Scientific citizenship and television in Ireland: a study of production, content and audience reception

Submitted by

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Abstract

Because of increasing dependence on scientific knowledge, citizens, if they are to participate democratically in society, need to be able to take part in decision-making about scientific issues. The ideal of citizenship has always included the concepts of rights and obligations; the notion of scientific citizenship (Irwin 2001) can be perceived as a normative ideal which implies not only that scientific knowledge is important for citizenship in contemporary society but also that citizens can lay a legitimate claim about accountability in scientific research. Citizens interact with science through the mass media, particularly television, which is such a part of the routine of daily life. This interaction is part of their cultural citizenship, the idea of individuals patching together an identity as citizen from all available sources, including mass media, using everyday media texts and culture to understand, take up, reflect on and reform identities that are embedded in communities of different kinds. This thesis examines scientific citizenship by looking at how publics use ‘science on television’ as part of an ethno-epistemic assemblage to inform their everyday actions. Television fits into this assemblage as television viewing practices are embedded in everyday life; this means that local contexts of text–reader interaction are a salient part of ethno-epistemic assemblages.

Thematic representations of the assemblages of ‘science on television’ emerged from a production–content–reception analysis of science on Irish television, a framework known as the circuit of mass communication. This research privileges the reception analysis, which was carried out with focus groups of television viewers, because in talking together citizens construct and shape their responses to science on television.

The analysis follows how focus group participants, as non-experts, participate in science by talk; speaking is, indeed, their political action, and they use the resources of their particular ethno-epistemic assemblages to construct and contest their paths to knowledge. This is a positive view of the potential of the idea of scientific citizenship. However, this potential is not matched by the television content on offer, which is too often formulaic and uncritical of the institutions of science. I call for an ethos of public journalism which emphasises the relationship between the practice of journalism and the democratic work of citizens in a self-governing republic, and suggest that television journalists and producers are ideally suited to help constitute vital “publics” to deliberate complex issues and engage in collective problem-solving activities. Critical comment on science is a crucial aspect of this public journalism, and television, in conjunction with new media, can become a forum for scientists to hold an interactive dialogue with citizens. Focus group participants are already negotiating their scientific citizenship through talk, and scientists and policy makers need to join these discussions, as science, and its consequences, does not end at the laboratory bench.

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AAAS, American Association for the Advancement of Science

AVSA, Audio Visual Science Audiences in Europe

BBSRC, Biotechnology and Biological Sciences Research Council

BAI, Broadcasting Authority of Ireland

BDI, Biomedical Diagnostics Institute

CCCS, Centre for Contemporary Cultural Studies

CLS, Coalition for the Life Sciences

CoMC, Circuit of Mass Communication

DTA, Discourse Theoretical Analysis

GM, Genetically Modified

GUMG, Glasgow Media Group

IAMCR, International Association for Media and Communications Research

NSB, National Science Board

PAC, Pesticides Advisory Committee

ProAm, Professional–Amateur

RCEP, Royal Commission on Environmental Pollution

RTÉ, Raidió Teilifís Éireann

SCN, Stem Cell Network (Canada)

SCST, House of Lords Select Committee on Science and Technology Committee

SFI, Science Foundation Ireland

SPRU, Science Policy Research Unit at the University of Sussex

STI, Strategy for Science Technology and Innovation

STS, Science and Technology Studies

PRTLI, Programme for Research in Third-Level Institutions

PUS, Public Understanding of Science

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This thesis is dedicated to the memory of my uncle Colm 'The King' McGlinchey, late of Kilaned, Glencolmcille.

'Do your own thing'

1 Introduction

Science is so specialised, so esoteric, how can a non-scientist engage with it? As television is the most ubiquitous and pervasive medium that citizens use to find out about science, this thesis takes science on television as a starting point and looks at how this engagement happens and how this specific form of media engagement contributes to the scientific citizenship of television audiences. It examines in particular how focus group participants construct their scientific citizenship for themselves.

1.1 Introducing the research questions

The central question which this research attempts to answer is:

> How do the meanings that users make of science content on television contribute to their scientific citizenship?

I plan to approach this question in a multidisciplinary manner, using a qualitative and quantitative research design that allows for a variety of theoretical perspectives such as: science communication, media studies, science, technology and society (STS), and cultural studies. This multidisciplinary approach means that explorations of one perspective can illuminate others; however it also offers the greatest challenge as the language and methodological approaches of each discipline differs. Margaret A. Somerville defined the problem at a UBNESCO conference on Transdisciplinarity in 1998:

> We speak the language of our discipline, which raises two problems: first, we may not understand the languages of the other disciplines; second, more dangerously, we may think that we understand these, but do not, because although the same terms are used in different disciplines, they mean something very different in each.
>
> (Somerville, 1998, p. 5)

Another, possibly more serious, challenge in doing interdisciplinary research is that “different disciplines are continually rediscovering one another’s discoveries, because they all have different names for them” (Smolensky, 1999, quoted in Pellmar and Eisenberg, 2000, p. 43).

The major concepts which I use in this research are: scientific citizenship, the ethno-epistemic assemblage, the circuit of communication and discourse theoretical analysis. My reasoning for using these is explained below.

The first major concept that I use is the idea of scientific citizenship. Scientific citizenship has emerged as an idea because in this scientific society, citizens need to be able to participate in decision making about scientific issues to fully participate in society. The concept of the scientific citizen is the idea that citizens can engage with and participate in informed debate over complex ethical, legal, economic or health issues brought about by scientific and technological development. Fiorino (1990) gives the three most compelling arguments for scientific citizenship: substantive, normative and instrumental, these arguments were later developed by the Professor of Science and Technology Policy at SPRU, Andy Stirling (2008).

The substantive argument suggests that lay judgements are at least as valid as those of experts and less technically narrow. As Brown (1987) observes in his essay on popular epidemiology, without popular involvement in the environmental movement, experts would not have had the professional impetus to target the appropriate questions and would have missed such risks as DES[1] and Agent Orange[2].

Indeed, sociologist of science Brian Wynne (1989) showed that toxicologists working for the Pesticides Advisory Committee (PAC) made assumptions about the social and practical contexts in which Agent Orange was being used; and advised that the herbicide was safe. Wynne described the toxicologists as engaging in what he called a "naive sociology", that is, working with an idealised picture of the social world and ignoring the uncertainties and contingencies of the practical use of the pesticide on farms. Later, Wynne (1996) demonstrates, in his classic account of Cumbrian sheep farmers, that although scientists tend to dominate the space of public debate about environmental hazards, they do not have a monopoly on valid knowledge—sheep farmers possessed knowledge of Lake District farming practices which was simply unavailable to the scientists. Fiorino explains this as non-experts having a sensitivity to social and political values that experts' models would not acknowledge, while American political theorist Benjamin Barber (1984) describes non-experts as having a capacity for "institutionalizing regret" (p. 258), that is, accommodating uncertainty and correcting errors over time through deliberation and debate. Wynne also noted that the farmers he studied were quite reflexive about the social basis of their opinions, something which was missing in the understandings of official science and policy making. The strongest support for the substantive argument is probably that of Bryan (cited in Goldman's 1990 chapter about the philosophy of engineering in western culture) who says that

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[1] Diethylstilbestrol (DES, former BAN stilboestrol) is a synthetic non-steroidal oestrogen that was first synthesized in 1938. From about 1940 to 1970, DES was given to pregnant women in the mistaken belief it would reduce the risk of pregnancy complications and losses. In 1971, DES was shown to cause a rare vaginal tumour in girls and women who had been exposed to this drug in utero. The United States Food and Drug Administration subsequently withdrew DES from use in pregnant women.

[2] Agent Orange (whose name is derived from the orange-striped barrels in which it was shipped) is a phenoxy herbicide, first used in the US in the 1940s, and later used by US military to destroy trees and vegetation in Vietnam during the 1960s. Several decades later, concerns about the health effects from these chemicals continue.

since all science decisions are really political questions, and as scientists and policy makers are no more inherently moral than other citizens, their opinions should not be privileged. This was echoed by former Royal Society President Martin Rees, speaking at the Cambridge Centre for Science and Policy in December 2011:

> But there's one thing that scientific advisors in any democratic system mustn't forget. When really big and long-term policies are in contention—whether about nuclear weapons, nuclear power, drug classification, or health risks—political decisions are seldom purely scientific: they involve ethics, economics and social policies as well. And in domains beyond their special expertise, scientists speak just as citizens, with no enhanced authority.
>
> (Rees, 2011)

The European Environment Agency makes similar substantive arguments:

> The point is not that lay people are necessarily more knowledgeable or environmentally committed [than specialists]. Rather the benefit of attending to lay knowledge rests in its complementary character, its sometimes firmer grounding in real world operational conditions …. and the associated independence from the narrow professional perspectives that can be a downside of specialist expertise. Often too, lay knowledge of a technology or risk may be based on different assumptions about what is salient, or what degree of control is reasonable to expect or require, whereas technical specialists may simply respond to granted authority without further reflection.
>
> (European Environment Agency, 2001, p. 177)

Even more strongly, Helga Nowotny, president of the European Research Council, makes the argument: "more involvement on the part of society means not a better social solution, or a better adapted solution, or one that brings social tranquillity to a community, but a better technical solution" (2006, p. 53).

The normative argument suggests that elite domination of policy making is incompatible with democratic ideals; and the instrumental argument suggests that lay participation in decision making legitimises the results in the public's eyes by broadening the range of values incorporated into the decisions, for example it has been argued that lay people have important and distinct knowledge about sustainability issues, such as knowledge of local communities and environments, so that a combination of lay and expert knowledge contributes to 'better' environmental decisions (Brown, 1992, 1993; Wynne, 1996; Irwin, 1995; Dickens, 1996).

Related to this idea of scientific citizenship is the idea of the ethno-epistemic assemblage. The term 'ethno-epistemic assemblage' has been used to refer to the "mixing up" or hybridisation of heterogeneous resources, practices, things, techniques and sets of relations as differently located people engage with science and make knowledge claims (Scott and Du Plessis, 2008, p. 106). The idea of assemblage has been drawn from the work of Deleuze and Guattari, principally from their 1987 book *A Thousand Plateaus*. Deleuze and Guattari describe an assemblage entailing a territory made up of various heterogeneous fragments. The concept of an ‘ethno-epistemic’ assemblage is one where knowledge about science is constructed in a local context, with local cultural conditions. This concept, when applied to the idea of scientific citizenship, allows us to examine the array of practices, materials, and discourses that constitute scientific citizenship. According to the sociologist of science and technology Mike Michael (2006, p. 78) ethno-epistemic assemblages (ideally) allow for the exploration of the means by which publics (and experts) construct, reinforce and blur the boundaries between science and society in various ways and, in the process, articulate (and perform) their citizenship in at once routine but also unexpected ways. The particular ethno-epistemic assemblage that this research examines is the assemblage surrounding audience meaning-making about science on television. Some elements of this assemblage are: the producers of science programmes, the television journalists working on science news stories, television studios, cameras, lights etc., the content of programmes, the audiences who use television, the audience’s experience of science in school, televisions, laptops or other media that audiences use to watch television and so on.

It was beyond the scope of this PhD to examine all possible elements of the assemblage, so I concentrated on the ‘circuit of mass communication’ related to the assemblage. The circuit of mass communication is a model developed by the Glasgow University Media Group (Miller et al. 1998; Miller 1999; Philo 1999). Philo (1999) characterises the circuit of mass communication as a dynamic, organic, continuously moving system, within which sets of actors interact to influence media coverage (Miller, 1999), this model challenges essentialist views of production and interpretation of media content (Miller et al., 1998). Holliman (2004) described a circuit of mass communication which influenced the production, content and reception of media coverage of cloning, this circuit of mass communication comprised: the public, media, scientists and scientific institutions, and decision makers. Holliman showed that they all had a role in influencing the coverage, however, the level of influence varied. Boykoff (2007, 2008) presents an example of how science and policy about climate change shape media reporting and public understanding, and also details how journalism influences climate science and policy decisions. Thompson (1988) argues that there are three elements in the circuit of mass communication—production, content, and reception—which can be delineated and analysed, the analysis of these three elements gives insights into the assemblage surrounding audience meaning-making about science on television. Relationships develop between these elements, for example, television audience members can ‘speak to’ television producers through new media such as twitter, this can in turn contribute to how the television content is produced.

> These three elements: production, content, and reception are interconnected, but for the purposes of analysis it is valid to separate them out as, in general, the context of production (for example, media professionals working in a newsroom) is removed from the context of reception (for example, a family watching the television news). In essence, the relationship between production and reception is “characterised by a distinctive kind of *indeterminacy*”
>
> (Thompson, 1999, p. 17, emphasis in original).

To begin with, the producers of media messages, in the case of this research television programme makers, do not have direct contact with their audiences. Instead they interact with their audiences through letters, phone calls, email and social media. Social media in particular is increasingly popular as a way for audiences to talk back to programme makers. Programme-makers also use ratings as a way of monitoring their audiences. The choices that audience members make about whether to watch a particular programme or not, and about whether to communicate with the media outlet, for example by posting on their facebook page, means there is feedback going from the receiver to the producer, which means that rather than a one-way linear model of communication, the process is circular, i.e. a circuit of mass communication. As Holliman (2004) outlines, this circuit of mass communication “provides a methodological framework for analysing production, content and reception at the same time, facilitating a more detailed and systematic examination of media coverage of science.”

For the purposes of this research, the production, content and reception elements of science on television are not three equal parts: the heart of the research is the reception analysis which was carried out by focus group research. The focus group discussions were carried out first, participants in the discussions mentioned particular programmes and types of programme and these were then followed up by the content analysis and the analysis of representations of science. At the beginning of each focus group session participants were asked about their general television viewing habits. Most participants said that they watched the news regularly (exceptions to this were the two school groups), so I chose to look at news. Focus group participants also consistently gave the example of the BBC’s *Horizon* as good science television, though when they relaxed more into the discussion, they talked about ‘shock docs’ such as *Half Man Half Tree* and indeed these were the most animated portions of the discussions, so I chose to look at both *Horizon* and the *Half Man Half Tree* episode of the *My Shocking Story* strand.

The discourse analysis model I used to analyse the focus groups was 'Discourse Theoretical Analysis' (DTA), a concept developed by Laclau and Mouffe, initially defined in their 1985 book *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics*. The key point of Laclau and Mouffe's theory of discourse is the post-structuralist idea that discourse constructs the meaning of the social world, and that, because language is fundamentally unstable, meaning can never be permanently fixed. No discourse is closed. Discourses constantly change through contact with other discourses. The idea is that social phenomena are never finished or closed, and meaning is never fixed. This gives us constant social struggles about definitions of society and identity. Discourse analysis plots the course of these struggles to fix meaning at all levels of the social world. However, even though meaning is never fixed, we constantly strive to fix the meaning of signs by placing them in particular relations to other signs. Discourse is a temporary closure: it fixes meaning in a particular way, but it does not dictate that meaning is to be fixed exactly in that way forever. A discourse can always be undermined by articulations that place the signs in different relations to one another. Meaning cannot be permanently fixed because every concrete fixation of the signs' meaning is contingent; it is possible but not necessary. The aim of discourse analysis is to map out the processes of these constant attempts that never completely succeed, to explore the way in which the meaning of signs is (contingently) fixed, and the processes by which some fixations of meaning become so conventionalised that we think of them as natural.

Returning to the central question which this research attempts to answer:

> How do the meanings that users make of science content on television contribute to their scientific citizenship?

In order to answer this research question, first of all science content on television was examined, specifically the science content and the representations of science in the three main kinds of science programmes which emerged as significant from the focus group discussions, i.e. *RTE News*, *Horizon* episodes, and the *Half Man Half Tree* episode in the *My Shocking Story* strand. Precisely, this examination of content looked at:

> What science, and in what amounts, is broadcast in television news in Ireland?
>
> Why is science presented by *RTÉ News* in this way?
>
> How is science represented in the two science documentary series *Horizon* and *My Shocking Story*?

> Why is science represented in this way in the in the two science documentary series *Horizon* and *My Shocking Story*?

Although the heart of the project is audience research, carried out with focus groups, this content analysis of television news and analyses of the representations of science on television documentaries allowed a better understanding of the focus group participants' responses to science on television. These were examined together with the main discourse themes in the focus groups. Specifically, the discourse analysis looked at:

> What are television audience responses to science on television?
>
> What are the main discourse themes in the focus group discussions about science on television?

Then these analyses were supported by examining the representations of science and the discourse themes in the interviews with programme makers.

This thesis posits that citizens construct their own scientific citizenship through talk—that talk is in itself a political action. This everyday talk about television programmes was examined in focus group discussions to discern how group participants used television when constructing their own scientific citizenship for themselves.

1.2 Background—position of media in science and society models

Society is becoming more and more technologically demanding. In order to participate in this society, citizens need to engage with science and technology. Dorothy Nelkin (1995) and Laugksch (2000) have posited that understanding of science and technology is critical for a society increasingly affected by scientific developments and policies influenced by scientific expertise. National science bodies and national and EU governments have voiced their concerns about the need for citizens to be able to deal with science in order to maintain a democratic ideal. In the United States, the National Science Foundation (NSF), the National Academy of Sciences, and various academic scholars have pointed out that a scientifically literate population is needed for democratic processes to properly take place (Brossard and Shanahan 2006). In Europe, the European Union's Science and Society Action Plan (2002) discusses the need for citizens to be able to obtain information on ethical issues in science, and to get access to information on legislation, codes of conduct, best practices, and debates taking place in the different European countries. Another impetus for getting citizens to engage with science is economic, and as I show later in this thesis in section *6.2.1 It's the economy stupid* on page 217, the economy discourse, with respect to Ireland in particular, tends to overwhelm all other discourses. The Lisbon declaration sets Europe the goal of becoming: “the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion” (Lisbon, 2000), and Healey (1999) notes that public competence in science is an important prerequisite for maintaining this economic pace (Healey, 1999).

Ireland has committed itself to the pursuit of a ‘knowledge-based economy’ (Trench, 2009). Research and innovation are central to public policy. The Strategy for Science, Technology and Innovation 2006-13 (Government of Ireland, 2006) has among its aims that:

> Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture.

This Irish policy dates back to the 1995 Report of the Science, Technology and Innovation Advisory Council (Tierney Report), which proposed new organisational arrangements to reflect the importance of science, technology and innovation to development policies including a cabinet committee on science and technology, and the establishment of a national office of science and technology. Then in 1999, the Irish Council for Science Technology and Innovation made the argument for a commitment of over €650 million from government funds over six years to research in biotechnology and information technology. They argued that Ireland was evolving, or could evolve, into a knowledge economy and Science Foundation Ireland was established in 2000 as a vehicle for this expenditure on science. Also in 2004, the state industrial and technological policy agency, Forfás, in their publication *Science and Technology in Ireland*, stated that “as part of its strategy to develop as a knowledge and innovation-based economy, Ireland has significantly increased its investment in science and technology over recent years” (p. 2).

Media coverage of science forms part of this policy. The Report and Recommendations of the Task Force on the Physical Sciences (2002) was critical of Irish media, observing that they had a low level of interest and expertise in covering science, instead coverage was led by public relations activities, ‘good news’ stories and: “PR-led items that make limited demands on editorial resources and are easy for the mainstream media to handle.” The report recommended that a significant cultural shift in attitudes be brought about to improve communication between the scientific community, the media and the public. To achieve this, government agencies, such as the Environmental Protection Association (EPA), Teagasc, and Science Foundation Ireland (SFI) have sponsored science series on RTÉ such as *The Investigators* and

The Science Squad. However, these programmes may not be fulfilling their sponsor's aims (please see section *6.2.1 It's the economy stupid* on page 217 for a discussion of focus group participants' criticism of *The Investigators* programme). The Irish Government has maintained its commitment to the knowledge economy ideal post-2008, i.e. after the Celtic Tiger, pledging support for, in particular, "innovation". As Trench (2007) has observed, official commitment to the knowledge economy was restated even as the economic crisis developed from mid-2008. Presenting the emergency Budget of October 2008, then Minister for Finance Brian Lenihan underlined that "the very significant investment in promoting the knowledge economy" was being maintained. There were small increases (up to 5 per cent) in some of the relevant allocations at a time when cuts of 10 and more per cent applied elsewhere. In January 2009, the fifth cycle of the PRTLI programme, worth €300 million over four years, was announced, signalling yet again, in the words of the Minister for Education and Science Batt O'Keeffe: "the government's determination to prioritise investment in Ireland's development as a knowledge-intensive economy" (Department of Education and Science, 2009).

Because of the Irish Government's commitment to the knowledge economy and because modern science—particularly the research carried out in universities—is publicly funded, publics have a genuine interest in who pays for research, what research is carried out and what the results of this research are. Publics are also stakeholders in the decisions made on ethical issues involving science, for example, climate change, stem cell research or the creation of DNA databases. Media audiences, who are also citizens, need to understand the complexities of these issues to make informed assessments and choices.

Publics can be constructed in this way—as citizens—or as stakeholders of scientific issues, consumers of scientific products or as a mass to be educated. And it matters. The ways in which publics are constructed by scientists has real implications for the relationship between science and society. As Nicola Marks (2012, p. 11) argues, in her examination of how scientists talk about therapeutic cloning, the image that scientists hold of the public affects the reality of science and society relations.

> … In the same way, putting forward an image of publics as uninformed and scientists as neutral information-providers can create a reality where engagement becomes education and scientific citizens are only those who have been educated and accept a scientistic framing of the issues. By contrast, describing both publics and scientists as having relevant concerns can create a reality where engagement becomes respectful conversations between a diversity of scientific citizens who can challenge the usual scientistic framing of engagement.
>
> Marks (2012, p. 11)

The way that media construct publics also has implications for the relationships between science and society. Coming from a cultural studies perspective, Ang (1991) argues that television media constructs the public as a mass audience. This understanding continues in spite of changes to models of television viewing, such as on-demand services and personalised menus leading to an increased fragmentation of the audience.

Maja Horst (2007) argues that enunciations of specific expectations of technoscience identify specific assemblages of hybrid identities. Horst presents three (conflicting) assemblages of the public in relation to a controversy over genetic therapies in Denmark: an assemblage of consumption in which medical scientists are producing goods in the form of knowledge and cures; an assemblage of comportment in which the relationship between scientists and other actors is a one-way dissemination of knowledge; and an assemblage of heroic action in which the individual patients can only hope to encounter an action hero, who might provide them with a last chance, because medical science is not expected to produce anything of value to specific people in need of a cure for cancer.

Irwin (2008) argues that the relationship between science and society needs to be examined in the context of the operation of national policy processes in an increasingly globalised setting, and of the increasing power of transnational companies. These increasingly complex global and business contexts call for a review of ways of thinking about science and society, Irwin terms these different ways of thinking as first order, second order and third order.

First order thinking is the thinking behind the deficit model of science and society relations. The deficit model has two aspects. The first is the idea that public scepticism towards modern science and technology is caused primarily by a lack of adequate knowledge about science. Related to this is the idea that, by providing sufficient information about modern science and technology to overcome this lack of knowledge—or ‘knowledge deficit’—the public will change its mind and decide that both science and the technology that emerges from it are ‘good things’ (Dickson, 2005). Irwin (1995, p. 53), in his review of the BSE crisis in the UK, identified some characteristics of first order thinking: authority claims based on the certainty of science, the presentation of science as being absolutely central to the issues, an apparent faith that science can be trusted in a manner that would not necessarily apply to the industry or government, the top-down one-way ‘protection’ of consumers rather than their consultation, and very little account taken of the diversity or possible knowledgeability, of publics. This ‘first order’ perspective accommodates well with the pragmatically-expressed (but technocratically-derived) view of government as being primarily concerned with bringing rational principles to bear on political and social challenges (Irwin 2008).

Second order thinking about science and society places a greater emphasis on public engagement and dialogue. Calls for greater dialogue began in the UK in the 1990s. In the 1990s, the Biotechnology and Biological Sciences Research Council (BBSRC), one of Britain’s seven research councils, stated that it had devised “a programme of activities designed to enhance public access to science and scientists with a view to improving public confidence and stimulating open debate about science and technology” (quoted in Trench, 2008, p. 121). The council said its activities were increasingly about “mutuality” and “transparency in the way BBSRC interacts with the public”. The BBSRC held the first UK National Consensus Conference on Plant Biotechnology in 1994.

In Ireland, the strong reaction from citizen groups to trials of genetically modified (GM) crops—the planting of genetically modified sugar beet was disrupted when a protest group, the Gaelic Earth Liberation Front, destroyed the field trials on September 28th 1997 (Community of Inquiry report, 2012)—prompted scientists and companies in biotechnology and genetics to facilitate and engage in public debate, including debating with committed opponents of GM foods. A technology foresight report that contributed significantly to a radical increase in government spending on scientific research included among its recommendations a proposal for a “national conversation on biotechnology” and advocated a communications strategy in biotechnology that would use a partnership approach with on-going, transparent and open dialogue’ (Technology Foresight Ireland 1999). However, as the heat went out of the GM foods debate, this recommendation disappeared from view. In 2004, a website established by government specifically to facilitate public education and debate on biotechnology was closed down (Trench, 2008).

In 1999, Professor Michael Gibbons, former Director of the Science Policy Research Unit (SPRU) at the University of Sussex, writing in *Nature*, called for science not to merely communicate and provide interpretations of its work but to engage publics in dialogue. He claimed that because of the changing nature of science, that knowledge has to be “socially robust”, that is, valid both outside and inside the laboratory. This validity is to be achieved through involving an extended group of experts, including lay ‘experts’. Gibbons argued that because society has participated in its genesis, such knowledge is less likely to be contested than that which is merely ‘reliable’. In the UK, a report from the House of Lords Select Committee on Science and Technology Committee (SCST 2000) is usually credited with marking a change in direction from deficit to dialogue, the report suggested a key role for communication as a way of reducing tensions between science and society by moving away from a deficit approach towards a model that promotes greater dialogue and consultation. In the US, the American Association for the Advancement of Science (AAAS) also promotes the idea of dialogue, In 2003, AAAS CEO Alan I. Leshner wrote in an editorial in the journal *Science*: "We need to engage the public in a more open and honest, bi-directional dialogue about science and technology and the products they give rise to addressing not only the inherent benefits, but also the limits, perils and pitfalls" (Leshner, 2003 p. 977).

Michael and Brown (2005, p. 41) construct first and second order approaches as operating on a continuum of science–society relations:

> One pole is occupied by the Positivist (or Traditional) approach with its emphasis on survey analyses[3] of the contents of the public understanding of science and of attitudes towards science. At the other end sits the Interpretationist (or Critical or Ethnographic) perspective which deploys qualitative techniques (interviews, ethnography) to embed public knowledge within its local cultural context and in relation to broader institutional agendas … If the former aims to measure the public's scientific literacy, the latter explores the public's identity and trust in scientific institutions. Where the former aspires to educate the public and thus enfranchise it, the latter traces the ways in which the public's local knowledges are marginalised by the scientific institutions. For the former the public is comprised of cognising individuals who must be changed (corrected, educated) by scientific institutions, for the latter, lay people are social beings that are part of local communities whose views are sufficiently important to require change in scientific institutions.

I concur with Trench's (2008) review of the discussion of science communication models, where he questions the claim that there has been any large-scale shift along Michael and Brown's continuum from a deficit model of communication to a dialogue model, agreeing instead with Irwin's (2008) assertion that the deficit model co-exists with talk of dialogue and engagement. Indeed, sociologists argue that the focus on 'science literacy'—emphasising what is wrong with the public's knowledge—persists because it deflects attention away from any problems within science that may contribute to societal conflict (Irwin and Wynne, 1996). Science and society relations do not develop consistently along the continuum from one order of thinking to the next, rather, different 'orders' exist at the same time and are confused together. First order

[3] Although, note that Bauer et al. (2007) argues that PUS research has been hampered by this "essentialist" association between the survey research protocol and the positivist/traditional deficit model. They argue that this link is fallacious and that the automatic equation of particular agendas with particular research protocols, that is, deficit modelling with survey research; and critical and reflexive investigation with qualitative methodologies means that valid critiques of the deficit model, and the agendas sponsoring it, have resulted in stigmatising survey research.

deficit model thinking has not gone away but co-exists with talk of dialogue, engagement, participation and co-production (Trench, 2008).

Irwin advocates a new type of third order thinking about science communication which involves critical reflection, where an open and transparent stance on scientific development is not just an end in itself but is linked to scientific governance. Third order thinking about science and society acknowledges the complexity of the scientific issues it tackles, a complexity including scientific ignorance (Stirling, 2009); diversity of knowledges and experiences (Harding, 1998); and political leanings behind science communication policy strategies (Nelkin, 1995). Tom Wakeford (2010) borrows the concept of 'tame' and 'wicked problems' from organisational studies to describe this complexity. The term 'wicked' in this context is used not in the sense of evil but of an issue highly resistant to resolution. The Australian government policy paper *Tackling Wicked problems: A Public Policy Perspective* elaborates on wicked problems as being difficult to clearly define, they have many interdependencies and are often multi-causal, attempts to address wicked problems often lead to unforeseen consequences, wicked problems are often not stable and do not have clear solutions. Wicked problems are socially complex and are not within the responsibility of any one organisation (Commonwealth of Australia, 2007). Lazarus (2008) gives climate change as an example of a wicked problem because of the enormous interdependencies, uncertainties, circularities, and conflicting stakeholders implicated by any effort to develop a solution. Third-order thinking about science communication is essential for humans to devise means of dealing with wicked problems such as climate change.

It is through an assemblage of scientific institutions, scientists, publics, policy-makers and media that these orders of thinking are worked out. For citizens, who do not have direct access to scientific institutions, this thinking is worked out through the media, media representations of science may be the only representations many citizens receive (ENSCOT, 2003; Rennie and Stocklmayer, 2003).

As Nelkin (1995) stated:

> For most people, the reality of science is what they read in the press. They understand science less through direct experience or past education than through the filter of journalistic language and imagery. The media are their only contact with what is going on in rapidly changing scientific and technical fields, as well as a major source of information about the implications of these changes for their lives. (p. 2)

This was echoed by Matt Nisbet et al. in their 2002 paper:

> When formal education in science ends, media become the most available and sometimes the only source for the public to gain information about scientific discoveries, controversies, events, and the work of scientists. (p. 592)

Nelkin's assertion that people understand science mostly through media is especially significant with regards to one particular type of media—television. Notwithstanding the growth of new media, television has not been replaced, and indeed according to latest Nielsen figures, American citizens over thirty-five are watching more television than ever before, though this is tempered by a drop in the amount of time that Americans aged 12 to 34 are spending watching a television set (though Stelter (2012) notes that young people are still watching the same shows, but that they are streaming them on computers and phones to a greater degree than older viewers, Nielsen counts computer and mobile streams of shows separately to television. Also, according to data for the first nine months of 2011, children spent as much time in front of the television set as they did in 2010, and in some cases spent more, however, the proportion of live viewing is shrinking while time-shifted viewing is expanding). In an Irish context, 85% of people here still watch television on a television set at home, according to figures from the Broadcasting Authority of Ireland (BAI, 2013).

In the latest (2012) National Science Board Science and Engineering Indicators survey, television is still the primary source of information for news about current events (45% of respondents), and respondents were equally as likely to rely on television for news about science and technology as the internet (though the figure citing the internet is steadily rising year on year). Besley et al., 2006 argue, and I agree with them, that it follows that media may play some part in people's evaluations of science and scientists' behaviours.

Also, television channels are big players in the web market, according to comScore's *UK Digital Market Overview's* monthly snapshot of digital audience trends www.bbc.co.uk is the sixth[4] most popular website in the UK (it had 23,477 unique total visitors in May 2013) and www.rte.ie is the most popular website in Ireland (RTÉ Annual Report 2012, p. 47).

I argue that there is a crucial difference between how audiences use television and the internet. Television through its surveillance function tells its audience what is important in the world surrounding them, and what science is important. This agenda-setting function makes television inherently different to the internet, where users can seek out what is important to them, in accordance with their own agendas. Perhaps this is an area of science they have a pre-existing interest in, or they may be following up from the agenda setting function of television to find out more about the science that television says is important. In this research, when focus group participants were asked

[4] In May 2013, as measured by Google, bbc.co.uk had the most unique total visitors (40,249), followed by Microsoft, 32,277, Facebook, 30,374, Yahoo!, 25,430, and Amazon, 24,528.

about their general media use (not just television), I found that they perceived their use of television and the internet as being qualitatively different.

Given this, it is not surprising that in the same (2012) NSB survey, when respondents were asked: “If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information?” 59% of Americans cited the Internet, up slightly from 55% in 2008, and television ranked as a distant second at 15%, down from 21% in 2008.

Studies have shown that audiences have a high level of trust in television. Seventy per cent of Irish people surveyed said they trusted television the most for science, and television is also the preferred method in Ireland for getting information about scientific research (Eurobarometer, 2007). In a 2006 Pew survey, when asked where they get most of their news and information about science, 41% of all Americans say they turn to television for most of their science news and information; that translates to 80 million adults (Pew, 2006).

Nisbet et al. (2002) analysed data from the 1999 NSB Science and Engineering Indicators Survey, based on telephone interviews of a random-digit dialling sample of 1,882 respondents in the United States. They found that negative images of science on television appear to cultivate scientific reservations, whereas television’s portrayal of science as sometimes omnipotent, and offering hope for the future, appears to also promote a competing schema related to the promise of science. There have been criticisms of telephone survey methodology, especially because of the potential for selection bias (e.g. Smith et al., 1995), but Nisbet et al. (2002) state that television’s direct effect on reservations is reinforced through the medium’s negative relationship with science knowledge. Caulfield and Zarzeczny’s (2010) survey of scientist members of Canada’s Stem Cell Network (SCN) showed that their views about what the influence of science television is on the public were broadly in agreement with Nisbet et al. (2002) above: almost half (47.3%) felt that ‘popular culture’ (i.e. portrayals of science in film and television) tends to make people more suspicious of technology, while 41.8% thought that it makes people more accepting of it). Besley et al. (2006) on the other hand found that when it comes to perceptions of scientific authority, increased media use was associated with greater perceived fairness. Having controlled for science knowledge, they claimed that this relationship does not simply reflect a tendency for those who know more about science to support science. The educative function of television has also been much studied. Some scholars have argued that as television is targeted toward the lowest common denominator, it may therefore be more accessible to those with weaker cognitive skills and lower levels of background knowledge (Neuman et al., 1992; Prior, 2005). Also, as the news content of television is so limited, others have argued that those with stronger cognitive skills and lower levels of background knowledge gain little from watching it (Eveland and Scheufele, 2000), which means that it works to reduce knowledge 'gaps' between the two groups.

The political theorist William Gamson (1992) has used focus groups to research how US citizens frame their views of political issues (including nuclear power). First he examined the media frames used, and then observed people discussing these issues. By doing this he could probe the way people form collective opinions about current issues, he analysed how focus group participants invoked media texts in discussions of local and national politics. For example, when asked to think about the issue of how much nuclear power should be relied upon as an energy source, participants appealed to films like *Silkwood* and *The China Syndrome*, as well as television programmes, such as coverage of the Challenger explosion.

Scholars have observed that audiences do not just use factual representations to understand science topics. Bates (2005) convened 25 focus groups to explore the lay public's understanding of genetics and found that participants used compelling stories from fiction to articulate possible futures, going so far as to cite cartoon representations such as *Ninja Turtles* and *X-Men*.

However, hardly any research about public attitudes towards science, or on how publics use science on television has been carried out in Ireland. Given the government commitment to science, and the acknowledged importance of television as a medium, research is needed to study the ways that science on television is produced and then used by publics. The only studies of Irish television coverage of science are Trench's (2007) review of Irish media representations of science, and an EU-funded Framework 7 project, Audio Visual Science Audiences in Europe (AVSA), which found that 38 science programmes had been broadcast on Irish channels over five reference weeks in 2007 and 2008[5], the majority of these programmes (79 per cent) being imported[6] (Lehmkuhl et al., 2010).

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[5] AVSA's definition of 'science programme' included programmes on the natural and social sciences, as well as humanities and applied sciences such as engineering and medicine. Using a stricter definition of science programme would have given a smaller overall number of science programmes. For the full (some five pages) AVSA definition of a science programme, please see:
http://www.polsoz.fu-berlin.de/en/kommwiss/v/avsa/Downloads/Defining_Science_Programmes.pdf

[6] In comparison, of all the 386 television science programmes studied by AVSA which were broadcast in twelve other EU countries during the same reference weeks in 2007 and 2008, only 25 per cent were imported.

