tunnels. My god, what kind of backwards future are you imagining? The car drives itself. You just sit back and read a book, or enjoy a game, or whatever.

XKCDScience LED farm 100-fold more awesomer than farmland, July 2015

- (2) The more I learn about this [flying car] technology, the more optimistic I become [...] This game is on, all over the world. It's not a matter of states permitting it to happen. Every state must halt it in its tracks, and that can't happen. Worst case scenario is that Big Mother halts it in the U.S. and assorted other countries, but that only permits less risk averse nations to leap frog. I almost hope it happens. 20 years from now, Hollywood is a ghost town. Everyone wants to make their movie in Prague, because Prague is full of flying cars while Hollywood is stuck in the stone age, like the North Koreans.

SkepticsSTM Can A Scaled Up Multicopter, Dec 2013

- (3) User1: This is absolutely heart warming! I really hope this story gets some traction to bring some more widespread attention to the idea of open science. The system we have now is obsolete in the information age [...] I wonder how many people are out there right now who would think of something brilliantly novel if they were exposed to that one missing idea [...]

User2: "Science progresses one funeral at a time". Hopefully the next generation of those making decisions places more value in other things than the name of the journal.

r/EverythingScience Researcher Illegally Shares, Feb 2016

These examples illustrate that positive ideas of hope were usually expressed in relation to objects of the future, including technologies (1,2) or concepts such as the “idea of open science” (3). Negative ideas of hope drew attention to the unwelcome features of people in the present. In extract (3) User2’s comment used “hopefully” to open up a criticism of a

current system, in which “people making decisions” about publication placed sole value on the prestige of particular journals. In extract (1) User1 employed more positive emotional language (“the future is awesome”) and also passive voice (“transportation is all done underground”, “meat is grown”) rather than explicit references to people. By contrast User2 employed more negative and people-based language (“people would go crazy”).

In threads which focussed on ongoing scientific/technological developments, such as *SkepticsSTM Can The Scaled-Up Multicopter* (Dec 2013 - Jan 2016) and *IFLScience Scientists Grow Miniature Brains From Skin Cells Of Autistic Patients* (July 2015), ideas of hope and excitement were applied to the future outcomes of the developments (flying cars, lab-grown brains), whereas concerns and problems (risk of crashes, social stigma around autism) were expressed by references to present people. In summary, references to ‘hope’ followed the pattern drawn out in the previous sections: positive emotional expressions often appeared alongside references to objects (with people downplayed) while negative emotional expressions often occurred alongside references to people. Focussing on ‘hope’ brings a new element to this running contrast, in that it raises questions around how the contrast between objects and people also related to the distinction between present and future.

8.5.2 Hope, Technology, and Social Values

In talking of the future, participants did not hope simply for new forms of technology or knowledge. All also hoped for particular forms of collective social order, or realisation of values. In Box 8.11 we saw participants express hope for a more ecological and animal-friendly world (1), a re-shaping of national fortunes based on regulation of flying cars (2), and a more open system for sharing and developing scientific knowledge (3). In expressing their hopes, participants also made references to present social values. More extended examples are shown in Box 8.11.

Box 8.11 Hope and People

(1) User1: What a worthy cause to get behind. Respect for Alexandra Elbakyan and Aaron Swartz and all other crusaders for social good.

User2: So say we all

[...]

User3: So, I'm not opposed to sci-hub or other ways to "open-source" science, but it's not really about the scientists (to me) [...] Authors and peer-reviewers aren't paid, but the mooks who put in the actual hard work of publication (the Editor, the copy editor(s), and the technical editor) deserve to be paid for their time [...] So again, while we all agree that science should be free to access, for researchers and the public, who pays for the costs of publication? My own inclination is to nationalize all peer-reviewed journals and have the costs come out of tax money. I doubt many people would agree with me.

r/EverythingScience Researcher Illegally Shares, Feb 2016

(2) The greatest thing about this story is that multicopters are practically a product of the maker culture. The guys who started e-Volo with their big multicopter cushioned by a beach ball weren't working for Boeing or Lockheed. They were tinkerers. It's like the early days of aviation when guys in bicycle shops were inventing everything. It's also like the early days of personal computing when the only people with personal computers built them, and huge corporations like IBM didn't believe that a large market for them existed

[...]

I don't think [a proposed flying car design is] safe enough even with his ballistic parachute, and the parachute isn't worth much at low altitudes anyway. I give him a lot of credit for persistence though, and I hope he finds a way to fly it at least.

SkepticsSTM Can A Scaled Up Multicopter Become the Flying Car, Dec 2013

In Box 8.11 extract (1), Elbakyan and Swartz – computer programmers who were involved in prominent leaks of pay-for-access scientific papers – were praised by User1 and User2 as “crusaders for social good” for making scientific knowledge more freely available. Support for knowledge being freely available is familiar in science-related discussions, notably embodied in another Mertonian norm of ‘universalism’ (Merton 1942). In extract (2) the proponent of flying cars tied their excitement about the technology to valuing those with “persistence” – the “maker culture” and “tinkerer” – who through dedication and ingenuity beat the well-resourced “big boys” of Apple and Boeing. The hoped-for future worlds were not simply presented as scientific and/or technological progress, but also shaped by people who embodied certain values. These examples build on a finding of section 8.3.2, that

specific individuals were held as exemplars of social values; they also relate this to the realisation of future, better worlds.

Future worlds were not simply presented as *emerging* from certain social values; participants also expressed hope that such worlds would *reward* and *encourage* values. While User3 in extract (1) supported the social values of open science they also worried that this conflicted with another social value – that employees of journals should be respected for their “hard work” for which they “deserve to make a decent living”. Their hoped-for future world still rewarded this hard work by restructuring academic institutions through nationalisation, a form of economic organisation associated with a particular set of (usually left-wing) political values. It is likely that such values, rather than specific objections related to scientific publishing, explained their prediction that “I doubt many people would agree with me”. The valuing of underdogs in extract (2) can be related to the participant’s appearance in Box 8.10 (2). There they argued that the persistence of underdogs opened up new technological possibilities, and expressed an “almost hope” that the US would attempt to regulate¹³³ flying cars and thus be overtaken as a global superpower by Prague. Their ideal future involved successful technologies being produced by underdogs, but also the elevation of underdogs over powerful institutions; their even more ideal future involved each catalysing the other. In the language of much STS analysis, these expressions of hope incorporated the idea that technologies and social factors are co-produced: broader social ideas, values, and beliefs emerge alongside technologies, with each shaping the other (Jasanoff 2004).

These examples suggested that participants in the subfora saw a role for emotions in co-production. In sections 8.3 and 8.4 I discussed how participants referred to the emotions of other people as factors shaping certain kinds of behaviours. This theme can be seen in discussions of hoped-for futures. Examples of references to others’ emotions in Box 8.10 include appreciation for real meat (1), risk averseness against flying cars (2), and earning the praise of fellow scientists (3). These emotions were presented as a factor influencing the realisation/non-realisation of a certain future. This can be seen in more detail in the opposed stances of two participants on *SkepticsSTM Can a Scaled Up Multicopter* (Dec 2013). The proponent of flying cars believed that flying cars would become widespread once the technology was available, due to a “very widely felt exhilaration at the prospect of a personal air vehicle.” Another participant argued that widespread fear of flying cars – fear of using one, and also of the risks posed by their existence – would inhibit mass uptake of the technology. The original participant responded with an alternative view, that desire would pull people towards places which offer flying cars (and reshape nations in the process).

¹³³ Throughout the thread, the participant expressed distaste for state regulation.

Both participants incorporated references to the emotions of 'people' in general as factors shaping future usage of flying cars. A similar interplay between technology and the emotions of 'people' can be seen in Box 8.10 extract (1). The feasibility of underground tunnels depended on whether "people would go crazy" or whether self-driving cars would mean you could "enjoy a game" while travelling. In these cases, a variety of emotions (fear, earning praise, the sensation of eating meat) were presented as dramatic shapers of the interplay between technologies and social values, in present and future worlds.

Conclusion

In this chapter I have examined explicit emotional expressions. Though relatively infrequent, they still revealed 1) recurrent forms of expressed emotion and 2) more general features of discourse used, and impressions of values held, across the subfora. The most prominent general pattern was how positive emotions were most frequently expressed in relation to objects (natural phenomena, technological artefacts, and ideas) and negative emotions were generally expressed in relation to people. By this, I do not mean that objects exclusively provoked positive emotions, nor that people provoked exclusively negative emotions. Rather, the contrast is that positive emotional language tended to appear in association with references to objects, but appeared less when participants were talking about people. This was shown particularly clearly in sec. 8.1, when we saw how participants frequently praised the beauty of objects but rarely the skill of their creators. By contrast, when participants were using negative emotional language they tended to maximise references to people. For example in section 8.5 we saw that fear or distrust of new technologies was often expressed in relation to how people did or could use technology.

A second theme emerging from this chapter was that appreciation of 'science' was often tied to appreciation of other intellectual, social, moral, and/or political values. This, in combination with frequent negative references to 'people' (implying society in general) suggests that participants portrayed being 'scientific' as an alternative to wider intellectual, social, moral, and/or political failings of society at large. A notable finding here is that these values were often expressed more explicitly than appreciation for distinctively 'scientific' features. For instance, professional scientists were often referred to in emotionally neutral terms, even when they made 'cool' or 'beautiful' discoveries. However scientists who also represented values, such as a drive for combating ignorance or persistence in the face of economic or gender-based disadvantage, were more likely to receive positive emotional responses. This builds upon an argument from chapter 6 (sec. 6.3) that ideas of being

‘scientific’ were important to participants, but existed as part of – and did not necessarily hold the most prominent position in – a broader network of values.

A third theme is that participants presented emotions as important factors which shape behaviour, both within the subfora and in society more broadly. Participants referred to emotions such as ‘interest’ and ‘frustration’ to encourage/inhibit certain behaviours in other participants. They also saw a range of emotions, from excitement to fear, as factors which shape both present and future encounters between science and society. Many of the ideas discussed in this chapter – such as attempts to impose certain norms on discussions, or the relationship between social and technical factors in shaping future worlds – are familiar within STS. However this chapter has illustrated important roles for different forms of emotion within these processes. In the final chapter I reflect on these roles for emotion – and their implications for thinking about relations between science, expertise, and broader society – by drawing on findings from across this thesis.

“My god, what kind of backwards future are you imagining?”¹³⁴

9: Discussion and Conclusions

In this chapter I contextualise the findings and concepts of previous chapters with respect to existing scholarship in Science and Technology Studies (STS), and outline the contributions made by this thesis. Section 9.1 summarises findings from four empirical chapters, and proposes three key concepts: the RSC norm, musing, and identifying. In section 9.2 I address two of my three subsidiary research questions: specific factors which must be considered with respect to descriptive meaning-making in online platforms, and patterns in emotional meaning-making. In section 9.3 I consider the third, and more challenging, subsidiary research question – how to understand any specific features of ‘science’ as a concept in relation to meaning-making. In section 9.4 I address limitations, potential future directions, and broader implications which could follow from the results of this thesis. I present overall conclusions in section 9.5.

This project was an exploratory study, using the online setting to investigate how descriptive and emotional forms of meaning-making can interact in discourse about ‘science’. By descriptive meaning-making, I refer to the defining, demarcating, and/or interpreting of a certain concept. Emotional meaning-making refers to processes of engaging with a certain concept in a manner which demonstrates emotional significance, such as the performance of a desired personal identity and/or the creating of social bonds. In my literature review (chapter 2) I argued that STS has developed a much greater understanding of descriptive meaning-making, and that studies of emotional relations to science have only been explored within the limits of an instrumentalist framing. Building on Fan Studies (FS) literature, I have examined online non-professional settings in order to explore emotional meaning-making outside of an instrumentalist framing.

The case studies of this thesis were used as exemplars of broader phenomena, rather than as bounded topics of interest in their own right. I consider how the findings of this thesis could be applied outside of the subfora, following the two main aims of this thesis. The first aim was to contribute, for STS scholars, an understanding of how engagement with science takes place outside of professional research, communication, and/or education; and, more

¹³⁴ Comment on thread *XKCDScience LED farm 100-fold more awesomer than farmland* (Jul 2014).

broadly, how discourses around science can be shaped by emotional attachments and informal norms. I argue that such factors, though pervasive across many settings, have not been examined in STS to the same extent as questions of professional autonomy and socio-political stakes. Such an examination is particularly essential if Public Engagement with Science (PES) is to engage with the growing phenomenon of online participatory websites, where informal norms can play a greater role than traditional professional|non-professional divides. The second aim was to critically address commentary on how, in a supposed “post-truth” era, emotion and expertise conflict with one another online. I aimed to provide a more nuanced account than a binary expert|emotion conflict, and to examine how expertise and emotion interacts at the level of online discourse.

Reflexive Note

In this chapter I make meaning from the findings of previous chapters. From a constructivist premise of meaning-making, this is a process of selecting, representing, and finding significance in empirical data in a manner which is a partial rather than universal (Charmaz 2000). I apply a central premise of this project – that there is no ‘universal’ way of making meaning, but rather accounts which emerge from both descriptive and emotional factors – back onto this research. Scholars call this *reflexivity*, considering how our claims to knowledge are shaped by contextual processes in the same fashion as those who we study (Bloor 1976). In particular, analyses of emotion should acknowledge the emotional commitments of the researcher in interpreting the emotional commitments of others (Hills 2005).

I include reflexive discussions at points throughout this chapter. However in reflecting on the overall approach of this chapter, the stance on instrumentalism taken in my literature review (2.2) should be unpacked. This project began when, in 2012, I began reading scholarship on PES. As someone who had recently studied physics on grounds of enjoyment, I found myself surprised by the prevalence in this literature of politics over emotional attachments. In line with a dialogue practitioner encountered by Davies, I found myself a little “fed up with all this boringly worthy public engagement and thought that most people just wanted to have fun” (2014, 103). Political events over the period of this project have made me reconsider, both intellectually and personally, the divide between “boringly worthy” politics and everyday emotion. In this conclusion I therefore engage with emotional factors at play in community interactions, as intended at the outset of the project; but I also direct attention to one of the running themes present in the findings, the ways in which the low-stakes engagement drew on references to higher-stakes encounters between science and broader society.

9.1 Key Findings and Concepts

This thesis was structured as four empirical chapters, each examining a different form of meaning-making (see sec. 3.4.3 for more details). Each investigation was undertaken separately, but here I draw out findings which emerged from across the chapters. I summarise the key concepts I drew from these findings, and illustrate how they featured differently across the subfora.

The key theme of chapters 5 and 6 was the role of 'science' in creating distinctions between types of people. In chapter 5 I noted that participants across the subfora frequently expressed dislike of people who held views which ran counter to perceived scientific consensus, or who criticised scientific consensus without showing full engagement with the details. This dislike was often expressed in emotional terms (such as through anger or ridicule) and facilitated the creation of in-group bonds and/or the social identity of a 'scientific person'. In chapter 6 I showed that forms of boundary-work familiar from STS studies of other settings were used to direct participants towards respecting scientific consensus, and for opposing people who did not do so (both within the subfora and society at large).

The key concept developed from these chapters was the *Respect Scientific Consensus (RSC) Norm*: a communally enforced expectation that people should respect scientific consensus. This was *not* equivalent to an expectation that people would be knowledgeable of scientific consensus; ignorance and misunderstanding were accepted, as long as they were not accompanied by criticisms of scientific consensus.