1.3 The concept of scientific citizenship

The concept of “active scientific citizenship” is part of a wider contemporary agenda relating to public participation in political decision-making, a focus of critical attention in recent years. According to Petersen and Bunton (2002: p. 204):

> … active citizenship is a pervasive discourse in many contemporary societies, providing the framework for many discussions about genetic technologies and their purported benefits, as well as the rationale for diverse programmes and practices.

Jürgen Habermas (2006b, p. 4) characterises republican democracy as stressing “the political participation of active citizens” and as where “the cooperative search of deliberating citizens for solutions to political problems takes the place of the [liberal model’s] preference aggregation of private citizens or the [republican model's] collective self determination of an ethically interpreted nation (page 413)”. In everyday language, the word “public” is often accompanied by positive, active connotations, which recall the idealised era of Athenian democratic citizenry (Gregory and Miller, 1998 p. 95). Indeed, in her book *The Will to Empower,* Barbara Cruikshank notes that “in reformist and democratic discourses, citizenship and self-government are tirelessly put forward as solutions to poverty, political apathy, powerlessness, crime, and innumerable other problems” (Cruikshank 1999, p.1)

The Oxford University sociologist Andrew Barry (2000) claims that the revitalisation of the ideal of active citizenship has developed in the wake of the decline of traditional welfarist and social democratic notions of politics—these are today often regarded as implying a too passive model of civic engagement. Calls for a more active citizenship are also in response to a widespread consensus (in Ireland and elsewhere) that democracy is under threat; that the whole democratic process is in decline in contemporary societies. In the UK a Democratic Audit (2012) study into the state of democracy over the last decade warns it is in “long-term terminal decline” as the power of corporations keeps growing, politicians become less representative of their constituencies and disillusioned citizens stop voting or even discussing current affairs. In the USA, a (2005) international survey cited in “*Money, Participation, and Votes*” by Jeff Manza et al., showed that “turnout in U.S. national elections ranks an extraordinary 138th among 170 countries that hold elections.” (2005, p. 208). In Ireland, the November 2012 Children’s Referendum attracted barely a third of voters to the polls. Concerns about lack of participation in democratic processes is detailed in the Report of the Democracy Commission, *“Engaging Citizens: The Case for Democratic Renewal in Ireland”* (TASC, 2005) and frequently the solution is couched in terms of enhanced communication for and between citizens.

Also in a specifically Irish context, the Working Paper of the Taskforce on Active Citizenship (2007, p. 4) confirms that the country is also experiencing declining levels of electoral participation, particularly among young people in disadvantaged areas.[7] Other local trends include rapid economic and social change coupled with changes in expectations and values which have provided a context in which people may be less inclined to know or trust others—whether at the local or neighbourhood level or at the level of national politics and governance. Moreover, growing ethnic diversity alongside relatively high levels of socio-economic deprivation in some areas present a challenge to all sectors of society. Neil Collins (2004) writes about specifically Irish democratic shortcomings, he cites corporatism, which can offer consensus and stable policies but which challenges the vitality of parliament; clientelism, which may encourage high levels of constituency service but which undermines the legislative function; and corruption, which has impacted on the political system and the judicial means of dealing with it.

Kees Brants, in the concluding essay of the book *The Media in Question. Popular Cultures and Public Interests*, calls this decline a “sort of mid-life crisis” and lists the causes as globalisation, individualisation, fragmentation and depoliticisation (1998, p. 175). James Bohman (1996) blames pluralism, complexity and sheer scale. Robert Putman’s (2000) *Bowling Alone* is perhaps the most powerful metaphor for the consequences for a society of individuals becoming increasingly disconnected from family, friends, neighbours and democratic structures. Peter Dahlgren (2006) describes Putnam’s metaphor of “Bowling Alone” as capturing a decrease in communicative interaction and in access to social capital. Indeed, as Dahlgren asserts, mass democracy emerged alongside mass media, and are concomitant with each other. As he wrote in his 1995 book *Television and the Public Sphere, Citizenship, Democracy and the Media*:

> The health of democracy in the course of the twentieth century has more or less been linked to the health of systems of communication, though the course of democracy can not be reduced to issues of the media. However, the dynamics of democracy are intimately linked to the practices of communication, and societal communication increasingly takes place within the mass media. In particular, it is television which has gained a prominent position within the political systems of the modern world. Concern for democracy automatically necessitates a concern about television.

Dahlgren, 1995, p. 2

[7] CSO (2003) found that over 55% of those aged under 26 had not voted in any election since they became eligible to do so.

Ginsborg (2008) makes a similar analysis to Putman; citizens have, he says, withdrawn into private spheres; democracy itself has become hollowed out and the practice of politics has become the province of the elite, the privileged and the remote. Professor Paschal Preston, of the School of Communications, Dublin City University, echoed this claim in his closing address to the IAMCR 2013 conference in Dublin, when he said: “we have the forms of democracy but the heart is being emptied out”.

The communications theorist James Carey (1993), described the evolution of a political system of “democracy without citizens”, a system in which “journalism justifies itself in the public’s name but in which the public plays no role, except as an audience: a receptacle to be informed by experts and an excuse for the practice of publicity” (Carey, 1993, p. 15). In such a situation, the public becomes, to use Elizabeth Jacka’s (2003, p.181), phrase: “increasingly alienated and cynical spectators”.

Peter Dahlgren asserts that the current neoliberal hegemony, because of its focus on individual rights and minimal state involvement, attempts to remove any remaining obstacles to market dynamics. The hegemony is without any sociological perspective: “no experience is needed for the role of citizens and little activity is expected on their part” (Dahlgren, 2006b, p. 269). Benjamin Barber (1984, p. 4) associates this liberal hegemonic system with, as he terms it: “thin” democracy—rooted in an individualistic “rights” perspective that lessens the role of citizens in democratic governance. Barber acknowledges that it does work and that it has acted as a bulwark against the threats of military dictatorship and fascism, but he is critical of this “best of a bad lot”; this strategy where freedom equals selfishness and where people live in peace “for many bad reasons” (ibid., p. 20). The state, according to Barber, instils fear and then offers protection from it. Democracy becomes a contradiction—an exercise in bargaining and an appeal to the lowest common denominator (ibid., pp. 20-24), whereas the political theorist Chantal Mouffe (2000, p. 9) goes even further, contending that there is a fundamental tension between the logic of democracy and the logic of liberalism.

All this seems far away from the ideal of citizenship which has developed over the centuries. This ideal has always included the concepts of rights and obligations (Janoski, 1998). These rights and obligations formally define the legal status of a person within a state. This formal status is important because it is from this legal basis that individual citizens claim entitlements to national resources through such institutional arrangements as retirement, unemployment provisions, social security and welfare (Turner, 2001). There is an important reciprocal relationship between the possession of citizenship status and community membership (Bosniak, 2006, p. 40). Because the modern state has been typically a national state, citizenship is derived ultimately from membership by birth within an ethnic community, where the entitlement to citizenship is typically inherited from parents. Gender, nationhood and citizenship are closely related (Yuval-Davis, 1997). The right to citizenship through community membership defines one's identity as a public person. Although citizenship is a formal legal status, it is, as a consequence of nationalism and patriotic sentiment, intimately bound up with the sentiments and emotions of membership. Marshall (1950) traced the origins and evolution of citizenship and conceptualised it in three dimensions, each of which points to a set of rights: the civil, which aims to guarantee the basic legal integrity of society's members; the political, which serves to ensure the rights associated with democratic participation; and the social, which addresses the general life circumstances of individuals.

This ensemble of citizenship relations (legal status, resources, communal membership and identity) describes a field of moral behaviour, social practices and cultural beliefs that are collectively known as civic virtue, because they define what constitutes the virtues of the 'good citizen'. The earliest notions of contract involve ideas about proper conduct. Thus, Samuel Pufendorf in his *On the Duty of Man and Citizen according to Natural Law* (Tully, 1991) warned the citizen not to contemplate revolution, but to live with dignity and scrupulousness. The notion of 'civic virtue' is closely associated with civic republicanism, but there is no form of citizenship which does not also imply moral conduct. Citizenship is a status position which interpellates specific characters and identities. Selbourne (1994) argues that, generally speaking, obligation, not right, is the corner-stone of civic culture.

Joke Hermes argues (2006, pp. 158-160) that we can understand citizenship in two ways: agency and identity. Agency means offering a role for individuals based on the sets of practices which make them compliant members of the communities to which they belong. Identity means the constant revision of personal identification in response to all of the surrounding social forces; Dahlgren (2009, p. 119), maintains that individuals have multiple identities of which citizenship is one; multiple identities means avoiding the unrealistic "predetermined one-size-fits-all model", which leaves individuals with little room to manoeuvre psychologically, socially or politically. Social agents can identify themselves or indeed be identified within a certain discourse. Sayyid and Zac (1998, p. 263) give the examples of agents identifying themselves as "workers, women, atheists, British". Laclau and Mouffe (1985) call this component of identity a subject position, and define it as the positioning of subjects within a discursive structure. Just as democracy can be viewed as a construct, so also the way that citizens experience themselves as members of a grouping depends on a largely imagined bond.

This PhD uses ideas about citizenship outlined in Toby Miller's 2007 book *Cultural Citizenship: cosmopolitanism, consumerism, and television in a neoliberal age*, pulling away from Marshall's three dimensions of citizenship (civil, political and social), to describe three (partially overlapping) "zones of citizenship": the political (the right to reside and vote); the economic (the right to work and prosper); and the cultural (the right to know and speak). The third zone: cultural citizenship, is posited by John Hartley as the idea of individuals patching together an identity as citizen from the many sources and choices available to them, not least the "delightful demotic messiness" of the mass media (cited in Jacka, 2003, p. 186). This cultural approach, according to Jeffrey Jones:

> Unlike instrumental or transmission views, a cultural approach foregrounds the intimate role that media play in our lives—the myriad ways in which media are used and integrated into our daily routines; or what Todd Gitlin calls the ''wraparound presence'' of media (2002, p. 10); how this type of usage affects our understanding of and commitments to democracy; how the variety of narratives that comprise different media address needs we have as citizens and consumers; how we understand and make sense of the world through this media plenitude; and how these opportunities for engagement shape out identities as citizens.
>
> (Jones, 2006, p. 370)

Bryan Turner (2002, p. 12) defines cultural citizenship as:

> the capacity to participate effectively, creatively and successfully within a national culture. Superficially such a form of citizenship would involve access to educational institutions, the appropriation of an appropriate 'living' language, the effective ownership of cultural identity through national citizenship and the capacity to hand on and transfer to future generations the richness of a national cultural heritage.

Hermes (2006) characterises cultural citizenship as the way in which media audiences use media texts and everyday culture "to understand, take up, reflect on and reform identities that are embedded in communities of different kinds", for example in this research, in the focus groups which included parents, they discussed how the television images they watched of children enjoying science were different to their own experiences of science at school, another example is a focus group participant who said that he would ring a friend who had a specific illness if he saw a news story about scientific research into that illness. Hermes goes on to argue that part of this on-going activity of purposeful everyday meaning-making in relation to mediated culture is the production of distinctions, norms and rules. Cultural citizenship offers both the ground rules of interpretation an evaluation and the space to be excited, frightened, enthralled, committed or any of the huge range of states of mind and feelings that we connect with the use of popular media, rather than just be concerned or pleased as becomes the informed citizen (Hermes, 2006, p. 303).

There are criticisms of the concept of cultural citizenship, Nick Couldry contends that the mechanisms involved lack clarity and definition. On the whole he dismisses its usefulness contending that it is: “a little unclear in such cases what the word ‘cultural’ adds to our understanding of ‘citizenship’” (Couldry, 2006, p. 322). I disagree with Couldry on this, and argue that cultural citizenship is an important concept in that it provides us with a way of looking at what it actually means to belong to a society—to be a citizen. I agree with Toby Miller, who maintains that cultural practice matters as much to citizenship as do political rights and economic status; that understanding culture necessitates engagement with popular mass media, especially television; and that coming to terms with the mass media requires attention to the political economy in which it is situated (Miller, 2006, p. 179).

Public attention to media is a prerequisite for the exercise of economic or social influence, and in an increasingly media-saturated world, where the amount of media is growing quicker than our ability to consume them, a ‘poverty of attention’ as described by economics Nobel laureate Herbert Simon in 1971, becomes an issue with serious consequences. Lanham advised we should: ‘‘assume that, in an information economy, the real scarce commodity will always be human attention and that attracting that attention will be the necessary precondition of social change.’’ (p. 46).

Hartley (1999 p. 181) sees television as telling secular parables which work consciously or unconsciously to ‘ameliorate manners’[8] to considerable effect, the cultural citizenship which arises from this process gives a social cohesion based not on sameness but on difference, of identity not shared with the whole population but nevertheless shown to them; television teaching populations who their ‘others’ are and how usefully to de-politicise that knowledge.

But not all scholars agree that television viewers are so active. John Ellis (2009, p. 83) describes the condition of ‘mundane witnessing’ as a kind of ‘default’ experience of a paradigmatic (and de-historicised) television viewer. While mundane witnessing

[8] Hoggart discusses in more depth how television may be used by its audiences in unintended, even aberrant, but profoundly public ways:

> In any society a medium so intimate and pervasive will do this [be an ‘educator of manners’]; it is bound constantly to be putting before people other ways of shaking hands, of sitting down, of wearing clothes, of reacting to strangers, of eating, of carrying on conversations; it is bound constantly to be setting in motion numerous slight but widespread reactions ... And all the time, consciously or unconsciously, it is trying to ameliorate manners ... No doubt the effect of such half-art is slow, but it may eventually (in combination with the other forces of which it is both a part and a reflection) be considerable
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> (Hoggart, 1960: pp. 41-43).

involves a general: “awareness of events around us and of the people who make up our society and wider world”, it “does not require the detailed recall of news stories” nor any other kind of political or moral action. Only a traumatic event that may “bring up painful personal associations and deep fears” is enough to make the television viewer more engaged and attentive. Indeed, there are arguments in the literature about whether audience decisions to ‘seek information’ or ‘look away’ are primarily issue-driven (Kinnick et al., 1996), or prompted by judgments about how media represent these issues (Cohen, 2001), or by a general distrust toward media and other social institutions (Moeller, 1999).

I argue that audiences maintain (an often ambivalent) level of critical interpretation, rather than actively asserting their identity at every opportunity or alternatively passively allowing the world to pass by. To quote Sonia Livingstone. they work by: “drawing upon—and thereby reproducing—a somewhat ill-specified, at times inchoate or even contradictory sense of identity or belonging which motivates them towards but does not wholly enable the kinds of collective and direct action expected of a public.” (Livingstone 2005, p. 31)

Is it impossible to be engaged and attentive all the time? Moral philosopher Mary Midgeley thinks so. In her 1998 essay, *The problem of humbug*, she argues that there is: “no decent way to sort through the multiple claims on our time or philanthropy” in the face of the world’s atrocities (p. 45-46). However other scholars value audience activities of information-seeking (Kinnick et al., 1996), empathising and analysing (Donnar, 2009), donating money (Tester, 2001), or even the act of viewing rather than turning away (Cohen, 2001; Seu, 2003).

Luc Boltanski values the idea of speech and protest as responses to media narratives of suffering, contrary to concepts that ‘talk is cheap’. He suggests a modest, ‘minimalist’ ethics where ‘effective speech’ is viewed as a valuable moral action for spectators of distant suffering (Boltanski, 1999, p. 18-19). Paddy Scannell (1989, p. 154) argues that media should be celebrated and that the public life of broadcasting has created new contexts, realities and meanings rather than standing secondary to face-to-face communication. Both Boltanski’s and Scannell’s views are key to my approach, that is, the idea that members of television audience are performing citizenship through their talk, and that the importance of television is that can stimulate this talk.

Dahlgren (2003, p. 153) sums up the idea of cultural citizenship:

> It is not an ambitious theory; it does not anticipate being able to offer full explanations about citizens’ democratic participation or lack of it. Hopefully it will enhance our understanding of human action and meaning-making in concrete settings.

> Cultures consist of patterns of communication, practices and meaning; they provide taken for granted orientations—factual and normative—as well as other resources for collective life.

The rise of cultural citizenship is the seeming paradox of the era of mass communication and commodity culture. It is in this era that difference is established as a human right. A vast and unknowable audience is bombarded with commercial messages of childlike simplicity, and instead of turning into an undifferentiated mass of infantilised consumers, they instead produce "an endless succession of ever more weird and wonderful, actual and virtual cultural identities, each one carefully differentiated from the one next door" (Hartley, 1999, p. 178). While cultural identity has classically been conceived as proceeding from natural or territorial authenticity, determined by heritage and territorial location, contemporary identities rise from the private, domestic world of individual lifestyle, choice and preference; for example, identity based on sexual orientation and preference, or subcultural identities based on youth, taste or fandom. Identity in modern societies is complicated by cultural simulation; it appears to be fluid, transferable and reversible (Baudrillard, 1987). Mitchell (2003, p. 387) argues that this deterritorialisation of the citizen is a key facet of the twenty first century. So a dimension of citizenship comes to be based on a radically decontextualised network of meanings which locate identity in the media sphere, this dimension was dubbed "DIY citizenship" by John Hartley (1999, p. 179).

The idea of the DIY citizen is crucial in this research. The Do-It-Yourself citizen describes the practice of putting together an identity from the available choices, patterns and opportunities on offer in the semiosphere and the media sphere. Hartley posits that whether it is a fully 'fitted' identity, expensive, integrated and in a recognisable off-the-shelf style, or an identity more creatively put together from bits and pieces bought, found or purloined separately, is a matter of individual difference, the point is that 'citizenship' is no longer just a matter of a social contract between state and citizen, no longer even a matter of acculturation to the heritage of a given community; DIY citizenship is a choice people can make for themselves. Further, they can change a given identity, or move into or out of a repertoire of identities. And although no one is 'sovereign' in the sense that they can command others, there's an increasing emphasis on self-determination as the foundation of citizenship. Hartley further argues that individuals use television audienceship as a training ground to learn the "difficult trick of 'suiting yourself', as it were, while remaining locked in to various actual and virtual, social and semiotic communities" (p. 178). Audiences work together with texts—and by extension with the producers of texts—to make sense of their identities as citizens in what Brants (1998, p. 176) calls 'co-citizenship'. Jones (2006) goes further than that, arguing that the contribution of the media to the construction of the self as a political being is not just about furnishing information; but that there is a central role also for: “symbols, myths, metaphors and other significations. Media provide schema or mental maps to chart the political reality” (Jones, 2006, p. 368). He asks: “From where do we obtain the reservoir of images and voices, heroes and villains, sayings and slogans that we draw upon in making sense of politics and how are they involved in the creation of a political reality?” (ibid., p. 369).

With respect to science, this idea of a DIY citizen is similar to Steve Fuller’s idea of the “pick and mix” approach of “Protscientists[9]“:

> To be sure, ‘Protscientists’ are convinced of science‘s integral role in their own lives. For that very reason, they insist on taking an active role in determining how that integration occurs. Thus, they take soundings from alternative, often internet-based sources and supplement the methodological uncertainties of all scientific research with their own experience and background beliefs. But perhaps most importantly, Protscientists uphold their right to decide scientific matters for themselves because they are the ones who principally bear the consequences of those decisions. This results in a pick-and-mix approach to science that retains the vast majority of accepted scientific fact and theory while giving them a curious spin in light of distinctive explanatory principles and life practices.
>
> (Fuller, 2011, p. 24)

Hartley claims that it is among television audiences that DIY citizens can be found exercising their interpretive self-determination. But the relationships of the media sphere are not like those of territorial polities. For a start, the intentions of the addresser and the reading by the addressee are not causally related; as Umberto Eco (1972) posited, all mass communication is “aberrantly” decoded, that is, not in line with the intentions of the producer. Goode (2005, pp. 95-96) makes a similar argument that television and media in general are a resource for citizenship:

> The configuration and dissemination of symbols and cultural forms through the media facilitate the development of identities that draw upon discourses of nationhood, ethnicity, class, gender, style or taste subcultures, opinion and political affiliation, interest groups, status groups….. The extent to which citizens experience themselves as members of a political community, depends on the depth of a largely imagined bond.

Thompson (1995) argues in a similar vein, that individuals have to deal with an influx of media symbols, focusing them and filtering them in order to make sense. Thompson refers to Giddens’ (1991) theory on the formation of the self in modern society—a project that is both reflexive and open-ended, as we build and rebuild the narrative of

[9] Steve Fuller uses the term Protscience as short for "Protestant science". He compares today's democratisation of knowledge to the sixteenth and seventeenth century democratisation of knowledge of the protestant reformation.

our self-identity and as we become our own unofficial biographers. Riessman (2008, p. 7) writes of a "contemporary preoccupation with identity":

> No longer viewed as given and "natural", individuals must now construct who they are and how they want to be known, just as groups, organisations and governments do. In post-modern times identity can be assembled, disassembled, accepted and contested and indeed performed for audiences.

Taylor (1989 p. 27) sees identity as defined partly by spiritual view or background: "My identity is defined by the commitments and identifications which provide the frame or horizon within which I can try to determine from case to case what is good, or valuable, or what ought to be done, or what I endorse or oppose. In other words, it is the horizon within which I am capable of taking a stand." Taylor posits an essential link between identity and a kind of orientation. To know who you are is to be oriented in moral space, a space in which questions arise about what is good or bad, what is worth doing and what not, what has meaning and importance for you and what is trivial and secondary.

Individuals define themselves in terms of a set of different identities related to the social groups to which they belong (Abrams and Hogg, 1990; Hogg and Terry, 2000), identities are associated—in terms of prescribed characteristics, behaviour and values (Tajfel, 1982; Turner, 1991)—with both social conventions and personal norms, i.e. internalised rules prescribing values, beliefs and behaviours that are consistent with an individual's desired self-image or self-concept. These identities can be in conflict with each other, for example, an individual may identify herself as rational and scientifically minded, but also as someone who thinks there's 'something in it' with regard to horoscopes.

Citizens construct and shape their identities by talk. As Dahlgren (2002, p. 10) put it: "By talking to each other, citizens shape their opinions and this generates a collective will, that then has some sort of impact on policy", and also: "talk is seen as constitutive of publics and is thus morally and functionally vital for democracy" (2006, p. 267). In later chapters the talk of focus groups is examined to explore the constructions of the (scientific) citizenships of participants.

And talk—and more specifically language—is powerful. In Nicola Marks' (2012) examination of how scientists talked about therapeutic cloning during interviews and during the 2006 parliamentary debates on stem cell research, she found that when scientists used technical terminology, this helped the public take on a passive role, and to exclude those who do not have a technical background. In the same way, putting forward an image of publics as uninformed and scientists as neutral information-providers can create a reality where engagement becomes education and scientific citizens are only those who have been educated and accept a scientistic framing of the issues. By contrast, describing both publics and scientists as having relevant concerns can create a reality where engagement becomes respectful conversations between a diversity of scientific citizens who can challenge the usual scientistic framing of engagement. There are also a number of studies that focus more specifically on how language can be fundamental to the construction of scientific citizenship. They argue that particular utterances can bring into being particular social relations: they can “perform” scientific citizenship. For instance, depending on how science, doctors and expectations are described in the media, the patient/scientific citizen is given a role as a passive object for medical research, a consumer of science or an active fighter against his/her disease or the medical system (Horst, 2007). Sociologist of science Kevin Burchell (2007), building on Gilbert and Mulkay’s (1984) book, *Opening Pandora’s Box: A Sociological Analysis of Scientists’ Discourse*, also argues that scientists’ language in public can serve a performative function by delegitimising opponents, whose views are described as non-neutral and biased.

But what is this “scientific citizenship” that is being constructed?

Scientific citizenship has emerged as an idea because in this scientific world, citizens need to be able to participate in decision making about scientific issues to fully participate in society. The concept followed on from debates about top-down communication of science versus dialogue models (Trench, 2008). The concept of the scientific citizen is the idea that citizens can engage with and participate in informed debate over complex ethical, legal, economic or health issues brought about by scientific and technological development. The scientific citizen contributes to science and technology policy-making. Many factors influence the shaping of the scientific citizen, for example, formal education, workplace experience, media use or political views. This conceptualisation of scientific citizenship draws on ideas about citizen knowledge and citizen expertise, noting the diversity in how citizens come to make sense of science in the context of their everyday lives and their pre-existing knowledge and experience (Irwin, 1995). Much of the science communication literature is devoted to exploring how citizens engage (or don’t engage) with science.

Dhingra (2006) posits that scientific citizenship is an important socio-political goal (which has not yet been achieved by any society). He argues that it will exist when there is widespread public participation in decision-making about emerging science related issues and a recognition both of the indivisibility of science, society and citizenship and the complexities of most science related social issues. These issues commonly involve ethics, legalities and, usually, risk and uncertainty. The notion of scientific citizenship (Irwin, 2001) points to an increasing awareness of the intermingling between science and society. As Horst (2007, p. 151) puts it, it implies not only that scientific knowledge is important for citizenship in contemporary society but also that citizens can lay a legitimate claim about accountability on scientific research. As such, the notion can be perceived as a normative ideal concerning the appropriate form of democratic governance in a society that has become increasingly dependent on scientific knowledge.

I agree with Healey and Irwin (1999), who recommend a remodelling of science communication, in order to move towards the social construction of scientific citizenship. This, they suggest, entails new initiatives in science education and science communication—especially initiatives designed to encourage a two-way relationship between public and scientific knowledges. They also invite studies of the media treatment of science and social response—including media constructions of the public and its interests within scientific issues and concerns. Some of these initiatives may well be effectively targeted at science on television, across various programme genres.

The term scientific citizenship is often used—in scientific institutional websites and policy documents—as a synonym for scientific literacy by policymakers and scientific bodies[10], who are concerned with education and outreach activities but who do not have the processes in place to have a dialogue with citizens and give citizens the opportunity to be involved and contribute to research decisions from the beginning of the research process.

As Horst (2007) argues, scientific competence may facilitate human action and cultivate an enlightened citizenry; however, there is also a need for mechanisms to ensure that citizen concerns are in fact fed into decision-making processes. This is a crucial feature of third-order thinking about science communication, the issue is not one of mere communication, but of critical reflection by scientific institutions and policy makers. If modern societies are to be considered legitimate, citizens should thus also actively make use of their competence to lay claim on scientific practices and take part in public debate about scientific and technological developments. The inherently normative notion of (republican) participatory citizenship stresses the importance of full citizenship in terms of not only certain rights and privileges, which serve to protect and empower the individual on the one hand, but also—and equally important—an ideal of civicness as a sense of societal obligation or duty, in which participation is a virtue (Barber, 1984; Sandel, 1996). Participatory citizenship is not simply about enjoying the right to enter the sphere of decision making, but rather about actually entering it. In

[10] For example the Biomedical Diagnostics Institute, a research institute at Dublin City University states on its website www.bdi.com that they "actively promote the concept of Scientific Citizenship, providing citizens with the competencies, knowledge and skills to interact with science and technologies that extensively shape everyday life"; however, they do not go so far as to involve citizens in a dialogue about their actual research, or to give them any say in it.

terms of a “full” scientific citizenship, then, I argue that scientific competence makes it possible, and actual participation makes it happen. But participation is difficult, and cannot happen without publics becoming more confident and empowered. As Aneurin Bevan, trade unionist and Deputy Leader of the UK Labour Party put it, what is needed is a “bump of irreverence” towards science and scientists, a willingness to argue and ask questions:

> The People are excluded from forming judgement on various matters of public interest on the ground that expert knowledge is required, and that of course the people cannot possess. ... The debunking of the expert is an important stage in the history of democratic communities because democracy involves the assertion of the common cause against the special interest ... the first weapon in the worker’s armoury must be a strongly developed bump of irreverence. He must insist on the secular nature of all knowledge.
>
> (Aneurin Bevan, quoted in Smith, 1993)

Fiorino (1990) gives three arguments for scientific citizenship, asserting that a technocratic elite should not be allowed to dominate scientific policy making. Fiorino’s arguments are: a substantive argument, which suggests that lay judgements are at least as valid as those of experts and less technically narrow; a normative argument, which suggests that elite domination of policy making is incompatible with democratic ideals; and an instrumental argument, which suggests that lay participation in decision making legitimises the results in the public’s eyes by broadening the range of values incorporated into the decisions.

1.4 Ethno-epistemic assemblages

But how is this scientific citizenship constructed? This thesis is concerned with the idea of citizens making meaning of the science they watch on television and how that contributes to their scientific citizenship. Television viewing practices are embedded in everyday life; they are part of the everyday practices of ‘doing citizenship’ As Morley and Silverstone observed in 1990: “the use of television cannot be separated from everything else that is going on around it”.

In everyday life, individual responses to science on television do not conform to any single norm. Responses are distinct to individuals. For example, student participants in Dhingra’s (2003) study varied widely in their responses to televised science, indicating that they brought rich and differentiated schema to the interpretation of what they see. This is in agreement with Kozma (1991) who suggests that television viewers construct their own understandings of what they see. They saw a range of different programmes as dealing with science—from *Bill Nye the Science Guy* to *The X Files*. Van Evra

(1998) proposed that viewing activity includes factors such as programme preferences and judgements of realism, and as well as individuals' other experiences and conceptions of science outside of television. Dhingra (2003) gives the example of a sixteen-year-old female student participant who was so accustomed to complex data sources and to using specialised equipment in her science class that the experiments she saw on *Bill Nye the Science Guy* did not seem representative of 'real' science. Dhingra (2006) concluded that viewer understandings of the programmes they watch and the science they depict are grounded in their individual sets of experiences and interests. Dhingra (2006) looked at what happened after respondents interpreted science news stories, what were their responses? What action did they take? She found that there was a range of responses to the news stories, ranging from highly motivated respondents who were very interested in seeking out additional information, and applying the science stories to their own contexts, to individuals who remained ambivalent or apathetic. Dhingra concludes that this highlights the extent to which publics choose whether or not to make meaning of the science presented on television or by other media sources, based upon a wide variety of factors, including social context, education, alternative sources of information, pre-existing attitudes, beliefs and experience.

Some evidence from social psychology suggests that people may actually be "cognitive misers" who may exert little mental power to collect and process information about any given issue (Fiske and Taylor, 1991). Whether a fair description or not, this idea would seem to be particularly relevant for issues involving complex and unfamiliar science and emerging technology. Developments in such areas as nanotechnology, genetically modified (GM) foods, or stem cell research involve novel knowledge claims, ideas which many people may not have confronted previously. Forming a thoughtful opinion about them does require substantial cognitive effort, and it is also reasonable to propose that for these issues—involving substantial scientific uncertainty as well—a variety of heuristic cues may be especially important to opinion formation, even for those actively interested in the issues. Research in the field of risk communication also lends credence to the cognitive miser model. For example, Scheufele and Lewenstein's (2005) research on public perception of nanotechnology finds that the media's heavy emphasis on positive "frames" over negative ones indirectly fosters the public's generally positive reactions to this new technology. Factors such as trust in scientists and business leaders—who often act as new technology's spokespersons—provide people with cognitive shortcuts that they use to form their own attitudes, as do affective reactions (Cobb and Macoubrie, 2004; Lee et al., 2005). The cognitive miser model is named in a way that suggests a defect ("miser"), but in fact the use of shortcut strategies is probably inevitable—and potentially quite rational—in such cases.

Other models of the way that publics deal with the media content they are inundated with every day are summarised by Ten Eyck (2005) as two primary opposing points of view. The first was the ‘mass society school’ which theorised that members of the public are defenceless against the bombardment of media messages. This point of view is continued in more recent media effects theories such as cultivation and agenda-setting which continue to see the relationship between the media and the public as unidirectional. The opposing point of view are arguments that media messages reflect already existing opinion as much as they influence or determine public opinion, since reporters strive to both represent and cater to the interests of the public. Priest (2006) argues that publics may not be the passive receivers of media information that mass society theory had assumed, but instead are actively interpreting the same information differently. These arguments assert that the relationship between media and public opinion is neither simple nor one-way.

However, even within this complexity of relationships between media and publics, media can perform a strong heuristic role in shaping public perceptions on highly technical or scientific issues. Most members of the public will not have much experiential knowledge to draw from about these subjects, creating increased dependency on information from the media (Nelkin, 1995, p. 2; Rokeach and DeFleur, 1976). For example, Gamson and Modigliani (1989) find that media discourse provides an essential context for understanding the formation of public opinion on nuclear power, while many other studies have shown that media work as a key heuristic for non-scientific publics to understand scientific issues (Dunwoody and Peters, 1992; Mazur, 1981; Nisbet, 2005; Nisbet and Goidel, 2007; Scheufele and Lewenstein, 2005; Ten Eyck, 2005; Ten Eyck and Williment, 2003).

Publics come to understand scientific issues by ‘talking them out’ with each other, and it was a key goal of this research to facilitate talk (by focus group participants) that was informed by their complex social, cultural, personal and professional worlds. In this process participants constituted “ethno-epistemic assemblages”—hybrid forms of knowledge, interactive practices, sets of social relations and oral and written knowledge claims about science on television (Scott and Du Plessis, 2008). The concept of an ethno-epistemic assemblage, when applied to the idea of scientific citizenship, allows us to examine the array of practices, materials, and discourses that constitute scientific citizenship. According to Michael (2006, p. 78) ethno-epistemic assemblages (ideally) allow for the exploration of the means by which publics (and experts) construct, reinforce and blur the boundaries between science and society in various ways and, in the process, articulate (and perform) their citizenship in at once routine but also unexpected ways. The meanings that citizens make (by talking it out) of science on television contribute to their scientific citizenship. Scientific citizenship itself can be understood in terms of an ethno-epistemic assemblage. The term “ethno-epistemic assemblage” has been used to refer to the “mixing up” or hybridisation of heterogeneous resources, practices, things, techniques and sets of relations as differently located people engage with science and make knowledge claims (Scott and Du Plessis, 2008). The idea of assemblage has been drawn from the work of Deleuze and Guattari, principally from their 1987 book *A Thousand Plateaus*. Deleuze and Guattari describe an assemblage entailing a territory made up of various heterogeneous fragments.

The term “ethno-epistemic assemblage” requires some explanation. First, the idea of locality, ‘*ethno’,* such that knowledge is always produced and taken up in the context of local cultural conditions, in other words, it is situated. Social activity can only be understood by reference to where and when it occurs. Next the idea of knowledge, the assemblage is ‘*epistemic’*, in that it is related to knowledge or knowing. The assemblages being studied here are oriented toward the production and distribution of claims about what is true, concerning science. And this local situated knowledge-making takes place as part of an ‘*assemblage’*, that is a collection of various fragments—education, media, family, peers—which form a pattern of relations. Assemblages are not fixed, but are fundamentally unstable.

This idea has been used in several empirical analyses of science and society relationships. Maja Horst (2007) has used the concept of ethno-epistemic assemblages to describe differing public attitudes towards a controversy over genetic therapies in Denmark. Varughese (2011) discusses the ethno-epistemic assemblages which formed around differing alignments of position with regard to public controversies over science during disasters like earthquakes, and crucially the media’s key role in these assemblages. Allgaier (2010) used the concept to identify discursive connections and collaboratively acting networks between experts involved in a debate about the teaching of evolution in British schools and their role in the controversy.

Ethno-epistemic assemblages are characterised by their heterogeneity and fluidity. They are composed of scientific as well as other forms of knowledge and resources. The concept of assemblage does not imply a fixed and unchanging entity, but rather transitory communities “that coalesce and then melt” (Irwin and Michaels, 2003, p. 108).

The particular ethno-epistemic assemblage that this research examines is the assemblage surrounding audience meaning-making about science on television. Some elements of this assemblage are the producers of science programmes, the television journalists working on science news stories, television studios, cameras, lights etc., the content of programmes, the audiences who use television, the audience’s experience of science in school, televisions, laptops or other media that audiences use to watch television etc. Specifically, this research examines ethno-epistemic assemblages to do with science on television by investigating three elements of the assemblage: the reception of science television programmes, the content of science programmes, and the production of science programmes.

For the reception analysis, television viewing practices are embedded in everyday life; this means that local contexts of text–reader interaction are a salient part of ethno-epistemic assemblages.

The study of the content of television programmes is important because it is the major link between citizens and “expert” scientific parts of the assemblage. Television is the most trusted source for scientific information in Ireland (Eurobarometer 2007), and in the UK (Ipsos MORI / Department for Business, Innovation and Skills, 2011), and television mediates events from scientific institutions e.g. news stories based on the publication of a peer-reviewed journal article.