Chapters 7 and 8 focussed on recurring patterns of language in presentations of science and expressions of emotion. In chapter 7 I noted a separation between the use of 'object' and 'discursive' language to present science. Object language involved references to specific material objects such as 'stars', or non-material ideas such as 'spacetime'. Discursive language was dominated by commentary on claims and/or the ongoing discussion, often referencing 'people' (or types of people), and drawing on terms related to scientific methodologies or philosophical notions of evidence. A feature common to both forms of language was an expectation that, in a science-related discussion, any non-credible claims should be highlighted and corrected by members.

In chapter 8 I focussed on manifest emotional expressions. References to awe, personal interest, or hope often appeared alongside references to scientific objects. By contrast expressions of anger, disinterest, or concern often appeared alongside references to people, as well as other forms of discursive language used to critique the credibility of claims. This

corroborated the distinction drawn in chapter 7, and also illustrated that these two forms of language were associated with certain emotional expressions.

The terminology of ‘object’ and ‘discursive’ used in chapter 7 brings out the descriptive elements of the divide, but does not capture the emotional element. Gregg and Seigworth (2010) note that, in writing about emotion, it is important to try and encapsulate and represent emotional concerns within presentation of results. I therefore re-label the two forms of language to bring out the emotional associations, drawing a distinction between two states of discourse: *musings* and *identifying*.

In *musings* participants focussed on abstract objects, using depersonalised descriptions. ‘Science’ was rarely explicated, but when it was it was usually presented as a body of knowledge. The objects of science became the basis for personal responses of awe or intrigue, hope for social progress through science, and/or social cohesion around the excitement of creative speculations.

In *identifying* – which could be more fully described as *identifying with/of science* – participants identified certain people, claims, or behaviours as welcome (or unwelcome) in the thread, subforum, and/or ‘science’ more broadly. This discourse generally involved either polarised disputes or phatic tangents. Language use foregrounded references to people, whether by showing explicit recognition of others in the group or by referring to people in wider society. Often these references were accompanied by expressions of anger, dismissal, or ridicule, but sometimes they were more friendly or based around shared amusement. ‘Science’ was explicitly evoked more often, and presented in a wide variety of ways – as a series of methods, ways of thinking, and/or bounded professional community – which could be used to identify types of ‘good’ or ‘bad’ person.

I propose these concepts are broad enough to be potentially applicable to a variety of settings, both on- and offline. I do not claim that the *exact* ways in which these concepts featured in this thesis would be repeated in other settings. Their appearances in this thesis must be understood with reference to distinctive features of the case studies. For example, the patterns found by this thesis would probably appear differently if participants had alternative motivations. It is worth recalling from my methodological discussion of emotion (3.4.5) that I was not able to provide extensive detail on individual participants’ motivations. However building on interview data, corroborated by discourse analysis (especially in chapter 5), pointed to general motivations which shaped much behaviour on the subfora. These were: interest in receiving various perspectives on a given topic; combining information-seeking and social enjoyment; finding a sense of belonging amongst like-minded

people; and/or to create a desired social identity of a 'scientific person'. These may not be the case in other settings, even those related to discussing science. For example, in online citizen science projects participants are often motivated by the desire to contribute new knowledge (Curtis 2015). The RSC norm might therefore be enforced by referring to practical requirements of shared knowledge (upon which the citizen science project builds) to a greater extent than in the subfora. An offline face-to-face engagement activity might feature less explicitly hostile forms of identifying, due to the lack of the online 'disinhibition effect' (Santana 2014). However, I propose that the concepts are flexible enough to account for mediating factors of particular settings. This can be demonstrated by considering variations across subfora.

On XKCDScience and SkepticsSTM many participants contributed frequently enough that they recognised one another, creating a sense of a bounded community. XKCDScience participants showed greater recognition of themselves and/or fellow participants as domain-specific experts than on SkepticsSTM, and also showed a greater tendency towards keeping threads on-topic. Many threads took the form of extended musing on speculative topics, which often went beyond the bounds of scientific consensus. Risks that speculations might *contradict* scientific consensus were mitigated by expectations that expert members would be able to highlight any such mis-steps. As such, musing was more prominent in XKCDScience threads than identifying, and questions of whether something was 'scientific' were generally left tacit. The (relatively uncommon) participants who disrespected the RSC norm were seen as frustrating due to the way they derailed discussions, by necessitating explanations of 'basic' concepts rather than allowing for novel perspectives.

By contrast SkepticsSTM participants generally showed less domain-specific expertise, and instead displayed attachments to a broader 'skeptical' identity. There were regular participants who presented themselves as 'scientific' while disrespecting the RSC norm. Such participants were frequently sources of scorn and/or ridicule amongst other members, and were sometimes presented as emblematic of a concerning anti-intellectualism in society at large. These attitudes and interactions resulted in a greater prominence of identifying on SkepticsSTM than on XKCDScience. SkepticsSTM threads also featured musing, often taking a similarly speculative form as on XKCDScience. However where XKCDScience threads relied on the presence of domain-specific experts to maintain credibility, SkepticsSTM participants openly discussed questions of credibility and reasoning. This could lead to extremely lengthy antagonistic interactions, but also extended phatic interactions based on shared humour.

IFLScience and r/EverythingScience participants did not display recognition or the sense of a clearly bounded community in the same manner as the other two subfora. Instead participants incorporated these two subfora into broader Facebook / reddit usage. Though participants did not display recognition of specific other members, they did build up shared depictions of *types* of people who do not respect scientific consensus. Such people were associated with threats to society at large, and often discussed in relation to socio-political issues (such as healthcare or the US presidential election). Any non-RSC claims on threads were quickly recognised as unwelcome, and met with (often multiple) critical comments. Affordances of liking (Facebook) or voting (reddit) were also used to show the unpopularity of non-RSC comments. On IFLScience criticism of non-RSC claims mostly took the form of hostility or ridicule, frequently incorporating cultural memes. Criticism on r/EverythingScience was closer to that of XKCDScience, with more expert members providing reasons to doubt the credibility of non-RSC claims.

On both IFLScience and r/EverythingScience, debates between RSC and non-RSC perspectives were usually the lengthiest interactions. There was a wide range of other contributions – including jokes, personal experiences, social/ethical/political reactions, and further information on a topic – but these were often brief and/or did not receive many comments in response. Extended, collaborative speculations were less common than on XKCDScience and SkepticsSTM. The subject matter of posts of IFLScience and r/EverythingScience often referred to news stories (of emerging research, new technology, or similar), and musing usually took the form of showing excitement or appreciation for such developments.

These comparisons indicate how the concepts of the RSC norm, musing, and identifying can be understood with reference to a range of different factors. For this thesis, key factors were: membership, in particular the proportion of members with domain-specific expertise; available affordances such as quoting, liking, and voting; and whether the subforum was used as a standalone, bounded community (where some members recognised one another) or as part of a broader social media usage. Nevertheless, these concepts were ultimately derived from *common* features across the subfora. The following sections analyse these common features further in relation to the research questions and proposed contributions of this thesis.

9.2 Addressing Research Questions

The overall research question of this thesis was *how are descriptive and emotional meanings constructed in online non-professional discussions about science?* In chapter 1 I proposed three subsidiary research questions. These were intended to break down the overall research question into more specific components. The questions were:

1. How might existing STS analyses of descriptive meaning-making need to be adapted for online platforms and/or the absence of clear authoritative identities and organisation?
2. Can recurrent patterns in emotional-meaning making be discerned in online non-specialist discussions about science? If so, what factors shape these patterns?
3. What factors, if any, must be engaged with to specifically understand meaning-making around science, as distinct from meaning-making around other concepts?

In this section I address the first two of these questions – the third is more complex, and is the topic of section 9.3. In doing so I draw from across the specific chapter findings and the broader concepts outlined in section 9.1.

9.2.1 How might existing STS analyses of descriptive meaning-making need to be adapted for online platforms?

The basis for this question was my argument from sections 2.2 and 2.3 of the literature review: that features of online platforms, in particular the lack of organisational structures and clear identity labels, could prove a challenge to familiar ways in which scientific authority is exercised in PES encounters.

Factors which have been noted in studies of other online settings played a role throughout the subfora. For instance, work on the ‘disinhibition effect’ has shown that online interactions are often more overtly hostile than face-to-face interactions (Santana 2014). Online participants who value politeness often counter this with linguistic modifiers such as hedges or textual devices (such as ‘no offence’ or emoticons) which can minimise aggression (Baym 1996). Both of these phenomena were apparent throughout the subfora. Much of the sanctioning in the subfora took explicitly hostile forms; on the other hand, we also saw examples of participants using language which minimised potential offence (5.2.3). There were variations between subfora. Polite language was more common on

r/EverythingScience than other subfora. On XKCDScience, explicit hostility generally took the form of reprimanding other participants, while on SkepticsSTM and IFLScience hostility more commonly involved ridicule or insult. We also saw roles played by technical features of different websites. Ways in which participants recognised one another were related to whether the subforum existed as a bounded, standalone website or as part of a wider social media site (5.1). Affordances such as liking/voting or quoting shaped participant interactions, by visibly demonstrating dislike (5.1.3) or allowing extended point-by-point responses (4.4.3).

Most importantly, the ways in which in- and out-groups were constructed reflected forms of gatekeeping seen across other online communities. Throughout this thesis, particularly chapter 5, I noted comparisons with online fandoms. The ways in which behaviour was normalised, and unwanted behaviour sanctioned, by collaborative actions of the community is very familiar in FS (Baym 1993; Bennett 2011). Though accredited moderators played a role in shaping discussions,¹³⁵ much of the gatekeeping activity was carried out by the wider community. This was true not only of the subfora built on similar platforms to the groups studied in much FS (SkepticsSTM and XKCDScience), but also those built on newer social media platforms (IFLScience and r/EverythingScience). This sort of community-enforced gatekeeping also reflects behaviour within online settings more broadly; participatory websites ranging from Wikipedia to Second Life rely on community enforcement of member behaviour, often building on norms constructed through collaborative discussion (Bruns 2008; Tkacz 2014).

However, despite these features, findings showed remarkable continuity with many STS analyses of offline settings. The authority of professional scientists was reproduced through social behaviours which enforced respect of mainstream scientific consensus (the RSC norm) and presented science as an ultimately credible activity. As in offline PES activities (Kerr, Cunningham-Burley, and Tutton 2007), participants frequently portrayed themselves as outsiders to professional science, offering their views in ways which did not challenge mainstream scientific consensus (6.2.3). Participants who presented representations of science which *did* challenge mainstream consensus – most commonly, ‘science’ as personal scepticism – were generally sanctioned with disagreement, ridicule, and/or hostility from multiple other participants. They did so by drawing on representations of ‘science’, and demarcations of science from non-science, which are familiar from offline settings (Durant

¹³⁵ Note that much of the work done by moderators, for instance deleting comments which broke rules on r/EverythingScience or privately messaging behind the scenes, is likely to be invisible in the data used for this thesis.

1994; Gieryn 1995). Though the methods of community gatekeeping were shaped by the online setting, the sorts of people and claims which were excluded reflected a much longer tradition of science-related discussions.

The appearance of familiar PES patterns was also remarkable given that many of the conceptual tools I used to analyse the shaping of online participation – norms, phatic communication, and communal recognition – were drawn from FS. This finding is notable as STS scholars who have drawn on other social scientific disciplines have often found that the aspects of ‘science’ they study resemble other areas of social life (Latour 1987; Shapin 1992). While I certainly noted similarities with fandoms in how the subfora operated as communities (chapter 5), these findings suggest that features associated with ‘science’ can exercise a distinctive form of social shaping. This suggestion begins to encroach on the third subsidiary research question, and will be considered further in section 9.3.

The reproduction of features from offline settings was largely due to characteristics participants associated with *science*, rather than *scientists*. This distinction is worth elaborating on, as many PES accounts have shown that scientific authority is frequently associated with embodied ‘scientists’ in ways that do not self-evidently translate to online settings. For example Davies (2011) has shown how unequal power structures are created by the physical space of an event: allowing scientific experts an uninterrupted period of speech and locating them close to microphones gives these individuals greater power to shape interactions. Studies of political PES have shown how professionally accredited individuals have greater physical access to settings in which policy-relevant decisions are made (Irwin 2006; Wynne 1982). Practitioners and scholars of PES have asked questions about how to reproduce guarantors of scientific authority in online settings (Hine 2014; Trench 2008).

It is therefore notable that participants in the subfora rarely asked such questions. Any claims to personal expertise were very rarely supported with specific evidence, though still went largely unchallenged. Participants frequently referred to expertise as a property of the surrounding group, or of absent ‘scientists’, rather than as a source of *personal* authority (7.4). We saw in chapter 8 (8.2.2) that scientists were referred to in a variety of ways in the subfora – including positively and negatively, but mostly neutrally. However more abstract processes of ‘science’ were referred to in much more consistently positive terms. Those who disrespected the RSC norm were more usually sanctioned through accusations of ‘unscientific’ thinking or presented with ‘correct’ scientific consensus, rather than through references to specific scientific work (6.2.2, 8.2.2). This emphasis on science in the abstract suggests a possible mechanism by which the subfora came to resemble other offline PES

activities: participants had a shared (though flexible) set of ideas around how science 'should' work, and followed this pattern even in the absence of scientists. This allowed for a form of self-governance by the community, rather than direct governance by accredited authorities (Foucault 1977). The key point is that this self-governance promoted views, and excluded other views, in ways which were similar to other settings.

This phenomenon is likely due, in part, to the subfora in this study appealing to people who supported mainstream science. But this does raise an important question for PES scholars: to what extent can novel methods of communication between experts and non-experts actually lead to novel forms of knowledge production? This research has suggested online tools *can* allow novel forms of engagements between science and society. For instance, there were many examples of extensive, well-informed, personal contributions from non-specialists rather than straightforward dominance of expert perspectives. But these were ultimately shaped by views of scientific authority as an inviolable limit on discussion, and beyond criticism; views which scholars of PES have critiqued (Stilgoe, Lock, and Wilsdon 2014). This is not to argue that the subfora studied for this thesis *should* have been engaged in radical transformation of attitudes towards scientific authority. Rather it indicates the way in which novel online settings can be shaped by emotional attachments in ways which reproduce familiar roles for expert authority from offline settings. I shall focus on the details of emotional aspects in the next section; for the time being I raise two specific problems for PES which, according to the findings of this thesis, may be reproduced through emotional aspects of online participation.

Two Problems for Online Participation

The first problem is that unequal demographic participation in PES may be encouraged (or discouraged) by certain forms of digital science communication. Throughout the subfora, methods used to shape discussions often involved hostility and ridicule; this could be unpleasant or off-putting for many participants, particularly those who may already feel less confident about engaging with science.¹³⁶ Some commentators have argued that science communication should move away from an emphasis on knowledge of scientific objects and incorporate more discussions of scientific processes and people (Durant 1994; Trench 2008; Zhai, Jocz, and Tan 2014). However, an important finding of this thesis was that

¹³⁶ Women and minority ethnic groups are often under-represented in PES activities; such groups can also be less likely to engage and/or be at risk of greater levels of hostility in online discussions (Fox, Cruz, and Lee 2015; Hargittai 2011). The ways in which 'non-standard' writing styles were held to indicate lack of credibility (7.4.2) could also risk class-based and linguistic exclusion.

representations of science which emphasise people and processes can be associated with antagonistic, polarised forms of discussion (7.3, 8.2).

There are questions around whether features of digital settings encourage an emphasis on such aspects of science communication. For instance, we saw in chapter 8 (8.3) that prominent science communicators were referenced as exemplars of certain social values. However there should be concerns around the values they might exemplify, and how these are displayed through digital media. Some celebrity scientists, most notably Neil DeGrasse Tyson and Brian Cox, have frequently used social media to attack perceived unscientific behaviour, and elevate science over practices such as politics or philosophy (Pigliucci 2014; Temperton 2016; Tyson 2016). These have often taken an antagonistic tone – Cox has described his own communication style as “slightly belligerent” and “a rather violent opposition to anything that isn’t science” (Davis 2015). Through digital reproductions, such as memes and hyperlinks, such confrontations can be approvingly shared in various ways (5.2.2, 8.2.2). Humour, memes, and an ‘imagined other’ to attack can be resources for enjoyable interpersonal interactions and/or community formation. However, practitioners of PES should be concerned as to whether the identity of a ‘science person’ broadcast through such displays is one with which a range of people would wish to align themselves.

This is not to argue that PES should avoid discussions of scientific processes and people, or potentially antagonistic subjects. But there should be active critiques of the emotional impacts, whether deliberate or otherwise, this approach to communication can have.¹³⁷ This is a particularly vital question in a context of ‘convergence culture’, in which people engage with a mixture of media through social media feeds rather than choosing extended engagement with a single medium (Jenkins 2006a). Such a landscape has the potential to engage new audiences through serendipitous leisure-time encounters with scientific material. However this means that potentially off-putting ways of discussing ‘science’ can circulate beyond the critical engagement of professionals, in ways which are visible to potential engagers and non-engagers with science. Such approaches can be seen in a growing grassroots network of vocally pro-science accounts on Facebook, many of which dedicate a substantial proportion of their output to ridiculing perceived pseudosciences.¹³⁸ Convergence culture can take emotional aspects of community formation – the building of social identities and a sense of belonging by creating exclusionary barriers to out-groups and

¹³⁷ A similar argument has been made within atheistic and humanistic circles, that the explicit activism of ‘New Atheism’ (as represented most forcefully by Richard Dawkins) has damaged perceptions of atheism and shaped participation within atheist communities (McAnulla 2014).

¹³⁸ Examples include Facebook pages such as a Science Enthusiast (~790,000 likes), SciBabe (~280,000), The Credible Hulk (~170,000), and Insufferably Intolerant Science Nerd (~160,000).

‘others’ – and broadcast them widely (Jenkins 2006a). In relation to PES, such forms of exclusion should be seen as a concern.

A second problem is around how expertise functions in online settings. This is a question which goes beyond PES; there are extensive discussions within internet studies more broadly around new forms of distributed expertise and ‘collective intelligence’ made possible by digital tools (Forrest and Duff 2017; Levy 1997). However other work has shown that any transformational potential of online tools can be mitigated by everyday emotional attachments to familiar offline practices – seen, for example, in the way people use traditional photos in profiles rather than creating online avatars (Turkle 1995, 2011). This was the pattern I observed in my findings, specifically in relation to questions of scientific and expert authority. On the subfora, enforcing mainstream scientific authority often incorporated emotional elements (such as demonstrations of anger, or the building of interpersonal bonds through ridicule). Enjoyable aspects of participation, in particular opportunities for creative speculation and shared humour, were facilitated by references to traditional forms of expert authority and/or adherence to the RSC norm. This thesis has therefore demonstrated ways in which such emotional commitments can shape uses of expertise within online interactions, and roles for ‘traditional’ expertise in the formation of online community.

These findings contribute to a growing body of work on how two major uses of participatory websites – information seeking and socialising – interact. This argument is familiar at a more macro-sociological level, in particular through recent discussions of how social media sites bring informational and social networks into a single media stream (Jenkins 2006a). There have been concerns that information is filtered through friend networks and algorithms designed to maximise user enjoyment, rather than through expert mediation (Bakshy, Messing, and Adamic 2015; Tufekci 2015). It is argued that this leads to ‘echo-chambers’ and online tribalism (Mitchell and Weisel 2014; Wojcieszak and Mutz 2009). Commentators on the rise of the supposed ‘post-truth’ era have associated this phenomenon with the recent political successes of populist movements (Davies 2016b; Viner 2016). As discussed in my literature review (2.1.1), such commentary risks reproducing a problematic binary distinction between expertise and emotion. The findings of this thesis suggest that this distinction does not hold at the level of online discourse. I have demonstrated how ‘pro-expert’ attitudes are expressed in ways which reflect emotional commitments, including frustration at opposing views and formation of in-group bonds. Pro-expert argumentation can therefore take very similar forms to many other processes of online socialisation and gatekeeping. If we are to develop approaches to online discourse for a ‘post-truth’ age, I argue this will require

concepts of 'expertise' which account for roles of emotion. I discuss this further in section 9.4.2.

9.2.2 Can recurrent patterns in emotional-meaning making be discerned in online non-specialist discussions about science?

Emotional meaning-making refers to processes of engaging with a concept in a manner which suggests emotional significance, such as the performance of a desired personal identity and/or the creation of interpersonal bonds. I found patterns in emotional meaning-making, related to a variety of factors. For instance, different forms of emotional meaning-making were more prominent in some subfora than others. Creation of a strong social identity, with clear in- and out-group distinctions, was extremely visible on SkepticsSTM; this seemed to emerge from a strong sense of individualism associated with the 'skeptic' identity (4.1). By contrast IFLScience was dominated by forms of phatic communion which built on social networks beyond the group, a feature I related to Facebook usage more broadly (4.2.5).

There were also patterns which cut across subfora. For example, certain topics were associated with particular forms of meaning-making. Discussions which centred on visual material, in particular photographs of astronomical phenomena or technological developments, often involved shared expressions of enthusiasm (8.1). By contrast discussions which focussed on people, especially politicians, were frequently dominated by antagonism towards perceived out-groups (8.2). Most importantly for this project, I found that patterns in emotional meaning-making were associated with patterns in descriptive meaning-making. The concepts of 'musing' and 'identifying' were designed to capture regular examples of such associations.

As noted in 9.1, the patterns found by this thesis would probably appear differently in different settings (particularly in relation to participants' motivations). A more general argument is that these patterns emerged from ways in which particular forms of emotional and descriptive meaning-making can support one another. Certain descriptive meanings of science are appropriate resources for fulfilling certain emotional roles. For instance, interpreting 'science' as a body of knowledge provided participants with opportunities for interpersonal bonding as they shared, elaborated on, and built up discussions with this knowledge. On the other hand interpreting 'science' as a way of thinking could be used to present oneself as an intellectually and culturally superior 'scientific' type of person. Shared

emotional meanings of science can also encourage certain approaches to descriptive meaning-making. For instance, as we saw in chapter 6 (6.3.3), aiming to present oneself as a ‘skeptic’ or ‘science lover’ can engender a greater interest in explicit demarcation of science from non-science. By contrast, participants who were fulfilling personal interests in domain-specific knowledge saw such demarcation as an annoying distraction. Similar relationships could be seen in other settings, even if precise forms of emotional and descriptive meaning-making may differ from this thesis. Deriving such relationships offers a constructivist approach to both descriptive *and* emotional meaning-making around science, which I argue (2.1.4) has not been previously developed within STS.

Further examinations of emotion and expertise

I have argued that emotional factors shape descriptive meaning-making. Given that the role of descriptive meaning-making in shaping participation in science is widely accepted (2.1), a deeper understanding of emotional meaning-making has a role to play in understanding participation in science. Previous investigations into the role of emotion in PES have often framed ‘science’ as a unitary entity, and categorised non-specialist groups by emotional responses to this entity – for example, a desire to learn more about science, a lack of confidence when engaging with science, or apathy towards science (Falk 2009; Ipsos MORI 2014). I have presented a more fluid picture, which helps to understand how emotional and descriptive meanings of science are produced within and shaped by interactions. This is particularly the case for PES encounters where more practical stakes (such as career autonomy or threats to wellbeing) are absent, and alternative factors must be looked to in order to understand patterns of behaviour.

Many familiar STS concepts within higher-stakes settings could also be examined for relations between emotional and descriptive meaning-making. In particular, the approach taken in this thesis provides resources for thinking outside of professional|non-professional boundaries when analysing participation. Behaviour such as drawing boundaries around ‘science’ need not be seen as primarily as a ploy by scientists to protect their professional autonomy. It can also be seen as broader ‘pro-science’ groups encouraging forms of discussion from which they derive emotional benefits. Many participants on the subfora used references to ‘respecting scientific consensus’ to create a social identity, and present themselves as part of a morally, socially, and/or intellectually superior sub-group within society. Others enforced scientific consensus in order to create ‘good’ discussions – ones which brought stimulation and allowed novel and stimulating perspectives, rather than

devolved into frustrations over ‘basic’ explanations. Such emotional attachments need not be limited to online subfora for non-professional discussions. It is entirely feasible that professional scientists and science communicators, and participants within PES opportunities, may share similar concerns. Again, such concerns should not simply be thought of as factors which motivate (or discourage) engagement with science. They also shape, and are shaped by, forms of interpersonal interaction during engagements with science. This account contributes to recent work within STS around how identities are constructed within specific interactions (Horst and Michael 2011), by showing how these constructions draw on both everyday emotional factors *and* broader cultural representations of science.

More broadly, there are questions around how descriptive meanings of *expertise* might interact with emotional meaning-making. Work on marginalized groups has noted feelings of alienation from ‘science’ (Archer et al. 2015); it is worth asking how such emotional associations might feature in the construction of (potentially marginalizing) representations of ‘expertise’ more generally. In a mirror image of this argument, this thesis can be situated in a longer narrative of technical experts perceiving themselves as marginalized ‘geeks’ or ‘nerds’. This narrative can be seen in attacks directed at sites like IFLScience, which take the view that “until or unless you’ve paid your dues, you haven’t earned the right—or reason—to call yourself a nerd” (Maddox 2012, see also 4.2.1); it has also been employed to explain pro-science engagement in political action (Henderson 2012). It is a narrative which has featured in the origin stories of sites such as Facebook (Mezrich 2009), and has been noted in the rise of technologically sophisticated (and often ideologically disturbing) political movements (Bartlett 2014; Penny 2017). Within this framing, the various (and often benignly presented) depictions of ‘scientific’ people as superior to society-at-large seen throughout this thesis take on a more problematic edge. Uses of this narrative of ‘experts’ as a marginalized, but empowered, minority demand critical attention by STS scholarship; setting it against representations of ‘expertise’ by socially disempowered groups could produce a fuller account of emotional and descriptive meanings of expertise.

Applying the approach of this thesis to such longer narratives could draw out resonances with more macro-sociological STS work in the co-productionist idiom.¹³⁹ Such works show how groups such as ‘scientists’, ‘policymakers’, and ‘publics’ are co-produced with conceptions of ‘the state’ and ‘the law’ (see, for example, the collected works in Jasanoff 2004). Political philosophers have similarly considered ways in which certain forms of statehood are co-produced alongside shared conceptions of emotion (Nussbaum 2013). In

¹³⁹ See 8.5.2 for a fuller explanation of co-production.

this thesis I have shown how ideas of ‘expertise’ and ‘emotion’ were constructed together within discourse. Participants justified ‘appropriate’ forms of emotion by referencing expertise (5.2.3), and also presented ‘desirable’ forms of expertise by referencing emotion (8.3, 8.5). There are larger questions to be asked around how longer-term co-production of political order, ‘pro-expert’ and ‘anti-expert’ identities, and views around ‘appropriate’ and ‘dangerous’ emotions are used as rhetorical resources within specific discourses. Such questions are particularly pressing as debate intensifies around our supposed ‘post-truth’ era – a time when both experts and emotion, and their relationship to politics, is coming under scrutiny within public discourse (1.1). This is a debate to which emotionally detailed STS accounts have much to contribute. I shall address this further in section 9.4, when I consider future directions for this research.

9.3 What role for ‘science’?

My final subsidiary research question was *what factors, if any, must be engaged with to specifically understand meaning-making around science, as distinct from meaning-making around other concepts?* Addressing this question is a more complex matter than the other subsidiary questions. I shall begin by returning to the impetus for asking it and reflexively unpack some problems inherent within the question (9.3.1). I then consider the question by focussing on two key themes – consensus (9.3.2) and credibility (9.3.3) – which emerged from the data but also feature prominently within STS more broadly. In doing so I focus on how features associated with ‘science’ provided prompts for *creativity* amongst participants.

9.3.1 The problems of scientificity

The question emerges from a tension I raised in my literature review, around how to frame participation in science. I argued that much STS scholarship has framed participants in ways which emphasise instrumental concerns. In one common framing participants are seen as local groups with local concerns about scientific developments (Haklay 2013; Wynne and Irwin 1996). In others publics are framed as citizens with a right to democratic participation (Irwin 2001; Marres and Rogers 2005). Outside of policy-related settings, publics are framed as groups who possess certain levels of scientific knowledge and/or attitudes towards science which could be changed by PES experiences (McCallie et al. 2009) – though such factors also affect whether they choose to participate in such

experiences (Archer et al. 2015; Brickhouse, Lowery, and Schultz 2000). These framings account for factors which are distinctively associated with science, in particular expert authority and exclusionary barriers around professional science. However I argued (in my literature review, 2.2.2) that by emphasising instrumental concerns such accounts may downplay those factors which matter to participants. Other accounts have aimed to place more attention on the perspectives of participants. Public groups have been framed as groups of friends (Horst and Michael 2011) or families (Falk 2009) using PES spaces as opportunities for social bonding. An issue here is that any role for factors associated specifically with 'science' is unclear.

The analyses I have presented thus far have largely reproduced rather than addressed this tension. In section 9.2.1 I argued that the role for 'science' in the subfora is extremely similar to that presented in more instrumental STS: science enforces limits to participation, imposed by professional authority. In section 9.2.2 I presented findings which are more novel with respect to STS literature. However the concepts of 'musing' and 'identifying' do not engage to any specific extent with STS research. These concepts could theoretically be applied, seemingly without change, to other cultural spheres.¹⁴⁰ The overall impression of section 9.2 is that 'science' plays specific roles, which can be related in detail to a range of past STS literature, when it is acting as a *limit* on participation. However when we focus on the positive, creative aspects of participation, driven by interests and agency of participants, then any specific role for 'science' somewhat fades away.

I argue that these conclusions do not satisfactorily address one of the aims of this project, to develop an understanding of emotional meaning-making around science. The premise of this thesis was that people derive meaning from science – there is something distinctive about 'science' as a concept which matters to them. The only potential distinctive roles for 'science' I have derived are ones which *limit* participation; this does not fully address the idea of 'loving science' with which I began this thesis, nor does it offer much in the way of understanding the experiences participants derive from talking about science. It is worth drawing a comparison with FS. Objects of fandom certainly present limits to participation (2.1.2, 2.4.2). But FS scholars have also drawn out ways in which objects *drive* or *encourage* distinctive forms of creative participation. In the following sections I shall draw on these to consider distinctive creative possibilities offered by 'science' for non-specialist participation.

¹⁴⁰ For example one could point to politics, where there are questions around how abstract but positive messages might engender enthusiasm more successfully than negative attacks on personalities. For discussion see (Lau et al. 1999). I thank Kasim Khorasanee for this reference.

However the question of 'what is distinctive about science' must be approached with some caution. As shown by both STS literature and examples within this thesis, 'science' has many meanings. There is a risk that the question 'what is different about science' can erase this flexibility in the search for defining characteristics of science. Moreover, there is a risk of slipping from a constructivist view of science (in which 'science' gains meanings within particular interactions) and slip into a realist notion of science as a fixed reference point which can be objectively compared to 'not science'. I acknowledge that in the following analysis I may present 'science' as a somewhat singular concept, and elide some of the variety in how it can be understood or represented. Nonetheless I argue this is a constructivist approach which aims to construct meaning by engaging with things that matter to participants, through a lens of things which matter to me as an analyst (Charmaz 2000). The existence of a concept called 'science', with a series of characteristics which are deemed 'scientific', is something that matters to both me as an STS scholar and to people who are participating in subfora for talking about 'science'.