The production analysis illustrates the range of actors involved in producing television news and documentaries including scientists, scientific journals, media professionals and politicians. It investigates the motivations programme makers have for constructing television programmes in the way they do and how they perceive the rest of the assemblage. It looks in particular at how programme-makers construct their audiences—do they address them as consumers? Or as advocated by Engelman (1996, p. 36) as citizens: “who require information to participate fully in the nation’s political and cultural life”.Concluding remarks on the Introduction

This introductory chapter presents the research questions that this dissertation addresses, and explains the main theoretical ideas used. This chapter opens with the key research question ‘How do the meanings that users make of science content on television contribute to their scientific citizenship?’ The salience of this research question is explained at the beginning of the chapter, in the description of Irish, EU and international government policies about science and society, as laid out in various reports which have raised concerns about the need for citizens to be able to engage with science in order to maintain a democratic ideal; as well as laying out the economic imperatives to have a more scientifically engaged, scientifically literate, population that will enable countries to compete in a global knowledge economy.

The chapter then goes deeper into the analysis of the relationship between science and society by looking at what Irwin (2008) calls the ‘orders of thinking’ about science and society, the first order being the thinking behind the ‘deficit’ model of science and society relations, the second order being an emphasis on dialogue and engagement, and third order thinking, advocated by Irwin, involving critical reflection, which acknowledges the ‘wicked’ nature of science/society interactions. The relationship between science and society is ‘wicked’ in that it is difficult to define, changeable, and has many interdependencies. It is, as I argue in this introductory chapter, best described by Deleuze and Guattari’s (1987) assemblage theory, that is, an approach which emphasises the process-like, fluid, and temporal character of the relationship—assemblages are always ‘in the making’. I then introduce the idea of an ‘ethno-epistemic assemblage’, a hybrid form of knowledge, practices, social relations knowledge claims about a subject (in this case, about science on television), which is constructed in a local context, under local cultural conditions.

Like assemblages, citizens in a society are themselves ‘in the making’, they are involved in a project of continuously making and remaking themselves, putting together an identity from the available choices, patterns and opportunities on offer in the semiosphere and the media sphere. Hartley (1999, p. 179) calls this DIY citizenship, and I argue that scientific citizenship, the ability to engage and debate with scientific ideas, is then, a subset of this DIY citizenship. Scientific citizenship is a normative ideal which implies not only that scientific knowledge is important for citizenship in contemporary society but also that citizens can lay a legitimate claim about accountability in scientific research. Scientific citizenship can be investigated by looking at how publics construct their identities with respect to science. As most individuals do not have any direct contact with scientists or scientific institutions, they interact with science through media, and this is why I argue that in particular citizens use television viewing and talk about television to construct their scientific citizenship.

This chapter goes on to explain why I chose television as the particular medium to study, to briefly summarise, first of all television is embedded in everyday routines, second, the agenda-setting function of television tells its audience what science is important (newsworthy), third, audiences place a high level of trust in television science, and finally, I cite studies which show the strong heuristic role that television plays in forming opinions and attitudes about science, and the way that publics use television imagery to talk about science.

Finally this chapter explains the concept of the circuit of mass communication, the idea that science is always mediated during the process of communication, and that at all levels of the communication process, the elements of production, content and reception interact and influence each other. By delineating and analysing these three elements I can explore how four key groups of actors: scientific institutions, media, publics and policy makers co-construct the assemblage of scientific citizenship. The literature review in the following chapter examines how each of these four groups constructs itself and constructs the other elements of the assemblage. Later chapters describe the empirical research in focus groups which investigated how publics constructed their own scientific citizenship through talk, talk being in of itself a political action.

2 Literature review

2.1 Overview

This research attempts to show how the meanings that users make of science content on television contribute to their scientific citizenship. The concept of the scientific citizen is the idea that citizens can engage with and participate in informed debate over complex ethical, legal, economic or health issues brought about by scientific and technological development. The scientific citizen can contribute to science and technology policy-making. Many factors influence the shaping of the scientific citizen, for example, education, workplace experience, personal circumstances or political views. This research investigates how science content viewed on television contributes to the formation of the scientific citizen.

This thesis uses the idea of ethno-epistemic assemblages to explain the actors contributing to the creation/construction of the scientific citizen. It looks in particular at the ethno-epistemic assemblage surrounding audience meaning-making about science on television.

This literature review first of all looks at ideas of scientific citizenship and then goes on to examine the ethno-epistemic assemblages that comprise scientific institutions, scientific laboratories both private and public, science, funders of scientific research, scientists, science students (at all levels), science journalists, science documentary makers, PR agencies, audiences of science on television, various public(s), government departments and agencies, etc. It does this first of all by organising these individuals and bodies into four main groups: media, publics, science, and policy-makers and then reviewing the literature to see how each of these groups constructs itself and constructs the other three main groups of the assemblage. This literature then feeds into the empirical research part of the PhD which explores the ethno-epistemic assemblage surrounding audience meaning-making about science on television by investigating three elements of the assemblage: the production of science programmes for television, the content of science programmes and the reception of science programmes. Note that these are not three equal parts, the essence of this research is the reception study: this is the investigation of how focus group participants construct science using television and how they construct their own scientific citizenship.

2.2 Constructing the scientific citizen

Citizenship as an ideal has developed over the centuries. It has always included the concepts of rights and obligations. Scientific citizenship has emerged as an idea because in this scientific society, citizens need to be able to play a role in decision making about scientific issues to fully participate in society.

The pre-eminent place of science in society is recognised by policy makers. Government reports warn of dire outcomes for countries and economies if science is not brought to the wider community. The UK Science and Trust report (2010) warns of serious consequences in a knowledge-based economy such as the UK for young people who might be the engineers, scientists and researchers of the future if the science community does not:

> "…reach out to the wider audience not only to produce those future experts but also to evolve a more science aware society able to derive informed opinions"
>
> Science and Trust, 2010, p. 8

As the science journalist and writer Pietro Greco (2008) asserts, institutional thinking has changed from the idea that if scientists and science communicators teach people science they will come to love and support them, to thinking that if they communicate science and publics learn more they will be better able to make decisions, i.e. "The better you know, the better you make your choice" (p. 1).

Stirling (2008) and Delgado, Kjolberg, and Wickson (2011) have drawn on work and terminology from Fiorino (1990) to come at the question from a different angle, arguing as outlined in section 1.1 Introducing the research questions, that there are three reasons why a technocratic elite should not be allowed to dominate scientific policy making: substantive, normative and instrumental. As American political theorist Benjamin Barber (1996) puts it, democracy is not a fixed endpoint, once achieved to be mounted on the wall as a trophy, but a continuing process, an on-going experiment. I agree with Clarke (1994) in his book *Citizenship*, when he states that people are not citizens because they are equal; they are equal because they demand citizenship rights. I argue that this process of developing democracy needs to include decision making about scientific issues.

Andrew Barry (2000) gives three different models of (scientific) citizenship: the active consumer model, the public sphere model and the cooperative research model. The active consumer model view takes seriously the notion that in contemporary culture, identity is predominantly established through consumption. In this account, the old notion that citizens needed to be informed and knowledgeable about science is regarded to be paternalist and elitist and does not recognise that in today's consumer culture individuals make choices, not on the basis of what they should do, but on the basis of what is pleasurable and interesting. The old notion that individuals would simply recognise the importance of understanding science “was at best naive, at worst elitist” (p. 1).

Certainly, publics can be engaged as citizens or as potential users of the products of science, i.e. consumers. As STS scholar Alison Mohr (2011) found, in her review of different methods of science engagement and the publics that these construct[11], in practice, the dominant motivation behind a number of public experiments of science–public dialogue was ostensibly to engage publics as ‘citizens’ in dialogue, but this was in actual fact underpinned by a rationality of elicitation that engaged publics as potential future ‘users’ or ‘consumers’ to enhance public confidence in the products of science. Also, television viewers can be simultaneously hailed as consumers and as “citizens who must be reformed, educated, informed’ so that they might “better perform their democratic rights and duties” (Ang, 1991, p. 21).

Next Barry moves on to Habermas’s 1962 model of a (normative) public sphere which is echoed in the work of sociologists of science such as Brian Wynne. For Wynne, scientists tended to dominate the space of public debate about environmental hazards. Yet, as Wynne demonstrates, the experts' model of the effects of radioactivity in sheep were not complete, contradicting as they did the farmers' own knowledges about the contingencies of farming in the Lake District, and the idiosyncratic features of the area (Wynne, 1996)

The third model—which emerges from French sociologist Callon’s (1999) research—is the cooperative research model. Callon, in his research into patient groups for genetic diseases, showed that it is possible for non-experts to contribute to the production of scientific knowledge and engage in an on-going dialogue with experts about the direction and conduct of laboratory and clinical research (Callon 1999, p.90). In the cooperative research model, what emerges is a complex and negotiated division of labour between professional researchers and interested and active non-experts. In this, the conduct of an active scientific citizen involves an active engagement in the research process itself.

Leach and Scoones (2003) describe three different perspectives on citizenship and science: the liberal perspective, the communitarian perspective and civic republican perspective. The liberal perspective means that citizens are entitled to universal rights

[11] Mohr (2011) reviewed the NanoViv public debates in Grenoble, the Ile-de-France citizen conference, the 1999 Australian consensus conference on gene technology in the food chain, the Biotechnology and Biological Sciences Research Council (BBSRC) and the Medical Research Council (MRC) sponsored public dialogue on the science and the social and ethical issues of stem cell research in the United Kingdom.

granted by the state. Citizens are seen as individuals who act rationally to advance their own interests, while the state's role is to protect and enforce their rights. Rights are deemed universal in the sense that every citizen has equal rights regarding the state, including rights to participation through electoral democracy. Exercising rights is seen as the choice of citizens, on the assumption that they have adequate resources to claim these rights. Public participation is therefore seen as something to which all citizens have an equal right, and as conducted by individuals through engagement in democratic politics, overseen by a state whose benevolent motives are unquestioned. From the liberal perspective the state is seen as a benevolent protector of individuals, including, as Marshall's classic work (1950) emphasised, protecting them against major risks. The state is given a role in reducing uncertainties emerging out of the processes of capitalism, requiring various forms of welfarism. In the contemporary era and from a liberal perspective, a similar role might be imagined for the state to intervene in reducing risks encountered, and for state-sponsored science to guarantee the safety of citizens, through food safety regulations, pollution risk management and so on. Liberal understandings of citizenship thus hold faith in the modern state's expertise, and science has become its essential currency in the technology arena. Liberal theories of democracy connected with these defer decisions to elected elites who historically have been highly reliant on accredited scientific and technocratic expertise.

It is this kind of perspective on citizenship which underlies the 'deficit' model in science studies and policy, established so authoritatively with the 1985 Bodmer report of the Royal Society, which treats public scepticism about science as due to a deficit in people's knowledge and understanding of it (the assumption being that individual members of the public would come to respect and appreciate official scientific expertise if they could only be brought to understand this through education and the effective communication of science).

The communitarian perspective on scientific citizenship centres on the notion of the socially embedded citizen and membership of a community (Sandal 1998; Smith 1998). Individual identity is therefore subsumed to that of a group and the common good is prioritised over the pursuit of individual interests. The emphasis is on the pursuit of local agendas, with the state appearing more distantly if at all. A communitarian perspective allows for lay knowledges to be seen as culturally embedded and geographically specific.

This thesis argues for a promotion of civic republican perspectives on scientific citizenship which bridges aspects of the liberal and communitarian traditions, situating individuals as part of collectivities who press claims in the political realm. It recognises a diversity of interests within society and assumes that citizens will form factional groups around these. Citizenship is thus related to a common civic identity based on common public culture, and individual obligations to participate in communal affairs (e.g. Habermas 1984, 1996; Miller 1988). This participation is not confined to representative political systems as in liberal thought; rather civic republican thought promotes deliberative forms of democracy as a complement to or alternative to representative democracy (e.g. Dryzek 1990, 2000; Bohman and Rehg 1997). A notion of the common good is seen to emerge out of a rational debate among free citizens in which different claims have their say and give way to collective agreement. Much work around citizen science is underlain implicitly by a civic republican perspective. Such work draws attention to how claims and interests related to knowledge and experience emerge and are refracted through political dialogue. Factional groups, united by common experiences of science, technology and its risks, may press claims based on their experiential knowledge, as in the actions of HIV/AIDS activists, toxic waste campaigners, 'NIMBY' protest groups or parents concerned about vaccine risks and side-effects. The recent move towards deliberative and inclusionary processes explicitly invites such claims-making in new forums, whether citizens juries, consensus conferences, scenario panels and so on (e.g. NEF 1998; Bloomfield 2000; Holmes and Scoones 2000; Murphy, 2012). As Richard Munton, professor of human geography in University College London asserts, contexts of scientific uncertainty or where science and technology issues involve social and ethical judgements, plural perspectives and deliberative processes may be needed in order to reach socially legitimate and acceptable decisions (Munton 2003).

This is different to other constructions of scientific citizenship which are centred on the scientist, i.e. 'the scientist as scientific citizen'. In the USA, the Coalition for the Life Sciences (CLS) calls on scientists to take on the responsibility of being a 'citizen scientist', "encompassing the responsibility of the community of scientists to help the public and elected officials understand the impact of research on human health[12]", in this construction of scientific citizenship, scientific citizens are advocates and lobbyists for science, the CLS website gives advice on how to "be an advocate" on www.jscpp.org In the UK, Martin Rees, the British Astronomer Royal, gave the 2010 BBC Reith lectures, the title of the first lecture was "The Scientific Citizen" He describes 'scientific citizens' as scientists from all fields of expertise engaging, from all political perspectives, with the media, and with a public attuned to the scope and limit of science. He sees the scientific citizen as first and foremost a scientist.

[12] This advice is included in a section of the CLS website promoting that scientists become advocates for their research: http://www.coalitionforlifesciences.org/be-an-advocate/advocacy-tools

Another construction of citizens and science is that of “citizen science”. This occurs when citizens take part in gathering or analysing data for a scientific research project. The first large scale citizen science project was SETI@Home, launched in Berkeley in 1999. This project enabled people to donate their computer’s idle time to the task of processing raw radio signals for signs of intelligent life. This project was followed by others such as Folding@home, a distributed computing project which studies protein folding, misfolding, aggregation, and related diseases and also by many projects in the “Zooniverse”: an umbrella organisation which houses a growing collection of citizen science websites. Astronomy, which has a tradition of gifted amateurs, is at the forefront of these collaborations. However, the scientific community’s construction of these “collaborations” is very much one of the citizens ‘serving science’ as is clear from this quote, taken from the astronomer Knapen’s (2010) paper praising successful ProAm (Professional–Amateur) collaborations:

> Starting new ones [collaborations] depends on meeting the right professional astronomer, and may not be easy because there must be a good match between the quantity and quality of *the data that the amateur can offer and what the professional needs* to advance his or her scientific research. In general, such collaborations can be very fruitful [my emphasis].

Constructs of scientific citizenship which emphasise the education and scientific understanding of citizens, such as energy policy expert Laird’s (1993) assertion that: “...citizens must be given information and analysis that are genuinely educative. Citizen understanding must improve” are not truly democratic, but rather are another emergence of the deficit model of science communication. There are two features of the deficit model. The first is the idea that public scepticism towards modern science and technology is caused primarily by a lack of adequate knowledge about science. The second is the idea that, by providing sufficient information about modern science and technology to overcome this lack of knowledge—or ‘knowledge deficit’—the public will change its mind and decide that both science and the technology that emerges from it are ‘good things’ (Dickson, 2005 writing on the SciDevNet website). Science is held up (by scientists) as not just being inherently rational, but inherently moral as well. “Scientists give a model to moral citizens of how to live” (Lewenstein, 1997, quoted in Gregory and Miller, 1998 p. 23); the American Association for the Advancement of Science (AAAS 1989, p. 1) argued that a good science education should contribute to the development of “compassionate human beings … protecting a society that is open, decent, vital.” Indeed, psychologists Christine Ma-Kellams and Jim Blascovich argue that the association between science and morality is so ingrained that just thinking about science leads individuals to endorse more stringent moral norms and exhibit more morally normative behaviour (Ma-Kellams and Blascovich, 2013).

The following sections describe the constructions of different parts of the assemblage, i.e. science, media, publics and policy-making. As described earlier, the assemblage is characterised by its fluidity and heterogeneity, and elements of the science on television assemblage can of course also be part of other assemblages, they do not respect artificial boundaries imposed on them.

This characterisation of the assemblage as rootless, complex and acentred owes much to Deleuze and Guattari's (1987) idea of the rhizome. The contribution of the rhizome metaphor is that it highlights fluidity and complexity in the relations between science, media, publics and policymakers. Just as a rhizome can be split at any point, but can and will start up again (rebound) and fill the gap using old lines and making new ones, so too do the discontinuous fractured and nonlinear relationships between science and the rest of culture make and unmake relationships between themselves (Martin 1998, p. 33). No one view is privileged, the rhizome is a rejection of the assumptions and history of the dominant class. In this way the rhizome is a powerful metaphor for postmodern narratives, rather than follow a straight-forward, linear, hierarchical pattern toward a single idea like more traditional narratives do, postmodern narratives—like rhizomes—often branch out in multiple ways simultaneously, touching on or quoting other works, digressing along separate paths, connecting to other ideas, and sometimes, but not always, reconnecting with the original root stalk at some point. In this respect, dichotomies i.e. black and white, good and bad, are impossible, everything ties into and affects everything else.

> Any point in a rhizome can be connected to any other point, and therefore, it must be. If one point absorbs a contaminant, or, there is a resist in the system, the whole system is affected. A good example of this is when someone with a bad cold is on a trans-Atlantic flight. Every time that person coughs or sneezes, their cold germs are taken up by the air handling unit and neatly distributed to every other passenger on the flight. After twelve hours of this, everyone else on that flight will have the same cold …. The rhizome will always establish connections between semiotic chains, power structures, and the arts and sciences. This practice inherently decentralises authority—no ideal speaker or listener.
>
> MacDonald (2008)

This thesis argues that the ideal of scientific citizenship should be as Irwin (2001) proposes "an open and critical discussion between researchers, policy makers and citizens".

2.3 Six blind men describe an elephant[13]

The remainder of this literature review examines the literature surrounding the ethno-epistemic assemblage of science. As noted above, such assemblages are characterised by their heterogeneity and fluidity, and are composed of many forms of knowledge and resources. To fully understand the assemblage, care must be taken to look at it from many different angles; otherwise a complete picture will not emerge. Like a group of blind men trying to describe an elephant by touch alone, the assemblage cannot be understood from just one perspective. The following sections of this literature review look at how individual elements of the assemblage construct both themselves and other parts of the assemblage. They include summaries of academic writings on science in society and of television audience research, survey data on attitudes to science and to media, government policy documents about science in society, and accounts of representations of science in media. Brought together, they build a picture of the academic literature surrounding the science ethno-epistemic assemblage. As Mohr (2011 p. 668) puts it: different public, scientific, and policy actors operate with very different understandings of public engagement with science, and of publics themselves.

2.4 The scientific habitus—how science constructs itself

Gregory and Miller (1998) date the social distinction between science and the public as beginning with the formation of a community of science, that is, with the institutionalisation of science as an activity with designated participants and with agreed rules and practices that separated it from other activities. Gregory and Miller date the separation of the scientific community from the public at large as happening in the seventeenth century: with the scientific revolution, science developed as an activity in its own right. In England, the Royal Society was established in 1660, having as its fundamental purpose, as reflected in its founding charter of 1662 to: “encourage philosophical studies, especially those which by actual experiments attempt either to shape out a new philosophy or to perfect the old”. From the outset, the Royal Society

[13] An old Indian story says that six blind men were asked to determine what an elephant looked like by feeling different parts of the elephant’s body. The first blind man feels the elephant’s leg and says the elephant is like a pillar; the second blind man feels the elephant’s tail and says the elephant is like a rope; the third blind man feels the elephant’s trunk and says the elephant is like a tree branch; the fourth blind man feels the elephant’s ear and says the elephant is like a hand fan; the fifth blind man feels the elephant’s belly and says the elephant is like a wall; and the sixth blind man feels the elephant’s tusk and says the elephant is like a solid pipe.

A king explains to them:

> All of you are right. The reason every one of you is telling it differently is because each one of you touched the different part of the elephant. So, actually the elephant has all the features you mentioned.

acted as a lobby group for science as well as an arena for scientific debate, and to that end, for the first one-and-a-half centuries of its existence, there were at least as many non-scientist gentlemen as active researchers among its membership. (It was not until the 1820s that the Society started to take on its modern form as a mainly scientific forum, removing some of the gentlemen in the process.) From the outset, too, the Royal Society had its critics, fearful that this privileged body would, in turn, privilege science above other cultural activities.

According to the STS theorist Hilgartner (1990), scientists see themselves as an elite, and their scientific knowledge as the epistemic “gold standard” and it is up to scientists then to decide what simplifications are appropriate for publics. Elite journals also have this privileged status; Conrad (1999) argues that some science reporters may assume that a particular scientific finding does not require “balance” because science has already gone through a peer-review process. Some scientists maintain that science is an “elitist calling” and that as the mathematician Levitt (1999, p. 4) put it: “raw intelligence and special skills that far exceed what is to be expected of the average person are required to attain it”. Also, several authors have pointed to the problem that standards needed for evaluation of evidence underpinning scientific knowledge claims are beyond the reach of non-experts (Hardwig 1985, Bingle and Gaskell 1994, Norris 1995).

Other authors have highlighted the technical language and conventions used by scientists which serves to exclude non-specialists from participation. Sociologist of science Ludwik Fleck’s (1979) *Genesis and Development of a Scientific Fact* described the idea of the ‘denkkollektiv’ or ‘thought collective’:

> A thought commune becomes isolated formally, but also absolutely bonded together, through statutory and customary arrangements, sometimes a separate language, or at least special terminology ... The optimum system of a science, the ultimate organisation of its principles, is completely incomprehensible to the novice.
>
> Fleck (1979, originally published in German 1935, p. 103)

Fleck was suggesting that the linguistic conventions of a body of socialised professionals gave them—and only them—permission to speak. The language of institutionalised and specialised scientific groups is removed from ordinary speech, and even from the speech of scientists belonging to another (thought) community. This is both a sign and as a vehicle of the group’s special and bounded status. As the Harvard sociologist and historian of science Steven Shapin (1984) argued, not everyone may speak; the ability to speak entails the mastering of special linguistic competences; and the use of ordinary speech is taken as a sign of non-membership and non-competence.

Communications researcher Rae Goodell (1977) documented proactive efforts by scientists to influence press coverage on recombinant DNA. These efforts are part of what sociologist of science Tom Gieryn has labelled as ‘boundary work’, or the use of scientific discourse to demarcate scientific from popular knowledge in order to shore up scientific authority (Gieryn, 1983, 1995).

According to the Australian journalism researcher Reed (2001), scientists are strongly personally committed to the cultural norms and ethos of their profession. The beginning of the profession of the scientist can be traced to the 1830s, when the polymath William Whewell coined the term “scientist” at an early meeting of the BAAS to describe the members of what was becoming an increasingly professional group. It was at this stage—as science grew more assertive—that the “common context” with natural theology—and thus with the rest of culture—began to fragment (Young, 1985), science then became a ‘sub-culture’, and scientists’ professional identities became a vital part of how they saw themselves. The American sociologist Hermanowicz (1998) investigated how scientists constructed meanings of themselves. He took an in-depth look at how scientists identify with their work. Identification does not occur in isolation, but is rather socially situated in the environments in which people interact, in the professional sub-cultures of science. These professional sub-cultures and occupational identities resonate with Pierre Bourdieu’s concept of *habitus*:

> The habitus is the product of the work of inculcation and appropriation necessary in order for those products of collective history, the objective structures, (e.g. language, economy etc.) to succeed in reproducing themselves more or less completely, in the forms of durable dispositions.
>
> (Bourdieu, 1977, p. 85)

Habitus is related to the words habit/habitual and implies a tendency to act in a particular way, a ‘taken for granted’ world view that individuals carry around with us, deeply internalised in our bodies and minds, absorbed into our cognitive structures from a very young age. It provides the context within which we later perceive and evaluate all life experiences. Habitus is second nature, knowing how to speak and behave in particular situations: how to hold and orient ourselves physically, dress and so on. This habitus of embodied norms are unacknowledged, they are so taken-for-granted that we usually fail to realise that they shape our behaviour, our ways of thinking and doing. The habitus is powerfully generative rather than deterministic, it predisposes individuals towards behaving in certain ways, but does not disallow individual agency; in other words, individuals are disposed, not determined, to act in a certain way based on previous experience:

> Habitus is not the fate that some people read into it. … it is an open system of dispositions that is constantly subjected to experiences, and therefore constantly affected by them in a way that either reinforces or modifies its structures. It is durable but not eternal!
>
> (Bourdieu and Wacquant, 1992, p133).

In 1942, sociologist of science Robert Merton described the unwritten social norms which governed science as having four features: communism, universalism, disinterestedness, and organised scepticism. Since then, the significance of the Mertonian norms has been much disputed. They were originally conceived as structural elements in a theoretical model of the scientific culture. Nowadays they are often regarded as no more than useful words for moralising about actions and ideals in scientific life. However as the philosopher of science John Ziman (1996a, 1996b, 2000) asserts, in principle, they provide each member of the scientific community with a stable social environment. As long as everybody keeps to the rules, then their responses to events and to one another's actions are reasonably predictable. A community of otherwise independent individuals can thus organise itself spontaneously into a well structured institution.

Drawing on the work of Shapin and Schaffer (1985), feminist scholar Donna Haraway (1997: p. 24) provides an account of the development of a particular set of behaviours for chemists under the influence of the seventeenth-century scientist Robert Boyle which can be seen as fitting the criteria for a sub-culture or habitus (Bourdieu, 1977). These ways of thinking and acting developed the persona of the scientist as the 'modest witness', the 'legitimate and authorised ventriloquist for the object world' (Haraway, 1997: p. 24).

The material, literary and social technologies of Boyle's chemistry produced a specific modern 'culture of no culture' (Haraway, 1997: pp. 23, 25) by which 'self-invisible', transparent science spokesmen claimed and dominated a public space (i.e. the Royal Society) and witnessed on behalf of 'science' (Haraway, 1997, pp. 23-33). According to Haraway (1997, p. 24), the first of the three technologies was material (i.e. the air pump) and provided the 'objective' grounding of scientific knowledge. The second technology was literary, a specific way of communicating phenomena to those who did not directly experience them. The third was a social technology of the conventions used by scientists in their relationships; this technology complemented the other two, meaning that individuals could become 'virtual' witnesses, changing their practice based on the 'second' witness' written and spoken accounts. Scientific knowledge could therefore be presented as 'given', technical, neutral and outside of politics (Haraway, 1997: pp. 24-5).

Stephen Norris (1995) mentions the role and weight of consensus, publication and prestige in the scientific community as examples of criteria for judging experts. Similarly, current debates about the damaging environmental effects of science and the political nature of apparently neutral scientific developments have highlighted the different values among scientists (Merrifield, 1993), opening up cracks in the 'culture of no culture' and the invisibility of scientific spokespersons, particularly via the media.

Scientists can also look outside of their own work and institutions for ideas about themselves. In a survey of scientist members of Canada's Stem Cell Network (SCN) carried out by Caulfield and Zarzeczny (2010), almost half (44.6%) said that popular culture representations of science have made them think about science in a different way; and almost a fifth (19.6%), agreed that they thought about popular culture representations of science when making decisions about what projects to pursue.

2.5 Dealing with the deficit model—how science constructs publics

Understanding how scientists construct citizens is important, not just in terms of understanding those elements of the assemblage, but it is also critical in any attempt to understand the patterns of public engagement of science with citizens. Constructions of publics and models of communication with them are often inextricable (Maranta et al., 2003; Irwin and Michael, 2003). As Jack Stilgoe puts it:

> Studies of technology have suggested that technologies necessarily embed assumptions about users (Woolgar, 1991) (and sociologists embed assumptions about readers (Latour, 1988)), constructing their particular public. So experts, when dealing with questions of public engagement, might be seen as (re-)constructing their publics as they (re-)construct science-in-public.
>
> Stilgoe, 2007

The social construction of publics by experts[14] is emphasised by Maranta et al. (2003, p. 157) who describe experts as "lay person makers" and talk of the "imagined lay persons" they make, arguing that "experts cannot set up imagined lay persons without having a concept of how to communicate with lay persons", reinforcing the observation that the construction of the public is inextricably bound up with both characterisations of their knowledge and modes of engagement with them.

[14]I acknowledge that assuming a simple public/expert dichotomy ignores the way in which the lines between these categories are often blurred (particularly when considering the role of new social movements, pressure groups and advisory committees; Irwin and Michael, 2003), however, the purpose here is to consider how publics, public knowledge and interactions with those publics are conceptualised by people occupying a range of 'expert' positions in science.

The literature on the scientific community's construction of "the public" is dominated by critiques of the "deficit model" (Irwin and Wynne, 1996; Sturgis and Allum, 2001). The deficit model of science communication attributes a deficit of scientific knowledge to the public (Bauer, 2008). The model suggests that human inadequacies limit the public's capacity to be effectively involved in complex decisions. Some scholars, clearly of a deficit model mindset, express doubts about whether the public understands significant concepts such as "uncertainty" and the nature of science as an incremental process (e.g., Brooks and Johnson 1991; but see, e.g., Frewer, Howard, and Shepherd 1998 for counterclaims), or point to deficiencies in the knowledge and reasoning abilities of laypersons (Slovic, Fischhoff, and Lichtenstein 1982; Earle and Cvetkovich 1995). According to deficit model thinking, the extent of the deficit needs to be investigated by surveys and questionnaires of science that the public "should know", and the proposed solution is to increase efforts in science education to reduce the deficit.

The British Royal Society became very concerned with the deficit in public knowledge about science in the 1980s, and in the Bodmer Report produced in 1985, attributed the perceived lack of support for science to this deficit. The Royal Society assumed that more scientific knowledge would be the driver of more positive attitudes towards science, hence the axiom of the public understanding of science (PUS) movement "the more you know, the more you love it".

The traditional view is that decisions regarding technical issues should be left in the hands of experts and scientists. Environmental scientist Ralph Perhac (1996), for example, suggests that environmental policy based on the public's conceptualisation of risk (which has been shown to differ from that used by risk assessors; e.g. Renn 1992) fails to adequately protect fundamental human rights to health and liberty. The former Director General of Legislative and Regulatory Affairs for the Department of the Environment in Canada, John Moffet (1996) warns that policies involving the public must balance the desire to foster legitimacy and support for decisions (e.g., about risk priority setting) with concerns to avoid priorities being driven by "the crisis of the day." Some scholars have added that as well as ignorance, scientists sometimes construct the public as having a deficit of rationality, and other factors may limit the potential for the public to contribute to complex policy decisions related to their attitudes, beliefs, and motivations (Ravetz 1986; McCallum and Santos 1997). John Durant (1999) is concerned with a deficit of mutual trust between scientists and citizens and the lack of active public participation in decision-making processes regarding science and technology.

Burningham et al. (2007) in their account of how industrial scientists construct publics and public knowledge found that their industrial scientist interviewees generally interpreted public concerns about factory safety as issues of trust rather than simply scientific ignorance. However, rather than responding by trying to build trust through engagement or dialogue, the interviewees constructed the lack of trust itself as irrational and identified the appropriate response as education to correct misperceptions, effectively using the deficit model in the sense that a 'deficit of trust' could be remedied by education.

Burningham et al. also found that when they interviewed scientists working in industry, the scientists defended the perceived deficits of knowledge by arguing that not only are people not interested in acquiring knowledge, but indeed that they have no need to do so. This range of justifications of ignorance raises interesting questions about the impact of this version of the deficit model. The "classic" deficit model emphasising education, at least leaves open some communication with the public. In contrast, the way of thinking illustrated here—"they don't know, but why should they?"—implicitly legitimates lack of communication and discourages public engagement with industrial science. Alternatively, and more positively, these accounts can be likened to critiques of the deficit model which point out that ignorance may be an active choice; people will only seek knowledge if it is in their interest to do so (Michael, 1996). Indeed, Burningham et al.'s overall conclusion was that communication by industrial scientists with publics focuses on downstream risks, impacts and preferences (associated with products and factories) and there is little sense of the desirability of engaging with publics about broader questions about the "values, assumptions, visions and vested interests" (Wilsdon and Willis, 2004, p. 18) that underpin company activities. Indeed industrial science constructed the public largely as either "consumers" or "neighbours." Accordingly every contact between companies and publics was framed as seeking information or expressing concerns about either the product or the factory, requiring reassurance more than engagement. Consumers and neighbours were not regarded as the source of "facts," or broader values, "wisdom" or insights which might inform company thinking and practice (please see Irwin and Michael, 2003, p. 8).

Nisbet and Scheufele (2009) detail how prevailing deficit model assumptions have led scientists to use science media, in particular popular science outlets such as *Scientific American* or the Public Broadcasting System (PBS) programme *NOVA*, to educate the public about the technical details of scientific matters which are in dispute. The facts are assumed to speak for themselves and to be interpreted by all citizens in similar ways. If the public does not accept or recognise these facts, then the failure in transmission is blamed on journalists, "irrational" public beliefs, or both (Bauer, 2008; Bauer et al., 2007; Nisbet and Goidel, 2007; Scheufele, 2007). Also, as Irwin and Wynne (1996) identify, when scientists emphasise what is wrong with the public, they ignore the possibility that their own communication efforts may be part of the problem (Irwin and Wynne, 1996).

The assumed use of the deficit model by scientists is borne out by empirical research into scientists' attitudes to the public's understanding of their research. In a survey conducted by *People Science and Policy* with funding from the Royal Society, Research Councils UK, and the Wellcome Trust (Royal Society, 2006); when asked to respond on the degree to which their "research is too specialised to make much sense to the non-specialist public" on a five-point scale anchored by "strongly agree" (1) and "strongly disagree" the mean response was 3.54 (SD = 1.11). Younger respondents ($r = -0.10$, $p > 0.01$), men ($r = -0.09$, $p > 0.01$), and those in engineering ($r = -0.12$, $p > 0.01$), physics ($r = -0.09$, $p > 0.01$) and math ($r = -0.18$, $p > 0.01$) were more likely to view their research as too specialised. Those in medicine ($r = 0.19$, $p > 0.01$) and environmental science ($r = 0.07$, $p > 0.05$) appeared to view their work as more accessible to the general public (approximate $n = 1,475$, weighted).

Indeed scientific research is complex and technical and several authors have pointed to the problem that standards needed for evaluation of evidence underpinning scientific knowledge claims are beyond the reach of non-experts (Hardwig 1985, Bingle and Gaskell 1994, Norris 1995). And an expert in one discipline of science can be a non-expert, indeed a complete novice, in another—as Martin Rees put it, speaking at the Cambridge Centre for Science and Policy in December 2011 "We're all depressingly 'lay' outside our specialisms" (2011). This presents difficulties for scientists. The Royal Society's motto, *Nullius in verba*, is Latin for "Take nobody's word for it". The idea of sceptical scientists proving everything for themselves by experiment and accepting nothing on authority worked in the seventeenth century when an educated gentleman could actually try out everything for himself, or at least be a 'virtual witness', the term for the readers of Robert Boyles's texts, which were themselves constructed in a manner which was agreed to be reliable, and sufficient to produce in a reader's mind such an image of an experimental scene as obviated the necessity for either direct witness or replication. Nowadays science is so complex; requires such huge resources in terms of capital, equipment and personnel—that in effect even a scientist in one field has to take on authority almost everything else in science. That is why Martin Rees in his Reith lecture in 2010 on *The Scientific Citizen* saw a role for: "scientific commentators and critics, such as the best scientific journalists, because they in fact have a network that spreads across different subjects and they can calibrate the quality of work in different fields".

Returning to the notion of scientist's relationship with non-experts, Wendy Parsons, former Deputy Director of the Commonwealth Scientific and Industrial Research

Organisation (CSIRO)'s National Awareness Program, points out that science finds it hard to accept democracy's apparently irrational forces of popular belief, which means that scientists tend to avoid engagement in the public policy debate, often out of fear of having their findings given the same value as popular prejudice (Parsons, 2001). Practitioners of science, such as Nobel prize-winning physicist Steven Weinberg, claim to work out the properties of a rationally understandable world "to protect ourselves from the irrational tendencies that still beset humanity" (Weinberg 1996, p. 15). US environmental consultant Gary Rahl (1996) in his work on risk reduction through public participation in environmental decisions found that sponsors in the US Navy were wary of accepting binding votes and giving away all of their power to public participants in case this results in the compulsory implementation of a decision based on emotion or prejudice.

This fear of an emotionally prejudiced public is echoed by Carpignano et al. (1990), who describes the argument that public life has been transformed by a massive process of commodification of culture in particular, and by a form of communication increasingly based on emotionally charged images rather than on rational discourses, such that political discourse has been degraded to the level of entertainment, and cultural consumerism has been substituted for democratic participation.

Most recently, discussion in science communication has focused on the need to move public engagement "upstream" (Wilsdon and Willis, 2004): enabling public debate to take place at the development stages of science and technology, rather than later on when a technology is approaching exploitation. (Although in light of findings that show it is not risk per se that concerns the public (Gaskell et al., 2004), many researchers fear that upstream engagement mean their roles will be relegated to purely technical ones.) Most of the debate has concerned the way in which decisions are made in the public sector, even though recent work has highlighted the extent to which science-based industry plays a key role in innovations in science and technology: see for example discussions of the "triple helix" (Etzkowitz, 2003) and "mode 2" knowledge production (Gibbons et al., 1994). For the advocates of public engagement, there are clear normative reasons why industry should engage with "the public" as science-based industry is the source of most of the developments that will affect people's lives. Given the erosion of demarcation between university science and industrial science, social science research on industrial science is crucial for developing new understandings of publics and science. As the inclusion of lay perspectives is increasingly thought critical in achieving socially robust knowledge (Gibbons, 1999), the question of the extent to which this is recognised and acted upon within industry science is important.

2.6 *A tense or symbiotic relationship?—how science constructs the media*

Burningham et al. 2007, in their interviews with industrial scientists about how they construct publics, found many of them greatly concerned by the (negative) influence of media on “the public”. The interviewees depicted media content as partial (“completely biased”), superficial (“based on sound-bites”; “almost no detail”) and preferring bad news to good news. They were particularly concerned about media “scare” stories on chemicals and the chemical industry which, interviewees argued, provided misinformation and created unfounded anxiety. Caulfield and Zarzeczny (2010) found an overwhelming majority (85.7%) of their scientists respondents believed that popular culture has an effect on public opinion about science. This concern about media influence on public environmental knowledge reveals a linear or transmission model of knowledge transfer from the media to “the public”, who are depicted as passive recipients of partial, biased and sensationalist information. Science education researchers’ findings back up these views, for example Barnett et al. (2006), found that film and television portrayals of science (fiction) could lead to the development of stereotypes of science and scientists (p. 181).

There is little recognition (from scientists surveyed) that members of the public may have prior knowledge of their own, be able to draw on multiple sources of information or actively evaluate information (Burgess and Harrison, 1993; Hansen, 1991; Petts et al., 2001), or that the role of popular representations of science on public perceptions is a complex, nonlinear, phenomenon (i.e., the media both reflects and helps to shape public opinion, Ten Eyck, 2005).

Much has been written about scientists’ attitudes and views towards media, in order to give an overview of this literature the remainder of this section has been divided into five sub sections: Media influences on public policy and funding; Coverage of scientific mavericks; Media confuse the public; Scientist–journalist tension, and Fears of inaccuracy and the so-called symbiotic relationship. What these sub-sections have in common is that they show that scientists view media as being very powerful, but also of often not using that power to good effect.

2.6.1 Media influences on public policy and funding

Much science communication literature is devoted to scientists’ views of media. In a survey of scientist members of Canada’s Stem Cell Network (SCN) carried out by Caulfield and Zarzeczny (2010), the majority (57.1%) of respondents agreed that science is playing an increasingly important or prominent role in popular culture (e.g. movies, television, books, etc.). Scientists are concerned with media coverage of science as they believe that media coverage is strongly influential in people's opinions of science. The public may be misguided because they are swayed by biased or sensational news coverage (Blok et al., 2008; Burchell, 2007; Burningham et al., 2007; De Boer et al., 2005; Krystallis et al., 2007; Young and Matthews, 2007). Media coverage has been credited with both reflecting and impacting policy decisions (Nisbet and Lewenstein, 2002). Caulfield and Zarzeczny's (2010) study found that almost half of the scientists surveyed (48.2%) believed that popular culture representations of science do have an impact on funding decisions, while almost three-quarters (76.8%) agreed that popular culture representations of science affect policy decisions (for example, on what kind of research is or is not permitted in a jurisdiction). Nelkin (1995), for instance, linked media coverage to funding decisions related to cancer research, infantile paralysis, AIDS, and technology, agreeing with communications researcher Leah Lievrouw's (1990) assertion that popularisation can secure or ruin the prospects for support of certain lines of research. The science writer and editor Boyce Rensberger (1997) describes journalists as gatekeepers for the infusion of scientific information into the public sphere. Kirby (2000, 2003b) has suggested that scientists believe that popular cultural portrayals of science is connected to popular opinion and thus to funding. The influential Royal Society Bodmer Report (1985), *The Public Understanding of Science*, argued that the attitudes of news editors may be one of the major obstacles to science receiving more coverage.

Many authors have described a strained relationship between science and the media; for example, Tom Wilkie (1991), executive chairman or Europa Science, observed the tension between journalistic interest and scientific credibility, because ultimately "The criterion of interest is that of the reader—the consumer of the newspaper—not the criterion of the scientist" (1991, p. 576). Wilkie and Graham (1998) referred to a tension between scientists and journalists in their study of UK broadsheet coverage of Dolly the sheep. They characterised this tension as between scientists trying to put their scientific message across and newspaper journalists who were more interested in examining the cultural contexts of cloning.

2.6.2 Coverage of scientific mavericks

One issue often cited in science communication literature and by scientists critical of media coverage, is the attention given to so-called "maverick" scientists who do not conform to accepted theories, for example "climate change sceptics". The struggles of these contrarian researchers make a romantic story, described by Gilbert and Mulkay (1984) as resembling David and Goliath, with a seemingly bright go-it-alone scientist bucking an intransigent, conservative scientific establishment, whose representatives subjectively attack the personal credibility of the maverick. It is also no small part of a journalist’s training to distrust authorities and when a journalist is presented with radically different opinions from sources, the conventional journalistic resolution is to play quotes against each other, as Hilgartner (1988) expresses it, to let the experts ‘battle it out’ for the right to speak for science.

Communications researcher Dearing (1995) noted in his analysis of media reporting on “maverick science” that the journalistic norm of balance worked to make fringe claims more credible. As Stocking (1999, p.29) concluded:

> Sometimes, particularly in science addressing contentious public issues, journalists have been found to pit scientist against scientist, with little or no discussion of the reason for disagreements, and often without mention of the relative degree of scientific acceptance of the differing views. The resulting accounts of science give equal, but unequally deserving, weight to “duelling experts,” thus making the science appear more controversial and more uncertain than the bulk of scientists believe it to be.

Boykoff and Boykoff (2004) in a similar analysis, argued that balance too often means giving truth claims equal space, even when they are not, in fact, equally valid.

Dearing (1995) asserts that the intention of journalists writing about mavericks is not to “question the paradigmatic closed-mindedness of mainstream science” but to fulfil the expectations of both their editors and audiences that they treat the mavericks’ positions with respect. In Dearing’s survey of journalists, most responded that they did not believe the mavericks to be credible. Yet the framing of their stories constructs credibility, as, of course, news attention itself does, by conferring status (Lazarsfeld and Merton, 1964).

The BBC, in its editorial guidelines, does not aim for balance, but instead strives for ‘impartiality’, the idea being that impartiality implies more than a mere mechanical application of balance but instead that due weight is given to accepted norms and consensus in science. The Editorial Guidelines state:

> 4.4.1 Across our output as a whole, we must be inclusive, reflecting a breadth and diversity of opinion. We must be fair and open-minded when examining the evidence and weighing material facts. We must give due weight to the many and diverse areas of an argument.
>
> Breadth and diversity of opinion may require not just a political and cultural range, but, on occasions, reflection of the variations between urban and rural, older and younger, poorer and wealthier, the innovative and the status quo, etc. It may involve exploration of perspectives in different communities, interest groups and geographic areas.

As noted by independent programme-maker John Bridcut in his 2007 report for the BBC Trust, *From Seesaw to Wagon Wheel: Safeguarding Impartiality in the 21st Century*: "Impartiality involves a mixture of accuracy, balance, context, distance, even-handedness, fairness, objectivity, open-mindedness, rigour, self-awareness, transparency and truth." Likewise, the Editorial Guidelines (2010) also note that accuracy can mean more than getting the facts right; facts must be weighed and output must be "well sourced, based on sound evidence, thoroughly tested and presented in clear, precise language" (p. 3).

2.6.3 Concerns about media confusing the public

As well as concerns about the media attention accorded to mavericks, scientists also have concerns about the public being misguided because it is inordinately swayed by biased or sensational news coverage (Blok et al., 2008; Burchell, 2007; Burningham et al., 2007; De Boer et al., 2005; Krystallis et al., 2007; Young and Matthews, 2007). Such coverage is often criticised for emphasising the views of interest groups, industry and other vocal minorities rather than those of scientists and other experts perceived as impartial and authoritative (Burchell, 2007; Cook et al., 2004; Michael and Birke, 1994; Michael and Brown, 2000; Young and Matthews, 2007). Journalists' lack of specialist training is also seen as the cause of poor scientific coverage (Burchell, 2007; Petersen et al., 2009). There has been a tendency in much of the literature on science and journalism to see formal scientific training as not only desirable for science journalists, but also as a requirement for better and more accurate coverage of science. However, journalists who cover science have, as Nelkin (1995, p. 102) has pointed out, remained "divided as to the importance of formal training in science … While agreeing that there is a need for greater technical sophistication, some journalists argue that too much science education can handicap the reporter".

Some scientists appear to recognise that different types of journalists can produce different types of content, that scientists sometimes lack the ability to communicate effectively to reporters, and that science can be difficult to adequately report (Petersen et al., 2009). Scientists also appear to rely on a simple sender–receiver model of media effects that fits poorly with contemporary media effects research (Davies, 2008; Petersen et al., 2009).

A 2001 survey of 1,540 scientists in Britain sponsored by the Wellcome Trust (MORI/Wellcome Trust, 2001) and analysed in detail by Besley and Nisbet (2011) found that 53% of scientists said the main barrier to "greater understanding of science" among the public was lack of education. Another 35% said the problem was the media, 26% said the problem was lack of understanding about scientific processes, and 22% suggested that the problem was the lack of interest. Attitudes such as these held by scientists play into the deficit model of science communication, i.e. scientists construct ‘the public’ as a group that needs to be educated, rather than as diverse groups that can deliberate, discuss and contribute, and that have a stake in the outcome (Trench, 2008).

2.6.4 Scientist–journalist tension, fears of inaccuracy and the so-called symbiotic relationship

The great power that scientists ascribe to the media and its perceived influence over policy and funding, combined with scientists’ fears of sensationalised, skewed, inaccurate and confusing coverage has led to feelings of tension between scientists and journalists (Amend and Secko, 2012). Journalists make the counter claim that their role is:

> neither to educate the public nor to make the public scientifically literate, but a rather more modest goal of supplying interesting, informative, and entertaining coverage
>
> (Hansen 1994).

A central theme in numerous analyses of science journalism is the notion that science coverage occupies a unique place, and differs in many ways from the norms and factors which apply in news production generally. This argument hinges in particular on the notion that science journalists are locked in a relationship of symbiotic dependency with their scientific sources. Because of the complexity of much science, science journalists are seen as being uniquely dependent on the co-operation of their sources (Lafollette 1982).

Hansen (1994), in his study of science journalists, found that they see themselves as ‘journalists’ first and ‘science journalists’ second, and their specialist beats as journalism first and specialism second. Like specialist journalists in other fields (see, for example, Ericson et al., 1987 and Golding and Middleton, 1982) journalists in Hansen’s (1994) study emphasised journalistic training and skills as generally more important than a degree or other formal training in their specialism. They see their job as one of providing interesting, informative, and entertaining coverage of science, not as one of educating the public or proselytising on behalf of science. This is in agreement with Gregory and Miller’s (1998: p. 105) conclusion that science is not a special case in the mass media, and understanding science-in-the-media is mostly about understanding the media.

And it’s not just journalistic coverage of science that scientists worry about. Kirby (2003a) asserts that scientists worry that inaccurate portrayals of science in film and television has the possibility of decreasing public support for science.

2.7 A tense relationship—how science constructs policy makers

There has been much controversy between government and policy makers about what each of their roles should be, as well as between scientists and scientific institutions about how best to deal with policy makers.

Alm and Simon (2001) interviewed 129 scientists from the United States and Canada, asking such questions as: “Do policy makers listen to scientists?” They found that a consensus of scientists think that policy makers listen to them. However, other studies (Innvaer et al., 2002) have found that many scientists are sceptical about the extent to which their research is used by policy makers, and that many policy makers are sceptical about the usefulness of research.

In the UK, tensions between science and government came to a head over the “David Nutt affair”. Professor David Nutt, the government’s chief drug adviser, was asked to resign from the chair of the ACMD (Advisory Council on the Misuse of Drugs) after claiming in a paper that ecstasy, LSD and cannabis were less dangerous than alcohol and tobacco.

In a BBC News report following the resignation in 2009, Pallab Ghosh claims that some senior scientists who advise government (and did not wish to be quoted on the record) felt that the Nutt affair is reflective of the inner workings of providing scientific advice in Whitehall. As Professor Colin Blakemore, professor of neuroscience at Oxford University and former chief executive of the Medical Research Council, said in an interview with BBC News: “I worry that the dismissal of Professor Nutt will discourage academic and clinical experts from offering their knowledge and time to help the government in the future,” (BBC News, 2009).

Tensions between science and government also exist in the USA, almost halfway through President Obama’s first term of office, federal scientists were beginning to doubt whether he would deliver on his inauguration promise to “restore science to its rightful place” (Waltz, 2010). In Canada, the government’s poor record on openness has been raised in the scientific journal *Nature* (O’Hara, 2010). *Nature’s* news reporters report experiences of the cumbersome approval process that stalls or prevents meaningful contact with Canada’s publicly funded scientists. (Nature, 2012)

Scientists have accused government and policy makers of making it difficult for them to speak freely to the media, in effect gagging them. In 2006, charges that then-president George W. Bush's administration had silenced US government researchers made front-page news (*Nature*, 2012). In the UK, Ghosh (2009) reported that advisers to government to whom he spoke felt that their committees produce reports whose conclusions are inadequately reported because the publicity is tightly controlled by government press officers. Another criticism from scientists is the expectation for them to sign confidentiality agreements—a practice said to exist for commercial reasons—but which some critics claim can act as a legal gag on scientists who speak out on government initiatives (Ghosh, 2009).

Waltz (2010) writes about difficulties that US Government scientists experience when they wish to comment on policy matters. He quotes Thomas Sappington, a research entomologist at the Agricultural Research Service (ARS) office in Ames, Iowa, who experienced a hold up when he attempted to publish a recent commentary on biotech crops. "It was very difficult for me to get permission to be the lead author on the paper," said Sappington. "The ARS gets very nervous when its scientists write non-research pieces." In the end, the commentary got through the process with some minor wording changes, albeit delayed by a couple of months.

Waltz (2010) also interviewed National Oceanic and Atmospheric Administration (NOAA) employees, who are allowed to speak to the media about science without getting permission from the press office. Even so, when interviewed by Waltz, Mark Powell, a hurricane expert at NOAA's Atlantic Oceanographic and Meteorological Laboratory in Tallahassee, Florida, said that after the oil spill, a team of NOAA experts was assembled and 'cleared' to talk to the media. As Powell understood it, no one else was allowed to speak publicly: "I decided to turn down a local TV interview because I had not yet been cleared."

However, the NOAA is an example of a body with good relationships between policy makers and scientists according to the Canadian Science Writers' Association and several other organisations who have, in a letter sent to the prime minister on 16 February 2012, called for the Harper government to: "implement a policy of timely and transparent communication like those used by NOAA and the NSF" (*Nature*, 2012).

Another major source of tension between scientists and policy makers is the issue of funding. In the UK, protests by scientists over government cuts have been ongoing for the past year. One particularly spectacular protest, organised by the Science for the Future campaign, and attended by more than one hundred scientists, was a mock Victorian funeral procession—including a coffin representing the death of science—to number 10 Downing Street. One of the organisers of the protest, Tony Barrett, of

Imperial College London, described British Government policy towards science as a “Stalinist collectivization of science” (Bhattacharya, 2012). This point was amplified by Rebecca Goss of the University of East Anglia, who criticised the lack of funding for blue sky research and the emphasis on impacts and outcomes: “One of the things that worries me most is that you have to predict what the impact of your research might be—that way, you’re funding just incremental research” (Bhattacharya, 2012). The protest organisers argue that funding decisions are affecting fundamental research and claim that if the current policy—which asks grant applicants to predict the benefits of their research in advance—had operated in the past then penicillin and lasers would not have been developed.

The role of scientists in policy making is also an issue. Some scientists have made their views on this public. The American biologist Karr (2006) asserts that recent headlines suggest that science and scientists play less of a role in government policy making than ever before. There have been calls from scientists for policy makers to give them a stronger voice. For example, the British Royal Society, under the leadership of Sir Paul Nurse, is attempting to boost its role in government decision making by fostering greater involvement of its roughly 1500 fellows and foreign members in preparing reports. As Nurse is reported as saying in an article by Brumfiel (2011, p. 258) “The Royal Society has a responsibility to provide advice on difficult issues, even if they are contentious.”

The contentiousness of some scientific matters is no reason for scientists to shy away from comment and debate, according to Professor Colin Blakemore, professor of neuroscience at Oxford University and former chief executive of the Medical Research Council, who has said the government could not expect experts who serve on its independent committees not to voice their concerns if the advice they give is rejected: “If scientists are not allowed to engage in the debate at this interface then you devalue their contribution to policy making and undermine a major source of carefully considered and evidence-based advice.” (BBC News, 2009)

As well as disputes over policy, scientists perceive themselves to be in very real difficulties when they are presented with not simply different interpretations or conclusions to be drawn from findings but with blatant misrepresentation of facts. Karr (2006) presents the quandary faced by scientists when politicians and government institutions either misrepresent or ignore scientific findings and conclusions:

> Should scientists stay disinterested and neutral, and defer to the policy makers, thereby risking science that may be distorted or hidden? Or should they speak up and try to educate policy makers and the public, whose ecological, economic, and social well-being may be threatened when scientific facts and lessons are misrepresented? Should

> doctors be neutral about the lives of their patients? Should lawyers profess neutrality about justice and injustice? I think not, and I also contend that scientists should speak up. Not speaking up would be tantamount to dereliction of duty.
>
> (Karr 2006, p.287)

However, there are differences in opinion about when speaking up and educating policy makers about scientific issues turns into becoming an advocate for scientific, particularly environmental issues. John Marburger (2007), the former director of the US Office of Science and Technology Policy, maintained that the advocacy that scientists perform individually or through institutions or professional societies shapes the actions of government, and the impacts spread throughout society.

Ecologists have debated among themselves whether to assume the role of policy advocate. Alarmed by the loss of pristine ecosystems to study, many ecologists say that environmental change is happening too rapidly and that society should adopt policies to prevent, slow, or manage the changes to yield outcomes that they consider desirable. Statements that purport to be objective (in the sense that they are value free) and politically neutral (in the sense that they are advocacy free) are frequently based on the unstated values of the scientist, who often feels no obligation to express how personal values have influenced scientific judgement (Rykiel, 2001). Many biologists, like the fisheries scientist Lackey (2001), and ecologists see no problem with using their scientific credentials to champion personal policy preferences. Scientific credentials are used to portray the information provided to the public as objective and value free, with the implication that those traits confer greater weight to scientific opinions than should be accorded to the value laden opinions of non-scientists. The notion that scientific judgements are value free is disputed by both observers and practitioners of science (for example by the environmental scientist Robert Costanza, 2001, p. 459).

Ecologist Frederick Wagner (1999) fears that ecologists who assume the role of environmental advocates will lose their credibility in policy making because policy makers—and the public—will perceive their scientific statements as being biased by their political agendas. The environmental scientist Edward Rykiel (1997) asserts that when scientists are perceived to have a political agenda, they lose their credibility, and policy makers can therefore ignore any scientific information they provide. Wagner (1999) goes on to claim that scientists should be as neutral as possible in playing the role of analyst to environmental policy makers and should eschew the role of advocate for particular policies that are best decided in a larger social context. Forest ecologist Richard Pouyat (1999, p. 284) considered that: “if biologists and ecologists wish to be taken seriously in the policy making process, they must work at being viewed as members of the scientific community rather than as part of the advocacy community”. Other scholars disagree, for example, Mooney and Ehrlich (1999) suggest that ecologists should act as lobbyists for the policies they think are best.

However, Alm and Simon (2001) in their survey of 129 scientists from the United States and Canada found that a minority of natural and government scientists disapprove of advocacy. These scientists believe that it is not possible to separate science and policy making and, thus, advocacy will damage the scientific ideal of objectivity. However in the same survey, a majority of social and university scientists, began with suspicions about objectivity but in the end concluded that science and policy making could not be separated.

But not all constructions of policy makers by scientists are of conflicting bodies. Choi et al. (2005) expresses the hope that scientists and policy makers can draw lessons from ecology: a science that studies the co-evolution of different populations in their environment. Ecologists posit that populations can evolve together antagonistically or complementarily: in both cases the populations adapt both to survive and to work effectively in an environment shared with the other population.

Indeed, scientific associations are taking steps to improve relationships and understanding between scientists and policy makers. For example, the American Association for the Advancement of Science (AAAS) has a programme where scientists are actively encouraged to enter the policy making arena (Chubin and Maienschein, 2000). SciDevNet, a Science and Development Network, includes on its website practical guides on briefing policy makers on science-related issues (Nath, 2008); and telling policy makers about scientific uncertainty (Nath, 2012). SciDev.Net advises that it is “tremendously rewarding to work with policy-makers, and you’ll get a great buzz when you first hear your words quoted in a political debate” (Nath, 2008).

Many such guides have been written for scientists on how to communicate with policy makers. They usually address the different goals and attitudes towards information held by the two groups. Weber and Word (2001) have noted that scientists perceive communication as the sending of data that are received and absorbed by non-scientists. However, that view ignores the frame of reference of the receiver. They point out that non-scientists assume that scientists are advocating a position, while scientists believe that they are only providing objective information. Scientific knowledge is communicated in a public context of multiple frames of reference that may be disjointed, overlapping, or conflicting. Weber and Word (2001) support the view that facts take on meaning only when they are embedded in a story (narrative) that organises them. Guldin et al. (2005) recommended that scientists use multiple channels, including personal and informal contact, to get information to policy makers in a form they could comprehend; and remarked on the necessity for scientists to try to understand the policy process in order to increase effective communication. Carrada (2006) in his *A scientist's survival kit*, commissioned by the European Union asserted that it is not enough to translate science into simpler language, scientists also need to carefully plan their communication and realise they are engaging in a competition for attention. Choi et al. (2005) asserts that important issues affecting scientists and policy makers working together include lack of mutual trust and respect, different views on the production and use of evidence, different accountabilities, and whether there should be a link between science and policy. Pouyat (1999) posits that scientists naively believe that they know how to communicate and that it is the non-scientists who need to be educated to receive the message. Choi et al. (2005) goes on to say that scientists resent the power of policy makers to control research funding, and that scientists believe (and resent the fact that) policy makers frequently misuse scientific data to fulfil political policy agendas.

The ecologist Acreman (2005) also addresses differences between science and policy and concludes that the results of scientific studies are not always in the form required by decision-makers, which leaves considerable room for judgment in making final decisions. According to Sir Paul Nurse, president of Britain's Royal Society, scientists also need to be disabused of ideas of the perceived importance of their work, as he says in a BBC interview: "Nobody in politics reads an academic report, slaps the side of their head and says 'Wow!'" (Brumfiel, 2011).

Scientists and policy makers can also misunderstand what the other wants. For example, Janse (2008) found that policy makers find information on forest policy and forest resources most important, whereas scientists believe policy makers find information on forest ecology and management and forest products and socio-economics most important.

Also, it is not part of the culture of scientific institutions to reward scientists for engaging with policy makers. Phelan (2000), for example, states that research institutions tend to reward their staff for producing publications. Providing incentives for researchers to achieve research uptake is the exception rather than the rule. Applied and strategic research institutions must reward success in achieving uptake/adoption if researchers are to become more focused on achieving tangible impact.

Chubin and Maienschein (2000), agree that the current reward mechanisms simply do not work optimally to encourage policy makers and scientists to work together. The need for a partnership was pointed out in the 1998 Johns Hopkins Symposium on the ''Translation of Epidemiologic Evidence into Public Health Policy'' (Samet and Lee, 2001).

Scientists face a challenge when working in the policy arena. They want to protect their claim to authority over production of facts by making a clear division between "facts" and "values", i.e. between objective science and politics. However, science is culturally legitimated by the usefulness (to policy makers) of scientific results. So scientists are confronted with the task of keeping close to politics, in order to continue to have their scientific results accepted and used, but also to avoid being seen as being too close to politics, and therefore not independent or objective (Gieryn, 1995; Jasanoff, 1990). Negotiating this boundary—between science and policy—is increasingly difficult in the mode 2 science paradigm, which is socially distributed, application oriented, trans-disciplinary, and subject to multiple accountabilities (Gibbons et al., 1994). In environmental policy making, for example, if the boundary between science and politics represents a constantly negotiated contract between scientists and decision-makers, there is no real or clear-cut demarcation to fall back on when reinstating the independent authority of science. Instead, the science–policy interface represents a hybrid, or mutually constructed arena, where facts about the natural world are shaped by the social relations between scientists and those whom they advise (Shackley and Wynne, 1996; Jasanoff and Wynne, 1998; Miller and Edwards, 2001).

Lövbrand and Öberg (2005) argue that in order to move forward, to negotiate this boundary, it is necessary to instigate a reflexive and philosophically informed discussion about the situated and provisional nature of scientific advice in environmental policy making among scientists themselves and those making use of scientific results, while the German sociologist Ulrich Beck (1992) sees the challenging of the demarcation between science and politics as the way toward a more socially accountable and reflexive scientisation of environmental policy.

To challenge these boundaries, scientists need to address the social limits of scientific truth speaking and the plurality of knowledge claims. To acknowledge the provisional nature of scientific advice in policy making is to open up for a reflexive discussion about the epistemological and cultural assumptions underpinning science.

2.8 Open and transparent—how policy makers construct themselves

Policy-makers are working with the on-going project of democracy. Different types of democracy have been posited. Some people are satisfied with representative democracy, others want strong democracy where everybody participates, and others want communitarian democracy where the emphasis is on the common good.

Governments see their role as being open and transparent. In the UK, the Science and Trust Report (2010), describes how situations around climate change data, the use of scientific advice within government, and the final censuring of Dr Andrew Wakefield, have been accompanied by calls for greater openness and transparency. This followed on from the influential Royal Commission on Environmental Pollution (RCEP) 1998 report ‘Setting Environmental Standards’. This report advocated much greater transparency and openness within decision-making. The RCEP report also stressed the significance of public engagement and participation—with particular emphasis on public trust and the articulation of environmental and social values.

> Those directly affected by an environmental matter should always have the accepted right to make their views known before a decision is taken about it. Giving them that opportunity is also likely to improve the quality of decisions; drawing on a wider pool of knowledge and understanding (lay as well as professional) can give warning of obstacles that, unless removed or avoided, would impede effective implementation of a particular decision.
>
> (para 7.8, p. 102)

And also:

> Governments should use more direct methods to ensure that people’s values, along with lay knowledge and understanding, are articulated and taken into account alongside technical and scientific considerations.
>
> (para. 7.17, p. 104)

Different ideas about democracy emerge in every generation. As Tony Wright, MP for Cannock and Burntwood and joint editor of the Political Quarterly, has noted:

> Each generation in each place will come to the question afresh, trailing its own historical and ideological baggage. We may be all democrats now, but we may well not talk in the same way or even mean the same thing.
>
> (Wright, 1996)

Schumpeter’s (1943) definition of democracy as the “competitive struggle for the people’s vote” should, in some scholars’ opinion be superseded by a new type of collaborative democracy, this strong democratic theory means that the extent to which citizens are involved in the decision-making process is non-negotiable, and participation requires, as Fiorino suggests, the exercise of decision authority or the co-determination of policy in collaboration with government officials (Fiorino, 1990).

There is also support for a ‘communitarian’ democracy, which, while not hostile to the individual of direct democracy, places the emphasis on service to the common good rather than pursuing private ends, the communal rather than the private (Abramson et al., 1988; Etzioni, 1997).

So where does science fit in all this? How can democracy work in a society where decisions have to be made about complex scientific evidence? This is difficult as lay publics lack the expertise to make judgements on scientific issues, but these issues are important to the society that they live in. Bohman (1999) is among the growing number of commentators who argue that scientific and technological developments are rupturing—or have the power imminently to rupture—the long-accepted social norms by which members of democratic societies recognise and respond to each other. As science and technology become more and more embedded in society, a lack of scientific expertise means that individuals have less and less say in the running of society. As one critic put it: “We cannot hope to maintain even the limited degree of democracy that we now have (in the US) if the great majority of us are alienated from the language and methods of science” (Cooper, 1998, p. 25).

Implementing a democracy with broad participation in scientific decision-making, such as that called for in the RCEP report has considerable pitfalls. One difficulty is the problem in re-integrating disengaged citizens into the process. The challenge, as Nelkin (1977) has observed, is to reverse the increasing alienation of the individual citizen from political processes in an expertise dominated society.

2.9 An economic powerhouse—how policy makers construct science

Policy-makers’ construction of science is overwhelmingly as an economic powerhouse. This section examines the EU and the Irish government’s construction of science in this way by means of reviewing a number of government strategy documents and reports.

European policy is to encourage the setting up of a knowledge society/economy whereas Irish Government policy sees science as necessary for innovation and the creation of jobs. The Lisbon declaration set Europe the goal of becoming “the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion” (Lisbon European Council, 2000). For its part, Ireland is pursuing a ‘knowledge-based economy’ (Trench, 2009), and research and innovation are central to this public policy. The Strategy for Science, Technology and Innovation 2006-13 (Government of Ireland, 2006) emphasises this, it has among its aims that: “Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture,”

It was one of the aims detailed in the Innovation Taskforce Report (2010) that:

> by 2020 Ireland will have a significant number of large, world leading, innovation intensive companies, each having a global footprint, many of which are Irish headquartered and owned.

It is Irish government policy “to sharpen the focus of our national research system to target areas of potential strategic and economic advantage for Ireland” (Forfás, 2010).

A knowledge economy needs people with advanced scientific and mathematical skills in order to thrive, and according to a 2008 report titled *Future Requirement for High-level ICT Skills in the ICT Sector*, the ICT sector will play a vital strategic role in ensuring Ireland’s long-term prosperity and will need graduates with high-level ICT skills. Part of the solution to this is to engage young audiences (especially girls) with science and mathematics. According to the Report and Recommendations of the Task Force on the Physical Sciences (2002), there is currently a low level of engagement with science in the media, the report continues that this provides a challenge if Ireland is to belong to the scientifically literate community of the modern technological world. The Innovation Taskforce Report 2010 notes that “at second level we need to raise levels of competence and attainment in maths and sciences substantially such that they feed into Science, Technology, Engineering and Maths (STEM) disciplines at third and fourth levels and we need to develop and reinforce creativity and problem solving capacities across the workforce.”

This purely economic view of science is, this thesis contends, harmful to democracy, as it discourages policy makers from opening any dialogues with publics about scientific research for fear that such dialogues may slow down such research, and therefore act as a brake on the economy.

2.10 Misusing the dialogue model—how policy makers construct publics

This section draws mainly from government reports and policy documents to provide evidence for the ways in which policy makers construct publics for science.

In the UK, government reports mainly propose a dialogue model for interacting with publics on scientific issues. The British House of Lords Select Committee on Science and Technology (2000) suggested a key role for communication as a way of reducing tensions between science and society by moving away from a deficit approach towards a model that promotes greater dialogue and consultation. In Ireland, though government reports usually define science in terms of its beneficial economic impacts only, the 1999 Technology Foresight Ireland Report included among its recommendations a proposal for a ‘national conversation on biotechnology’ and advocated a communications strategy in biotechnology that uses a partnership approach with on-going, transparent and open dialogue.

The misuse of the dialogue model has been criticised (Papadakis, 1993, p. 103) in that dialogue—which can take place behind closed doors—if it has no practical consequences, simply leads to programmatic statements. Rowe and Frewer (2000) note the inequality of sides in any dialogue between institutions and publics. The lay side of the conversation does not have access to the resources that would enable them to make good decisions. Public hearings come in for particular criticism. It has been suggested that their main aim is often to co-opt public support and to change decisions rather than to seek informed consent and expand democratic choice (e.g., Nelkin and Pollak 1979). Some empirical evidence suggests that they have little influence on citizen behaviour or policy choices (Cole and Caputo 1984).

Governments often consider dialogue a panacea in dealing with the publics' relations with science. It can provide a prompt (and cheap) solution for the debate on, for example, genetic manipulation and food safety (issues identified in more expensive Eurobarometer (2001) polls). They have been seen as being quick, cheap, and simply administered means of satisfying any legal requirement for public participation (Smith 1983), and seen as giving the appearance of community involvement (Fiorino 1990). Indeed, public hearings often seem designed to contain and control participation (Middendorf and Busch 1997) by allowing only limited choices on narrow, short-term questions at a late stage of the policy process (e.g., as noted by the environmental lawyer Ellison Folk 1991 in his account of dioxin contamination in wells near the Koppers and Louisiana Pacific wood treatment facilities in Oroville, California.).

Nelkin and Pollack (1979) have proposed that public participation models which are dominated by elite expert knowledge and which restrict public input to an advisory rather than a decision-making role amount to no more than a 'welfare model' of participation. Wynne (1982) has suggested that many of the public dialogue hearings are more of a ritual than a participatory mechanism. Davison, Barnes and Schibeci (1997) said that such so-called dialogues may even be said to displace active forms of public debate. As Benjamin Barber (1981 p. 181) wrote: "He who controls the agenda—if only its wording—controls the outcome." Similarly, American political scientist William Riker writes, in his introduction to his book *Agenda Formation*: "Agendas foreshadow outcomes: the shape of an agenda influences the choices made from it" (Riker, 1993, p. 1). The political scientist Schattschneider, in discussing his theory of conflict displacement, an agenda-based approach to studying democratic processes, asserts: "The definition of the alternatives is the supreme instrument of power; the antagonists can rarely agree on what the issues are because power is

involved in the definition" (Schattschneider, 1960, p. 68).
Burns et al. (2003) notes that scientists may have scientific facts at their disposal, whereas members of the public have local or so-called lay knowledge of the problems. Both kinds of knowledge need to be exchanged for true dialogue to happen. The risk run by lay participants is that this legitimation can be tokenised so that the process becomes little more than a device to encourage public acceptance of controversial decisions (Nelkin and Pollack, 1979). However, these exchanges are happening with increasingly confident publics. As Helga Nowotny, president of the European Research Council, explains, the better-educated-than-ever population that inhabits the modern "agora" is also highly articulate. In the liberal Western democracies, experience of participation has taught many citizens how to express their views and articulate their demands Nowotny (2003).

Things are changing. Government thinking in the UK has developed to the point that the authors of the Science and Trust Report (2010, p. 6), were clear and unanimous in their agreement that they didn't want publics to blindly and uncritically accept what scientists tell them; rather: "we want to see all actors and influencers working together to enable a greater degree of critical reasoning and discussion, and better communication of scientific processes". However, Ireland is slower in adopting this thinking, and Padraig Murphy, in his research into public engagement with nanotechnology, has concluded that: "the emerging, underlying discourses of public engagement, however, have not yet taken root in Ireland" (Murphy, 2010, p. 14).