9.3.2 Consensus and Creativity: Science as 'Canon'

I begin by re-considering consensus. Recall that by 'consensus' I mean knowledge which is perceived to be agreed upon by mainstream scientists; alternative labels used in STS include 'uncontroversial' science (Collins 1974, 1975) or knowledge claims which have been "stabilised as a fact" (Latour and Woolgar 1979, 180). Scientific consensus played a substantial role in shaping interactions across the subfora, as shown most clearly by the RSC norm. This idea of consensus as a limit to non-specialist participation is common throughout various framings of PES. In the deficit model,¹⁴¹ scientific consensus is seen as knowledge which is passed (without alteration) from experts to non-experts (Lock 2011). In the dialogue model, scientific consensus is seen as a limit to effective public engagement. Within policy-based PES the idea of 'upstream engagement' works on the premise that once scientific consensus has been reached it is extremely hard for public engagement to have an impact (Wilsdon and Willis 2004). In all of these accounts, consensus is seen as a hard limitation on non-specialist participation.

However I propose that participation within the subfora shows that consensus can be related to both limitations *and* creativity. We can see participants using features of scientific consensus in ways which show personal agency, but are nonetheless shaped by the work of

¹⁴¹ Recall from the literature review (2.1.4) that this is a conception of 'the public' as a group who simply receives scientific knowledge from specialists without active re-interpretation.

professional scientists. This can be drawn out through comparison with FS work on media fandom. I argue we can see scientific consensus as a form of *canon*. Jenkins defines canon as a “group of texts that the fan community accepts as legitimately part of the media franchise and thus ‘binding’ on their speculations and elaborations” (2006a, 281). This usefully combines ideas of limits – ‘binds’ and ‘legitimacy’ – with the creative activities of ‘speculating’ and ‘elaborating’.

Comparisons with canon can accommodate, and extend upon, the various approaches to consensus which have already been discussed in this chapter. At one extreme, some forms of fan activity rely on accurately engaging with canon. For instance, fans may work individually or collaboratively to produce comprehensive summaries of canon (Booth 2010). This can be compared to the ‘deficit model’ interpretation of scientific consensus, and also the ways in which many participants used the subfora as spaces to teach or learn about scientific consensus (2.1.4). In showing accurate reproductions of official accounts fans – or subfora participants, or learners of science – also develop the identity of a ‘knowledgeable’ person (Bell, Lewenstein, Shouse, & Feder, 2009; Hills, 2015).

However reproductions of official accounts can also be seen as acts of communal creativity. Many collections of canonical knowledge are collaborative projects, with associated questions of how to select and present canon for a particular fandom (Hunting 2012).¹⁴² Baym notes how the task of summarising episodes was divided up on the soap opera fandom she studied, and that participants enjoyed seeing what aspects of personality each new summariser would bring to the task (2000). Similarly the subfora studied in this thesis provided spaces in which a single question – even one looking for an apparently straightforward answer – could produce multiple perspectives and collaborative discussion (7.2.1). Such discussions could even involve assessments of different ways to effectively present consensus knowledge. These ranged from links to favourite resources, to metaphors and thought experiments, to providing personal experiences (7.2, 7.3). The idea that scientific questions should have a ‘correct’ understanding can therefore be a prompt for acts of personal and communal creativity in striving to achieve this understanding.

At another extreme, some fan interactions seem to ignore canon in favour of other forms of engagement – as Baym noted in her study of TANs on the soap opera fandom *rec.arts.tv.soaps*, “talking only about soaps impedes the group’s ability to become a bunch of friends” (2000, 130). We saw numerous examples of TANs, as well as other apparently ‘off-

¹⁴² Indeed some such collaborations can become communities in their own right. One prominent example is the Wookieepedia site for the Star Wars franchise, which includes a discussion around processes of selecting canon modelled on Wikipedia ‘talk’ pages (Wookieepedia 2017).

topic' interactions (5.2.1). We can also draw a comparison with Horst and Michael's accounts of 'idiotic' behaviour, in which participants behave in ways which do not seem to engage with the intentions of the PES opportunity (Horst and Michael 2011; Michael 2012). However a key point of canon is that even seemingly off-topic interactions are shaped by features of canon. The TANs noted by Baym may not discuss soaps, but they are shaped by norms – the 'ethic of friendliness' – which were constructed in the context of discussing the emotional subject matter of soap operas (Baym 2000). Such norms shape the wider context within which participation takes place, whether or not the participation is directly related to the subject matter of consensus. We have seen throughout this thesis how features associated with the RSC norm could be discerned even in more irreverent or apparently off-topic interactions. For example, stereotypes of people who believed in incredible and 'unscientific' claims were regularly used as shared identity references (6.2.1). Similarly in 6.2.3 I argued that drawing boundaries around a singular notion of 'science' served a variety of purposes, from maintaining a shared reference point to creating humour.

The comparison with canon can also accommodate engagement which sits between these two extremes, i.e. where participants use specific ideas from scientific consensus to build up elaborations, speculations, and other creative activity which go beyond the original scientific consensus. This was most clear in many forms of musing, in which participants derived enjoyment and/or intellectual stimulation by discussing scientific objects in ways which could not be conclusively addressed by consulting official accounts. Examples discussed at particular length (in 7.2) included combining consensus knowledge from physics, geology, and biology to discuss phenomena on an imaginary planet (XKCDScience *Living on an Earth-Like Moon*, Jul 2013 - Feb 2015), and building anthropological interpretations of an incomplete fossil record (*SkepticsSTM Primitive Humans*, Aug 2015). Though such lengthy, multi-participant forms of musing were not common across all subfora; but participants did present personal speculations across all the subfora (for example on *r/EverythingScience To Get To Mars*, Feb 2016, and *IFLScience What Are Gravitational Waves*, Jan 2016) although these were generally not taken up by other participants. In this form of musing, participants used gaps in consensus, or novel combinations of scientific objects, to provide a space for personal creativity.

This can be compared to fan re-interpretations of canon. For a given object of fandom, whether a sci-fi series or a soap opera, canon provides specific details (such as people and places) from which to build creative re-interpretations while also setting limits (plot-lines, events) which cannot be re-written (Jenkins 1992). Fans do not (generally) produce fan fiction in the hope of creating or contributing to 'official' accounts (Green, Jenkins, and

Jenkins 1998; Jenkins 2006c). In a similar fashion, as we saw in chapter 7 (7.4.3), participants in the subfora did not present their musings as attempts to contribute to scientific consensus. Indeed, one participant on *SkepticsSTM Axioms of Science* (Dec 2015) was mocked for perceived over-estimation of their theories with the response “I look forward to your groundbreaking journal paper on that” (5.2.1). However, these alternative accounts can be extensive and well-resourced, and I argue their emotional salience cannot be captured by seeing them as simply an “adjunct” to scientific consensus (Kerr, Cunningham-Burley, and Tutton 2007, 407).

Finally, the comparison with canon can provide an understanding of how patterns in meaning-making cut across different subfora. Different fandoms of the same object may feature different forms of interactions, but the shared canon still encourages some common features. Speaking of groups for feminised discussions of Star Trek, one fan writer notes that “they may be more interested in people but they still enjoy speculating about Vulcan culture or Federation politics or Klingon languages or even starship hardware on occasion” (Meg Garrett, quoted in Jenkins 1992, 99). More generally, Bacon-Smith notes that “television products provide members with a ready-made symbolic discourse shared by initiates and outsiders alike” (Bacon-Smith 1992, 291). It is interesting to note which scientific objects prompted responses which were shared across the subfora. For example, relationships between politics and science prompted suspicions across the subfora (6.1). It is also notable that there were few clear disciplinary patterns in emotional meaning-making – ‘cool’ images received similar responses whether they were related to astronomy or engineering (8.1), and many extended musings drew indiscriminately across multiple disciplines (7.2). Just as fan fiction can teach an initiate to a fandom how to understand the shared emotional importance of certain features of canon, focussing on how non-specialists creatively use scientific objects can point analysts towards shared emotional salience of such objects.

9.3.3 Credibility as an Ideal

In chapter 6 I argued that references to credibility, most notably that ‘credibility will out’, was a common theme underlying various interpretations of ‘science’ across the subfora. Credibility also plays a role within fan attitudes towards canon. Even when discussing fictional worlds, fans expect new material to be consistent with the ‘reality’ of the world built up through canon (Jenkins 1992). However attitudes towards credibility in ‘official’ accounts of science – those produced by professional scientists – are very different to views regarding the credibility of official media outputs. In the process of assessing credibility, fans see

themselves equally as qualified (potentially more qualified) than the ‘official’ writers (Jenkins 1992). Scientific knowledge is produced by a very different set of processes to canon, which are intended to ensure that the official accounts are objective reflections of nature (Fleck 1979; Latour 1987). The resource-intensive and professionalised nature of such processes means that the ability to effectively criticise the credibility of claims is nearly always restricted to professional scientists (2.3, 2.4).

A second contrast is that fans may have an expectation that their assessments can be effective in *shaping* official accounts. As Jenkins (1992, 103) notes, “elaborations... assume the status of accepted ‘facts’ seen as binding not only on fans but on the program producers”. Though the full extent of Jenkins’ claims are disputed (Hills 2015), the idea that the views of non-specialists could have an effect on the production of new *scientific consensus* is much more heavily contested. Some STS scholars argue that such a phenomenon is neither feasible nor entirely desirable (Collins and Evans 2002); even proponents have noted the immense difficulties of ensuring genuine impact (Irwin 2014; Wilsdon and Willis 2004).

General attitudes of participants in the subfora studied in this thesis were much closer to STS accounts than to those presented in FS. Scientific consensus was seen as authoritative not simply because it was produced by ‘official’ outlets, but also because of the intellectual and professional processes involved in its production. Such attitudes were tied up with the RSC norm: disrespecting scientific consensus was seen as problematic because it ignored established official processes for ensuring credibility. However these official processes did not simply provide subfora participants with resources for shutting down participation. They were also associated with values such as intellectual engagement, self-criticism, and dedication to producing credible knowledge, and such values provided positive markers by which to produce and assess contributions to the community (5.1.2).

This can again be drawn out through a comparison with FS. In focussing on norms within the subfora, I drew on ideas from FS of fans learning to ‘read the right way’ (Jenkins 1992). Learning to read the right way is not simply a matter of avoiding non-permitted participation. It can also be a source of ‘meaning-pleasure’ as a participant successfully understands and demonstrates readings which are welcomed by the community (Bacon-Smith 1992). Some participants’ accounts were extremely well resourced, showing engagement with various sources (whether media outputs, other participants’ claims, and/or personal experience), personal creativity, and/or attempts to ensure clarity of argumentation (7.2). These were sometimes rewarded with explicit admiration, or (more commonly) taken up and extended by other participants – a feature Baym describes as a marker of “performative talent” within a

community (2000, 25). In other words, the characteristics which were seen as necessary for scientists to produce credible claims – intellectual engagement, self-criticism, emotional dedication – provided positive ideals for participants within the subfora to aim for. Crucially, these are ideals which allow personal creativity but do not require the experience and resources of professional scientists.

Creative discussion could also be prompted by *failures* to be credible. I showed that participants who recognised non-credible contributions often felt strongly impelled to correct errors (7.4). These corrections could take the form of more expert participants providing explanations – sometimes quite extensive – aimed at educating other participants in more ‘credible’ answers and/or processes for assessing credibility. Even when the RSC norm was invoked, this did not necessarily work to close down discussion. As noted in chapter 7 (7.3), invocations of the RSC norm often featured in a frequent form of identifying: lengthy, multi-participant discussions, which went beyond simple sanctioning and into extended constructions of in- and out-groups. While credibility played a role in shaping interactions, this was more complex than simply constraining perspectives.

A theme related to credibility, the idea that science can have universally ‘correct’ answers, played an important role in both prompting and limiting participation. This raises one important way in which the use of ‘science’ within the subfora differed from objects of fandom in FS accounts. Another finding of this thesis was that participants generalised the RSC norm beyond the subfora and into society at large (6.2.1, 8. 2.1). In some cases (6.2, 6.3) participants reproduced a general argument from the Public Understanding of Science movement: a society which agrees with scientific consensus will make more informed decisions and be supportive of ideas/technologies which lead to progress (Miller, 1983; Thomas & Durant, 1987). However more common were arguments that people who disrespect the RSC norm are immoral. They were presented as risking the wellbeing of others through doubting vaccinations or climate change; supporting anti-science policies which lead to social harms; or contributing to a general spread of misinformation in defiance of hard-won credible knowledge (6.3.1, 8.2.1). Where fans learn to read canon the ‘right way’ within a particular fandom, participants in the subfora suggested that ‘people’ in general should learn the RSC norm.¹⁴³

¹⁴³ There is a subtle distinction to be drawn with FS. Fans may suggest that the values exemplified by their fandom should be adopted by society at large. However this is not accompanied by a similar expectation that society should also engage with fan canon. For example, *Star Trek* fans may hope that producer Gene Roddenberry’s progressive worldview will be realised within society at large, but

I began this project by arguing it is important to focus on everyday low-stakes engagement with science, pushing against an emphasis within STS on forms of engagement which present instrumental problems to be solved. By drawing on FS scholarship, I suggested, we could draw out ways in which participation is simultaneously low stakes while still emotionally important to participants. The fan writer T.J. Burnside Clapp refers to a 'weekend-only world' of fandom, which aims to provide an emotionally stimulating space outside of high-stakes concerns (1987 quoted Jenkins 1992, p. 283).¹⁴⁴ But what my previous argument suggests is that, in amongst various other emotional concerns – such as sociability, identity performance, a sense of belonging – were references, both positive and negative, to broader social impacts of science. In other words, the high stakes of 'science' shaped low stakes engagement. Rather than constructing identities around particular domain-specific expertise, participants focussed on more broadly accessible understandings of 'science' and its role in society. This shows how macro-scale, high-stakes representations of science – as a producer of life-improving technologies, as a defence against regressive views, as a tightly-controlled space of professional authority, and as an epistemically superior method of knowledge-production – can be resources for creative participation and identity construction in informal, non-professional discussions.

9.4 Further Considerations

In this section I consider ways in which the approach and findings of this thesis could be broadened beyond this specific project. In section 9.4.1, I consider how further empirical studies could expand on this project. In section 9.4.2 I propose ways in which the findings of this thesis could be used to inform research and practice around more instrumentalist PES.

9.4.1 Broadening the Project

Alternative approaches to emotion

Discourse analysis of natural data from discussion threads is only one of a range of possible approaches to studying emotion (3.4.5). Taking this approach allowed for a detailed

this is not tied to an expectation that society should also engage *en masse* with details of the *Star Trek* canon (Jenkins 1988).

¹⁴⁴ It should be noted that many fans – particularly fan activists – might not agree with this characterization.

investigation of *how* participants discussed science online. However, as noted in 3.4.5, I have not been able to address *why* questions around participant motivations in detail. New data collection methods could begin to address these questions. The relationship I have built up with the subfora over the course of this project could help to recruit further interviewees, survey participants, and/or initiate threads in which participants could share motivations for participating and benefits received from participation. Questions could be left open-ended, and later compared with the findings of this thesis; alternatively discussions could build on the findings of this thesis. For instance, drawing on musing and identifying, I could provoke participants to reflect on whether they feel differently about discussing objects to discussing people. These approaches could also be applied beyond the subfora, for example by exploring whether concerns around misuse of scientific consensus motivate involvement in other forms of (online or offline) PES activities.

The work of this thesis could also be complemented using different methodological approaches to emotion. One example would be psychoanalytic approaches, to draw out individual motivations and emotional commitments in relation to life experiences and self-conceptions. Some interviewees referred to personal experiences of science through narrating life experience; whether of medical interventions, affective experiences of witnessing scientific procedures, or discovering a sense of belonging amongst pro-science groups (Skeptics-A, XKCD-I). Some described how they used subfora as a cure for boredom or a need for stimulating debate (Skeptics-A, XKCD-D). Others referred to keen interests in communicating science or scepticism through a range of means (XKCD-E, Skeptics-C). With further interviewing, or by opening up discussions on the subfora, such narratives could be explored through psychoanalytic approaches to explore how engagement with science “allows creative aspects of the ‘authentic’ self to be powerfully experienced and engaged with” (Hills 2005, 802). Such approaches could draw out motivations and emotional benefits to participating which interviewees themselves may not be immediately conscious of, and further explore the role of science in *personal* (as well as communal) identity formation.

Another alternative methodological approach to emotion would be to widen the scope and examine the role of affect in the formation of science networks. There were numerous examples of participants drawing on other digital engagements with ‘science’, from the meme images on IFLScience (5.2.2) to discussions with ‘Woo-sters’ on other fora (5.1.2). A study of how these subfora, and similar groups, might form an ‘affective network’ (Papacharissi 2014) could bring a deeper understanding of emotion to STS work on Issues Mapping (2.2.3). The findings of this thesis could also be used to train a classifier to detect

forms of sentiment such as opinions about scientific consensus or expressions of musing/identifying (3.4.2). Such an approach could allow large-scale tracking of emotional expressions through online networks. Mark Henderson (2012) has claimed that online networks have allowed “people with a love of science can get political, to create a force our leaders can no longer afford to ignore”; the sorts of online groups studied in this thesis, in conjunction with methods for studying interactions and affect through online networks, would understand the effects of “love” on the political result.

Broadening the Settings

With respect to questions of how meanings of science are constructed online, the methods of this thesis could be usefully applied to other case studies. In familiarizing myself with the subfora I drew on data from ‘comparison’ subfora from the same platform, but which discussed topics other than science. Due to limitations of time and additional ethical requirements (3.2), I did not carry out discourse analysis of these subfora. Further study of these groups could provide useful comparisons between the subfora studied in this thesis and subfora which share many contextual factors but differ in whether they talk about ‘science’.

Alternatively, comparisons could be made with science-related discussions on other websites. The subfora used in this thesis all exhibited broadly positive attitudes towards mainstream professional science. This decision was taken to ensure a high probability of science-related discussions (3.1.2). However this limits the generalizability of some of the key findings, in particular the RSC norm. There is room to explore perspectives towards ‘science’ exhibited by the sorts of people who were often sanctioned on the subfora. For example, many conspiracy theorists combine support for ‘scientific thinking’ with a distrust of the specific claims of mainstream scientists (Harambam and Aupers 2014). Studies of creationists have shown a more complex range of perspectives than straightforward opposition to mainstream science (Elsdon-Baker 2015). Online groups for discussing such topics could provide further sources of science-related discussions, with a broader range of perspectives than the examples studied in this thesis.

There is also scope for broadening the demographic range of participants. From the information available to me I was unable to determine the demographic make-up of the case studies in this thesis. Studies of other science-interested online groups – such as citizen science groups (Curtis 2015) and blog readerships (Jarreau and Porter 2017) – have shown a tendency towards male and educationally high-attaining participants. It is quite possible

that the subfora in this thesis followed this trend. For reasons of linguistic limitations, the groups were also dominated by Anglophone perspectives. Future work could explore the interplay of emotional and descriptive meaning-making amongst online groups intended for participants from a broader range of demographic groups, in particular those who are under-represented within professional science and PES activities. Such an approach could integrate the findings of this thesis with studies of Science Identity (Fraser and Ward 2009) and Science Capital (Archer et al. 2015) which examine the effects of demographic identity on long-term, self-directed participation in science (2.3.1).

Finally, it is worth considering how *offline* research methods could have contributed to deepening understanding of online data. Digital anthropologists have noted that offline contexts can shape both experiences and practices of online participation (Miller, 2011; Turkle, 1995). There were suggestions within my data of possible links between online and offline engagement with science. IFLScience organises (infrequent) offline occasions, from conventions to pub crawls. One of my interviewees (XKCD-E) told me they had been to meetups with people from the XKCD forum in ‘meatspace’ (offline), while another spoke of their involvement in a local Skeptics community (Skeptics-C). It would be worth examining, through interviews, ethnography, and/or focus groups, how offline circumstances may act as a context shaping descriptive and emotional meaning-making. This could be valuable for understanding the perspective of so-called ‘lurkers’, those who read but rarely contribute (Nonnecke and Preece 2000). Questions could be asked around aspects of online science discussions which potentially discourage them from participating, and also whether online discussions still have an influence in meaning-making around ‘science’ in their offline lives.

9.4.2 Implications for Public Engagement with Science

Expanding framings of ‘Engagement with Science’

In this section I highlight particular points from my conclusions which could have implications for the practice of PES. My comparison of scientific consensus with canon drew attention to ways in which non-specialist engagement with science can take similar forms to Jenkins’ ‘textual poachers’: participants take aspects and ideas from ‘science’ which matter to them, and produce personal re-interpretations. The idea that individuals interpret ‘science’ through a lens of things that matter to them is not a new one to PES (Bell et al. 2009; Wynne and Irwin 1996). However the comparison with canon extends this idea in two ways. Firstly by noting how participants in the subfora drew features from scientific consensus, in conjunction

with other cultural resources, in a great variety of idiosyncratic and unpredictable ways. This is in contrast to many PES depictions of ways in which non-specialists contextualise scientific knowledge, which often focus on questions of local issues or concerns associated with particular public groups (Archer et al., 2015; Michael, 2009). For instance, a report on using PES in science education has argued that events could “frame the focus of the PES activity so that it clearly touches people’s lives and values in a direct way” and that giving a topic “local relevancy... [can] provide people with an incentive to learn about it” (McCallie et al. 2009, 47). The findings of this thesis support Horst and Michael’s (Horst and Michael 2011) argument that engagement with science overflows such framings, and that PES practitioners should be cautious of pre-supposing factors which matter to participants.

More positively, the comparison with canon shows how engagement with science can act as a community-forming activity. Being a ‘textual poacher’ of canonical material is not simply a case of producing individual re-interpretations; it can involve building interpersonal bonds through sharing interpretations amongst a fandom. Again, studies of PES have shown how individual interpretations of scientific material are shaped by surrounding social groups. However these have generally focused on family or friendship groups (Falk 2009; Horst and Michael 2011). This study showed how social bonds and communities can be created around engagement with science. Previous studies of this phenomenon have often focused on how groups become mobilized around particular socio-political issues (Chilvers 2010; Marres and Rogers 2005). However I have shown that social bonding, community formation, and identity construction can occur around more everyday, low-stakes engagement with science.

A practical question here is to what extent this was made possible by the disorganized settings, in which participants were relatively unconstrained by roles such as ‘audience’ and ‘communicator’. Some of the phenomena I observed in these settings would be considered positive outcomes in many framings of PES. The subfora demonstrated characteristics of dialogic spaces (2.1.4): they brought together multiple perspectives, and the power to shape interactions was distributed amongst a range of participants (c.f. Davies 2011). Participants in the subfora who labelled themselves as non-experts still contributed technical suggestions, not limiting themselves to social or ethical “adjuncts” (Kerr, Cunningham-Burley, and Tutton 2007, 407). Participants who did claim specialist expertise contributed perspectives – sometimes critical – from within the scientific profession (6.1.3), a process Brian Trench has referred to as “turning science communication inside-out” (Trench 2008). Interviewees described the subfora as valuable places to develop specific knowledge, broader thinking and discussion skills, and/or a personal identity, in some cases over very

long-term participation.¹⁴⁵ These sorts of outcomes are considered positive evidence of learning according to Informal Science Education frameworks (Bell et al. 2009). On the basis of these observations, I argue that the subfora provide evidence that positive PES opportunities can (and do) take place with relatively little organisation, and in the absence of professional scientists and/or communicators.

These findings contribute to ongoing discussions about how to balance unexpectedness and flexibility with elements of professional design and evaluation (Bultitude and Sardo 2012; Horst 2011). In particular we can note how the assumed presence of experts facilitated non-specialist creativity, allowing participants to discuss unconventional views in the expectation that ultimately ‘credibility will out’ (7.4.3). We can also point to ways in which the respect invested in more expert participants (sometimes) helped mediate potentially aggressive confrontations (5.2.3). In other words, the online settings provided instances of how professional experts can play valuable roles beyond providing information, and can positively shape PES interactions as an occasional, background presence.

However the findings also raised concerns about forms of social behaviour made possible within relatively disorganized settings. Some phenomena observed in this thesis – particularly the uses of hostility and ridicule – should raise concerns for scholars and practitioners of PES. In an organized PES setting such behaviours can be limited by the presence of clear authorities (Davies 2011; Kerr, Cunningham-Burley, and Tutton 2007). The same was true in the subfora; the more tightly moderated r/EverythingScience demonstrated less hostility than the more loosely moderated SkepticsSTM and IFLScience. However, the findings of this thesis show that moderating behaviour cannot be separated from controlling how ‘science’ is discussed, as responses to social behaviour act to shape discussions of information (and vice-versa). This can raise complicated judgement calls with respect to moderation. Is criticising another participants’ credibility a personal attack or a useful consideration? Should apparently harmless jokes about ‘unscientific’ people be restricted, as they could encourage participants to mock certain views? In the subfora such judgements were based on communal norms, built up over long-term participation; people who did not agree with these norms either (presumably) did not participate, or chose to participate in the face of social sanctions. But relying on long-term norms and risks of self-exclusion is not a straightforward option for maintaining an instrumentalist PES experience.

¹⁴⁵ Though there was little visible evidence within my dataset of repeated, long-term participation within IFLScience and r/EverythingScience, this does not preclude the possibility of people participating regularly as readers and/or outside of my scraped windows – research on lurkers notes that many people move between periods of regular participation and little participation (Edelmann 2013).

In addition to expertise on curation, events management, and/or producing media content, there may also be substantial benefits to employing expertise in online community management in future PES experiences. In some cases, such expertise may even be more important than subject-specific scientific knowledge – as shown in this thesis, downplaying clear ‘scientific expert | non-expert’ roles can still produce creative, active engagement with science.

Emotion and Policy-Relevant PES

An important concern amongst STS scholars who adopt an instrumentalist approach is the relation between expertise and citizenship (Irwin 2001; Stilgoe 2009). Much policy-relevant PES recommends new approaches to expertise, which better account for democratic accountability (Collins and Evans 2003; Wynne 2016). However, how to determine the role(s) for expertise within civil society is a fraught problem. Underlying the dispute between Collins and Wynne’s accounts of expertise is a question of how democratic decisions should be made in situations which require specific expertise (Collins and Evans 2002; Wynne 2003). Recent works within STS have argued that we should examine how ideas of citizenship interact with questions of expertise through macrosociological concerns of crises of trust in elite institutions (Wynne 2016) and microsociological examinations of affective experiences within ‘uninvited’ participation (Davies 2016a). To these questions, I add two more. The first relates to emotional associations around mainstream consensus. The second is how emotional and descriptive meanings of expertise may interact in future discussions around socio-political roles for expertise.

I showed that respect for mainstream scientific consensus – i.e., the consensus produced by professional experts – can be related to emotional concerns. People who showed disrespect for mainstream scientific consensus were not simply treated as ‘incorrect’; they provoked anger and frustration, and were portrayed as exemplars of poor social values (intellectual laziness, stubbornness, and poor clarity of argumentation). Even in less antagonistic instances, monist presentations of science were tied to expectations of ‘good’ interactions in a form of language-game (6.3.3). A key point of language games is that if people refuse to accept the rules, one cannot convince them otherwise without re-framing the debate (Wittgenstein 1953). As has been argued by many STS scholars, positive democratic outcomes cannot be achieved by simply trying to impose ‘expert’ versions of problem-solving. Scholarship of policy-relevant PES has argued that expertise within political decision-making must be contextualized: decision-making should be accompanied by questions about what forms of expertise are being acknowledged, and why. I argue that

this contextualization should also include an emotionally reflexive element; a critique of whether expert-decisionmaker relationships are being shaped by factors such as the comfort of shared values, or an in-group suspicion of a perceived 'non-normative' out-group.

Such emotional attachments may raise questions around STS approaches towards extending expertise. STS has associated questions of expertise with marginalization of certain groups, whose 'local' knowledge is often disempowered in the face of 'universal' expertise (Wynne and Irwin 1996). Similar arguments have surfaced in relation to recent political events, such as the EU Referendum and US Presidential Election, portraying them as a backlash of local concerns over attempts at universal 'globalising' solutions (Goodhart 2017; Hochschild 2016). In response to concerns of marginalization, STS scholars have proposed that labels of 'expertise' should be extended, to acknowledge and empower forms of lay expertise (Rip 2003; Wynne 2008). I argue such discussions should also engage with perceptions and narratives of expertise and marginalization.

One argument that has run consistently throughout this thesis is that positioning oneself inside or outside the space of science is not only a question of epistemic authority. It also relates to self-perceptions of desired identity, and emotional relations to society at large. What forms of *emotional* resistance might any attempts to extend expertise encounter, both from those who stand to 'lose' a monopoly over expertise and those who stand to 'gain' expertise? If the current political climate suggests a growth in anti-establishment sentiment, extensions of expertise should engage with this in addition to questions of democratic accountability and socially useful knowledge. Ideas such as 'expertise' or 'mainstream consensus' are associated (positively or negatively) with issues of personal identity and emotional significance (Hoftstadter 1963; Medway and Parker 2016). It is not clear how a notion of 'expertise' which allows for democratic, dialogic, and emotionally rewarding interaction between many different groups would look. But to paraphrase a motto of constructivist STS (from Shapin and Schaffer 1985), I argue there is more to be said around how *perceptions* about problems of knowledge are related to *feelings* about social order.

9.5 Conclusion

Studying online non-professional discussions about 'science' allowed for close investigation of everyday, low-stakes behaviours, which can be less visible in more organized engagements with science. In particular, I explored how emotional language interacted with representations of science in discourse. I studied four participatory websites; these varied in membership sizes, technical affordances, and general expectations of expertise and of

‘good’ forms of behaviour. This allowed me to examine how references to science were shaped by different contextual factors, and to see features which persisted across these contexts. In doing so I integrated ideas of meaning-making from STS with those from Fan Studies, a discipline which has applied insights from cultural studies to understand how communities are brought together (often online) through shared emotional commitments. This provided perspectives on community formation and emotional discourse which are novel to STS; moreover, it allowed for delineation of distinctive factors associated with ‘science’ as a cultural reference.

The findings contribute to STS by illustrating how science can play a role in a variety of informal interpersonal interactions. Participants in the subfora shared and developed creative perspectives (both technical and non-technical) on scientific topics; they combined science-related material with other cultural references to create humour and build social bonds; and they constructed personal and social identities, displaying a range of communal values in the process. Despite this variety, I found two key patterns in how science was discussed in descriptive and emotional terms.