2.11 Helping to increase public support and understanding—how policy makers construct media

Media is seen by policy-makers as one of the key elements in engaging people (especially young people) with science. For most citizens, knowledge about science comes largely through mass media, not through scientific publications or direct involvement in science. As Nelkin stated in her book *Selling Science*, the public understands science "less through direct experience or past education than through the filter of journalistic language and imagery" (Nelkin 1995). In an Irish context, Trench (2007, p. 129) notes that government and other social interests with a stake in science often look to the mass media (as well as to the educational system and direct promotional initiatives) to help develop awareness of science in the general population, going as far as funding media such as the science television programmes *The Investigators* and *The Science Squad*. The 1995 Report of the Science, Technology and Innovation Advisory Council (Tierney Report), was critical of Irish media, observing that they had a low level of interest and expertise in covering science. It recommended that a significant cultural shift in attitudes be brought about to improve communication between the scientific community, the media and the public, while the 1996 White Paper on Science technology and Innovation noted “the weak representation of STI issues in public affairs” (Government of Ireland, 1996).

Specific areas of science would also benefit from public awareness through the media. In the Eurobarometer Survey (2007), when respondents were asked what news related issues they were interested in, 19% mentioned scientific research (this compares to an EU average of 31%). To put this in context, 54% of Irish respondents mentioned sport and 42% mentioned entertainment and celebrities. The areas of scientific research which are of most interest to Irish people are—again according to the Eurobarometer 2007 survey—medicine, cited by 45% of respondents as a field of scientific research they are interested in, and the environment, cited by 42%. Government policy regarding public engagement with scientific research in medicine is outlined in the Advisory Council for Science, Technology and Innovation’s 2006 report *Towards Better Health: Achieving a Step Change in Health Research in Ireland* which recommends raising awareness of the value of scientific research into innovative products and therapies. With regards to the environment, the 2007 White Paper from the Department of Communications, Marine and Natural Resources discusses the need for commentary and analysis on energy matters in the media.

The 2007 Eurobarometer survey also investigated which media sources the respondents trusted the most for obtaining information on scientific research. Irish respondents overwhelmingly (70%) cited television as their most trusted source. As the Irish respondents trust television more than other media, it is not surprising that they prefer traditional television channels to provide them with information on scientific research (51%), while 31% cite thematic television channels and 27% cited radio (the figure for radio is particularly interesting as it is quite a bit higher than the EU average of 16%). In the UK, respondents to the Public Attitudes to Science survey carried out in 2011 responded that they heard or read about new scientific research findings most often on television (54%), and print media (33%), followed by internet excluding blogs (19%), very few (2%) use science blogs specifically as one of their most regular sources (Ipsos MORI / Department for Business, Innovation and Skills, 2011). In workshops carried out as part of the same survey, participants said that they trusted television more than newspapers for providing science information, “mainly because they felt they could see the evidence for themselves on the screen” (p. 40), and were ambivalent about information from the internet, as: “They thought the internet had many conflicting opinions on the same issues, so it was more difficult to know what to believe”. In the US, a study by Paul Brewer and Barbara Lee at the University of Wisconsin, which gauged audience perceptions of the trustworthiness of sources of scientific information about the environment, respondents rated television programmes or channels about science such as *Nova* and the Discovery Channel as the most trustworthy sources (compared to university scientists, the U.S. Environmental Protection Agency, environmental organisations such as the Sierra Club and the Environmental Defense Fund, the local daily newspaper, science magazines like Popular Science and Scientific American, and science websites and blogs like Discover.com and ScienceDaily.com), with 47% saying that they trusted science television either a great deal or a good deal. Among the sources studied, the news media were the least trusted sources of scientific information about the environment: only 14% trusted television news a great deal or a good deal, and the same percentage trusted the local daily newspaper.

The Special Eurobarometer report (2007) on scientific research in the media proposes the following role for media:

> The media can play a crucial role as an interface in the science domain, helping to increase public support and understanding regarding the need to create a knowledge-based society. In addition, it could contribute to encouraging investments in research and justifying public funding. By attracting the attention of the young towards science a solid basis can be created for next generation of scientists which is essential for the lasting competitiveness of the EU.
>
> (Eurobarometer, 2007, page 2)

2.12 Journalists first and science journalists second—how media constructs itself

The communications researcher, Colleen Cotter (2010), describes two self-referential aspects of news-practitioner habit (and habitus) as key to understanding journalistic discourse: their professional (internal) identity enacted through a craft ethos, and their public (external) commitments. Craft is important in creating a self-identity: the practice of journalism means mastering a craft and subscribing to values that the group maintains through an apprenticeship dynamic. Community is another important framing concept: the news media sees itself in relationship to the community they cover, as responsive and responsible, as a friend and as an authority.

Journalism craft or practices are an important part of how the media constructs itself. News is constructed according to a number of these specific norms and practices, as discussed in media sociology (Berkowitz 1997). The texts that are constructed are not a reflection or distortion of what is going on “out there”, instead, what is seen on the screen or heard on the radio reflects the practices of workers in the organisations that produce this content (Fishman 1982: p. 220). Professionally, the media sees itself in an adversarial, confrontational stance with regard to newsmakers. Its foremost claim is that journalists are continuously in search of the truth. By implication, those who are the subjects of reporting seek to conceal or obscure at least part of the truth (Thompson, 1985). In the words of Louis Heren, most famously quoted by the BBC's Jeremy Paxman "Why is this lying bastard lying to me?" This can make journalists cautious of university PR departments, Tunstall (1971) in the first major social science study of specialist journalists in the UK, noted that a key dimension of the professional ideology of journalists is to avoid that which is readily available.

Hansen (1994), in his study of science journalists, found that they see themselves as 'journalists' first and 'science journalists' second, and their specialist beats as journalism first and specialism second. Like specialist journalists in other fields (see, for example, Ericson et al., 1987 and Golding and Middleton, 1982) journalists in Hansen's (1994) study emphasised journalistic training and skills as generally more important than a degree or other formal training in their specialism. They see their job as one of providing interesting, informative, and entertaining coverage of science, not as one of educating the public or proselytising on behalf of science. This is in agreement with Gregory and Miller's (1998: p.105) conclusion that science is not a special case in the mass media, and understanding science-in-the-media is mostly about understanding the media.

Much is also made of the 'competitor–colleague' relationship in journalism, this relationship has been noted as a distinguishing feature of science journalists in previous studies (e.g. Dunwoody, 1979). It is important to emphasise that while it may be a prominent characteristic of science journalists, it is not unique to this group: it has been found to apply also in other groups of specialist reporters (Tunstall, 1971).

As for the ideologies behind these professional practices, the media sees itself as the purveyor of absolute truth, the standard of right, the new clerisy (Lant, 1983). Hansen (1994) concludes that journalists are acutely aware of the constant attempts at manipulation and news management by sources, including by valued source forums such as government and government departments, and more generally by industry and business. The need to cope with the daily pressure to cover, rather than source pressure to prevent coverage, in itself helps explain the emphasis which these journalists put on their journalistic professionalism rather than on their science qualifications or other formal training in science.

Another orientation often criticised in journalists is to consistently go to the 'top guy' in the field, rather than to the scientist with the most expertise in the area. This authority-orientation of science journalists is not simply a matter of uncritical establishment-reporting. It is essentially part of the professional ideology of journalists, geared to securing and safeguarding the journalist's credibility in the reporting on complex issues and claims which can rarely be readily validated or assessed by the news medium itself. Another journalistic ethos that is often criticised by scientists is the requirement to get "two sides of the story". This journalistic ethos which demands that, particularly where controversial claims are involved, these be 'bounced off non-government-related sources, be they university scientists, or, as is often the case with "environment" stories, established environmental pressure groups. (Greenberg, 1985; Hansen, 1993). Scientists complain about this practice as it can—in their opinion—lend a disproportionate weight and credibility to so-called maverick scientists, though studies have found that the consensus scientific point of view is overwhelmingly the most reported (Dearing 1995; Corbett and Durfee, 2004).

For all the notions of journalistic ideologies of searching for the truth, avoiding the too readily available, going to the most credible sources, Steven Rose has emphasised again and again the cheerleading nature of much science coverage and the lack of enough critical scrutiny. In an article in *The Guardian* in 2004 Rose states:

> It is the task of the media to look just as critically at scientific statements and the interests of scientists making them as is now routinely done with politicians and industrialists.

2.13 'Somehow removed from the common culture'—how media constructs science

In her descriptive account of science in American media, Nelkin (1995, p. 21) suggests that the media perpetuate the mystique of the scientific enterprise with their presentations of science as an arcane and extraordinarily complex activity. Quite often, scientists are treated as "somehow removed from the common culture", and as if "science is a superior form of knowledge, and those who have reached its pinnacle have some special insight into every problem". Hornig (1990) found that the episodes of the science documentary series *Nova* maintained the 'sacredness' of science by portraying scientists as special and distinct from other professions. Hornig posited a structuring device within the typical *Nova* narrative, a distinction made between the scientific and what she calls the mundane.

> The opposition between science and nonscience … is central to understanding how scientific realities are socially constructed. The distinction between a sacred scientific activity and a profane nonscientific one is a … fundamental opposition apparent in these NOVA productions. (p. 18)

Nova has also been accused of not getting involved in controversy, and in fact not representing the controversy at all in programmes about controversial topics (Oberacker, 2007).

Much of the literature about the media's construction of science is based on Film Studies and looks at how science is represented in film. Sociologist Peter Weingart and his colleagues undertook a quantitative study of 222 films of all genres, created over 80 years, looking for both recurring themes and changing patterns in the depiction of science in cinema (Weingart et al. 2003). Unsurprisingly, given its dominance in news media (Pellechia 1997), medical science is the most common research field depicted in films, followed by the physical sciences (chemistry and physics). These fields are also the most likely to be shown as 'ethically problematic' and to have scientist characters working in secret laboratories. In addition, Weingart et al. (2003) find that depictions of scientists are predominantly white, male and American. The overwhelming picture painted by both these studies is a cinematic history expressing deep-rooted fears of science and scientific research in the 20th century.

According to Susan Sontag (1966), the American writer and intellectual, a science fiction story earns much of its credibility from the visual fidelity of its scientific equipment and the role of that equipment in the story. The TV show *Law and Order* usually includes scenes where a detective looks over the shoulder of a fingerprint analyst watching digitised records from the FBI's Automated Fingerprint Identification System (AFIS) database race by on a computer screen. They also consult medical examiners and ballistics specialists who hover over microscopes and recite the results of scientific tests (Gever, 2005). And of course *CSI* scarcely has a scene which does not include the paraphernalia of the laboratory, even when attending a crime scene the protagonists use digital cameras and their trademark UV light torches.

Many films portray science to be dangerous to one's spiritual well-being because it is too clinical, too abstract, and the scientists who control the mysteries of modern secular knowledge are unaccountable to conventional standards of morality. Social anthropologist Toumey (1992) posits that often the supposed evil of science is invested in the personality of the scientist; in the three film adaptations of the 1896 H.G. Wells novel *The Island of Dr. Moreau* the protagonist Dr. Moreau is at once charismatic, obsessed, and insane. On the other hand, science can be portrayed as a force for good. The television series *CSI* demonstrates the benefits of modern science in the fight against crime (evil). In *CSI* morality operates as an expression of scientific truth, equated with the generalised social good (Gever, 2005).

In news media, science is represented somewhat differently: it is portrayed as being run by an elite of white coated persistent dedicated scientists, whose inventions are miraculous. Scientists are shown to have all the answers and to be able to explain, rationalise and solve problems.

Some tensions may exist between journalists and scientists based on differences between their occupational cultures. As the German social scientist Hans Peter Peters (1995) found, journalists accept the entertainment function of the news, see the media as having a more significant and critical role in disseminating science information, are less interested in the scientists' goals, and may tolerate a greater expansion of the narrow scientific norms when reporting science through the mass media.

2.14 Where is the audience?—how media constructs publics

Ang (1991) presents any attempts to 'freeze' the audience, as problematic. She defines the audience as an "uncertain discursive construct" that is "socially-constituted and institutionally produced" (p. 3); the television audience is a social construct—television programme makers and journalists construct their audiences (or publics). They do this with the help of audience ratings figures, and feedback from individual audience members, although Hansen (1994), in his study of science journalists, found that both popular and quality press journalists hold clearly different images of their target audiences and the image of the audience owes more to journalistic judgement and casual feedback than to systematic readership data.

The media constructs the public as a mass audience (Ang, 1991). This understanding continues in spite of changes to models of television viewing, such as on-demand services and personalised menus leading to an increased fragmentation of the audience. Mass audiences are the product of urban industrial society, and are characterised (by the American sociologist Herbert Blumer, 1939) in terms of: "largeness of scale, anonymity, and rootlessness," for Blumer, the mass audience are joined by their shared attention on an object outside of their immediate environment. According to McQuail's (1997) definition, a mass audience is heterogeneous, making active choices in terms of what to consume. Furthermore, research has shown that the individuals who make up mass audiences will not interpret messages in the same way, but draw on a range of resources, prior knowledge and experience:

> … people do not passively absorb everything that is beamed from their television set. Instead they interpret and contextualise. Public views are not formed from thin air. Equally, they are not simply dictated by the media or by ministerial pronouncements or by lay 'perspectives' or 'cultures'. Judgements are made according to information available from the media, education, friends and family and other sources and evaluated against previous experience and information.

(Miller, 1999, p. 218)

In this way, members of the audience use their prior knowledge, experiences, attitudes and beliefs to make sense of mass media (Holliman, 2004).

Ang describes the two main models for television audiences as that of a market of consumers and the paternal model of the audience as a group to be educated. The marketplace model approaches the television audience as a collection of consumers rather than citizens, thinking in terms of: “what the audience wants” rather than: “what it needs” (Ang, p. 166). Commercial broadcasters approach the audience as a market in this manner. They use ratings as there is no simpler means of widespread feedback. Ratings estimate audience numbers, demographics, etc.

RTÉ carries out research on the size and make up of its audiences and on the effectiveness of its advertising. The media sales pages of the RTÉ website www.rte.ie details research into audience figures, top rated programmes, audiences for sports coverage and out of home audiences, the effectiveness of television as a medium for advertising, audience recall of advertisements, attitudes to advertising, attitudes to brands, understanding how media channels fit into people’s lives, research into innovative forms of advertising such as live ads or themed ad breaks and “semiometrie”, “a quantitative tool by which we can assess the sub-conscious desires of respondents to allow users to discover just what it is that consumers really want as opposed to what they claim they want”. RTÉ uses Nielsen Television Audience Measurement to provide their ratings measurement service. Nielsen use a representative panel of 800 homes to gather information about Irish television viewing.

The paternal system on the other hand is defined by the cultural theorist Raymond Williams (2006) as: “… an authoritarian system with a conscience; that is to say, with values and purposes beyond the maintenance of its own power.” The BBC Reithean commitment to public service is a paternal system, in its aims to inform, educate and to entertain.

Contemporary critics have proposed alternative models such as public journalism (Massey and Haas, 2002; Rosen, 1999) that asked for a more reciprocal relationship between reporters and their audience, suggesting news should be a conversation rather than a lecture (Gillmor, 2004; Kunelius, 2001). The “public journalism movement” emphasises the relationship between the practice of journalism and the democratic work of citizens in a self-governing republic, and suggests journalists are ideally suited to help constitute vital “publics” to deliberate complex issues and engage in collective problem-solving activities (Merritt, 1998; Rosen, 1999). Public journalism has set out to help members of the public come to see themselves as citizens, and hold them accountable for grappling with the full complexity of issues and become participants in civil society rather than mere spectators of it (Nichols et al., 2006).

2.15 Concluding remarks on the literature

To begin with, the review of the literature examines the idea of scientific citizenship. It then looks at why it is needed, noting especially Fiorino's (1990) three reasons why the technocratic elite should not be allowed to dominate scientific policy making (substantive, normative and instrumental arguments). This review then places the idea of scientific citizenship firmly in the context of wider democratic citizenship, with Bryan's assertion (cited in Goldman, 1990) that all science decisions are really political questions and as scientists and policy makers are no more inherently moral than other citizens, their opinions should not be privileged. I then review the literature about different perspectives on scientific citizenship, and argue for a promotion of civic republican perspectives on scientific citizenship, given that plural perspectives and deliberative processes may be needed in order to reach socially legitimate and acceptable decisions about science. I propose an ideal of scientific citizenship "an open and critical discussion between researchers, policy makers and citizens" in agreement with Irwin (2001).

The next part of the literature review examines the ethno-epistemic assemblage of science, by looking at how individual elements of the assemblage construct themselves and each other. I find that the literature shows that scientists construct themselves in terms of their professional sub cultures, that they construct publics in 'deficit model' terms and that they construct media as being very powerful and having a strong influence on their audiences. All in all, what is most striking about this literature, much of it based on surveys and interviews with scientists about their attitudes towards media and publics is that the academic discourses of science communication, and the policy makers acknowledgement of a requirement for dialogue has not impacted on these scientists' thinking in the slightest. Scientists still maintain a very simple (hypodermic needle) view of media effects and they are wary of media because of this. They do not engage with the idea of dialogue, in fact they are wary of it because they see the public as being so irrational that they could not be trusted with any real power to make decisions about science. The scientists interviewed and surveyed did do some communicating with the public through media, but this was mainly aimed at raising their profile to make them more attractive to funders.

From the policy makers perspective, science is overwhelmingly constructed as an economic powerhouse, I show in later chapters how this public policy attitude seeps into media coverage of science and public attitudes (please see section *6.2.1 It's the* *economy stupid*, on page 217). Unlike scientists who don't even acknowledge the dialogue model, policy makers pay lip service to it in their construction of publics, misusing it as a mere token, a (often quick and cheap) panacea. See for example how policy makers construct media, privileging it as a very important way to engage publics, but this engagement is purely as a means of supporting science and making more young people choose science subjects in school and university (again to support the economy).

Media for its part, and in a similar fashion to science, constructs itself in terms of its professional identity. A large part of this professional identity is the ideology to seek truth, however they could do better, section *5.2.1.3.1 Cautionary comments*, oppositional comments, and controversy

, on page 181, shows that RTÉ news is not in any way critical of science. In terms of covering science, what is needed is an ethos of public journalism which emphasises the relationship between the practice of journalism and the democratic work of citizens in a self-governing republic, and suggests journalists are ideally suited to help constitute vital "publics" to deliberate complex issues and engage in collective problem-solving activities. I see Martin Rees's call for critical commentators on science as an important aspect of this public journalism. This public journalism should help members of the public come to see themselves as citizens, and hold them accountable for grappling with the full complexity of issues and become participants in civil society rather than be as James Carey (1993, p. 15) put it "a receptacle to be informed by experts", or as Elizabeth Jacka (2003, p.181) wrote: "increasingly alienated and cynical spectators".

3 Rationale for method

3.1 Using discourse analysis to examine the assemblage

Discourse analysis is a series of interdisciplinary approaches that can be used to explore many different social domains. Underlying the concept of discourse is the idea that our ways of talking do not neutrally reflect our world, our identities and our social relations but rather create and change them. Discourse analytical approaches take as their starting point the claim of structuralist and poststructuralist linguistic philosophy that our access to reality is always through language; with language, we create representations that are never just reflections of a pre-existing reality but rather contribute to constructing reality. These approaches include the general idea that language is structured according to different patterns that people's utterances follow when they take part in different domains of social life, examples are 'medical discourse' or 'scientific discourse'. Discourse analysis analyses these patterns.

This PhD research uses the concepts of discourse analysis developed by Laclau and Mouffe, initially defined in their 1985 book *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics*. The most important point of Laclau and Mouffe's theory of discourse is the poststructuralist idea that discourse constructs the meaning of the social world, and that, because language is fundamentally unstable, meaning can never be permanently fixed. No discourse is closed. Discourses constantly change through contact with other discourses. The idea is that social phenomena are never finished or closed and meaning is never fixed. This gives us constant social struggles about definitions of society and identity. Discourse analysis plots the course of these struggles to fix meaning at all levels of the social world, however, even though meaning is never fixed, we constantly strive to fix the meaning of signs by placing them in particular relations to other signs. Discourse is a temporary closure: it fixes meaning in a particular way, but it does not dictate that meaning is to be fixed exactly in that way forever. A discourse can always be undermined by articulations that place the signs in different relations to one another. Fixing meaning forever is ultimately impossible because every concrete fixation of the signs' meaning is contingent; it is possible but not necessary.

The aim of discourse analysis is to map out the processes of these constant attempts that never completely succeed, to explore the way in which the meaning of signs is (contingently) fixed, and the processes by which some fixations of meaning become so conventionalised that we think of them as natural.

3.2 *The circuit of mass communication: production–content–reception*

The study aims to answer the research questions by means of a production, content and reception analysis of science content on Irish television. Devereux (2003) calls these the three zones of critical importance in doing media analysis.

This theoretical framework was devised by the Glasgow Media Group (GUMG) and is known as the Circuit of Mass Communication (CoMC) (Miller, Kitzinger et al., 1998). The CoMC is a theoretical model that takes account of the different elements in the process of communication: the production, content and reception of media messages, by addressing the interactions of four sets of actors that interact to construct and interpret media messages.

The four sets of actors are: the media, the public, social and political institutions, and decision-makers (Miller, 1999). Holliman (2004) described a circuit of mass communication which influenced the production, content and reception of media coverage of cloning. This circuit of mass communication comprised: the public, media, scientists and scientific institutions, and decision-makers. Holliman showed that they all had a role in influencing the coverage, however, the level of influence varied. These categories were developed from the work of the political scientist John Thompson (1984, 1988). As he argued:

> Let me begin by distinguishing three aspects of mass communication. These aspects are closely interconnected in the process of producing and transmitting media messages, but by distinguishing them we could delineate three object domains for analysis. The first aspect is the process of production and diffusion … the second aspect is the construction of the media message … The third aspect of mass communication is the reception and appropriation of media messages
>
> (Thompson 1988, pp. 373-374).

Boykoff (2007, 2008) presents an example of how climate change science and policy shape media reporting and public understanding, as well as how journalism influences climate science and policy decisions.

The production of television programmes can be analysed by looking at the various contexts—cultural, economic, legal, organisational, political, social and technological—in which a specific television programme is created. This approach helps explain the dynamics involved in the making of a particular programme and forms a backdrop towards furthering understanding of the programme’s actual content and reception.

The content of television programmes broadcast in Ireland can be analysed by looking at the narrative, language, imagery, topic, length, music, or special effects used. This, coupled with a quantitative content analysis can offer a more systematic view of output. Content analysis can be used to investigate the portrayal of science and scientists on television. Used in combination with analyses of production and audience reception it can give insights into the representations of science used by television audiences.

The reception of television programmes broadcast in Ireland can be analysed by looking at the meaning that users of television programmes make from the representations they see on screen. Audiences can accept, appropriate or reject television programmes depending upon a wide range of sometimes complex circumstances (for example education or peer group).

The relationship between the production, content and reception of media texts is not straightforward, it is, as Thompson (1999, p. 17) puts it: “characterised by a distinctive kind of *indeterminacy”* (emphasis in original). The producers of mass communication texts such as television programmes rarely have direct contact with their audiences and the audiences are rarely in direct contact with the producers.

Audiences are, generally neither so passive and accepting as traditionally supposed by hypodermic needle theorists[15] nor generally so organised and so effective as to meet the high standards of those defining public participation. Rather they maintain (an often ambivalent) level of critical interpretation, to quote Sonia Livingstone: “drawing upon—and thereby reproducing—a somewhat ill-specified, at times inchoate or even contradictory sense of identity or belonging which motivates them towards but does not wholly enable the kinds of collective and direct action expected of a public.” (Livingstone 2005, p. 31)

McQuail (1997) defines a ‘mass audience’ as being heterogeneous, composed of individuals who differ and are different from each other and who make active choices in terms of what to consume. Other researchers such as Holliman (2004) have shown that the individuals in mass audiences do not interpret media messages in the same

[15] The Hypodermic Needle Theory, also known as the Magic Bullet Theory, was the first major theory concerning the effect of the mass media on society. Originating in the 1920s, the theory was based on the premise of an all-powerful media with uniform and direct effects on the viewer or audience. The Hypodermic Needle Theory is therefore an effects theory that contends viewers are passive, and directly affected by what they view; people accept the message they see without considering its merits. In that way media content is shot at the audience like a magic bullet, directly penetrating the viewer’ mind.

Wallace (2000) states early thinking about the mass media held that when media audience members were separate from one another, they were vulnerable targets easily influenced by mass media messages. Magic Bullet Theorists believed the media could shape public opinion and persuade the masses toward any desired point of view. In this way messages strike all members of the audience equally causing a uniform thinking among them.

way, but use their prior knowledge, experiences, attitudes and beliefs to make sense of mass media. Miller (1999) summarises:

> […] people do not passively absorb everything that is beamed from their television set. Instead they interpret and contextualise. Public views are not formed from thin air. Equally, they are not simply dictated by the media or by ministerial pronouncements or by lay ‘perspectives’ or ‘cultures’. Judgements are made according to information available from the media, education, friends and family and other sources and evaluated against previous experience and information.
>
> (Miller, 1999, p. 218)

3.2.1 Reception—examining the non-existent audience

Martin Allor defined the nature of the media audience as a discourse twenty-five years ago: “The audience exists nowhere; it inhabits no real space, only positions within analytic discourse” (1988, p. 228). In his analysis of approaches to understanding the site of media impacts as the convergence of individual and social practices, he demonstrated that what has always been “the audience” in media studies is actually a heterogeneous range of multiple subject positions and structural positionings. An audience is an abstraction, a socially constructed reality, constituted of and constructed by academic definings of what people do with the media and what the media does to people (Fiske, 1988; Hartley, 1988; Webster. 1998). An audience is the manifestation of citizens actively engaging with television programmes. The reception study in this research applies to what the actions of the audiences engaging with television programmes are, it is in examining this activity that the understanding of an audience is determined.

Rather than having direct effects on viewers’ understandings, Condit (1989) and Dow (1996) argue that television texts are rhetorical entities, that they are persuasive texts. Condit (1989, p. 115) posits that television programmes introduce “certain limited pieces of information to different ranges of audiences at different times.” That is, in the production of media, the decisions made by media producers can limit the interpretive materials available to audiences by not selecting some materials and can encourage audiences to accept some information by making it more available. Not only do these become the most available materials to the audience members, Dow (1996, p. 7) claims that these selections ‘work to make some ideas, positions, and alternatives more attractive, accessible, and powerful to audiences than others.’ Kellner (2003, p. 9) goes further again, claiming that in fact “media images help shape our view of the world and our deepest values: what we consider good or bad, positive or negative, moral or evil.” Although dominant understandings of issues and topics emerge from these media and are often reflected in the beliefs and attitudes of audience members (McQuail, 1987; Noelle-Neumann, 1984), audiences should not be seen as duped by the dominant culture. Audience members can, and do, provide resistant readings in which they have the opportunity to “resist, alter, and reappropriate the materials” (Radway, 1984, p. 17) and in which “viewers have considerable control, not only over [the text’s] meanings, but over the role that it plays in their lives” (Fiske, 1987, p. 74). Livingstone (1990) in her book, *Making Sense of Television*, makes a crucial point that the viewer is an active interpreter of what they are watching. Livingstone says that the audience develops a proto-relationship with the characters. Nevertheless, the additional cognitive energy and the strong commitments to these alternative constructions needed for successful resistance make it easier for the reader to accept the dominant perspective shown on television than to generate resistant readings (Condit, 1989). Moreover, when the audience is considered as a whole, the dominant messages encoded in a text are more likely to be decoded by the consumer than an emergent oppositional reading (Dow 1996; Fiske, 1987; Gitlin, 1982).

Studies of the reception of science on television have investigated its educational benefits: Gunter et al. (1997) studied children between the ages of eight and fifteen who watched three science programmes broadcast on television in Britain. The results showed fairly high levels of recall and comprehension of the material. All children showed significant improvement in their understanding of the scientific concepts discussed in the programmes compared to their pre-test scores. There were no significant age differences in the level of improvement. Mares et al. (1999) conducted two studies exploring the conditions that facilitate positive responses to children’s television programs involving science. In Study 1, children enjoyed television science content more and learned more from it when it was presented in the context of a related feature story than when it was shown out of this context. Children also responded more positively when the segment was not explicitly labelled as “science”. In Study 2, repeated exposure to a weekly children’s magazine show with regular segments involving science in context was associated with more favourable attitudes towards science, whether the viewing occurred in school or at home.

Recent reception studies agree that individual users of television programmes interpret them differently depending on their different subjective relevance structures (Bilandzic, 2006) or the legitimacy accorded to television as a source of knowledge and the type of memories left by their school experience (de Cheveigné and Véron, 1996). Dodds et al. (2008) found that scientific arguments that were congruent with existing health knowledge tended to be accepted while pseudoscientific knowledge was regarded sceptically and concerns were raised over the accuracy and believability of the pseudoscientific claims.

Bates (2005) carried out a study based on 25 focus groups convened to explore the lay public's understanding of genetics. The study found that the public processed a great variety of messages including documentaries, non-science-fiction films, and popular television, science fiction and news media. They processed these messages about genetics complexly and critically. On the basis of these findings, the study suggests that researchers should include a greater variety of texts about genetics in their research and attend more fully to audience processing in addition to content analyses of these texts.

Sometimes scientific information received from media simply has no relevance to users. Zehr (2000) hypothesised that the global climate change issue lacks salience and simply doesn't fit into conversational needs or need for pragmatic, day-to-day information.

3.2.1.1 Talking it out in focus groups

Focus groups were used in this project because they are good at providing ideas and insights into the way participants form opinions (although they are not so good at answering specific questions). Focus groups can investigate how—as Silverstone (2002) writes—media technologies have become increasingly central to the ways in which individuals manage their everyday lives: central in their capacity, in broadcast schedules and the consistencies of genre, to create a framework for the ordering of the everyday, and central too in their capacity to provide the symbolic resources and tools for making sense of the complexities of the everyday.

Burri's (2009) research is an example of this, he conducted focus groups on how Swiss citizens assessed nanotechnology, he found that participants used analogies with other risk technologies and their own personal experiences as patients and consumers to form an interpretative pattern to help them understand and cope with nanotechnology.

Another example of focus group research being used to investigate how opinions are formed is Bates (2005) whose focus group research into public understanding of genetics found that participants used a great many sources to form opinions including documentaries, non-science-fiction films, popular television, science fiction and news media. Also Murphy (2008) used focus groups to investigate the politics of genetics based on discussions of the actions of onscreen characters.

The focus groups for this study were analysed to elicit participants' opinions on emerging technologies and what influences participants to form these opinions. In particular, I examined general attitudes towards science and future implications.

The value of focus group discussions as opposed to qualitative interviews is that not only do they identify group norms (Kitzinger 1994), but also themes emerge when participants argue and justify their opinions. Focus groups “provide a window into how others think and talk” with the particular advantage of mimicking natural conversations and interaction, and creating an active, dynamic “process of sharing and comparing among participants” (Morgan, 1997). Lunt and Livingstone (1996, p. 85) described focus group discussions as “a simulation of these routine but relatively inaccessible communicative contexts that can help us discover the processes by which meaning is socially constructed through everyday talk. When participants discuss an issue with each other they develop arguments, share expectations and express concerns that might not have occurred in individual in-depth interviews (Lassen and Jamison 2006). Duggleby (2005) and Wilkinson (1998) believe that this group interaction is an important part of focus group data as it can give us insights into how participants make meanings for themselves.

According to Kitzinger (1990), group sessions encourage the kind of acting out that goes on among peers where they provide an audience for each other that might not occur in interview. In this way, focus groups give indications on how judgements are made on emerging technologies.

Focus groups were chosen as a research method as, although they are not suitable for finding answers to specific questions, they are a useful tool for providing ideas and insights into the way participants form opinions.

3.2.1 Content—linking the ‘citizen’ and ‘expert’ parts of the assemblage

Until the recent recognition that cultural context was important, many earlier studies had focused on more “objective” measures of media content, such as accuracy and readability (see e.g. Baker 1990; Bostian 1983; Dunwoody 1982; Hayes 1992). These studies had reinforced the idealised vision of “simplification” that had come with the commitment to a “diffusion” model of scientific popularisation. But with growing attention to science journalism from critical studies researchers in communication studies (e.g. Hornig 1990; Thomas 1990) and in science and technology studies (STS) (e.g. Collins 1987, 1988), the idealised vision of science popularisation is no longer viable.

The study of the content of television programmes is important because it is the major link between citizens and “expert” scientific parts of the assemblage. Television is the most trusted source for scientific information in Ireland (Eurobarometer 2007) and television mediates events from scientific institutions, e.g. news stories based on the publication of a peer-reviewed journal article.

3.2.2 Production—the programme maker 'as a political person'

According to Miller (1999, p. 206), to obtain a proper understanding of the media, it must be located in the context of wider formations of power and influence and of historical processes. It is not the role of media to simply report on newsworthy happenings, but rather to construct the news itself:

> 'News' is the end product of a complex process which begins with a systematic sorting and selecting of events and topics according to a socially constructed set of categories
>
> (Hall, Chrichter et al., 1978: p. 53).

As Tuchman (1976) acknowledges, it is not demeaning or disrespectful to news, or to the journalists that produce it to understand that news "like all public documents, is a constructed reality possessing its own internal validity" (p. 97). News does not just happen, there is agency behind it, what is important and worthy of being reported must be selected. This mediation is complex, and involves, according to Miller (1999), a large number of contending and co-operating social factors and groups. These include institutions and corporations, media organisations, a range of publics, and policy, cultural and political outcomes. (p. 208).

Media coverage of science is not unique, and indeed looks a lot like coverage of other areas, primarily because the main drivers of coverage patterns are not the content areas on which stories are focused but, instead, the production infrastructure through which that content must pass (Dunwoody, 2008, p. 19), this research investigates that infrastructure and the motivations and constructions of citizenship used by media professionals, i.e. television programme makers..

My perspective here sees the coverage of science on television as the end result of a complex process of construction in which a host of factors are influential in determining both how certain topics are selected for media coverage and how, once selected, they are then inflected and presented. I agree with Hansen and Dickinson (1992), that as numerous studies of the production of news (although few of them concerned specifically with the production of scientific news) have shown, the factors influencing news include: the economic constraints of media organisations, the professional ideologies of journalists and other media personnel, 'news values', the editorial policies of media, the nature of the subject matter, the nature of relationships between media professionals and their sources, and the publicity practices and general media orientation of sources.

From this perspective, a television science programme is neither a reflection nor a distortion of what is ‘out there’ but is, rather, a “reflection of the practices of workers guided by established editorial concepts” (Fishman, 1982, p. 220). Reese, Grant and Danelian (1994) suggest that there are “common socialisation patterns of news workers, large conglomerate ownership of news organisations, information subsidies through public relation efforts, and the dominance of a few key wire and syndicated news services”. According to Gardner and Young (1981, p. 171-172), any adequate analysis of television’s view of science would have to deal with the following issues (among others): the social and cultural formation of television’s practitioners, their view of the television process and their role within it, including their class, education and training, as well as the subculture of media and cultural theory within which they move; and also the specific labour process of television, the division of labour within television practice and the institutionalisation of science’s own division of labour within different television departments, including the separation of content from the requirements of production and the barriers between writers, presenters, researchers, directors, etc.

Studies of ‘science in the media’ usually conceptualise journalism as a mediator between science and lay audiences. They critically reflect on the picture of science which journalism draws (e.g., Pellechia, 1997; Kua et al., 2004; Major and Atwood, 2004). Hornig in her 1990 study of the representation of scientists on *Nova*—a high production value science documentary series broadcast on Public Broadcasting Service (PBS) in the USA—described their portrayal as that of elite knowledge-holders, and described the producers of *Nova* as speaking to a specific college-educated audience. More recent research (Metz, 2008) on NOVA has confirmed that this remains the case. However, as Dhingra (2006) asserts, in the absence of any attention to how producers make the choices that shape the programmes, these studies lack an important perspective.

Producers of science television follow routines in their selection of stories and aspects of stories to cover. Lublinski (2011), who studied three German radio science programmes and a news agency extensively through participant observation, called these decision-making programmes “editorial concepts”. These editorial concepts restrict what is reported. According to Dunwoody (1996, p. 46), the tight deadlines and the wide variety of stories covered means that the routines/editorial concepts that journalists must use form a set of barriers to the accurate presentation of scientific uncertainty as they “corral the behaviour of journalists and mediate against the full telling of the story”. For example, media routines rely more on individualised, rather than sociostructural explanations for phenomena (Saguy and Almeling, 2008), so news reports on a medical story like, for example, obesity tend to be “people-centred,” where “clearly identified individuals personify or stand in for larger, more difficult to grasp social forces," and "news tends to simplify complex social processes in ways that emphasise melodrama, that turn a complex set of phenomenon into a morality tale" (Schudson, 2003, p. 48). The larger infrastructural systems are also important. Göpfert (1996) concludes from his comparison of science on television in Germany and the UK that the broadcasting systems, e.g. the number of channels, the mix of public service and private channels as well as scheduling policies affect the amount and nature of science programmes broadcast.