The first pattern was a frequent rhetorical distinction between two types of people: those who respect mainstream scientific consensus, and those who do not. This distinction was often applied to society at large; people who respected scientific consensus were contrasted with those who did not, in manner which allowed subfora participants to position themselves as members of a ‘scientific’ in-group. This distinction also played a role in shaping responses to others. Participants who disrespected scientific consensus, or were perceived as doing so, were in the minority across the subfora; however their presence greatly shaped communal behaviour, prompting social sanctioning through which community values were demonstrated and in-group bonds reinforced. The expectation that people should not contravene scientific consensus was not simply an informational matter of dividing ‘credible’ and ‘non-credible’ claims. It was also rhetorically related to emotional factors. People who made claims which ran counter to scientific consensus prompted frustration, concern, and/or scorn; they were ascribed behavioural characteristics, such as lacking intellectual engagement or holding entrenched (or dishonest) beliefs, which marked them out as an undesirable sort of person. From these findings, I argued that the subfora exhibited a communal expectation I called the *Respect Scientific Consensus Norm*.

The second pattern was that certain representations of science were associated with particular forms of emotional meaning-making. Presenting ‘science’ as a collection of objects (phenomena, technologies, and/or ideas) provided participants with specific resources to incorporate into theorising, joking, or expressions of enthusiasm. In doing so,

participants associated this form of 'discussing science' with emotional expressions of excitement, hope, and interest. By contrast, depictions of 'science' as a way of thinking were used to construct identities (both personal and social), and comment on the behaviour of fellow participants and of 'people' more broadly. Such references were often accompanied by emotional expressions of frustration, concern, or scorn. I referred to these two sets of rhetorical associations, in which certain forms of descriptive meaning-making were associated with particular forms of emotional meaning-making, as *musings* and *identifying*.

These approaches to representing science were shaped by the online setting. Expectations of credibility drew on the presumed presence of more expert users within the community, and the ability to draw on resources from other websites. Boundaries between 'science' and 'non-science' were enforced through online social behaviour, such as mass responding, voting, and liking, which visibly displayed the unpopularity of certain views. These findings therefore extend STS understanding of engagement with science online. However, my broader arguments around how participation was shaped by emotional factors – particularly ways in which scientific consensus facilitated forms of interpersonal bonding, and the varieties of dislike felt towards non-RSC views – could feasibly be extended to other settings, though the form in which they appear would be different.

I began the thesis by arguing that STS studies of public engagement with science should broaden beyond instrumentalist framings, in which engagement is related to aims of learning, sharing of information, and/or democratic shaping of scientific research. Taking this approach showed how scientific consensus has creative potential within non-specialist discussions. I drew this idea of creative potential out through a comparison with uses of canon by fan communities. Both canon and scientific consensus provide specific objects, produced through 'official' activity; participants could reproduce official interpretations of these objects, combine objects with other forms of cultural reference to produce personal re-interpretations, or (seemingly) ignore these objects in 'off-topic' forms of social activity. This framing accommodates the variety of social activities seen within the subfora. It also highlights how these activities should be considered with respect to social values and expectations of behaviour associated with the specific canon, or in this case scientific consensus.

Most importantly, scientific consensus (like canon) placed restrictions on what participants could 'legitimately' or 'credibly' discuss. Through these restrictions, discourse on the subfora was shaped by features of science which STS scholars have derived from more instrumental settings. Though many participants expressed enjoyment at creatively speculating beyond scientific consensus, they saw their interactions as ultimately bound by requirements of

credibility; such credibility was ensured through deferral to forms of accredited scientific authority. Descriptions of 'science', and 'non-sciences', drew upon representations familiar from within professional science and science communication. And, as already noted, mainstream scientific consensus played a substantial role in shaping both informational and emotional interactions within the subfora. The overall result was that official accounts of 'science', circulated by professional researchers and communicators, shaped participation even when such professionals and/or their instrumental concerns were absent.

STS scholarship has shown that meanings of 'science' circulated by representations of professional research need not determine what 'science' means to everyone else. Throughout this thesis we have certainly seen a variety of idiosyncratic, creative, and surprising approaches to engaging with science. But this thesis shows how, through a variety of emotional attachments, meanings of science constructed within professional settings can exert a strong influence on meaning-making within lower-stakes, leisure-time settings. The authority of 'science', which has emerged from professional institutions and high-stakes disputes, can shape everyday forms of social behaviour and emotional interaction. It is worth considering how the reverse might also be true.

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Appendix 1: Ethical Approval Documents

1.1: Confirmation of Institutional Approval

DEPARTMENT OF
SCIENCE AND TECHNOLOGY STUDIES



This document certifies that


Oliver Marsh

has received ethical approval for their project entitled

**How are meanings of science constructed in interactions
in online science social groups (OSSGs)?**

in accordance with the UCL Department of Science and Technology
Ethical Research policies and procedures.

Application reference number: STSEth038

Signed: 

Department Manager

Date of Approval: 01/11/2014

1.2: Text from Personal Web Page

What Do I Need to Know?

In order to preserve the privacy and anonymity of research participants, I shall be carrying out the following default processes to all data collected. No-one except me will see the data prior to these processes.

- I shall be anonymising all data by changing all names, including usernames, of all participants (including interviewees).
- Though I may report information such as the gender, age, profession, or institution of a user, this will be made too vague to locate specific individuals (e.g. 'age mid-20s', or 'from a university in California').
- To avoid participants being identified using internet search tools, quotations from publically available sources will not be connected to any personal information acquired through interviews.
- All data will be stored on an encrypted and password-protected physical hard drive, and not through any networked cloud storage.
- When interviews are conducted through electronic means (emails, Facebook messaging, etc.), the thread will be deleted at the close of the research. At your request, emails/messages can be deleted earlier and only retained as an offline copy at any point during the course of the interview.
- I will never ask you to disclose any personally sensitive information – such as information which could be used to establish your physical location or state of health – during interviews, and if you willingly disclose such information during interviews I will not use it without your recorded permission.

Only after the above processes have been carried out:

- The anonymised data will be used to produce a PhD dissertation and in academic and public outlets (e.g. journal articles, summaries for websites, conference presentations, etc.).
- Following the rules of the Economic and Social Research Council all the anonymised data will be stored with the UK Data Service (<http://www.esrc.ac.uk/about-esrc/information/data-policy.aspx>).

PLEASE NOTE THAT at any point during research you can request to opt out of the research, and/or request specific details not to be retained or reported. The last date for such withdrawals or modifications will be 31/7/2016.

Equally, if you would like to modify any of the above processes (for example, if you would like your real name to be reported), please request.

Appendix 2: Web Scrapers

For details of terminology, see appropriate sections in chapter 4.

2.1: Additional Details and Known Errors across all Scrapers

- All scrapers were written in Python. Facebook and reddit scrapers were designed using the Application Programming Interfaces provided by these platforms. Skeptics and XKCD scrapers were written using details from page source view.
- Data was saved to MySQL databases, but manipulated in Excel. The exception was IFLSFeb data, which was too large to be manipulated in Excel so quantitative values were derived from MySQL commands.
- All scrapers required continual internet access. A break in internet access caused the scrapers to freeze, which required a restart. August and February scrapers were programmed so they could skip straight to the post on which the scraper had frozen; however responses to such posts may have been double-scraped. These duplicates were removed in Excel manipulation.
- Due to the risk of scraper breakdown, they were set to scrape posts from up to 1000-1500 hours in the past; this is longer than a month (720 hours), but provided contingencies in case of scraper breakdown. This, in addition to the fact that scraped windows were sometimes assembled from multiple runs (as described above) means that scraped windows were actually between 1 and 1.5 months in duration. Scraping also did not begin at the end of each listed month, so scraped windows do not map exactly onto each month – so, for example, the IFLSMarch window actually encompassed 23 Feb 2015 - 23 March 2015.
- On the SkepticsSTM and XKCDScience fora, posts are organised by date of last comment rather than by date posted. The scraper therefore picked up the entirety of any

thread which had a *response* within the scraped windows. For some very long-running threads, particularly ‘stickied’ posts, this included some responses which had been posted considerably before the scraped windows. As these smaller fora did not risk causing data overload, I included these responses in my analyses to maximise available data.

- Response count was calculated by the scraper by summing the number of scraped responses, rather than using values provided by fora.
- In March2015 datasets, word counts were calculated after scraping using the Excel function `(=IF(LEN(TRIM([cell with text]))=0,0,LEN(TRIM([cell with text]))-LEN(SUBSTITUTE([cell with text], " ", ""))+1))`, which counts the number of spaces between words and adds one. For August2015 and Feb2016 datasets, words were counted during scraping by a Python command which split words into a list and counted the length of the list. For SkepticsSTM and XKCDScience This command included subtracting quoted text before counting words.

2.2: Facebook Scraper

Variable	Explanation
counter	Begins at 1 when scraper is set running, iterates upwards 1 for each item scraped
page_name	Name of Facebook page
data_type	Post, Comment, or reply
replying_to	If comment or reply, ID number of the original post
data_id	ID number assigned by Facebook to the item
replying_to_text	If comment or reply, text of the original post (added after March scrape)

created_time	Time item was created
reply_delay	Time delay between comment/reply and post/comment it is replying to
poster_id	ID number assigned by Facebook to the user contributing the item
poster_name	Name of the user contributing the item
message	Text of the message
message_length	Number of words in the message
picture	url of any attached pictures
link	url of any linked material
tagged	Any tagged names
shares	Number of times item shared at time of scraping (for comments and replies, this is zero)
likes	Number of likes the item received at time of scraping
reply_count	Number of comments received by a post, or number of replies received by a comment, at the time of scraping. This data is provided by Facebook (which may differ from scraped data, due to privacy settings). Also for posts it does not include the number of replies to comments on that post. It may therefore not be equivalent to the total number of scraped responses to an item.
url	url of item
data_updated_time	Time scraping commenced
search	A unique ID created by the scraper, combining the page name, time scraping commenced, number of hours input for scraper to search back, and the counter value of the item

Additional details and known errors

- Posts were scraped from most recently created post to least recently created post.

- The scraper was programmed such that any post with over 20,000 comments (according to Facebook) was scraped, but responses to the post were not. These are rare, but when they occur they can receive upwards of 80,000 comments. This takes an unfeasibly long time to scrape fully. Due to the high volume of activity on Facebook, a thread which had 20,000 comments at commencement of scraping could multiply rapidly over course of scraping, hence the decision to set the limit at 20,000.
- The March scraper could not account for non-Latin text, and any post, comment, or reply with non-Latin text was *entirely* replaced with 'Write Error'. Subsequent scrapers were re-programmed to account for non-Latin script, but still could not recognise emojis – these were replaced with 'Write Errors', but the surrounding item was scraped.
- Scraping a month's worth of posts and responses from IFLScience took a little under 1 week.

2.3: Reddit Scraper

Variable	Explanation
counter	Begins at 1 when scraper is set running, iterates upwards 1 for each item scraped
redditor	Redditor's username, automatically pseudonymised by randomly selecting letters from their username and adding numbers. This was carried out so that names could not be easily associated with past reddit history.
redditor_duration	Length of time, in days, the user has had a reddit account.
is_mod	Is the redditor a moderator of the subreddit being scraped
link_karma	The redditor's total 'link karma' (accumulated votes on all posts)
comment_karma	The redditor's total 'comment karma' (accumulated votes on all comments)

subr_p_num	The total number of subreddits submitted to or commented on by the user (maximum 100)
total_sub	The total number of posts made by a user (maximum 100)
subr_c_num	The total number of comments made by a user (maximum 100)
total_comment	The total number of submissions made by a user to the subreddit in question (maximum 100)
subr_sub_num	The total number of posts made by a user on the subreddit in question (maximum 100)
subr_link_karma	The total link karma acquired by the user from posts on the subreddit in question
subr_comment_num	The total number of comments made by a user on the subreddit in question (maximum 100)
subr_comment_karma	The total comment karma acquired by a user from comments on the subreddit in question
subreddits_posted	Full list of subreddits posted on by user (over last 100 posts)
subreddits_commented	Full list of subreddits commented on by user (over last 100 posts)
redditor_flair	Any flair the redditor has on the subreddit in question
data_type	Post, comment, or reply_n (where n=1 when replying to a comment, n=2 for replying to a reply_1, and so on).
data_id	The reddit-assigned id number of the post/comment
subreddit	The subreddit the post/comment appears on
replying_to	For a comment, the data_id of the post or comment it is replying to.
title	The title of the post / the post a comment is replying to
submission_flair	The submission flair of a post/ the post a comment is replying to
message	Text of the item
message_length	The number of words in a post or comment

reply_count	The number of replies to a post or comment
score	Total of upvotes – downvotes
created_time	When the item was created
url	Url of item
search	A unique ID created by the scraper, combining the page name, time scraping commenced, number of hours input for scraper to search back, and the counter value of the item

Additional details and known errors:

- Posts were scraped from most recently created to least recently created (reddit allows various options for ordering posts, but other options would favour more popular posts).
- Reddit only allows a scraper to search back a maximum of 1000 posts on a subreddit. This means the scraped windows for r/EverythingScience are shorter than one month.
- Deleted responses show [deleted] for 'message', and error values for all other values.
- Scraping 1000 posts (with associated responses) from r/EverythingScience took approximately a day.

2.4: Skeptics and XKCD Scraper

Variable	Explanation
counter	Begins at 1 when scraper is set running, iterates upwards 1 for each item scraped
forum	Subforum being scraped

id	A unique ID created by the scraper, combining the page name, time scraping commenced, number of hours input for scraper to search back, and the counter value of the item
name	User name
date	Date and time user account created
posts	Total number of posts and responses made by user on forum
duration	Length of time (in hours) since user account created
captions	Any captions and signatures on the user's profile
data_type	Post or comment
title	Title of post / post replying to, for comments
text	Text of item
msglength	Length of item, in words, including quotations
quotes	Any quoted text
links	Any hyperlinks in text
replying_to	ID of post replied to, and any comments quoted
url	url of page at which item can be found

Additional details and known errors:

- Posts were scraped from most recently responded to least recently responded to.
- March version of scraper only scraped the first of any 'double-posts', i.e. two or more responses made consecutively by the same user. Missing responses were manually added for threads analysed for this thesis.

- Scraper ignored any 'announcements' or stickied posts on a subforum, except for the Feb scrape when stickied posts were scraped. This avoided scraping stickied posts across multiple scraped windows.
- Scraping one month's worth of posts took less than a day.

Appendix 3: Comparison Groups

3.1: IFLScience

Page	Likes ¹⁵⁷ (to nearest million, Nov 2015)	Genre
CNN	19m	News broadcaster
Game of Thrones	16m	TV show
Madonna	18m	Musician
Disneyland	17m	Theme park

3.2: r/EverythingScience

Subreddit	Subscribers (to nearest 1,000, Dec 2015)	Purpose
r/thingsforants	43,000	For posting picture of objects which resemble miniature versions of much larger objects; The title refers to a joke in the film Zoolander in which a character mistakes a model school for a real school, and queries whether it is “a school for ants”.
r/vxjunkies	68,000	For discussing a ‘VX’, a type of (fictional) technology, using extremely complicated specialised terminology.
r/futureporncreated	65,000	For posting “high quality images that depict a believable view of the future”, created by participants.

¹⁵⁷ To nearest million, information correct November 2015; Disneyland estimate based on August 2017 value as value not captured by Internet Archive.

r/asksciencefiction	56,000	For asking questions about fictional universes. Despite the name, fictional universes are not limited to the science fiction genre.
r/unexpectedcena	43,000	For posting videos featuring (or edited to feature) unexpected appearances of wrestler John Cena.
r/science	9,957,000	For discussing peer reviewed research. Selected for comparison of different levels of expertise, rather than for similar size.

3.3: *SkepticsSTM*

Subforum	Total # threads / responses, all time ¹⁵⁸	Description on Forum
Magazine	112 / 1292	Discussion of Skeptic magazine and Letters to the Editor
Activism	63 / 679	Ways and means of promoting skepticism
Skepticism and Critical Thinking	2300 / 59006	How should we think about weird things?
UFOs, Cryptozoology, and The Paranormal	1279 / 59006	PSI, Mediums, Ghosts, UFOs, Things That Go Bump In The Night
Healthcare	797 / 20768	A skeptical look at medical practices
Origins	687 / 23894	Creationism, Intelligent Design, and Evolution.
Scams	88 / 2307	Step right up for 3-card Monte...
Events	236 / 299	Calendar of Upcoming Skeptic Events
Monster Science	12 / 235	No caption [for discussions of cryptozoology, sightings of creatures from myths and folklore]

¹⁵⁸ This information is provided by the Skeptics forum, rather than my scraper. Ordering reflects original ordering on forum. Numbers, which are provided to give a sense of popularity, correct as of 9th Jan 2016, except all Community subfora, plus Climate Change, History, and Conspiracies subfora, correct as of 26th August 2017, as these values are not retained by the Internet Archive.

Monster Episodes	67 / 332	Talk, debate, discussion, observations, etc... regarding episodes of <i>MonsterTalk</i> .
Monster General	340 / 7408	Feel free to talk about anything and everything in this board.
Monster News	51 / 330	Did you see something about a monster in the news? Tell us about it.
Monster Suggestions	34 / 174	Have you got a helpful suggestion for our show or for these forums?
Letting God Go	803 / 18088	General discussion on the subject of religion, losing religion, and having no religion to lose...
Letting God Go Books	158 / 1083	Read any good books lately?
Letting God Go Film Etc	207 / 2576	Sort of like "The Bookshelf" but for... you get the idea.
Letting God Go Links	186 / 2019	Stuff of interest on the Web...
Community Nexus	1186 / 37615	Introduce yourselves here, get to know everyone else. Kick back and relax.
Community BrainTeasers	121 / 2731	If the red house has blue shutters and the green house has red shutters, what's this section for?
Community Funny	510 / 9008	Laugh it up...
Community BookReviews	204 / 2418	Share your thoughts on the written word.
Community PopCulture	393 / 7041	Weird things people do.
Science, Technology, and Mathematics	1668 / 29319	What does make the world turn?
Belief and Philosophy	2225 / 64463	God, the FSM, and everything else.
Brain and Mind	574 / 17992	What you think about how you think.
Climate Change	1339 / 35552	Heated discussions on a hot topic.
Economics	274 / 4600	Fun with supply and demand.
History	398 / 8469	Where have we been?
Politics and Government	1664 / 39065	Where no two people are likely to agree

Guns	24 / 4124	Duck and cover
Conspiracies	318 / 9858	Who else knows what we know, Jerry?

This excludes the Junior, Education, Rules and Guidelines, and HelpDesk subfora, as these did not feature responses during scraping. This also excludes Holocaust Denial (a subforum which largely opposes, rather than supports, Holocaust Denialism) as the high rate of activity and very distinctive terminology resulted in over-dominance of Iramuteq analyses.

3.4: XKCDScience

Subforum	Total # threads / responses, all time ¹⁵⁹	Description on Forum
Individual XKCD Comic Threads	1617 / 282823	This forum is for the individual discussion thread that goes with each new comic.
What If?	153 / 9332	What if there was a forum for discussing these? [xkcd.com 'What If' articles]
News & Articles	5786 / 284312	Seen something interesting in the news or on the intertubes? Discuss it here.
XKCD Meetups	482 / 17434	For discussion of group meetings in the meat-o-sphere.
General	6779 / 553042	Things that don't belong anywhere else. (Check first)
Science	5501 / 105355	For the discussion of the sciences. Physics problems, chemistry equations, biology weirdness, it all goes here.

¹⁵⁹ This information is provided by the Skeptics forum, rather than my scraper. Ordering reflects original ordering on forum. Numbers, which are provided to give a sense of popularity, correct as of 9th Jan 2016, except all Community subfora, plus Climate Change, History, and Conspiracies subfora, correct as of 26th August 2017, as these values are not retained by the Internet Archive.

School	1337 / 28272	The school experience. School related queries, discussions, and stories that aren't specific to a subject.
The Help Desk	3994 / 25542	"Please leave a message at the beep, we will get back to you when your support contract expires."
Coding	3797 / 54291	A place to discuss the implementation and style of computer programs.
Computer Science	1367 / 14422	A place to discuss the science of computers and programs, from algorithms to computability. Formal proofs preferred
Hardware	1764 / 19261	The magic smoke
Religious Wars [about computing]	396 / 19028	Please compose all posts in Emacs.
Logic Puzzles	2055 / 36988	A forum for good logic/math puzzles.
Your Art and Links	1362 / 13277	Think your art is better or your stick figures worse? Got a link to a site you want to share? Post it here!
Fit Club	614 / 13636	The Food Forum's Evil Twin. Trying to lose weight or get in shape? Tips, encouragement, status reports, and so forth go here.
Gaming	1849 / 135042	Of the Tabletop, and other, lesser varieties
Movies and TV Shows	1203 / 57727	Rot your brains, then rot our boards
Music	1249 / 43807	It's only cool if no one's heard of it.
Books	904 / 32045	A slow, analog alternative to the internet
Food	589 / 27042	Apparently, people like to eat.
Site/Forum issues	1068 / 12615	Need the mods or admins to do something for you? Post here. Read the "About" post first.

This excludes the Rules and Guidelines, and HelpDesk subfora, as these did not feature responses during scraping. This also excludes Mathematics, Language/Linguistics, and Games as the high rate of activity and very distinctive terminology resulted in over-

dominance of Iramuteq analyses. Finally, this excludes Serious Business and Free As in Destitute as these are designated safe spaces for members.

Appendix 4: Sampled Threads

4.1: Chapter 5, Latent Emotion

In addition to all other sampled threads (see sections 4.2.-4.4), I also selected topics (for comparison) which appeared in three or more subfora: the NASA New Horizon flyby of Pluto in August 2015, the discovery of gravitational waves in February 2016, flying and/or self-driving cars, primitive humans, disputes over evolution, and effects of climate change. For IFLScience only the three threads with highest number of words replied were selected.

Site	Dataset	Title	Reply Count	Words Replied	Score / Likes
<i>Pluto Flyby</i>					
Everything Science	Feb	NASA's New Horizons team discovers vast reserves of H2O ice on Pluto	4	774	54
Skeptics	Feb	Pluto Flyby Mission - 2015 JUL 14	30	897	
XKCD	August	Pluto down, next stop...interstellar?	25	6131	
IFLScience	August	How much did it cost to send a spacecraft to Pluto? The Real Cost Of NASA's New Horizons Mission To Pluto iflscience.com	842	24294	16692
IFLScience	August	How Pluto felt this week. Original cartoon by Imgur user BennuBird	6043	14196	176066
IFLScience	August	Absolutely loving all this Pluto news. It just gets cooler and cooler. Scientists Find Something Very Bizarre Behind Pluto iflscience.com	1283	9169	77183
<i>Gravitational Waves</i>					
Everything Science	Feb	My university's marketing team thinks that one of our professors singlehandedly discovered gravity waves..	34	916	317
Everything Science	Feb	Einstein's theory about gravitational waves could be confirmed tomorrow	22	808	243
Everything Science	Feb	'Woohoo!' email stokes rumor that gravitational waves have been spotted	13	349	114

Everything Science	Feb	Gravitational wave discovery expected	18	321	183
Everything Science	Feb	5 Reasons You Should Care About the Discovery of Gravitational Waves	1	124	7
Skeptics	Feb	Gravitational Waves Detected	26	1236	
XKCD	Feb	LIGO Gravity Waves: Questions and Answers	48	4979	
IFLScience	Feb	If correct, this could be one of the biggest discoveries in the history of physics. Rumor Claims Gravitational Waves Have Been Detected At LIGO iflscience.com	1275	14054	50716
IFLScience	Feb	What are gravitational waves?	637	7418	28740
<i>Flying / Self-Driving Cars</i>					
Skeptics	Feb	Can a scaled up multicopter finally become the flying car?	124	19959	
XKCD	August	Flying cars and jet-powered batwing	105	33524	
IFLScience	March	Who wants a flying car? Company Claims Their Flying Car Will Hit Markets In Two Years iflscience.com	7119	62195	118792
IFLScience	Feb	Whoa. Meet The Futuristic, Electric, Self-Driving "Batmobile" iflscience.com	903	5910	21523
IFLScience	March	This driverless Mercedes has been spotted driving around San Francisco.	8832	34792	123308
<i>Primitive Humans</i>					
Skeptics	Feb	Ancient peoples were ecological vandals.	16	1727	
Skeptics	August	Primitive humans caused widespread animal extinctions	52	4965	
XKCD	August	Homo naledi: Another link	22	2332	
IFLS	Feb	Where do Irish people come from? Not where you'd think. Study Of Ancient Genomes Reveals Something Very Strange About Irish People iflscience.com	3355	25859	34573
IFLS	Feb	Ötzi was infected with a stomach bug that according to current theories, he should never have had contact with. Ötzi The	365	2890	15817

		IceMan's Stomach Bacteria Is Helping To Trace Human Migration iflscience.com			
IFLS	March	Probably not what you would expect. What Did Neanderthals Sound Like? iflscience.com	3208	15113	29524
<i>Climate Change</i>					
Everything Science	Feb	How climate change destroyed Britain's 'Atlantis'	10	593	17
Everything Science	March	My father sent me this article, passive aggressively claiming it was 'interesting', can someone help me wade through the crap? [Climate Change Skepticism]	58	6881	219
Everything Science	March	Science Museums Urged to Cut Ties With Kochs. Dozens of climate scientists and environmental groups are calling for museums of science and natural history to "cut all ties" with fossil fuel companies and philanthropists like the Koch brothers.	33	2055	603
Everything Science	March	A Wisconsin state board has prohibited its employees from working on global warming issues on state time, including the daughter of the founder of Earth Day	21	907	457
Everything Science	March	Global warming limit of 2 degrees Centigrade hangs in the balance	3	253	40
Skeptics	Feb	The Anthropocene is balmy.	10	250	
XKCD	March	How long can we (human society) survive global warming?	39	4201	
IFLSscience	March	Ted Cruz recently compared himself to Galileo, and compared those who accept climate change to flat-Earthers. No. Just no. Image via Forecast the Facts.	12885	173429	106376
IFLSscience	March	Earth hour represents the knowledge that we must all work together to combat climate change and protect our planet.	11188	124245	233903
IFLSscience	March	I'm sorry, what? Florida Bans Employees From Mentioning Climate Change IFLScience iflscience.com	7636	80296	69494
<i>Evolution</i>					

Everything Science	March	Defending Darwin: I teach human evolution at the University of Kentucky. There are some students I'll never reach.	79	5298	504
XKCD	March	[BIOLOGY] Evolution	33	5424	
IFLScience	March	I fucking love science added a new photo. [Teaching Stork Theory]	9127	154332	138700
IFLScience	August	Mass extinctions could actually have a positive effect on evolution. Mass Extinctions May Actually Speed Up Evolution iflscience.com	1472	20472	27719
IFLScience	August	Robots that evolve with each generation. "Mother" Robot Builds Evolving Babies iflscience.com	1342	9284	19416

4.2: Chapter 6, Manifest Science

Data was taken from two purposive samples of responses. One sample was aimed at developing a fuller understanding of the contexts around references to 'science' and 'not-science'. I began by selecting all post titles which suggested discussions of 'science' as a concept were likely to occur as part of the thread. These decisions were made based on findings from prior STS literature and my prior familiarisation with the data, as discussed in chapter 3 sec. 4.3. The data in the second sample was made up of all responses below these posts. This sample is listed below.

The second sample was designed to capture a breadth of instances in which 'science' was explicitly discussed. I used an Excel query to create, separately for each subforum, a randomly ordered list of responses which contained the string 'scien' (so as to capture 'science', 'scientific', 'scientist', etc.). Responses were located in original threads to check context.

Site	Dataset	Title	Reply Count	Words Replied	Score / Likes
------	---------	-------	-------------	---------------	---------------

Everything Science	Feb	Neurologist Analyzes Why Cruz's Strange Smile 'Disturbs' and 'Unsettles'.	123	3975	475
Everything Science	Feb	Researcher illegally shares millions of science papers free online to spread knowledge	52	3835	661
Everything Science	Feb	Why is homeopathy still paid for by the NHS?	57	2326	271
Everything Science	Feb	Sorry, Science Says Speed Reading Doesn't Work	34	1456	215
Everything Science	Feb	Let's just try that again - Reproducibility should be at science's heart. It isn't. But that may soon change	20	1286	146
Everything Science	Feb	The Water Next Time: Professor Who Helped Expose Crisis in Flint Says Public Science Is Broken	10	612	339
Everything Science	Feb	Basic science disappearing from medical journals, study finds	12	476	229
Everything Science	Feb	Do you have blue eyes? According to SCIENCE this is your common ancestor	6	242	0
Everything Science	Feb	Is There Really A War on Science? People who oppose vaccines, GMOs and climate change evidence may be more anxious than antagonistic	6	167	3
Everything Science	Feb	The People Who Believe Electricity Rules the Universe - "Electric universe" theory is at odds with everything modern science has determined about the universe. Yet something about it sparks fervor in the hearts of believers.	1	160	2
Everything Science	Feb	Science Teachers' Grasp of Climate Change Is Found Lacking	1	142	18
Everything Science	Feb	Iran is top of the world in science growth between 1996 and 2008	10	130	194
Everything Science	Feb	On "island hopping" and emphasizing the unknown in science communication	1	126	8
Everything Science	Feb	We can't trust common sense but we can trust science - Peter Ellerton	1	126	0
Everything Science	March	The "Food Babe" Blogger Is Full of S***	121	5853	766
Everything Science	March	Defending Darwin: I teach human evolution at the University of Kentucky. There are some students I'll never reach.	79	5298	504

Everything Science	March	Neil DeGrasse Tyson's genius plan to make science a hit on late-night TV	22	612	329
Everything Science	March	Michael Mann - Real Scepticism	1	226	11
Everything Science	March	The hidden map of science: Pre-publication history of articles tells us that rejection leads to higher citations	1	147	2
Everything Science	March	Female scientists have contributed to some of science's biggest breakthroughs, from unraveling the structure of DNA, to discovering fission, to mapping the ocean floor. So why don't we know their names?	6	112	11
Everything Science	March	What are the top science questions the candidates for president should answer?	1	111	4
Everything Science	March	Like tiny scientists, babies learn best by focusing on things that surprise them.	5	110	219
Everything Science	March	'I Fucking Don't Understand Science' is the perfect 'I Fucking Love Science' parody blog.	9	104	304
Skeptics	Feb	Monty Hall redux	340	102961	
Skeptics	Feb	The axioms of science	95	13960	
Skeptics	Feb	The Energy Industry, Corporate Hegemony and Actual Science	8	1343	
Skeptics	August	Show me scientism	30	3512	
Skeptics	March	libertarian' 'science'	13	1765	
XKCD	Feb	Should we consider string theory to be science? (Philosophy)	28	8729	
XKCD	Feb	Science Websites	67	3983	
XKCD	Feb	"Miracles" of science idea for a XKCD panel	7	1059	
XKCD	Feb	I trust science. So I let it make decisions for me.	21	815	
XKCD	Feb	Bad Science	4	389	
XKCD	March	The Science of Autumn	6	1137	
IFLScience	March	I fucking love science added a new photo. [What TV channels really show]	7084	49033	270752

IFLScience	March	43 papers have been withdrawn so far. Dozens Of Scientific Papers Withdrawn After Peer-Review Fraud Uncovered iflscience.com	3227	46226	37800
IFLScience	August	How to actually make an impact on anti-vaxxers. How To Argue With Anti-Vaxxers, According To Science iflscience.com	2382	148650	33139
IFLScience	August	Some of these are absolutely amazing. #FieldworkFail Reveals The Hilarious Perils Of Science iflscience.com	1353	7610	56083
IFLScience	March	By Jason "Danger" Block via The Skeptics' Guide to the Universe. [If you're only skeptical of things that contradict your already established beliefs...]	1031	12331	62206
IFLScience	Feb	When evidence can be a bad thing. When Too Much Evidence Can Be Bad iflscience.com	103	3050	3550

4.3: Chapter 7, Latent Science

I separated threads in each separate subforum into three strata based on number of words; the longest third of threads from each subforum, the shortest third, and the remaining mid-length threads. Random sampling was then carried out using Excel to assign each thread a random number, and then using the threads in each strata with the highest five assigned numbers for further analysis. This produced 15 threads for deeper consideration from each subforum, for a total of 60.