Story selection is one of the biggest determinants of the nature of the science that is constructed on television and interpreted by viewers. It is a complex topic which involves many different factors (Clark and Illman, 2006, p. 497). These factors include interests, experience level of journalists and editors, the need to attract the 'right sort' of audience, as well as events and trends within the sphere of science and technology. Another relevant factor is the influence of the production process (Gans, 1980: pp. 158-60).

Media professionals refer to 'news values' to explain the criteria they use in selecting stories for coverage. An analysis of the news values in the selection of scientific news can help to explain why some topics are selected and others not. For example, Greenberg et al. (1989) concluded from his study of coverage of environmental risk by American television networks that journalists, in the case of television, select topics partly depending on the availability of interesting or dramatic images—important according to León (2006, p. 105) because in today's television environment: "news programmes tend to situate spectacular images very high in their scale of values". News values have been defined as a series of factors "that seem to be particularly important" in the selection of news (Galtung and Ruge, 1965, pp. 64-5), they work as a "deep structure or a cultural map that journalists use to make sense of the world" (Hall et al., 1978, p. 54). News values are as applicable to science stories as to any other field. Hansen's (1994) study on journalistic practices of science reporters in the British press shows that specialist journalists follow conventional news-value criteria and emphasise the importance of a "relevance to the reader" criterion in the selection of science news.

There is also the practical day-to-day business of producing programmes. Journalists make decisions depending on deadlines and the size of the 'news hole' (Dunwoody, 1979; Shook et al., 1996). Availability of sources, technical resources and raw material to produce the item also matter. In many cases, topics are directly suggested by public relations officers. For example, a survey of health reporters in American local TV stations showed that more than half of the reporters received ideas from a health source who personally contacted them (Tanner, 2004). Also, Kaniss (1993) observed that some topics are selected because they are easier to cover, rather than by the intrinsic interest that they may have for the audience.

Alison Leigh (1998), the editorial director of the World Congress of Science and Factual Producers, described the wide range of proposals that did not get produced during her ten year career as executive producer of science programmes in ABC Television in Australia. Commercial pressures and practices, combined with large budget cuts, have led to decreasing support for natural history programmes and documentaries on Australian television, as well as in Canada and on the BBC. Current strategies to get programmes produced and on air include coproduction, by means of which the investment is shared, and producing different, culturally acceptable versions of a programme, so that it appeals to a range of different markets. For example, an Australian scientist, Tim Flannery, presents his own ideas in *The Future Eaters* but, in international versions of the programme, Tim Flannery is not present, since he is not well known outside Australia. Even in the presence of a wide range of outlets for science stories on television (Discovery, The Learning Channel, National Geographic, BBC, cable and satellite channels, and a large number of pay TV channels), there is an increasing streamlining of content to cater to international tastes. According to Leigh, there is a growing international market for science programmes even if, to quote a broadcast magazine in the UK, commissioning editors are on the lookout for what sells, which tends to be “sex, space, weather, disasters, dinosaurs, and freaky people” (Stocklmayer et al., 2001, p. 181). Science on television seems to be moving further away from Irwin and Wynne (1996) and Irwin’s (1995) notion that local knowledges can be supported in local contexts.

The kind of topics that are selected for coverage is important because of the ‘agenda setting’ role of media (McCombs and Shaw, 1972). Briefly, agenda setting describes a very powerful influence of the media—the ability to tell people what issues are important. Summed up by Bernard Cohen (1963) as: “The press may not be successful much of the time in telling people what to think, but it is stunningly successful in telling its readers what to think about.” Research on the agenda of science related television news shows that the topics selected vary very much. In de Chevigné’s (2006, p. 89) study, 61 per cent of the stories were only covered by one channel, and only 7.7 per cent of events were covered by more than half of the channels.

Several authors use models of editorial concepts to show that journalism’s selectivity—i.e. the decisions about what will or will not make a ‘good’ science story—are based less on individual biases of reporters and editors than on various social factors that can be classified analytically (Dimmick and Coit, 1982; Shoemaker and Reese, 1996) Specifically, decisions made on higher levels impose constraints which narrow the choices on lower levels. These models provide heuristic frameworks to reduce complexity and organise empirical data and relevant literature (Löffelholz, 2009). Political initiatives regarding science on television and in the media generally could also be expected to affect television production practices; however literature on this is scarce with the exception of a report from Maeseele and Desmet (2009) who analysed science reporting on public television channels in Belgium. They noted a decrease in the total amount of science between 1997 and 1999 and an increase from 2000 onwards which they link to increased government efforts at promoting the popularisation of science, technology and technological innovation.

In television documentary production, on the other hand, Silverstone (1984) studied the narrative strategies used in an episode of the BBC's flagship science documentary series *Horizon*[16]. Silverstone posits that science in television documentaries is frequently framed in a heroic mould and that the transformation of science, which tends to appear dull, slow and rarely successful, into interesting images on television, involves a range of rhetorical styles working on each image, sequence of images and voice. An in-depth exploration is made of these rhetorical styles by deconstructing the science shown on the programme. Silverstone (1983) observes that the commonly used formal patterns of storytelling signify an ideology of their own, in addition to the programme content. The work of a science documentary on television, maintains Silverstone, is to transform another reality into one that is familiar and reassuring, by use of generic conventions of television's storytelling devices.

However, Silverstone's study of *Horizon* was carried out almost thirty years ago, and science documentaries have changed since then, and according to some commentators—not for the better. Palfreman (2002, p. 33), a science documentary maker from the late 1960s until the early 1990s, critiques most contemporary documentaries for having "settled instead for a limited set of bankable topics that would bring in viewers". He notes that the combined demands of ratings and long shelf life mean that producers have moved away from journalistic films in which new science is explored and in which "un-sexy but important science" is presented. According to Palfreman, only a handful of genres of science documentaries have survived until today: the archaeology genre, dealing with expeditions, lost treasures, mummies, dinosaur bones, etc.; the forces of nature genre, dealing with volcanoes, tornadoes, mountains, sharks, etc.; the modern history genre, exploring certain mysteries left over from past wars such as missing submarines of Hitler's Third Reich; the cool gadgets

[16] The late Roger Silverstone, in his research about the relations between science and television, acted as a participant-observer over the two years of the construction of a television documentary on the (then new) Green Revolution as part of the BBC's flagship *Horizon* series.

genre, dealing for example with racing cars and helicopters. Palfreman maintains that although many excellent films are still produced, they have less and less connection to the real life activity of research laboratories and science in action.

Cottle (2004, p. 82) describes shifts in “production ecology” which encompass producers, distributors, broadcasters, and their organisations. These shifts lead, he claims, to an evolution in television genres. He goes on to describe the evolution of nature and wildlife documentaries which have been transformed to now include frequent inclusion of animal killing scenes, use of celebrities to present the programmes, increased use of digitalisation and computer graphics to enhance viewer perspectives on animal killing, incorporation of emotional storylines and human interactions, and increased programme diversity (to appeal, for example, to teenage audiences). Thus, the nature of science stories on television shifts in response to shifts in social habits and tastes, and in technologies.

There is criticism of these new evolved science and nature programmes, often from scientists themselves. Frank Close, a theoretical physicist at the University of Oxford, UK, has accused *Horizon* of dumbing down, with particular reference to their 2007 programme which claimed: “that when the Large Hadron Collider (LHC) comes online at CERN next spring, it could end up creating mini black holes that destroy the Earth” (Close, 2007).

One strong criticism of media coverage of science and technology is that it does not include the necessary contextual information (e.g. Kua et al., 2004; Rogers, 1999; Rowan, 1999) which León (2008) interprets as a weakness of the coverage. Cantrill (1993) posits that this omission makes it more difficult for the audience to understand the meaning of the topic that is presented, since viewers perceive each story as an isolated element, which they cannot integrate in a system of knowledge, agreeing with Field and Powell’s (2001) assertion that the public needs to be able to frame the new information in the context of the current scientific knowledge of a specific field, as well as in the significance of the scientific methods and the socioeconomic elements of research practice. Without context, the information is “interesting but difficult to relate to a current situation or a long-term application” (Kua et al., 2004, p. 320). Competition for time among the different topics reduces the chances of including the “background material and qualifications useful in conveying complex technical issues” (Nelkin, 1995, p. 107). In addition, twenty-four hour news cycles and an emphasis on breaking news makes it difficult for the journalist to have enough time to provide contextual information (Gisolf, 1993). León (2006) calls for alternative formats for news programmes to allow for longer stories, which can include contextual information and explanations of scientific concepts.

This PhD uses interviews with programme-makers to investigate the production of science on television. As Deacon et al. (1999, p. 63) point out, there are six main ways in which questions can be delivered in research: self-completion questionnaires; standardised face-to-face interviews; telephone interviews (which can be structured or unstructured); semi-structured face-to-face interviews; non-directive face-to-face interviews; and focus group interviews. Semi-structured interviews are one of the most commonly recognised forms of qualitative research method. For this reason, Mason (1999) argues, it is not unusual for a researcher to assume that their project will involve qualitative interviews, without actually giving due consideration as to why this should be the case. Mason thus advises that researchers examine the usefulness and drawbacks of a semi-structured, open-ended "conversation with a purpose" (ibid: 67) in relation to data gathering.

In pursuing this 'conversation with a purpose', I have engaged in what Schutt describes as "intensive interviewing", which entails relatively unstructured questions and which aims at eliciting in-depth information about the interviewee's feelings, experiences and perceptions (2006: p. 311). Such a technique enables or allows interviewees to respond in their own words. It allows for active engagement with the subject and for lengthy explanations and follow-up questions. Unlike surveys or more structured forms of interviewing, semi-structured or qualitative interviewing enables a depth and roundedness of understanding rather than a broad understanding of surface patterns. Less structured questioning techniques has a significant advantage over more structured as it offers scope to elaborate and raise questions and to ensure greater clarity and understanding between interviewer and interviewee. Furthermore, semi-structured and open-ended interviewing generates a 'fairer and fuller representation of the interviewees' perspectives' (Mason, 1999: p. 67).

I also heeded Mason's warning that the interviewer must be aware that the extent of the effectiveness of such a method of gathering research data is largely dependent upon the ability of the interviewee to "verbalise, interact, conceptualise and remember" (Mason, 1999: pp. 63-64).

3.2.3 Science in television news

Academic research on science in television news is scarce. A number of general studies of television news have provided some information on science news. Stemple (1988) analysed content in five network newscasts in the US, Roe (2001) in CNN and BBC World, and Harrison (2000) in the UK. Although these studies provide some information on science news coverage, in most cases, the sample of news about science is small. In most of these works, science and technology appear as marginal topics. For example, Heinderyckx's (1993) research on the content of 17 news programs in six European countries, concludes that the category that includes science and health, represents only 0.75 per cent of the stories (on average, 0.1 stories, out of a total of 13.3 stories per broadcast). A number of studies have focused on television news about specific topics related to science, mainly the environment and medicine, for example, network news coverage of breast cancer (Cho, 2006), agenda building and source selection in health news (Tanner, 2004), coverage of cloning (Holliman, 2004), biological ideas on sexuality (Wilcox, 2003), coverage of research in network news (Kierman, 2003), reporting of the "gay gene" (Miller, 1995), and scientific sources' perception of network news accuracy (Moore and Singletary, 1985). The results of these studies do not provide sufficient data to obtain a picture of science news on television. Among the few comparative studies on science television news, research on 15 European channels of eight countries, coordinated by the Centre National de la Recherche Scientifique (France) in 1994, found that coverage of science varied from one country to another. Germany and France were the countries where more scientific stories were broadcast, whereas Italian channels broadcast the least (de Cheveigné, 2006: p. 89).

As outlined in section 3.2.2 Production—the programme maker 'as a political person' on page 85, one frequent criticism of media coverage of science and technology is that it does not include the necessary contextual information, due to constraints of time and resources.

This research studied television news by means of a content analysis of RTÉ television news programmes. Content analysis is a reliable and replicable quantitative research technique with a long history of application with media content (see Krippendorff, 2004). This quantitative technique produces valid results for quantifying phenomena as they appear in media representations, and although not restricted to textual content, is highly suited to it.

Content analysis is regarded as an appropriate methodology for quantifying the salient and manifest features of a large number of texts where the statistics can be used to make broader inferences about the 'processes' and 'politics' of representation (Deacon et al., 2007). However it not completely value free, as any process that involves subjective coding of data is open to interpretive influences. Choices made during the process in relation to sample, measurement, coding and statistical analysis as well as clarity in relation to methodological decisions on all of these points, are crucial to achieving and maintaining rigour in such quantitative assessment exercises (Lacy and Riffe 1993).

3.3 Strengths and limitations of research design

3.3.1 Strengths and limitations of focus groups

Focus group interviews, discourse analyses and content analysis all have their limitations as methodologies. Focus group research has the advantage that it is relatively inexpensive and efficient in comparison to individual interviews. It can produce concentrated amounts of data on precisely the topic of interest (this is an advantage it has over participant observation). As focus group research is by its very nature qualitative, it has the advantage that it allows the researcher to look beyond the facts and numbers that might be obtained via survey methodology—to learn or confirm the meaning behind them.

The discussions in focus groups are more than the sum of separate individual interviews, as the participants both query each other and explain themselves. This "group effect" (Carey 1994; Carey and Smith 1994) and the ability to observe the extent and nature of interviewee's agreement and disagreement are unique strengths of focus groups. Morgan and Krueger (1993) emphasise the value of this group interaction between participants in focus groups, as such they offer valuable data on the extent of consensus and diversity among the participants.

Some limitations of focus group research are that participants are self-selected and study results are therefore harder to generalise to the larger population. Also focus groups require very skilled moderation, to encourage quieter participants to talk, to prevent outspoken participants from dominating the discussion and, in particular, steering the group discussion to maintain focus but crucially not influencing the group's interactions by doing so. This problem of researcher influence is not unique to focus groups, indeed the researcher influences all but the most unobtrusive social science methods. In fact, according to Morgan (1997), there is no hard evidence that the focus group moderator's impact on the data is any greater than the researcher's impact in participant observation or individual interviewing, which would seem to create at least as many opportunities for researcher influence.

Another disadvantage of focus groups is that the vast volumes of qualitative data which it produces are inherently messy and difficult to analyse.

There is much debate in the focus group methodology literature about whether it is best to use pre-existing groups or groups of individuals brought together specifically for the purpose of the focus group. Pre-existing groups may take a variety of forms: a collection of individuals who are no more than acquaintances (for instance, in certain work settings; see, for example, Kitzinger, 1994b); family groups (Khan and Manderson, 1992), social groups (see, for example, Farquhar and Das, 1999), support groups or friendship groups are all forms of pre-existing groups. The advantages of pre-existing groups is that, as Jenny Kitzinger argues, by utilising friendship groups the researcher may be able to tap into interaction which approximates to "naturally occurring" data (such as may be collected by participant observation). She notes: "Above all it is useful to work with pre-existing groups because they provide one of the social contexts within which ideas are formed and decisions made" (Kitzinger, 1994, p. 105). Using pre-existing groups also has the advantage that recruiting the group can take less effort, also, pre-existing groups may result in reduced attrition rates as attendance at a group is less likely to seem daunting to individual participants if the group consists of people of whom they have prior knowledge. However, focus groups consisting of strangers may potentially have the additional advantage of allowing people to speak more freely and openly than they would in a pre-existing social group (the sense of confessing all to the stranger on the train) without fear of repercussions after the group is over (Bloor et al., 2001), and the practice of individual group members challenging each other and pointing out contradictions in expressed views and behaviour can still occur in groups where individuals have no prior knowledge of each other (Wilkinson, 1998).

In order to take advantage of the benefits of both pre-existing groups and groups of individuals brought together specifically for the purpose of the focus group, I recruited a variety of different groups. In some groups the participants knew each other very well, in some they were acquainted with each other, in some groups, some of the participants knew each other beforehand and some did not, and in some, the participants had never met each other before.

3.3.2 Strengths and limitations of content analysis

The advantage of using content analysis is that it is a readily-understood, relatively inexpensive research method. It is also unobtrusive (Webb et al., 1981). Content analysis may also be used non-reactively (Neuman, 1997): no one needs to be interviewed or to fill out lengthy questionnaires; rather the researcher can conduct analytic studies using (in this case) recordings of television programmes. Establishing reliability in content analysis is straightforward, the results are easy to replicate.

The biggest limitation of content analysis is that it is a purely descriptive method. It describes what is there, but may not reveal the underlying motives for the observed pattern (i.e. the 'what' but not the 'why'). Another limitation of content analysis is that it is ineffective for testing causal relationships between variables. The proportion or frequency with which a theme or pattern is observed may be presented, but this kind of information is only appropriate to indicate the magnitude of certain theme codes; it is not suitable to attach causes to these data.

It is for this reason that content analysis becomes most powerful when combined with other research methods such as interviews, discourses analyses and so on. In this research, content analysis was combined with discourse analyses, both of these supporting the core analysis which was using a focus group methodology.

3.3.3 Strengths and limitations of discourse analysis

The biggest limitation of discourse analysis is the general lack of explicit techniques for researchers to follow, however, a good grasp of basic concepts can be applied to any chosen area.

The research aim was not to draw conclusions about audience responses to science on television, but to describe the discourses surrounding science on television, aiming for a better understanding of how audiences construct science through their use of television, and how in doing this they construct their own scientific citizenship.In the discourse analysis of the focus group discussions, television programmes and programme maker interviews, there is really no generally accepted formula for the validity of discourse analysis text choices. Therefore, the researcher's personal judgment and interpretative biases must be acknowledged. Again care was taken to provide clarity where such issues arose, to indicate the basis for particular interpretations and to offer alternative and oppositional readings where possible. The research aim formed the overall guiding principles for the methodological approach, which was not to search for a single answer or meaning for science on television, but to seek out and attempt to explain the competing and complementary discourses around it.

4 Method

4.1 Methodological design for this study

This chapter outlines the specific research design adopted for this study. It outlines the three main parts of the empirical research.

1. Reception study, focus group research—description of the make-up of the focus groups, the discussion guide, the stimuli used and the analysis of the discussions.

2. Analysis of television content—description of the content analysis on *RTÉ News* and discourse analysis on the television series *Horizon* and *Extraordinary People.*

3. Production analysis—description of the semi-structured programme-maker interviews, together with a list of interview questions and a list of interviewees.

4.2 Part 1, Reception study

4.2.1 Make up of focus groups—pre-existing and constructed according to specific criteria

The focus groups for this study were analysed to elicit participants' opinions on emerging technologies and what influences participants to form these opinions. In particular, I examine general attitudes towards science and future implications.

As this research does not concentrate on any particular sub-group of citizens, ideally, the participants of the focus groups would make up a representative sample of the population. This is impossible to achieve given the size of the sample. However, the reception analysis was organised to include groups with different backgrounds (i.e. age, education, interest in science etc.).

Participants were recruited from both pre-existing groups and by a professional recruiter who recruited participants according to specified criteria including age, educational level etc.

The aim of the reception research was to find out how participants' television viewing contributes to their scientific citizenship. Participants were asked about what kind of television they watch, why they watch it, what they think of it, and what other sources of science information they use.

The following is a list of the focus groups used:

Group 1 - Pre-existing group

This focus group was held in Aislainn Cill Chartha, Kilcar, Co Donegal. This group and Focus Group 2 served two purposes:, focus groups for this PhD research, and a data-gathering exercise for Dr Pádraig Murphy's STRIVE project about public engagement with nanotechnology (Murphy, 2010). This group comprised ten women, mostly in their late thirties or early forties. The women were studying for a Certificate in Preparatory Studies in Higher Education (CPSHE), this is an access course run by Letterkenny Institute of Technology. Classes take place in Aislainn Cill Chartha three days a week. The women take modules in IT, maths and communications. All the women have children, some at primary school, and some at secondary.

Group 2

This focus group was held in Dublin City University. Participants of this focus group did not know each other before meeting for the session. The group comprised three female participants and one male participant.

Group 3 – Young people

This focus group was held in Confey Community College in Leixlip, Co. Kildare. Participants knew each other beforehand. The group comprised four female participants and five male participants. All participants were aged 16 years.

Group 4 – Young people

This focus group was held in Coláiste na Carriage, Carrick, Co. Donegal. Participants knew each other beforehand. The group comprised four female participants and five male participants. All participants were aged 16 years.

Group 5 - Active

This focus group was held in Dublin City University. Participants for this group were recruited because of their active interest in science. Participants were scientists, science teachers, worked as science communicators (either professionally or on an amateur basis), regular attendees of the Alchemist Café or Science Gallery. The group comprised three female participants and five male participants.

Group 6 – Active

This focus group was held in Dublin City University. Participants for this group were recruited because of their active interest in science. Participants were scientists, science teachers, worked as science communicators (either professionally or on an amateur basis), regular attendees of the Alchemist Café or Science Gallery. The group comprised six female participants.

Group 7 – Aged 30-49

This focus group was held in Dublin City University. Participants in this group were aged between 30 and 49 years and educated to university degree. The group comprised five female participants and four male participants.

Group 8 – Aged 50+

This focus group was held in Dublin City University. Participants in this group were aged 50+ years and educated to university degree. The group comprised five female participants and five male participants.

Group 9

This focus group was held in Dublin City University. Participants had mixed educational backgrounds, and were aged between 30 and 49 years. The group comprised five female participants and four male participants.

Group 10

This focus group was held in Dublin City University. Participants had mixed educational backgrounds, and were aged 50+ years. The group comprised five female participants and five male participants.

The next sections discuss in detail the recruitment, running and handling of the focus groups, and in particular my role as researcher.

4.2.2 Recruiting participants for focus groups

Participants for focus groups 7, 8, 9, and 10 were recruited with the assistance of a professional recruiter, These focus groups were used for this research and also formed part of a larger EU-funded FP7 project “Audio Visual Science Audiences in Europe” which funded the recruiter’s fees. I recruited participants for the other focus groups myself.

The professional recruiter has more than fifteen years of experience in recruiting and organising participants for focus group research and for other qualitative research projects. She has worked mainly in market research but does have some experience of recruitment for academic research as well.

She maintains a large database of potential participants, this database includes individuals with a variety of ages, occupations, educational backgrounds and so on.

It was important that the focus groups recruited fulfilled two conditions:

1. They watched science programmes on television

2. They included groups with different backgrounds, the most important of these were deemed to be age and educational level achieved.

Therefore, to ensure these conditions were fulfilled, the recruiter was instructed first of all to use the following screening question when making her first contact with potential participants: “Do you regularly, occasionally, hardly ever or never watch television programmes about science?” Only participants who answered 'regularly' to this question were then recruited for the focus groups.

In order to fulfil the second requirement, that participants come from a variety of different backgrounds, the recruiter was instructed to select potential participants for the four groups she was recruiting for as follows:

Focus group	Age	Education
Focus group 7	Between 30 and 49	University degree or equivalent professional qualification
Focus group 8	50+	University degree or equivalent professional qualification
Focus group 9	Between 30 and 49	Mixed educational backgrounds, that is, at least two participants from each of the following groups: • low educational level (8 to 10 years of education • medium educational level (13 years of education • high educational (university degree)
Focus group 10	50+	Mixed educational backgrounds, that is, at least two participants from each of the following groups: • low educational level (8 to 10 years of education • medium educational level (13 years of education • high educational (university degree)

Table 4.1 Criteria for recruiting focus group participants

The recruiter was also instructed to recruit roughly equal numbers of male and female participants for each group.

Focus groups 3 and 4 were held in schools with students aged around 16. I organised the recruitment of participants for these focus groups in co-operation with teachers. I attended Coláiste na Carriage from 1985 until 1990. My former physics teacher has since been promoted to principal at the school, we have kept in touch and I e-mailed him to ask for permission to hold a focus group in the school. He telephoned me back to say he was happy for me to conduct a focus group with the students, we agreed a time and date and he volunteered to recruit around ten participants (in the event, I had nine students from Coláiste na Carriage in focus group 4).

I asked the Biomedical Diagnostics Institute's (BDI) education and outreach officer who has a lot of science teacher contacts, to e-mail them and ask them if they would be willing to allow me to conduct a focus group in their schools; she passed on my contact details. A science teacher from Confey Community College in Leixlip, Co. Kildare contacted me via e-mail, and volunteered her transition year class for the study. I telephoned the teacher back and we arranged the time and date for the focus group.

I also benefited from the help of the BDI education and outreach officer in recruiting adults for the focus groups 5 and 6, made up of adults with an active interest in science. She maintains a database of science teachers and people who work or volunteer in science communication in Ireland, and she agreed to send them an e-mail telling them about the opportunity to take part in a focus group about science on television and giving my contact details. I also e-mailed former students of the MSc Science Communication at DCU, again asking them if they would like to participate and giving my contact details. Furthermore, I arranged for the organisers of the Alchemist Café to make an announcement at their event about the focus groups, and I made a similar announcement to the MSc science communication class at DCU before one of their lectures. I also explored online spaces for people with an active interest in science, using them to look for volunteers. www.boards.ie is an internet forum based in Ireland, it is one of the largest indigenous Irish websites online. I posted messages in the science forum of www.boards.ie looking for volunteers.

I received phone calls, texts and e-mails over the week following this recruitment drive from people volunteering to participate in the focus groups. All in all, seventeen people agreed to take part, though some did not turn up so the two active focus groups went ahead, focus group 5 with eight participants and focus group 6 with six participants.

As noted above, Focus groups 1 and 2 served two purposes: they acted as focus groups for this PhD research using an Irish television science documentary (about nanotechnology research) as a stimulus, and they also worked as a data-gathering exercise for Dr Pádraig Murphy's STRIVE project about public engagement with nanotechnology (Murphy, 2010).

I wanted to use an adult group from outside Dublin for focus group 1, so I contacted the course-co-ordinator of the Certificate in Preparatory Studies in Higher Education (CPSHE) course, an access course run by Letterkenny Institute of Technology. Classes take place in Kilcar, Co. Donegal, and modules taught include IT, maths and communications. The course co-ordinator gave the e-mail address of the communications lecturer; I e-mailed her to ask for permission to hold a focus group with the class. She telephoned me back to say she was happy for me to conduct a focus group with the students, and we agreed a time and date. Focus group 1 comprised ten women.

For focus group 2, participants were recruited by placing an ad in the *Northside People* (a Dublin free newspaper), placing ads on noticeboards in local shops and posting in popular online fora such as www.boards.ie, and through personal contacts of myself and Dr Padraig Murphy. In the event, two would-be participants did not show up, so the focus group went ahead with just three female participants and one male participant.

4.2.3 Conducting the focus groups

Focus group 3 was held in the home economics classroom of Confey Community College, focus group 4 was held in the science laboratory of Coláiste na Carriage and focus group 1 was held in a classroom in Aislainn Cill Chartha. All the other focus groups were held in a classroom in Dublin City University, this space was used because it was easily accessible for participants, and was also available to me at no charge. The room was arranged as shown in figure 4.1. Note that the screen at the top of the room which is comfortably visible to all the participants; and the recording equipment set up unobtrusively at the back of the room, out of the direct eye-line of most participants.

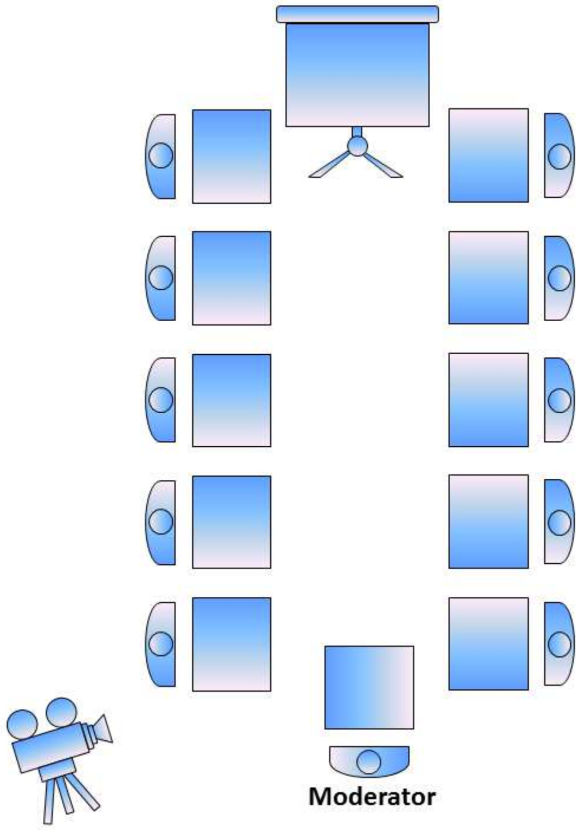

Figure 4.1 *Focus group room layout.*

I was aware from the beginning that in my role of moderator, the way I conducted the focus group sessions could significantly affect data collection. As participants arrived to the session I welcomed them, showed them to their seats, gave them a questionnaire about how they used media and introduced participants to each other. I made the environment as relaxed and friendly as possible. Conversation during this preliminary stage promotes a setting where participants are willing to interact with each other throughout the forthcoming focus group discussion. While I encouraged social chat among waiting participants (upon topics such as the weather, traffic etc.) I avoided any talk about the research topic itself.

The data gathered in the media-use questionnaires is summarised in Appendix H. When all the participants had arrived and finished filling in the questionnaires, I began the focus group session. I opened each session with an introduction that included: a welcome; a brief explanation of the research aim and purpose; a statement of the importance of each participant's opinions to the study and an invitation to diversity of opinions; an outline of what the format of the focus group session would be, a brief description of my role as moderator; a reminder of how the session's data would be recorded and an assurance to participants that they would be anonymised in any reporting of the session. An effective introduction is critical to the session as the initial atmosphere set for the focus group can affect data quality (Dawson et al., 1993). Once introduced, I guided the focus group conversations to maintain a focussed discussion.

Data collected from the focus group sessions was taken in note form, and also audio-recorded. I used audio-recording in preference to note-taking alone as it permits full transcription of the session which is necessary when the data collected is narrative in nature and analysis requires exact statements of the participants to be available (Sim, 1998; Bertrand et al., 1992).

The audio recording equipment used had a multidirectional microphone which helped to ensure successful capture of all the discussion. It can be difficult to identify different voices from the audio-recordings, so at the beginning of each focus group session, I went around the table, asking each participants to introduce themselves, and describe what kind of television programmes they typically watch. As well as serving as a warm-up exercise, this was helpful at the transcription stage in that I could connect each voice to a name which greatly assisted with later identification of their audio-taped responses. I also, as far as possible, took note of the order of the speakers.

I then went on to ask participants the questions as listed in the guide (the focus group discussion guide is given in full in Appendix C.), and probed participants to elaborate further when necessary. Note that participants were not asked questions in turn, rather the questions were ‘opened to the floor’ to develop and encourage conversation and discussion. Moderation was carried out with a light touch throughout.

A number of authors experienced in the use of focus groups agree that use of stimuli can provoke thought related to the research topic to encourage and enrich discussion thereby enhancing group effectiveness (Jackson, 1998; Greenbaum, 1998; Kreuger, 1994; Stewart and Shamdasani, 1990). Posters, pictures and other material may be used to augment oral questioning in an attempt to stimulate discussion (Jackson, 1998). I used clips from television programmes about science as stimuli. Participants were shown the stimuli clips (as listed below) and asked to respond.

Because the uniqueness of focus group data is based in the group interaction, focus groups’ interaction/dynamics and non-verbal behaviours were observed and recorded in notes for each group session. There is disagreement in the literature about whether the group or the individual is the unit of analysis of focus group data (Kidd and Parshall, 2000). I decided that I wanted to take into account both the individual and the group and be sufficiently flexible to identify if one is influencing the other before I drew any conclusions.

During the focus group session, I paid particular attention to the way the group interacted with each other, i.e. at points of general agreement and disagreement, at points in the discussion where there was conflict, where participants agreed with each other and where participants supported each other. A break was taken half way through the sessions and tea, coffee and biscuits were served. Participants all received a gift as a thank-you for taking part; these gifts were distributed at the end of the session.

4.2.4 Stimuli for focus groups—nanotechnology, coeliac disease, the missing link and digital intelligence

The first two focus groups held, Group 1 and Group 2 were shown a full episode of *The Investigators* about nanotechnology as a stimulus. The other focus groups were shown three different short clips, which were chosen to give the participants a variety of presentations of science to discuss. One clip was taken from a news story about science, one from a documentary about a 'big issue in science' and one from a programme which explained science's place in everyday life. These clips were shown to participants by an overhead projector onto a screen at the top of the room (please see figure 4.1).

4.2.4.1 *The Investigators*, nanotechnology episode

The Investigators was broadcast by RTÉ. *The Investigators* television programme was used as a stimulus with two focus groups (Group 1 and Group 2). It has the advantage that it is short (22 minutes) and so can be shown in its entirety, also it is an Irish-produced programme, and concentrates on work done by Irish scientists at home and abroad. Each episode of the programme concentrated on a specific area[17]. In series two the subjects included: Ireland in Space, Ageing, Sensors, Climate Change, Crops of the Future and The Nano Revolution.

The Nano Revolution episode was used as a stimulus for the focus groups. This episode was an interesting stimulus to use because it is a subject about which little is known and which appears very seldom in the media. For example, a search on Lexis Nexis of Irish publications over the ten years from 2000 to 2010 gives 14 stories for "nanotechnology"—compare this to the more than 1027 stories for "genetically modified".

There is not much public interest in nanotechnology either compared to other branches of science. *The Investigators* episode about nanotechnology achieved viewing figures

[17] The series was sponsored by Environmental Protection Agency, Enterprise Ireland, Science Foundation Ireland, Teagasc, Higher Education Authority and Discover Science and Engineering. Discover Science and Engineering is Ireland's national science promotion programme.

of 92,000 while, for example, another episode about ageing (including research into Alzheimer's disease) achieved viewing figures of 183,000.

The other focus groups watched three clips each, which were taken from different programmes. The clips are described below:

4.2.4.2 Science news report

Two science news reports from RTÉ news were used as stimuli. They were accessed from the RTÉ website at www.rte.ie and shown to the focus group participants on a projector screen. The clips are described in the following sections.

Scientists discover coeliac genes

This clip is an extract from Six One News, the early evening news programme on the public broadcaster RTÉ One. It describes a new discovery by scientists in Trinity College Dublin of seven gene regions which can be linked to coeliac disease. It describes how coeliac disease is very common in Ireland and that this discovery is a breakthrough which could lead to new treatments. The clip includes interviews with scientists involved in the research, shots of people working in a laboratory and shots of people shopping for groceries including bread.

Researchers find new way to fight superbugs

This clip is an extract from Six One News, the early evening news programme on the public broadcaster RTÉ One. It describes a new method for combating antibiotic-resistant superbugs such as MRSA which has been developed by researchers at Queen's University, Belfast. The report contains interviews from two scientists involved in the research as well as shots of hospital operating theatres and the laboratory where the work was carried out.

4.2.4.3 Documentary on big issues of science

Two clips extracted from the BBC *Horizon* series were used as stimuli. They were accessed from YouTube at https://www.youtube.com/watch?v=TJIQreNwP2o and https://www.youtube.com/watch?v=h3Nodwb0vTU&list=PL_YPLhyztdA-KD992F5_q95pCSY3B9tlI&index=1 and shown to the focus group participants on a projector screen. The clips are described in the following sections.

The Missing Link, BBC Horizon documentary

This is a programme from the BBC's flagship *Horizon* series. This programme describes new evidence into how fish evolved to have legs and walk on land. The programme begins by describing a discovery of a new fossil "the likes of which had never been found anywhere in the world", but does not explain what this fossil was or why its discovery was so important, thus setting up a puzzle which makes the viewer want to keep watching in order to see it resolved. Dramatic music and imagery are used throughout the programme.

The Death Star, BBC Horizon documentary

This is a programme from the BBC's flagship *Horizon* series. This clip is from a programme about the origins of the universe and the very first stars. It opens with dramatic imagery of space and stars and shows explosions in space, the narrator links these space explosions with human life and "How we came to be". Dramatic music and imagery are used throughout the programme.

4.2.4.4 Programme about scientific explanations of the everyday world

Digital Intelligence - Royal Institution Christmas Lecture

This clip is taken from the Royal Institution Christmas lectures in Britain. These are public lectures given in front of an audience of young people each Christmas. These lectures have been held in London since 1825 and have been broadcast by the BBC since 1966. This clip describes the difference between the way that humans and machines learn. The lecturer involves volunteers from the audience to demonstrate some of his points.

Fight, flight and fright, Royal Institution Christmas Lecture

This second Royal Institution clip is taken from a programme about the fight or flight response, the lecturer uses devices such as loud bangs to startle the audience and an interview with a soldier about his frightening experiences in battle and how he responded to it.

Participants in focus groups 3-10 were shown the following stimuli:

One (of the two described above) science news report, both of these clips were taken from RTE news bulletins.

One (of the two described above) report on big issues in science, both of these clips were taken from the BBC *Horizon* series.

One (of the two described above) report on scientific explanations of the everyday world, both of these clips were taken from The Royal Institution Christmas Lectures.

4.2.5 Analysing focus groups—recording, transcribing and analysing

Qualitative methods, such as focus group discussions, aim to understand in depth a certain complex phenomenon—which unlike quantitative data—cannot be fully explored by numbers (McLafferty 2004). Judging the rigour of these reported findings is difficult. To make this easier, a detailed account of how the analysis was carried out, together with certain measures to resolve potential problems, is given below

Focus groups were recorded and transcribed. In the transcripts, participants' names were changed to preserve their anonymity. The following naming convention was used:

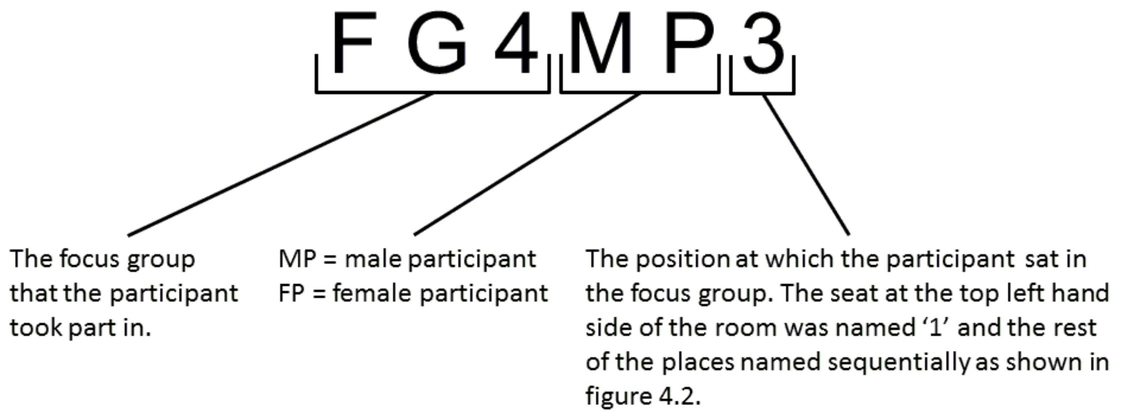

Figure 4.2 *Naming convention for focus group participants.*

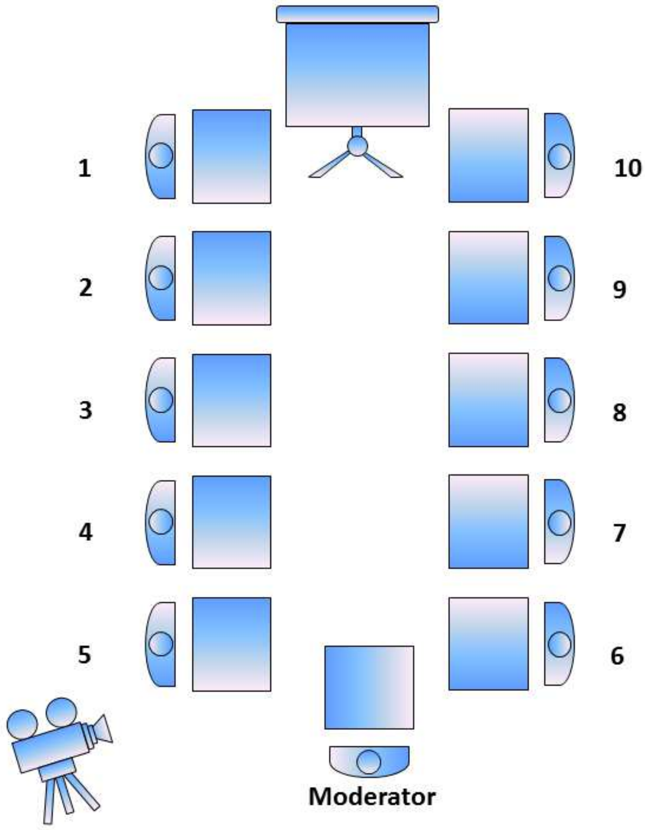

Figure 4.*3 Numbering convention for focus group participants.*

Each focus group was recorded and the recordings listened to several times, ensuring good familiarity with the content. Each focus group was transcribed verbatim into a separate identified document. These transcripts were subsequently audited for the quality of transcription. This was achieved by listening to the audio-taped interview whilst reading the transcriptions. During this procedure a code was attached to each response to anonymously identify the participant responsible (in accordance with the naming convention described above. Each transcription was then read several times.

This listening, re-listening, reading and re-reading allowed me to become immersed in the data and to become intimately familiar with the ethno-epistemic assemblages being studied.

As already stated, the researcher is an instrument of the research process and the data analysis depended on my analytical critical thinking skills to determine connections and meaning from the subjective focus group data (Lane et al., 2001). My self-awareness was a factor to consider during this process, and I needed to explore my own personal perceptions and biases (Lane et al., 2001).

The comprehensive analysis of the data occurred after all focus groups have been conducted, however, I did need to perform some analysis directly after each group session took place (in most cases, I carried out this preliminary analysis the following day). I began by reviewing my fieldnotes from the focus group session, which comprised observations of the participants during the session, and then I developed these notes into a journal of each group session. I read each transcript through line-by-line to scan for central themes. This process was accompanied by note taking about each transcript. Once the themes of each manuscript were established, parts of the transcripts which were irrelevant to the study—spandrels—were identified and excluded from the analysis[18].

When all the focus group sessions were completed and transcribed, I began the detailed analysis. The data generated from focus groups is cumbersome and complex (Robinson, 1999), nevertheless, the fundamental issue is to identify themes embedded in the many words of a text.

To begin the detailed analysis, I read the transcripts a number of times in conjunction with the observational notes and the audio-taped interviews, this enabled me to become immersed in the data.

Discussing the analysis of focus group discussion data, Barbour and Kitzinger (1999) argue that the data can be basically analysed as other qualitative self-reported data. However, it is crucial to maintain a sense of the whole group within the analysis of this research. This means that it is the group that is the unit of analysis as well as individuals within the group (McLafferty 2004). Although the social context in a focus group is not a natural one, the use of focus groups presents an opportunity to observe group interactions within this social context (Morgan, 1996).

Duggleby (2005) presents focus groups as producing three kinds of data:

(1) Individual data

(2) Group data

(3) Group interaction data

For this research, all three kinds of data were examined by looking for themes and patterns in the recordings and transcripts. Themes emerging from the data as well as predetermined themes (obtained from a review of the literature) were extracted.

Group interaction data

Group interaction data was the most valuable for our purposes, as it presents us with the opportunity to observe meaning being made in a social context (albeit not a natural

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[18] Excluding parts of the transcripts could involve bias because subjective decisions as to whether data is relevant or not, it is helpful for the development of data that are specifically of significance to the work objectives (Miles and Huberman, 1994). In the current study, if a doubt arose about what to exclude from the analysis, both the relevant literature and the main themes were examined. Thus, the possibility of errors due to subjectivity was kept to a minimum. At the end of the analysis, irrelevant materials were reviewed again to see if they fitted in with the overall picture of the data emerging.

one). Please note that group interaction data in this context means interaction between group members not between the moderator and the group.

Group interaction data was analysed by looking at:

Conflict:

What topics and themes cause conflict within the group?

How are these conflicts resolved?

Does one side back down or is a compromise reached?

What is the background difference between participants which causes the conflict?

Agreement:

What topics and themes cause agreement within the group?

What issues are seen as “common sense” by all group members?

Support:

How do group members support each other?

What topics and themes cause group members to offer support to each other?

Careful attention was paid to obvious ambiguities, latent disagreement and “unfinished business” that arose during the conduct of the focus groups (Barbour and Kitzinger, 1999).

Analysis of the data involves the researcher searching the data for similar words, patterns and concepts. The transcripts were analysed by hand rather than by using software analysis tools such as NVivo, as although NVivo allows the user to collect, organise and analyse content efficiently, analysing data by hand allows the user to remain closer to the data[19]. The software tools rely only on the transcript, meaning they do not take into account the performative aspects of the focus group discussions. I share Denzin and Lincoln’s (2003) concerns about over-reliance on software analysis tools for the production of coding:

> [Software tools] allow researchers to consolidate and establish patterns of consistency in their materials. However they can also create negative effects, including the false hope that such programs can actually write a theory (or a case) for researchers. …

[19] Gibbs’ (2002, p. 13) points to the danger that software tools such as NVivo or NUD*IST could be used to impart a ‘gloss of rigour’ to research. As these tools offer users the opportunity to analyse more data more rapidly, their use can lead to significantly poorer quality analysis of what, ostensibly, are more firmly grounded findings. One criticism is that they can cause the loss of the richness of qualitative data (Silverman, 1993; Gilbert, 2002; Seidel and Kelle, 1995). At the opposite extreme, others complain that the effort of coming to grips with them drives researchers to pursue their qualitative research in stereotyped and unilluminating ways, or worse still to use a mechanistic approach to the analysis and presentation of their data (David and Sutton, 2004; Morison, 1998).

> Coding and retrieval schemes can lead to an over-emphasis on the discovery of categories and indicators, with a corresponding under-emphasis on the multiple meanings of experience in concrete situations. The search for grounded theory can shift attention away from the theories of interpretation that operate in the social world (Denzin and Lincoln, 2003, p. 54).

I coded segments of text for these similarities and organised it into categories. I placed the coded segments of text collectively under categories to enable data to be managed more easily and to be analysed as aggregate data. I carried out this process by highlighting text in different colours to sort and catalogue it. The categories formed the basis for identification of emerging themes. When the list of categories is exhausted, the categories were then condensed into broader categories or themes.

Bias could not be entirely eradicated from the analysis; arguably, the only way of analysing qualitative materials without bias would be to offer the manuscripts whole and unanalysed, so readers themselves could judge them (Miles and Huberman, 1994). However, practically this was not possible given the amount of data created by this research, coupled with difficulties in understanding the content.

The next stage of the analysis was to perform a Discourse Theoretical Analysis (DTA) on the focus group discussions.

To do this, particular attention is paid to some of Laclau and Mouffe’s concepts which can operate as useful tools for empirical analysis:

- Nodal points, master signifiers and myths, which can be collectively labelled key signifiers in the organisation of discourse;
- The concept of chains of equivalence which refers to the investment of key signifiers with meaning;
- Concepts concerning identity: group formation, identity and representation; and
- Concepts for conflict analysis: floating signifiers, antagonism and hegemony.

First, to explain more about the different key signifiers: nodal points, master signifiers and myths. Nodal points generally organise discourses (for example, ‘public service broadcasting’), and master signifiers organise identity (for example, ‘member of the public’), myths then organise a social space (for example, ‘Irish society’). All of these concepts refer to key signifiers in the social organisation of meaning. When key signifiers are identified in specific empirical material, for example in this case in focus group discussions, the investigation can begin of *how* discourses, identity and the social space respectively are organised discursively. This is done by investigating how the key signifiers are combined with other signs. What the key signifiers have in common is that they are empty signs: that is, they mean almost nothing by themselves until, through chains of equivalence, they are combined with other signs that fill them with meaning. So, for example, ‘the scientific method’ becomes the scientific method through its combination with other carriers of meaning such as ‘scientists’ and ‘experimental research’. By investigating the chains of meaning that discourses bring together in this way, one can gradually identify discourses (and identities and social spaces). It is important to remember that non-linguistic practices and objects are, according to Laclau and Mouffe, also part of discourses. Therefore physicists, white laboratory coats, and microscopes all belong to the discourse of the scientific method.

The combinations of meanings in chains of equivalence can also be used to investigate individual and collective identities and maps of the social space. A social space such as ‘Irish society’ typically links a geographical part of the world to, for instance, ‘European’, ‘Celtic’, ‘the Catholic church’ and ‘liberal democratic institutions’. Note that the elements in the chain of equivalence are both linguistic and non-linguistic; also entities (discourses, identities or social space) are always established relationally, that is in relation to something which they themselves are not.

‘The scientific method’ is an example of a floating signifier, and different discourses struggle to fill it with different meanings. As posited by Laclau and Mouffe, discourses are never completely stable and uncontested, so the conflict between different discourses attempting to fill floating signifiers with meaning can be used as a methodology to locate the lines of conflict in the empirical material. What different understandings of reality are at stake, where are they in antagonistic opposition to one another? And what are the social consequences if the one or the other wins out and hegemonically pins down the meaning of the floating signifier?

Using these concepts, it is possible to investigate the functioning of discourses in the focus group discussions: how each discourse constitutes knowledge and reality, identities and social relations; where discourses function unobtrusively side by side, and where there are open antagonisms; and which hegemonic interventions are striving to override the conflicts—in which ways and with which consequences.

4.3 Part 2, Content study

The study of the content of television programmes is important because it is the major link between citizens and “expert” scientific parts of the assemblage. Television is the most trusted source for scientific information in Ireland (Eurobarometer 2007), and in the UK (Ipsos MORI / Department for Business, Innovation and Skills, 2011), also, television mediates events from scientific institutions e.g. news stories based on the publication of a peer-reviewed journal article.

Three particular types of programme were chosen for analysis, because they emerged as common types of programmes watched and referred to by participants in the focus groups. The three types referred to were:

- BBC's *Horizon* series
- *Half Man Half Tree*—a documentary in Discovery Channel's *My Shocking Story* strand
- *RTÉ News*

4.3.1 *Horizon* strand—Pure science, sheer drama

Horizon is the BBC's flagship science programme. The strand has been running since 1964 and was the subject of some of the earliest (and still most important) research into science communication on television (Silverstone 1984, 1985), as well as current research (Mellor, 2012) of gendered representations of science in the past five years of *Horizon* (building on the findings of the content analysis of the BBC's science coverage conducted for the BBC Trust, Mellor et al., 2011). In this research, *Horizon* was cited by participants of focus groups as the "best quality" science programme, and was chosen for analysis because of this.

The entire *Horizon* series 48, i.e. 2011-2012 was chosen for analysis. The entire season was analysed in order to make sure that the programmes covered a broad range of topics and styles. This particular season was chosen because it was broadcast closest in time to the organisation of the focus group research.

The *Horizon* programmes were recorded from BBC2 using the Sky Plus system, a personal video recorder which allows the user to record television onto an internal hard drive inside a set top box.

For the purpose of analysis the programmes were watched on a television set rather than a laptop or desktop computer, and this was how focus group participants reported viewing the programmes.

I began the analysis by watching the entire series (all fifteen episodes) back to back over three days. This gave me a good overview of the style and content of the *Horizon* programmes. The titles of the fifteen programmes are given below. For descriptions of the individual programmes, please see Appendix I.

- *Seeing Stars*, first broadcast on 15 August 2011
- *The Core*, first broadcast on 31 August 2011
- *Are You Good or Evil?* first broadcast on 7 September 2011
- *Is Nuclear Power Safe?* first broadcast on 14 September 2011

- *Playing God*, first broadcast on 17 January 2012
- *The Truth About Exercise*, first broadcast on 28 February 2012
- *Solar Storms*: The Threat to Planet Earth, first broadcast on 6 March 2012
- *Out of Control?*, first broadcast on 13 March 2012
- *The Truth About Fat*, first broadcast on 20 March 2012
- *Global Weirding*, first broadcast on 27 March 2012
- *The Hunt for AI*, first broadcast on 3 April 2012
- *Defeating Cancer*, first broadcast on 10 April 2012
- *The Transit of Venus*, first broadcast on 7 Jun 2012

After watching the entire season back-to-back, each episode was watched individually, and notes taken about the style of presentation, the presenters, the representations of science, scientists and non-scientists, and about the presentation of science's position in society. When the notes were completed for all the programmes, they were examined for common emerging themes, and then the programmes were watched again, and frequently paused and restarted to allow quotes from the programmes to be transcribed.

4.3.2 *Half Man Half Tree*—using emotionally compelling stories to explain scientific phenomena

In the focus group discussions, 'shock-docs' were almost always referred to when participants were asked an open-ended question about what science programmes they watched. "Shock docs" or "shockumentaries", a sensationalised style of documentary designed to shock the audience, in this case by presenting people with bizarre medical complaints. Focus group participants talked about a programme called *Half Man Half Tree* in particular, and these portions of the discussions were especially animated.

Half Man Half Tree was produced and broadcast by the Discovery Channel as part of its My Shocking Story strand, and was also broadcast by Channel Five as part of their Extraordinary People strand. Channel Five categorise *Extraordinary People* as part of their science output—and in their 2006 strategic report, state that: "our reputation is for using emotionally compelling stories to explain scientific phenomena".

Half Man Half Tree was not available on Sky Plus, so I searched for it online and found the entire episode was available on YouTube.

For the analysis the programme was watched on a desktop computer. I began the analysis by watching the entire programme straight through. Following this, I watched it again, this time taking notes about the representations of science and medicine, the representations of doctors and patients, the manner of the narrator, and about the presentation of science's position in society. Following an examination of the notes, the programme was watched again, this time it was frequently paused and restarted to allow quotes from the programmes to be transcribed, and for screenshots to be captured.

The analysis found themes of medicalisation, voyeurism and the position of the 'extraordinary' person with respect to the 'norm' in the programme, these themes will be discussed in detail in section 5.2.3 *My Shocking Story* on page 192.

4.3.3 *RTÉ News*—independent, accurate and impartial

This part of the research comprises a content analysis of the science stories in news bulletins on Ireland's public broadcaster RTÉ. These programmes were chosen for analysis because in the focus group part of the research, focus group participants talked about news television programmes being their main source of information about the world. The *RTÉ Nine O'Clock News* was chosen for analysis because it features consistently in the top twenty most watched television programmes in Ireland according to the TAM ratings, for example the TAM ratings for January–December 2011, show that *RTÉ News: Nine O'Clock* was the tenth most watched programme for that year (please see Appendix D for full details). *RTÉ Nine O'Clock News* is far ahead of its rival news programmes.

Rank & Programme	AV TVR	AV 000's	AV Share
1. The Late Late Toy Show	35.03	1195.3	65.19%
2. Eurovision Song Contest	29.96	1016.5	63.08%
3. All Ireland Senior Football Final	28.2	962.3	70.30%
4. The Frontline Leader's Debate	27.44	935	59.13%
5. Mrs Brown's Boys Christmas Special	24.9	849.6	48.72%
6. The Late Late Show	24.53	835.9	56.62%
7. Mrs Brown's Boys	24.43	832.5	52.04%
8. Prime Time Leader's Debate	23.16	789.2	49.80%

9. The Rose of Tralee	22.61	767.2	53.16%
10. RTÉ News: Nine O'Clock	22.56	769	44.15%

Source: Nielsen Television Audience Measurement / Arianna
Based on National, ROI Commercial Channels, January–December 2011, Consolidated

Table 4.2 TAM ratings for January–December 2011

Focus group participants also discussed how watching *RTÉ News* formed part of their everyday routine.

The RTÉ website makes available recordings of every RTÉ news bulletin dating back as far as 14 December 2008 at www.rte.ie/news/player/nine-news/. I began by watching three months of these news bulletins in order to get a rough idea of how many science stories were included and how big my sample would have to be to ensure manageability. I decided that my sample size needed to be a full year's worth of programmes. This ensured that the programmes I watched covered a broad range of topics, and also took into account any seasonal variation in coverage of science (Irish television is seasonal, e.g. popular chat shows like The *Late Late Show* are not shown in the summer months, this also goes for news programmes, for example July and August are known as the Silly Season, because Dáil Éireann[20] is in recess and there are far fewer political news stories. I decided to watch every episode of *RTÉ Nine O'Clock News* for a year because many stories with a scientific aspect, for example food contamination risks or natural disasters are clustered about a few days or weeks, so using a random sample or even constructed weeks would perhaps not give a full picture of the frequency of science stories in RTÉ News.

The coding instrument

The coding instrument used was based on that used for Mellor et al.'s (2011) report: *Content Analysis of the BBC's Science Coverage for the BBC Trust*. The decision to use similar coding categories to those used in by Mellor et al. was taken in order to allow for ease in comparing results with findings in the UK.

The data was captured and analysed using SPSS, as this is a software tool designed specifically for research in the social sciences and I had experience in using it to capture and analyse media content. To set up the SPSS template, I referred to the coding categories detailed in Appendix One of the Mellor et al. report, and used the relevant parts of it to create my coding sheet which is given in full in Appendix E. In SPSS, I set up a column for each category given in my coding sheet, and then

[20] Dáil Éireann is the principal chamber of the Irish parliament.

assigned a numerical code to each possible option for all the categories. For example, for the scientific field category, the numerical codes were assigned as follows:

1 = Scientific field

2 = Physical sciences

3 = Life sciences

4 = Medical science & technology

5 = Climate science & technology

6 = Engineering & technology

7 = Mathematics

8 = Mixed

9 = Other

The unit of analysis was the individual story, including studio introduction, package and studio discussion as appropriate. News stories were first of all sorted into three categories:

- science stories,
- stories which alluded to science
- not science stories.

For the purpose of this analysis, and again in order to facilitate comparison with UK BBC news programmes, I used the same definition of a science story as that developed by Mellor et al. (2011), that is, to count as a science story, at least one of the following must form a significant component of the story:

- activities or findings from the natural sciences, the applied sciences, medical science, or mathematics;
- activities or findings which are referred to as scientific;
- references to scientific institutions;
- references to individuals who are identified as having scientific expertise either by virtue of their disciplinary base or by their institutional role;
- references to individuals who are identified as being “experts”, or “researchers”, or equivalent, where the implied subject of their expertise is the natural sciences, the applied sciences, social science, medical science, or mathematics;
- the research and development stage of new technologies.

Stories which alluded to science were defined as those with a brief undeveloped reference to science (as defined above). Included in this category were any items which may be inferred to involve science or which may have a potential science angle, but where this has not been developed within the item beyond a brief reference, or stories which include explanation based on established scientific knowledge but which have not met the required criteria for a science item.

Stories which were not science stories were defined as stories with no reference to science; use of the word "science" or scientific terminology out of context without reference to scientific claims or activities; reference to facts which can reasonably be ascribed to general knowledge or to the standard knowledge base of professional practitioners (e.g., medical doctors, engineers).

I watched each news programme and each individual story in its entirety as I did not want to rely on the headline only to see if was a science story as I wanted to see if a non-science story alluded to science in any way, for example, a crime story could have had a forensic science element to it.

I noted the broadcast date of all the stories coded as science stories or stories which alluded to science. I did this so that I could navigate to them again easily as these stories were then analysed further.

Fr the next stage of the analysis, I returned to the science stories, and watched each one full screen on a desktop computer, frequently pausing and restarting to allow me to transcribe each story in full and to capture screenshots. I then watched the stories again and this time coded them using the SPSS template as described above. I entered the individual codes for each story into SPSS directly (on a laptop), using a hard copy of the coding sheet in Appendix E as a guide.

The content analysis measured:

- The prominence of science in the story
- The scientific field the story refers to
- They type of news event the story refers to (research, science policy, natural event/accident etc.)
- The reporter's beat
- The gender of contributors to the story
- The expertise of the contributors
- The title of the contributors
- The affiliation of contributors

- Whether the story contained cautionary comments about the science
- Whether the story contained oppositional comments about the science
- The overall approach of the story (informational, questioning/investigative, light hearted)
- The tone of the story
- Whether the interviewer uses humour
- Whether the interviewer is aggressive in his/her questioning
- Whether the story gives links to a website
- Whether the experimental design is mentioned
- Whether controversy is indicated
- Whether uncertainty is indicated
- Whether a funder is indicated
- Whether a publication is indicated
- Whether peer review is mentioned

4.4 Part 3, Production study

The analysis of the production of science programmes was conducted by carrying out semi-structured interviews with producers, editors and journalists of news and current affairs programmes and producers and editors of specialist science programmes. The interview guide is given in full in Appendix A—Programme maker interviews.

Interviews were recorded or detailed notes were taken and written up shortly afterwards.

4.4.1 Interviewing programme-makers

4.4.1.1 Documentary-maker interview

I chose the documentary-maker because he worked as a producer and director for the BBC (*Horizon*, *Tomorrow's World*) and then as an independent producer making programmes for Channel 4 and Discovery

The interview took place in a café in Canary Wharf, London.

4.4.1.2 Television journalist interview

I chose the television journalist (who specialises in health) because for a long time there was no science correspondent at RTÉ so any scientific/medical stories landed on his desk (out of 109 stories about science or alluding to science, broadcast on RTÉ Nine O'clock News in 2011, fifteen were by this journalist—more than any other correspondent).

The interviewed took place in the RTÉ canteen.

4.4.1.3 Programme commissioner

I chose this interviewee because she is a commissioner for factual and specialist programming employed by the Discovery Network International. She commissioned the *Half Man Half Tree* programme of the *My Shocking Story* strand.

The interview was carried out over the telephone.

5 Findings: production, content, reception

This chapter gives an account of the findings of the research, and the next chapter discusses the themes which have emerged from these findings. This chapter gives a comprehensive account of the content analysis, interviews with programme makers, analyses of representations of science, and focus groups. In the next chapter the themes that emerged from all these data are outlined, and links are made explicit between the different parts of the research.

In this study, the production, content and reception elements of science on television are not three equal parts: the heart of the research is the reception analysis carried out by focus group interviews. Therefore I used these key focus group discussions as a guide for selecting which television programmes to concentrate on for the content analysis and for the analysis of representations of science, and also as a guide for selecting programme makers to be interviewed for the production part of this study.

5.1 Reception analysis, focus groups

This section gives a comprehensive account of the focus group discussions and responses to the stimuli clips. The next section, chapter 6, *Discussion: emerging themes from the* research, will outline the themes emerging from this account as well as from the production and content parts of the research.

5.1.1 Focus group media use

To begin with, participants in focus groups 3-10 filled in questionnaies about their media use. The results of these questionnaires are presented here, summarised in table 5.1 below:

Focus group	**Average time spent watching television (minutes)**	**Average time spent listening to the radio (minutes)**	**Average time spent reading newspapers**	**Average time spent browsing the internet**
Focus group 3	100	28	11	62
Focus group 4	100	31	12	68
Focus group 5	116	41	46	167
Focus group 6	99	138	31	148
Focus group 7	108	88	33	74
Focus group 8	148	93	63	51
Focus group 9	156	99	44	93
Focus group 10	155	102	32	73
Total	982	620	272	736
Average	122.75	77.5	34	92

Table 5.1 *Summary of focus group participants' media use.*

One of the notable features of these findings is that the two school groups—focus groups 3 and 4—watch less television than the other groups, an average of 100 minutes each per day. It might then be expected that they would spend more time on newer media, i.e. using the internet, however this is not borne out in the findings which show that focus groups 3 and 4 spend 62 minutes and 68 minutes respectively browsing the internet each day. Indeed, in the case of focus group 4, four of the participants spent no time at all on the internet, this can be explained by the fact that they live in a remote area of Donegal where fast broadband internet service is stilled being rolled out. The school groups also spend less time than the adults listening to the radio, around half an hour rather than the average of an hour and a half that focus groups 5-10 admitted to, this can probably be accounted for by the longer commutes which the adults engaged in. The younger groups also spent much less time (about a third) reading newspapers than the adult groups, focus groups 3 and 4 spend 11 and 12 minutes respectively reading newspapers, the adult groups spent an average of 41.5 minutes, this can be accounted for by the fact that newspapers are not targeted towards adults.

It can also be noted that the three groups that watched the most television on average were focus groups 8, 9, and 10, all reporting watching more than 108 minutes each day. Focus groups 8 and 10 are the older groups (50+), and they also spent the least amount of time browsing the internet: 51 minutes and 73 minutes respectively (excluding the school groups which as noted above spent less time on the internet than the other groups).

The focus groups made up of participants with an active interest in science—focus groups 5 and 6—used the internet, on average, more than any other group, at 167 minutes and 148 minutes respectively. Focus group 6 also spent more time listening to the radio than the other groups, an average of 138 minutes (the average for all the participants surveyed was 92 minutes).

Focus group 8, made up of participants aged over 50 and educated to university degree level, stood out as the group that spent the most time reading newspapers. They spent, on average, more than an hour each day reading newspapers, the average time spent by all the other groups reading newspapers each day was 34 minutes.

Another question which was asked of participants was what television channels they watched. The most popular channels are listed in table 5.2 below (the most popular channels for each focus group were deemed to be those cited by three or more participants).

Focus group	**Most popular channels (watched by more than three participants)**						
Focus group 3	RTÉ1	RTÉ2		BBC1		Channel 4	
Focus group 4	RTE1	RTE2		BBC1		Channel 4	
Focus group 5	RTÉ1	RTÉ2	TV3	BBC1	BBC2	Channel 4	ITV
Focus group 6	RTÉ1	RTÉ2		BBC1			
Focus group 7	RTÉ1	RTÉ2	TV3	BBC1	BBC2	Channel 4	ITV

Focus group 8	RTÉ1	RTÉ2	TV3	BBC1	BBC2	Channel 4	ITV
Focus group 9	RTÉ1	RTÉ2	TV3	BBC1		Channel 4	ITV
Focus group 10	RTÉ1	RTÉ2	TV3	BBC1	BBC2	Channel 4	

Table 5.2 *Most popular television channels*

Note that the Irish public broadcaster RTÉ was popular in all the focus groups, as was BBC1, also note the absence of satellite channels, this may be accounted for by—as some participants noted in the focus group discussions—the fact that they used the 'zapper' to scroll between channels and often didn't pay attention to what channel they were watching.

Participants were also asked about the science television programmes that they watched. The most popular programmes for each focus group are listed in table 5.3 below. Programmes were deemed to be the most popular if watched frequently by at least three participants.

Focus group	**Television science programme(s)**
Focus group 3	N/A
Focus group 4	N/A
Focus group 5	*Horizon*
Focus group 6	N/A
Focus group 7	*Surgeons*, *Horizon*, *Eco Eye*, *Megastructures*
Focus group 8	*Eco Eye*, *Horizon*, *Megastructures*, *Naked Science*, *Science Shack*, *Surgeons*
Focus group 9	*Horizon*, *Megastructures*
Focus group 10	*Families in Trouble*, *Horizon*, *Megastructures*, *Naked Science*, *Storm Force*, *Surgeons*

Table 5.3 *Most popular science television programmes*

Note that there was not much agreement about television programmes among the school groups or the 'active' groups, but the other four groups agreed on a number of programmes, three of them Irish-produced, two US-produced and three programmes made in Britain.

As for science radio programmes, the most popular one among participants was *Mooney Goes Wild*, a magazine programme about wildlife broadcast on RTÉ Radio One every Friday from 3pm to 4.30pm. Radio audiences are very dependent on the time of day, and this is a popular time-slot. As shown in table 5.4 below, focus group 8 (aged more than 50 years and educated to university degree) were the only group where at least three participants frequently listened to other science radio programmes, namely *Mind Matters*, a programme about brain research, and *Icons of Irish Science*, a programme about eminent Irish scientists whose work has had a global impact.

Focus group	**Radio science programme(s)**
Focus group 3	*Mooney Goes Wild*
Focus group 4	*Mooney Goes Wild*
Focus group 5	*Mooney Goes Wild*
Focus group 6	N/A
Focus group 7	*Mooney Goes Wild*
Focus group 8	*Mooney Goes Wild*, *Mind Matters*, *Icons of Irish Science*
Focus group 9	*Mooney Goes Wild*
Focus group 10	*Mooney Goes Wild*

Table 5.4 *Most popular science radio programmes*

With respect to reading newspapers, the school groups again were different to the adult groups in that they did not have any newspapers which were popular (again defined as most popular if read frequently by at least three participants). Among the adult groups, *The Irish Times* was the most frequently cited newspaper (please see table 5.5 for details).

Focus group	**Newspaper(s)**
Focus group 3	N/A
Focus group 4	N/A
Focus group 5	*The Irish Times*
Focus group 6	*The Irish Times*

Focus group 7	*The Irish Times*, *Evening Herald*
Focus group 8	*The Irish Times*, *Irish Independent*
Focus group 9	*The Irish Times*, *Irish Independent*, *Evening Herald*
Focus group 10	*The Irish Times*, *Irish Independent*

***Table 5.5** Most popular newspapers.*

As for specialist science sections, *The Irish Times Science Today* section was the most popular.

5.1.2 The Investigators as a stimulus

Focus group 1 and focus group 2 used as a stimulus an episode of *The Investigators* documentary series about nanotechnology. As noted in section 4.2.4 Stimuli for focus groups—nanotechnology, coeliac disease, the missing link and digital intelligence on page 104, focus groups 3-10 were shown three different short clips, one from a news story about science, one from a news story about science, one from a documentary about a 'big issue in science' and one from a programme which explained science's role in everyday life.

This section gives a brief description of *The Investigators*, followed by an account of the findings from the focus groups 1 and 2, this is followed by a joint account of the other eight focus groups.

The Investigators, used as a stimulus for focus groups 1 and 2 has the advantage that it is short (22 minutes) and so can be shown in its entirety, also it is an Irish-produced programme, and concentrates on work done by Irish scientists at home and abroad. Each episode of the programme concentrated on a specific area[21]. In series two the subjects included: Ireland in Space, Ageing, Sensors, Climate Change, *Crops of the Future and The Nano Revolution*.

The Nano Revolution episode of *The Investigators*, perhaps unsurprisingly for a sponsored programme, was very much focused on Irish scientific research making significant progress and competing on a world stage. Some examples of the representation of scientific research as progress are:

> There's a revolution underway

[21] The series was sponsored by Environmental Protection Agency, Enterprise Ireland, Science Foundation Ireland, Teagasc, the Higher Education Authority and Discover Science and Engineering. Discover Science and Engineering is Ireland's national science promotion programme.

[Narrator]

Scientific odyssey

[Narrator]

May offer mankind the solutions

[Narrator]

I think nanoscience in general is really going to change peoples lives, I think this is going to be one of the greatest achievements in science in the next decade. I really believe we're at a crossroads, if we can understand this we can do wholly new things.

[Professor Kenneth Dawson]

Ground breaking activity

[Professor John Boland SFI Professor of Chemistry, Director, CRANN Nanoscience Centre]

Breakthrough

[Narrator]

I think it's a wonderful opportunity for these different threads of science, physical and biological sciences and medical sciences, to come together to do something that really will change peoples lives. So nanotechnology is going to really revolutionise society.

[Professor Kenneth Dawson]

This really is the cutting edge of what bionanoscience can do for mankind.

[Professor Kenneth Dawson]

This is the nanoworld, welcome to the new frontier

[Professor Mike Coey]

It'll open a new world of innovations and of new products that people haven't even dreamed of yet.

[Professor John Boland, SFI Professor of Chemistry, Director, CRANN Nanoscience Centre]

Scientific research is represented as progress, the fact that Irish scientists are succeeding in this research means that they can compete on a world stage. Scientific research is very much represented as a competition, and Ireland as a strong competitor. Some examples of the representation of Ireland as a competitive nation in science are:

> So what motivates us, what motivates most scientists is curiosity and competitiveness
>
> [Professor Mike Coey]

> Basically these R and D efforts are a type of horserace, we start off with many possibilities, at the moment it's being whittled down to 2 or 3 and Mike is among one of those last possibilities
>
> [Professor John Boland]

> As the race for the next breakthrough in computer technology reaches its conclusion, the scientific and commercial communities are watching closely to see who will reach the finishing line first.
>
> [Narrator]

> There's an international race on at the forefront of computer technology and the winner will be credited with literally revolutionising the industry one of the frontrunners in the field is Professor Mike Coey in Trinity College Dublin.
>
> [Narrator]

> One of the reasons that Ireland has really taken a leading role in this field is that we entered the field at the very beginning
>
> [Professor Kenneth Dawson]

> It'll be very exciting if in fact the type of device that Mike is looking at should in fact be the successful winner it will be a huge win for Ireland
>
> [Professor John Boland]

The Nano Revolution episode of *The Investigators* was a good prompt for discussion because it is a subject about which little is known and which appears very seldom in the media. For example, a search on Nexis of Irish publications over the ten years from

2000 until 2010 gives 14 stories for “nanotechnology”—compare this to the more than 1027 stories for “genetically modified”. There is not much public interest in nanotechnology either compared to other branches of science. *The Investigators* episode about nanotechnology achieved viewing figures of 92,000 while, for example, another episode about ageing (including research into Alzheimer’s disease) achieved viewing figures of 183,000.