Site	Dataset	Title	Reply Count	Words Replied	Score / Likes
Everything Science	Feb	LIGO likely to announce first detection of gravitational waves 100 years after predicted by Einstein	26	1954	114
Everything Science	Feb	Australian government to sharply cut back on funding for climate sciences.	5	313	31
Everything Science	Feb	Do you have blue eyes? According to SCIENCE this is your common ancestor	6	242	0

Everything Science	Feb	Brian Greene breaks down how the gravitational waves were detected	3	169	20
Everything Science	Feb	World's top scientists pledge to share all findings to fight Zika	3	156	84
Everything Science	Feb	5 Reasons You Should Care About the Discovery of Gravitational Waves	1	124	7
Everything Science	Feb	Nasa is considering Photonic Propulsion tech to get to Mars in 3 days	6	123	15
Everything Science	Feb	Does LSD permanently change the Brain	5	115	13
Everything Science	Feb	Why is this candle flickering in a strange way?	3	111	14
Everything Science	March	Smithsonian Stands By Wildly Misleading Climate Change Exhibit Paid For By Kochs	18	727	259
Everything Science	March	There's no such thing as a sex drive	4	376	0
Everything Science	March	One of the Baltimore Ravens Just Published an Insanely Complex Study in a Math Journal: John Urschel worries that his hitting position could interfere with his future as a math scholar	10	319	155
Everything Science	March	Why is the scientific world abuzz about an unpublished paper? Because it could permanently change human DNA	3	124	37
Skeptics	Feb	Not Newsworthy, But . . .	32	3741	
Skeptics	Feb	Google Decay	31	2245	
Skeptics	Feb	Perpetual Motion Debunking	3	166	
Skeptics	August	Primitive humans caused widespread animal extinctions	52	4965	
Skeptics	August	Crop circle formations show complex math and computer generated images	106	3897	
Skeptics	August	CERN, the end of the world as we know it.	25	2145	
Skeptics	August	Worldwide mass extinctions caused by modern women	4	169	
Skeptics	March	Question for physicists	26	1190	
Skeptics	March	Tropic of Cancer	10	900	
Skeptics	March	Population III stars	10	629	

Skeptics	March	WTF	27	600	
Skeptics	March	Fun with Casey Lukin	11	593	
Skeptics	March	Partial (Not Total) Lunar Eclipse - April 4	8	582	
Skeptics	March	T-1000 will soon be among us..	2	439	
Skeptics	March	The bell that has been ringing for the last 175 years	4	77	
XKCD	Feb	Landing rockets upright is unnecessary?	62	11349	
XKCD	Feb	Landing a Rocket on the Mun	24	3677	
XKCD	Feb	Acceleration near a black hole	19	2933	
XKCD	Feb	Unbihexium density?	12	954	
XKCD	Feb	Energy of a collision	4	664	
XKCD	August	How does "The Dress" illusion work on a computer screen?	13	2763	
XKCD	August	Name for speed at which tropospheric bubbles occur?	16	2066	
XKCD	August	Boiling the oceans off	6	595	
XKCD	August	Based on your star-sign which super-imposed microbe are you?	5	412	
XKCD	March	Living in a earth-like moon orbiting a planet	39	8410	
XKCD	March	What is the smallest object that has gravity?	39	4177	
XKCD	March	Human Gut Microbiome: Essential or Not?	31	3406	
XKCD	March	Spectrum of antimatter excursion	11	1194	
XKCD	March	[ASTRONOMY?] [MATHEMATICS?] [SF?] Trying to make log scale	3	981	
XKCD	March	A solution to the black hole information paradox?	2	243	
IFLScience	August	How does one can of coke affect your body? Is This Really What Happens To Your Body 60 Minutes After Drinking A Can Of Coke? iflscience.com	13071	81464	71606
IFLScience	March	This driverless Mercedes has been spotted driving around San Francisco.	8832	34792	123308
IFLScience	March	I fucking love science added a new photo. [Cox quoting Sagan]	1905	13140	80144

IFLScience	March	I fucking love science shared a link. Scientists Convert Cancer Cells Into Harmless Immune Cells iflscience.com	2369	20320	157499
IFLScience	Aug	There's no escape. This Species Of Spider Can "Fly" Through The Amazon Rainforest iflscience.com	4936	25784	24941
IFLScience	Feb	Whoa. Meet The Futuristic, Electric, Self-Driving "Batmobile" iflscience.com	903	5910	21523
IFLScience	Feb	How you are most likely to die, based on your race, sex and age. This Interactive Graph Predicts How And When You Are Most Likely To Die iflscience.com	700	7468	12388
IFLScience	Feb	This energy-producing toilet could save millions of lives. This Nanotech Toilet Uses No Water And Produces Energy From Human Waste iflscience.com	1138	13232	36250
IFLScience	Feb	I fucking love science shared a link. Microsoft Co-Founder's Yacht Destroys Coral Reef In The Carribean iflscience.com	1480	29602	12855
IFLScience	Aug	I fucking love science shared a link. Dutch Architects Create A Habitable Windmill That Could Power A City iflscience.com	1118	10371	76748
IFLScience	Dec	The most dangerous pathogens in the world, according to the WHO. These Are The World's 8 Most Dangerous Pathogens iflscience.com	280	2837	9834
IFLScience	Aug	I fucking love science shared a link. Scientists Grow Miniature Brains From Skin Cells Of Autistic Patients iflscience.com	385	7536	19949
IFLScience	Dec	The science of sobbing. You Produce Three Different Types Of Tears iflscience.com	325	3275	10302
IFLScience	Dec	I fucking love science shared a link. 3D Printing Lets Blind People "See" Paintings iflscience.com	243	2585	23710
IFLScience	Aug	I fucking love science shared a link. Jupiter Twin Found Orbiting Sun-like Star iflscience.com	83	1154	13976

4.4: Chapter 8, Manifest Emotion

For this chapter I used all other samples combined. I also used NVivo's text search functions to search for manifest emotional expressions outside of these samples. Instances used in the chapter were located in the original threads to develop an understanding of context.

Appendix 5: Codebooks

5.1: Chapter 5, Latent Emotion

Theory-driven coding; codes developed from reflecting on themes from familiarisation through the work of Baym (1993, 1995, 1996, 2000) and Bennett (2009, 2011, 2013). Note that although I use Baym and Bennett's terminology in reportage – for example 'norms' and 'TANs' – the labels I used during coding were chosen to reflect what I felt participants were *doing* with discourse. This followed the discourse analytic approach outlined in chapter 3.

Code	Brief Definition	Full Definition	Clarifications on When to Use	Clarifications on When Not to Use	Examples
Modifying Expressions	Modifying expressions using tone and/or displays of emotion	Modifying other expressions using emotive language or other textual resources (e.g. hedges, exclamations, emoticons)	I did not make judgements about whether an emotion is 'intense enough' - e.g. didn't include 'love' but exclude 'like'. Also include references to other people's emotions, not just self-references - e.g. 'you are getting too excited'.	When participants offer opinions or preferences justified using rationality or logic rather than emotion (e.g. 'I like this because it's cheaper').	'I don't want to offend, but...'; 'STOP WITH THE BS!'
Labelling People or Groups	Ascribing characteristics to people, whether self or others	Expressions where participants relate particular characteristics to particular individuals or groups, including self. As a manifest level this involves description, such as 'person X or group Y' always does...'; at a latent level, this involves using labels which implicitly encode such characteristics, e.g. 'scientist' or 'woo-natic'.		When participants refer to self or others purely to maintain conversational tone, rather than refer to particular characteristics, e.g. 'you say that but...' would not be coded as it only refers to a previous statement, 'you would say that' would be coded as it ascribes a characteristic to the interlocutor.	'I'm the sort of person who...'; 'People don't trust scientists'; 'experts would say that...'
Regulating Conversation and Phatic Communication	Expressions which show how to conduct a conversation on the forum, rather than showing engagement with specific content.	Expressions which indicate to other users how to turn the conversation into something more than the exchange of content and information. At a latent level this involves phatic communication, i.e. language which is used to show/build social relations to other users (inc. small-talks, welcomes, jokes, and insults), as this indicates expectations of behaviour towards other users.	R.e. phatic communication - contra literature on phatic communication which excludes anything deemed 'informational' (Miller 2008), I am coding informational statements if the speaker also express a social relation to the other speaker..		'What are you trying to accomplish?'; 'we need to define what we mean by...'; 'thanks'; 'Hi [user]'

5.2: Chapter 6, *Manifest Science*

Coding for this chapter took a theory-driven approach. Drawing on the concept of boundary-work (Gieryn 1983, 1995, 1999) I coded instances of participants distinguishing 'science' from other practices, describing certain characteristics as 'scientific' or 'unscientific', or presenting certain activities as limited to 'scientists' (Gieryn 1983, 1995, 1999). As previous, labels I used during coding were chosen to reflect what I felt participants were doing with discourse rather than strictly reflecting the labels used by Gieryn.

Code	Sub-Code	Definition	Clarifications on When to Use	Clarifications on When Not to Use	Examples
Science! And jokes		Using 'science' as an exclamation, in a non-standard format for humorous intent, or to make a joke		Don't code jokes which are simply related to science topics, only code jokes which use terms like 'science' to create the humour (usually through incongruity or nonstandard usage)	'Woo Science' : 'They are doing a good science'
	Science is or Science Does	Explicitly saying 'science is' or 'science does'			'Science follows the scientific method' : 'science is a religion'
Describing or defining science	[Others]	Statements which ascribe (inc. by implication) characteristics to the label 'science' (or 'scientific').			'That isn't very scientific'
		Using science to try and control what others do in the conversation	Avoided being 'too latent', as all conversation is to a certain extent shaping future conversation - stuck to instances where people are clearly trying to make future comments follow a certain path		'If you don't understand the physics you shouldn't be talking about this'
To control conversation					
Giving Science a status		Ascribing characteristics to science which either elevate, degrade, or complicate its status	Sticking to instances where the user seems to have had a clear intent to elevate, degrade, or complicate the status of science, rather than simply ascribing qualities which some people might think were good/bad. By 'complicate the status' I mean statements that go against claims that science is straightforwardly a good/bad thing		'We have so much to thank science for' : 'science is just another ideology, nothing more' : 'scientists are great, but they do have biases'
Referencing People, Groups	I	Using science to say something about oneself	User is manifestly trying to present an image of themselves, manifestly referencing 'science' or equivalents, try to avoid looking for too much latent material	Do not code people are simply using 'I' or 'me' to express a thought or opinion without clearly also trying to characterise themselves.	'I am the sort of person who likes thinking scientifically' : 'I am not a physicist' : 'actual scientist here' : 'I have a masters degree in this subject'
	You	Using science to say something about specific other person(s) in the conversation. All details as above but with 'other user' instead of 'self'			'You clearly aren't very science-minded' : 'the science says you are an idiot'
	One other	Using science to say something about specific other person(s) who is not in the conversation.			'Bill Nye is not a real scientist' : 'Ted Cruz has very dodgy views of science'
	We	Using science to say something about a group of people amongst which the user explicitly includes themselves			'In this forum we use scientific evidence'
	Out-Group	Using science to say something about non-specific person(s) using a group identity label which the speaker has not explicitly identified themselves with	Noy too specific about 'group' labels - 'people', 'the public' etc. are included.		'This misunderstanding of physics is typical of pseudoscientists' : 'people believe anything if it sounds scientific'
	Scientists	Same as either 'we' or 'outgroup', but only with the label 'scientists' (or more specific disciplines, e.g. 'physicists', 'doctors')		Don't code 'experts' or 'academics' unless it's clear it refers to scientists	Scientists don't care what you think'
		Mentioning science as part of saying something about the page or the forum	Inclusive, don't just stick to times when science is explicitly mentioned: also bear in mind criticisms of content are often also criticisms of page (e.g. 'this is clickbait' should be seen as criticism of page for hosting it)		'This page is great, there's so much expertise' : 'This isn't science, why should we be interested'
	Referencing Page, Forum				

5.3: Chapter 7, Latent Science

Coding followed a data-drive approach. Based on Iramuteq analyses, I examined the sample (section 4.3) for uses of:

- (1) 'Object language': terms which refer to specific material objects, such as 'stars', or non-material ideas, such as 'spacetime'
- (2) 'Discursive language': terms connoting commentary on argumentation and/or discussion, often related to scientific methodologies, philosophical notions of evidence, and/or terms suggesting hostility.

These distinctions were made based on the above definitions, in conjunction with words produced by Iramuteq analyses (and synonyms) and Iramuteq's 'corpus en couleur' feature (which applies the colour of the word classes produced by Iramuteq back onto the original text, to show which text segments are associated with which classes).

Following the discourse analytic approach outlined in chapter 3, I considered the use of these two forms of language with respect to the following questions:

- 1) How and why does the separation of object and discursive language shown by Iramuteq analyses come about?
- 2) How does object and discursive language appear alongside grammatical features – in particular personal pronouns, tone, and any textual devices to increase/decrease strength of agreement/disagreement
- 3) How, if at all, are distinctions made between 'scientific' and 'unscientific' objects and discussions? I asked this question in order to compare the findings of this chapter with those emerging from my analysis of manifest meanings of science (chapter 5).

5.4: Chapter 8, Manifest Emotion

Analysis for this chapter followed a data-driven approach. This involved coding instances in which participants explicitly mentioned emotion; interpreted broadly, to include expressions which made emotion apparent through modifiers such as profanity, hyperbolic language, and emoticons. For example, the statement 'please stop talking' would not be coded, while

‘please stop talking it’s making me angry’ or ‘stop {!#%#@} talking’¹⁶⁰ would. I examined all samples listed in sections 5.1-5.3 combined, and derived the five themes of chapter 8 – visual language, dislike, neutrality, interest, and hope. I also used NVivo’s text search functions to search for these expressions outside of these samples. NVivo allows for searches to include synonyms, but I also manually searched for synonyms, expressions which had recurred in the first stage of coding (including expressions of characteristics which were regularly applied to certain types of people, and opposites thereof). A non-exhaustive list is presented below. * searches for any combination of letters:

- Visual Language: Beaut*, Cool, Amaz*, Ugly, Neat, Wow
- Dislike: Angry, Anger*, Frustrat*, Dislike, Annoy*, Sad*, Idiot, Stupid, Unintelligent, Woo*, Hate, Disappoint*, {!#%#@}
- Neutral / Scientific: Calm, Rational, Intelligent, Dedicat*, “Hard work”*, Intellect*
- Interest: Interest*, Hope, Care, Cares, Cool, Amaz*, Like
- Hope: Hope*, Hoping, Wish, Futur*

¹⁶⁰ This sequence automatically replaces any profanity in SkepticsSTM. For other subfora I coded a wide variety of profanities.