5.1.3 Focus group 1

The composition of focus group 1 is described in detail in section 4.2.1 Make up of focus groups—pre-existing and constructed according to specific criteria on page 96.

The focus group session was held in Aislainn Cill Chartha, situated in the village of Kilcar in Co Donegal in the North-West of Ireland. Women travel to the classes from the nearby villages of Glencolumbkille, Carrick and Killybegs. This is a remote part of Donegal, the main employment is in fishing, fish-processing, sheepfarming and tourism.

Aislainn Cill Chartha is a community centre, it houses a library, pre-school, gym and cinema and hosts art exhibits. Various community groups such as the over 55s club and Weightwatchers use it for meetings. The centre is located in the middle of the village. The women were all familiar with the centre before they began the course there.

I began the session by explaining the purpose of the focus group before showing the first clip from *The Investigators* programme.

Participants then introduced themselves and described what kind of television programmes they watched. They initially mentioned: soaps, reality programmes, *CSI*, *Horizon* (“if it’s something relevant to me”) news and documentaries, before responding to the stimulus clip.

The participants were generally very positive towards the clip, although they did express concerns about the speed at which scientific research and development was progressing at, and that society was not able to keep pace with it with respect to regulation and ethical considerations.

> FG1FP3: But if you heard of that as a medical application, its fabulous, a camera so small it can image your whole body you don't have to go into a scanning device, but if you're looking at it as a military development it seems sinister. I think technology has advanced beyond our moral concepts of what's right and what's wrong. You know, it's outstripped it, its science fiction off the telly becoming real. If you watch old episodes of like *Star Trek* the original, I mean half it's ridiculously outdated now because we are doing those things in the real world, automatic doors, that go “SSShhhhh”.

As mentioned above, this focus group, as well as forming part of the research for this PhD, was also used as a data gathering exercise for Padraig Murphy's STRIVE project about public engagement with nanotechnology. As noted by Murphy (2010):

> The all-female focus group, however, raised many issues to do with science fiction becoming reality, the benefits of human/cognitive enhancement, privacy, ethics and regulation issues, as well as comparisons to other emerging technologies such as GM food and nuclear energy. This arguably, was the most successful activity in terms of range of topics, and some passion, in the exchanges. The fact that participants knew each other was a contributing factor. But there was sophistication in the responses: while sci-fi imagery was used, for both utopian and dystopian futures, discourses became grounded very quickly to speak about health and current environmental concerns.
>
> Murphy (2010), p. 49.

In common with other focus groups, they considered the economic benefits of scientific research as being very important and discussed the possibility of what one participant jokingly called "nanojobs". Unsurprisingly for a group of parents, they talked about the possibility of future jobs for their children, a discussion which led on to conversation about science education, where the participants compared their experiences of science in school (where, as girls they were discouraged from taking science subjects) to their childrens'.

> FG1FP2: Where I went to school you were put off doing science.
>
> [inaudible]
>
> FG1FP3: It depended, when you were choosing your subjects if it was grouped with something else, whatever was on the menu.
>
> FG1FP4: I think that was a lot of it too—we're a bunch of women here and when we were growing up we were geared towards the book-keeping and the biology if you wanted to be a nurse, and you were discouraged to do honours maths even, you know, never mind physics and all them.

The Focus Group 1 discussion differed from the other groups in that participants were more mistrustful of science than other groups, even going so far as one woman in her late thirties who said: "I'm all about the conspiracy theories". This was picked up by other participants, as the following interaction shows:

> FG1FP5: I don't think we're aware of half of what's going on, I think we're just kinda kept in the dark here.
>
> FG1FP6: We might be better off not knowing.
>
> FG1FP5: It's advanced a lot more than what we know; they're not keeping us informed.

And participants went on to discuss espionage and how military intelligence could “tune into keywords”.

5.1.4 Focus group 2

This group and Focus Group 1 served two purposes, they acted as focus groups for this PhD research using an Irish television science documentary (about nanotechnology research) as a stimulus, and they also acted as a data-gathering exercise for Dr Pádraig Murphy’s STRIVE project about public engagement with nanotechnology (Murphy, 2010).

Focus Group 2 was held in Dublin City University. It differed from Focus Group 1 mainly in that they were very critical of *The Investigators* programme. Focus group participants recognised the representations of ‘scientific research as progress’, and ‘competitive Ireland’ described earlier, and were sceptical of the programme because it was so ardently in support of nanotechnology research. They described the programme as “very one-sided”. They saw it as an advertisement, a marketing tool, rather than as a balanced documentary. As three of the participants said:

> FG2MP1: Really, it was like a party political broadcast, I don’t think it was a *Horizon* type of thing or programme, in that ehm I don’t think; it was a different type of programme. *Horizon* is produced by the BBC which is public service.
>
> Female, mid-thirties, Focus Group 2

> FG2FP3: I thought it was more like a marketing tool for Ireland for nanotechnology or for the pharmaceuticals you know saying where we are up front there.
>
> Female, mid fifties, Focus Group 2

> FG2FP2: I think it was a very Utopian view of the science. I would think they’re kind of the main arguments that are given to, kind of government promoting the knowledge economy, and the centrality of science to that. They are giving that Utopian view to the public and I don’t know the downsides of nanotechnology, but I definitely thought it was very imbalanced.
>
> Female, mid-thirties, Focus Group 2

Participants in the same focus group went on to discuss the lack of detailed information in the programme:

> FG2MP1: One thing about all this, they want to put the emphasis that it’s important for a country like Ireland to be near the cutting edge of technology, but they didn’t give any

information of how it is funded at all, how much these things actually cost. Whether Ireland can really compete, or is it just, you know, the low budget, low side of this cutting edge technology. I suppose that's totally the case, they may have, I don't know, altogether a few hundred thousand a year or maybe?

Male, mid thirties, Focus Group 2

The focus group discussion suggests that the sponsored programme lacks subtlety, and that a more nuanced, balanced account of scientific research is required to engage audiences.

5.1.5 Focus groups 3 - 8

Focus Groups 3 to 8 used as stimuli three short clips. Please see section 4.2.4 *Stimuli for focus groups—nanotechnology, coeliac disease, the missing link and digital intelligence* for a full description of clips used. The focus group discussion guide is given in full in Appendix C. Appendix H gives a brief summary of the media use of focus group participants (this information was gathered in a pre-focus group questionnaire).

Each focus group began, after brief introductions, with asking participants about their general ideas and thoughts about science. To begin with, they answered this question by mentioning the science they learned in school, that they saw in various media and that they came across "everywhere" and "in everything all around us". As the discussions progressed, many of the focus groups reflected on the nature of science and their understanding of it. Several participants queried whether particular topics were science, they were unsure, for example, whether astronomy was science or not. In several focus groups participants agreed that they weren't really sure what was science and what wasn't. In one group, comprising people over 50 years of age, the uncertainty was summed up by one male participant:

FG8MP8: I think if you ask people 'what do they mean by science', I mean I think we're even confused, like we're totally confused by what science is.

FG8FP1: Yeah

FG8FP3: That's right

FG8MP8: You know, I mean at the beginning we were all talking about something very very narrow right, but it's opened up now about science, so you know if we're the average, you know, what I mean, so the average person doesn't understand what science is.

Notwithstanding this "confusion" over what science is, almost all of the respondents referred to the natural sciences only, they did not include the social sciences in their discussion, with the exception of one woman who was surprised that she was the only one who “thought straight off of political science”. Participants volunteered that science was about “how things work”. Some focus groups included participants who had a science background, these participants in particular described the enjoyment they got from figuring out “how things work and fit together”. A few participants described science as being like “solving a puzzle” and took especial pleasure in it when “something clicks with you and you see a pattern”.

Progress was another common theme in this part of the discussions. The idea of “moving forward” and “achievement” were stressed by participants. As one 30-year-old female participant put it:

> FG7FP8: You associate science with sort of progression, you know it’s constantly moving, constantly evolving, constantly learning new things and its always, if you read an article in the paper it’s always “Scientists have discovered..!”, like there’s this big room full of scientists somewhere working away discovering these things. It covers I guess so many aspects, so many different disciplines, that it, they just call them ‘scientists’ whatever, but it’s the idea that we’re moving forward I think.

Separate to the theme of progress and moving forward, science was also described by participants as being very slow-moving and painstaking, with conscientious progress happening step by step. As one 36-year-old female participant responded:

> FG9FP2: You get the impression that it’s very slow moving though, that to discover something takes years and years and years, and loads of experiments and trials, and while its progressive it can be slow too.

Participants in the focus groups discussed the sites where they came into contact with science in everyday life. They mentioned advertising, school, and media stories. Participants treated the scientific language and imagery used in advertising lightly. They did not take the scientific claims or language used seriously. They recognised the purpose of the advertising as “they're trying to sell stuff, it's [science] being used a bit in that context to fob us off”. Participants also treated conflicting science news lightly, as one twenty-nine-year-old laboratory scientist joked:

> FG6FP2: Some of the things you hear are ridiculous and contradict each other, like one will say drinking loads is good for you one week and bad for you another week.

These contradictions were observed by the groups to be especially prevalent in stories about nutrition and diet.

5.1.5.1 Science in the news

Participants also discussed science news stories they came across, they talked about how science news stories were usually structured in a similar fashion, and there was what they described as a “typical” news story or what one respondent called an “off the shelf science news story”. Participants agreed that the news stories usually began in the same manner i.e. “Scientists have discovered…” and that common topics covered in the stories are health research and stories about “green energy”. Controversy was also mentioned by participants as a trigger for reporting science stories:

> FG6FP3: Anything about cloning gets covered, because it’s controversial, people are divided on it, anything that happens in that area will get huge coverage.

As well as cloning, participants mentioned stories about BSE, Foot-and-Mouth disease, avian flu, contamination of public water supplies with *E. coli*, swine flu and controversies about immunisation policies. One group debated about whether these stories could in fact be “classed as science” or not, as one participant maintained that these stories would be classed as current affairs rather than science as they did not involve actual discovery. In all the discussions, even though participants began by describing news stories about what “Scientists have discovered…”, the bulk of the discussion about science news stories centred around stories of controversy and risk and these stories were the most readily recalled by participants. With a couple of exceptions, such as the coverage of the Large Hadron Collider, almost all the actual stories discussed by participants were about risk and controversy.

5.1.5.2 School science

The science that participants encountered in school was discussed in every group, not just the groups comprising young people. This is in common with the findings of de Cheveigné and Véron’s (1996) reception research about science television programmes in France. They found that memories of school influenced the appreciation by participants of the limits of their own knowledge and of their capacity to learn and understand science. Some participants, when asked: “What comes into your mind when you think of science?” immediately answered: “Biology, chemistry and physics”, naming the three science subjects studied for the senior cycle (Leaving certificate) in Irish second-level schools. Some participants who had studied science at third level also immediately associated “the word science” with their own studies.

> FG5MP8: When I think of science I just think of what I've done because I spent four years doing biology, microbes all that kind of thing.

A few participants cited positive school experiences that prompted their interest in science, “I liked it in school because there was always a right answer and a wrong answer” and “I got good marks so I thought I must be good at it”. One 16-year-old male participant liked the investigative nature of science: “I like testing stuff to see if it works, instead of just accepting it.”

One particular participant, who is herself now a science teacher said:

> FG6FP4: Actually one of the things that interested me in science in the beginning was actually my teacher, and for weird reasons like she was glamorous, but, I know that sounds weird but it was a very structured class, as opposed to actually being the content itself which was kind of boring for me as well, but yeah, it’s funny how, you know when you have like a kind of a positive influence in a classroom it kind of, you kind of get into science from it then.

Other participants had a more negative view of school science, either because “our science teacher wasn't really good” or because it was perceived as being a “very difficult” subject.

Individuals in the focus groups comprising older participants, and in particular individuals who had children themselves, discussed how attitudes to school science had changed over the years. Participants talked about how science covered a much wider range of subjects and areas that they had never considered when they were studying it in school.

> FG10FP9: Science years ago when we were in school was very difficult—if you liked science you were you know—but now you know with these programmes I’d say more people would now be into it, you know science because like forensics and people didn’t think about any of that years ago, so I think these channels are brilliant because it opens up
>
> FG10MP4: Knowledge.
>
> FG10FP9: Knowledge, exactly.

In particular, they spoke about environmental science, and the school-based initiatives surrounding it. They discussed how science was no longer seen as a narrow discipline but, with the environmental initiatives “all the kids are into it”. The changes to the curriculum were summed up by one parent who said: “At school that would never have been part of what we thought in science, now in school where science is on the curriculum its part of everyday life.”

5.1.5.3 Science relevant to 'everyday' life and 'ordinary' people

This idea that things have changed regarding science was not just discussed regarding school science but also regarding science outside school. Participants talked about how science had expanded to cover many areas that they had not considered scientific in the past. Participants gave examples of weather, environmental science, forensic science, food science and sports science:

> FG6FP3: I think now it's changed an awful lot, even here things like food science and things like sports science. I mean a lot of the top premiership clubs use sports science and they use food and balance and dietary balance performance, how it'll enhance performance you know, so like science it does cover everything.

As well as science itself expanding to cover more areas of life, participants acknowledged that their own interest in scientific subjects had also grown. As FG7FP3 said, after describing a science programme she had watched and enjoyed: "Ten years ago I would have never have watched something like that". Participants credited television programmes and the internet with contributing to their increased interest in science because they "opened up" science, bringing subjects like forensic science, which "people didn't think about any of that years ago" to their attention. This opening up of science, making it into something which participants could see as relevant to their everyday lives and take an active interest in, is one of the key ways that watching science on television can contribute to participants' scientific citizenship. As one participant put it very simply: "with the internet and everything, there's more out there these days".

Particular groups also had particular reasons for being interested in science. Participants in one of the school groups were especially interested in science programmes which followed the school curriculum and would help them prepare for examinations, while the older (over 50s) groups were especially focused on health and medical science. They acknowledged this interest, as one participant said: "At our age we're more interested in health and stuff". Also, participants who had suffered health issues were particularly motivated to seek out information about their illness, as it was relevant to their daily lives, unlike some other areas of science which were less pertinent. As one woman said about a television programme about computer intelligence: "It won't change my life if a computer can't tell the difference between a dog and a cat".

In general, and apart from discussions of the contradictory findings common in scientific nutrition studies, participants found science to be trustworthy and even saw scientists fighting against big business, for example by challenging claims about the health benefits of certain foods such as breakfast cereals and publicising the fact that they were “full of salt and sugar”. Participants said they were suspicious and sceptical and used science to help them assess messages and information.

> FG10FP1: I suppose it’s just that, I suppose a sense of awe and a sense of questioning and I think nowadays, we’re much more suspicious about stuff
>
> FG10FP3: Yeah
>
> FG10FP1: And science in some way, it gives me a logic, it gives me a way and even if I follow stuff up you don’t even have to watch a programme on the internet, you kind of follow stuff up, it’s a bad thing sometimes because the information it’s not always correct, it’s the way you go but even stuff about various drugs, tests, illnesses just stuff that’s very relevant, even stuff about food and products that we’re all using and I think a lot especially the investigative stuff challenges that scientific way and it also challenges the interested parties a bit, or informs us about who the interested parties are. Some science seems pure for the want of a word and then you find it’s Unilever or something that’s behind it.

Participants also discussed how science was not something that could be wholly understood by “ordinary” people. Some participants argued that ordinary people are not able to understand the implications of a scientific discovery unless it is spelled out for them and the applications explained:

> FG7FP6: I think you have to have an application as well, because it’s all very well somebody could give you something that would be within the science community and that’s brilliant, but to your average Joe Soap how do you apply that to real life? And I think if you can apply it and say this is the kind of problem this is going to solve and this is the kind of difficulties people are having today, and I think if you can apply it then and people can see.

Participants in the two focus groups comprising people with an active interest in science, i.e. science teachers, science communication professionals, scientists and so on, discussed at length the responses of people to science. They disagreed about whether “ordinary” people were interested and engaged with science or not. Please see section *6.3.1 Ordinary Joe—rooted in the everyday* on page 225 for more discussion on how ‘ordinary’ people are perceived to deal with science.

5.1.5.4 Constructing scientists

Focus group participants were asked to describe scientists. They described stereotypical images of scientists. He (it was invariably a he) was described variously as a:

“crazy scientist”

“mad scientist”

“nutty”

“nerdy”

“not of this planet”

“men running round in white coats and test tubes”

As the discussions continued, participants volunteered some more positive representations of scientists such as:

“very smart”

“there's a wild lot of stuff to keep in your head, to remember”

“creative”

“very focused”

“single minded”

Participants in Focus Group 10, which comprised participants aged over fifty years but with mixed educational backgrounds, elaborated:

> FG10FP3: You know, fairly intelligent I’d say, but you know, not of this planet I’d imagine, most of them I’d say
>
> FG10FP1: Very focused I’d say and single minded
>
> FG10FP3: Yeah but not to common sense I’d imagine

5.1.5.5 Science television programmes

Participants were asked about what sort of television, particularly about science, they watched. They perceived science programmes, and particularly blue chip documentaries rather than more entertainment-based formats, as being a worthwhile activity.

> FG9MP1: I think watching science as well you don’t feel like you’re wasting time if you sit watching *The Simpsons* you feel like you’ve wasted half an hour.

Participants said that they enjoyed watching high quality programmes, one 16-year-old male student said he liked to watch such programmes because: “It gives you a break away from all the reality TV. It gives you interesting stuff that is real”. This was echoed by a participant in another focus group who said: “There's nothing more interesting than real-life experience”. The poor quality of television programmes in general was cited by participants as a reason they enjoyed science programmes:

> FG7MP5: I’d watch anything in absence of watching something like *EastEnders* or *Coronation Street*. I’d find something that’s not *Coronation Street* or *EastEnders* or *Emmerdale Farm*, or something like that, and the it only takes about three or four seconds to engage if it something interesting, mildly interesting, more interesting than *Coronation Street* or *EastEnders* then I’ll dig into it, yeah.

> FG8FP3: To get something that's non-violent, there's an awful lot of stupid films on, so it’s nice to be able to have something in wildlife, or you know as another girl said, something topical to sit and watch and learn something from.

Participants took pleasure in the narrative of science documentaries: “I was dying to see the end of it”. Or “waiting to see what'll happen next”, and they discussed different styles of science documentary. In several groups, participants talked about science being explained “step-by-step”. Some participants liked this style of documentary:

> FG9FP10: I think its nice when it’s explained to you like you’re a six year old, I think it’s more interesting, and it’s not patronising like it’s explained that little bit better and it holds your interest, rather than using scare tactics you know like that is the way we came from ‘That’s your arm! Now that’s the way it is!’ You know that kind of way. Because the kids are interested now, they all want the green flags for school and they’re interested in getting all these things, so they could explain just a little bit more.

Participants also mainly agreed that a prior interest in the particular science topic was necessary to enjoy a programme about it, this presents one of the difficulties in producing science programmes, that it may be hard to stimulate audience interest in novel subjects that audiences have no experience of and therefore no prior interest:

> FG4FP5: My sister is obsessed with elephants, so if there’s anything on about elephants
>
> FG4FP6: My mother is as well
>
> FG4FP5: So if there’s anything about elephants, elephants and giraffes, she has to watch it.

Participants also agreed that they would need to “be in the mood” to watch some science programming as the material was quite challenging and not always what they wanted to watch after a long day at work or school:

> FG4MP4: When you finish a day at school you don’t really want to think too much, so I’d watch the fun one, because you just kind of, you don’t have to use your head too much.

Participants talked about the motivations for making science programmes, Focus Group 3 in particular (one of the school groups) discussed how “They're all aimed at trying to get you involved in science”. This group went on to discuss the fall-off in interest in science courses at third level, and saw science programmes as a response to this. As one sixteen year old male student said:

> FG3MP5: and science courses are, not as many people are doing science courses or mathematical courses, so they’re kind of trying to spring some life into science again.

Participants found science programmes to be mostly credible, but they did have some doubts, especially when it appeared to them that the presentation was overly dramatic or sensationalised. In one focus group, a couple of the participants expressed doubts about the validity of Darwin’s theory of evolution. One participant in particular said she did “not believe in evolution” and was sceptical of the claims made in one of the clips shown—a clip from an episode of the BBC *Horizon* strand about evolution. She went on to say:

> FG6FP7: I would have watched it, but it would be more to challenge it than—even as it was I was challenging it, because at the end of the day if you do believe in evolution in the between hand as they’re changing you know you can’t just go well: one day you’re going around as a fish and the next day you’re a person, you know what happens them when they’re doing that? Just, just I don’t buy into it.

This participant was exceptional in disagreeing with current scientific thinking but many of the groups criticised not science itself, but television’s portrayal of science. One participant explained it thus: “television exaggerates science and programmes like *CSI* glamorise it”.

Participants were also sometimes frustrated when science programmes were promoted in a sensationalised manner and then ended up delivering less than they promised.

> FG7MP5: The other things I find about these programmes, it may not be specific to this, there are a number of programmes where there’s a misnomer in the name, they say ‘Who shot John F Kennedy’ and you say ‘Great, I’m gonna watch this now and I’m gonna find out who shot John F Kennedy’ and at the end of it then you’re left with more questions than answers, and sometimes I’ve actually seen one or two science programmes suggesting it’s a theory, again they just open it all up, with no proof, there’s nothing again, and you’re no wiser at the end of it they’re just throwing a few theories at you and it just poses more questions and it sensationalises it all.

Participants in the focus groups talked about what aspects of science programmes they liked and what they would like to see more of. Many participants suggested that applications of scientific discoveries and research could be described and explained.

> FG7FP6: I think you have to have an application as well, because it's all very well somebody could give you something that would be within the science community and that's brilliant, but to your average Joe Soap how do you apply that to real life? And I think if you can apply it and say this is the kind of problem this is going to solve and this is the kind of difficulties people are having today, and I think if you can apply it then and people can see.

Participants discussed the most common topics they saw on science television programmes. The topics that the focus groups came up with the most were the environment and health issues. Participants were interested in the scientific explanations surrounding global warming both on a global and a local scale, they linked this interest to their own behaviour regarding recycling and so on in their homes and in their communities. Participants often had a personal interest in science stories about health research, either because they or someone they knew suffered from a particular condition. This personal interest made them watch the television programme in a different 'active' way, and follow up afterwards with perhaps their own research or by discussing the programme with friends or family. One of the school groups (focus group 3) was unusual in that they also mentioned chemistry and geography as being common topics for science programmes.

The focus groups discussed the formats of science programmes that they watched. The formats which they spent the most time discussing were natural history documentaries, such as those BBC productions presented by David Attenborough, entertainment formats, such as the Discovery Channel's programme *Mythbusters* or Granada production's *Brainiacs*, documentaries with an emphasis on shocking images and stories, often about people with unusual medical conditions, documentaries about forensic science used to catch criminals and dramas about forensic scientists—the most famous of which is *CSI*.

Some groups named only natural history programmes when asked to describe a science programme, unless they were prompted by the moderator to mention other types of science programme. Most of the participants immediately spoke about television programmes on satellite (i.e. not Irish) channels rather than terrestrial channels.

Participants agreed that entertainment was important for television and that programmes which were not entertaining would not be watched, especially by young people. Focus groups discussed audience viewing figures for television programmes. One participant (in one of the 'active' groups), and a producer of science television programmes described the pressure that television companies were under to get ratings:

> FG5FP4: I think that competition, that competing for the prime time is a big thing on TV because there's limited outlets so in Ireland you only have four channels. RTÉ isn't really commissioning that much any more at the moment so any show they put on has to get those viewership figures so television really is about entertainment.

Two of the entertainment-based programmes mentioned in almost all the focus groups were *Mythbusters* and *Brainiacs*. These were mentioned because “FG4FP2: They would be more likely to grab their attention, and they would stay and watch longer” and they gave information while being “easy to watch”.

One female participant, aged 30, talked about *Brainiacs*. It suited her because she liked watching bite-sized chunks of science:

> FG9FP9: *Brainiacs*, they’re kind of like your little snapshots, you know, a little bit of science for the day instead of watching, instead of sitting down to your high-brow David Attenborough programme for an hour, do you know what I mean, they’re kind of making it interesting for maybe the younger population, I don’t know, and me.

Participants in the two focus groups comprising young people were particularly keen on these entertainment formats for science programmes. In one of the school groups a 16-year-old male student enthusiastically described a section of *Brainiacs* he liked called “Will It Break Or Will It Bounce?”:

> FG4MP7: They would have one thing before the break or something and they would kind of stop it before it hit the ground, and then they would pause it and say: ‘Do you think it’ll break or bounce?’ and then they show you after.
>
> FG4FP2: I’d say more things broke than bounced.
>
> [laughter]

The younger focus groups were also especially interested in shocking documentaries, although these programmes were discussed by almost all the focus groups. Focus Group 4 had a particularly animated discussion about several of these programmes, in particular a programme called “*Monsters Inside Me*”:

> FG4MP9: There was something like that on Sky or something, its “*Monsters Inside Me*”
>
> FG4MP2: Oh yeah, there was maggots growing inside a man’s head
>
> FG4FP3: Yuck, ugh
>
> FG4MP2: And they were pushing out of his skin and all
>
> FG4FP5: Aw, that’s disgusting

Interest in these type of shocking programmes was not confined to young people. In all of the groups, if a participant described a particular episode of one of these programmes, then other participants would enter the discussion as they recognised the episode being described as they, too, had seen that particular episode.

For example, this discussion in Focus Group 10:

> FG10MP5: And then they had one, it was about the tallest woman in the world, she was Chinese.
>
> FG10FP8: Yeah, eight-foot-two or something
>
> FG10MP5: And they had the problems with the tumours, basically growing out of his head
>
> FG10FP9: And the man who fell out of a tree and a branch, he was a lumberjack, and a branch of a tree stuck up his backside. That was a really serious one I mean that was brilliant. And that woman with the 200lb tumour. They were all, you'd never know about these people.

Forensic science programmes were mentioned by some participants, usually in quite a jocular fashion as they joked that they would "be able to commit the perfect murder from what they had learned". Dramatic portrayals of forensic science were also discussed in almost every focus group. Sometimes, if a participant mentioned *CSI*, other participants in the group would joke that it wasn't really a science programme:

> FG3FP4: When I think of science programmes I think of *CSI Miami*,
>
> FG3FP3: That's not real
>
> FG3FP4: I know [laughs]

Focus group participants disagreed about *CSI*-type programmes, some saying that "there's a lot of science in them" and others disputing the accuracy of the shows claiming that it made science appear more excitng and glamorous than it was.

Participants of focus groups discussed the features of science programmes which attracted or repelled them. They discussed visual imagery and programme presenters in particular. In several of the groups, the visuals used for natural history documentaries were discussed. These visuals were popular with participants as they gave them access to footage they would never see otherwise.

> FG6FP2: That's like, that's why David Attenborough's programmes are so popular as well, because it's the imagery that goes with the science, and what they can do with the cameras to make a plant grow and you see it in two minutes, that would have taken years.

Visual images (not just in natural history programmes) were said by participants to "grab your attention", participants agreed that they were the main advantage of television over other media. Images make the science easier to understand and absorb. As a 54-year-old male participant in one focus group said:

> FG10MP6: As an interested lay person, I need it visual, now there's no point in putting a pile of figures in front of me because I can't relate to it you know but if you put the image in front of me it's easier to understand. It's no harm reading about it
>
> FG10FP9: It's better to see it.

One of the younger focus group participants had a similar response to the discussion of imagery:

> FG3MP1: Pictures kind of keep you focused and make you more aware of it, if they're just speaking you know, it's not exactly accurate in your own mind if you're trying to figure something out.

5.1.5.6 Television presenters

The presenters of science programmes were also much discussed by focus group participants. Participants agreed that it was important to have an engaging presenter, as one laboratory scientist put it:

> FG6FP2: It's good if the presenter engages you, it's nice to have someone you can relate to.

In other focus groups the point was made even more forcefully:

> FG5MP3: It reinforces the point that the presenter, the scientific presenter, is absolutely crucial in any sort of science programme. It's true to say that the whole thing rests on that guy.

The importance of the presenter was perhaps best expressed by one female participant, a student of the MSc Science Communication in Dublin City University, who talked about the presenter not just in the context of science programmes but of television in general.

> FG5FP6: Even with property programmes, the most successful ones are the ones that have like Kirsty and Phil and they have the banter and talking and the chat or whatever, and like, that's what people watching want, to kind of get involved in the programme.

There were some qualities which presenters of science programmes needed to have, according to focus group participants. Participants agreed that they should be enthusiastic and energetic and "someone you can relate to".

Participants rated enthusiasm in their presenters very highly, as these quotes about two of the most popular presenters David Attenborough and Steve Irwin show:

> FG9FP8: When Steve Irwin was doing it he was so into it himself the enthusiasm coming out at you through the television he was brilliant.

> FG6FP5: David Attenborough is so genuinely interested in science he passes on that enthusiasm to the viewers.

The younger focus groups in particular valued energy in presenters, even going so far as giving the example of the television weatherman as an example of an energetic presenter who kept their attention.

> FG3MP7: If you look at TV3 at your man Martin King doing the weather, it sort of always makes it interesting, he gets your attention which is a bit better and they kind of put up pictures that viewers can send in and they show them. It kind of keeps your attention compared to a monotone voice.

> FG3FP9: He sort of jumps around a bit

> FG3FP4: Yeah he's live compared to someone who just sits there and tells it all.

> FG3FP9: They kind of just look dead when they're saying it.

The discussions about presenters led onto talk about using celebrity presenters. The younger focus groups were particularly keen on this idea. The reason that participants gave for wanting celebrity presenters was that they wanted "someone you can relate to", participants also agreed that it was "good to have a familiar voice". Younger participants perceived that they would have difficulty relating to scientists because:

> FG3MP5: Scientists you feel are a different—not species—but when you're watching it you want to be able to see these people are on my side you know, they can understand something else.

The presenter, was then, used by focus group participants as a bridge between scientists and the audience, in effect, he was a stand-in for themselves, for the naïve public. However, in the older focus groups, there was disagreement about whether celebrity presenters were a good idea or not.

> FG8FP3: With the celebrities, sometimes if they're good speakers, I mean look at Al Gore, he made a speech and a film about you know

> FG8MP8: But then, it gets to be you know 'get a celebrity and then doing something',

> FG8FP3: sometimes they're good speakers though.

> FG8MP8: I know they're good speakers, but that shouldn't be the way to go with a programme.

Many presenters were named by the participants of the focus groups, the two presenters which were discussed the most and stimulated the greatest response in the participants were David Attenborough and Steve Irwin.

5.1.5.7 Television as a medium for science

Focus group participants reflected on television itself as a medium for science and how it compared to other media. Participants agreed that television was a relaxing activity and agreed that they enjoyed “slumping in front of the telly” after a long day. Participants agreed that the relaxing nature of television watching was one of its biggest advantages. As one participant, female, age 45, said:

> FG7FP3: Well, I find that I love to sit down and curl up. I find that more enjoyable to actually sit down and watch it on the TV.

This comment speaks to the pleasure of watching television, and indeed sums up, why even with increasing social media and digital platforms, television will not go away. Though participants did criticise television as well. They found fault with it for sometimes being too sensational, and for exaggerating and glamorising science. Some participants also believed that the quality of television programmes had deteriorated over the years and that today's programmes were appealing the lowest common denominator. FG5MP4, an MSc Science Communication student, said: “I think people recognise it as being overblown, you know it’s gone a bit too far I think. I don't know if I'd call it dumbing down or what I'd call it, but it’s just it’s almost a stereotype.”

Participants reflected on the way that they watched television. They discussed how the way they use television has changed over the past number of years with more channels and better recording capabilities:

> FG7FP2: I think things have changed so much now I think if you looked at your TV Guide and said ‘right I'll watch…’ I don't think people do that any more. You might if you're lucky enough to catch it but you never really look at the TV Guide, now I would never plan my viewing.

Participants also talked about how they flicked between hundreds of satellite channels while watching television, which meant that they often weren't aware of what channel or even what programme they were watching at a particular time, as one woman said:

> FG9FP2: A lot of the time you don’t even know the name of what you’re watching, I’ll be watching something and then I’ll say ‘Oh, that’s what it’s called’.

Participants thought of science programmes as being broadcast mainly from the satellite channels. After some discussion, participants agreed that they tended to watch particular channels rather than to plan to watch particular programmes. They had expectations of the style of programmes from particular channels, as FG4MP3 said: “You would know by what channel it’s on what it'll be like”. Participants also discussed how they talked about television with their friends, family and colleagues. One man, FG10MP5, said he would “get on the phone and text my friend straight away” to tell him if there was an interesting programme on television. Participants acknowledged that watching a science programme on television could lead them to further follow up the science topic.

> FG7FP6: Oh yeah completely, I mean it does create the interest. I think there’s definitely a position for those type of shows, and it does grasp peoples attention, and you might find that show interesting and then go on and read a book about it, or look more up on the internet they’re a starting point.

By actively following up on science programmes that they watched, perhaps by doing their own research or by discussing the programme with friends or family participants were performing their own DIY scientific citizenship.

5.1.5.8 Responses to clip 1 - science news story

Participants in all of the focus groups said that they were used to seeing the same types of “generic” images of laboratory scenes in any news report about a new scientific discovery. Participants admitted that they did not understand what the scientists in these shots were doing, as one male 30-old participant said:

> FG9MP9: But it makes you wonder: they could have been dropping bits of coca cola into the test tube or whatever.

Participants discussed how they were not engaged by these repetitive images of scientists working in a laboratory. As the exchange between these 16-year-old school students shows, these images were regarded as irrelevant by the focus group participants.

> FG4FP5: Yeah, because it showed them watching on the wee Petri dishes.
>
> FG4MP4: Like you always see stuff on but you never listen.
>
> FG4FP5: Aye, there’s always someone in a lab doing something but you don’t pay attention to it.
>
> FG4MP4: It’s nothing to do with you.

Participants in the two focus groups comprising people with an active interest in science, i.e. science teachers, science communication professionals, scientists and so on, reflected at length the value of the images used in news reports about scientific subjects. It is interesting to note that these ‘active’ groups shared the opinion of the other groups, that is, that the images of science such as white coats and Petri dishes were tedious and did not add much to the presentation of the news stories. They talked about the production routines of news programmes and the need for easily recognisable “wallpaper” images of scientists working in laboratories. One MSc Science Communication student, said:

> FG5FP1: I really wonder as I was sitting here, and I suppose it’s because I’m sitting here, at the value of the generic lab for quite as long as it did have it. I think it’s nearly like the generic picture of the politician, because I can imagine them saying ‘oh, let’s show some pictures of scientists doing things,’ but watching it I thought: ‘why are we still watching people putting things into things?’ I’m getting really bored of that.

In one of the focus groups one male participant, FG8MP6, aged 54, immediately classed the news story as a “filler-inner” which would be used on a “slow news day”. This led to a discussion about how television news stories were produced. Participants discussed press releases and how stories were structured for television. One participant referred to this story as a “standard off the shelf science news story”, as it included everything that he expected to see.

Focus group participants responded positively to the RTÉ news clip showing scientific research being carried out in Ireland and recalled other similar stories:

> FG7FP2:There was something on the news as well about the Irish guy who discovered water on the moon, and I was like ‘Great, brilliant, an Irish man and he’s out there in NASA or wherever he is’, but it’s great to think there’s an Irishman. I told my father about that, and I told my husband about that, and it’s just, I think it’s a thing about the way Irish people are, we just love to have a little boast if it’s an Irishman.

One participant complained that not enough Irish research was shown on television compared to newspapers:

> FG8FP1: You'd think from the television we're doing very little here.

The RTÉ news clip shown was about a health topic, participants agreed that this was particularly interesting as the topic (coeliac disease) is very common in Ireland: “FG8MP4: Well, I think most of us know someone who's a coeliac.” Participants agreed that they would take action if they saw the news clip about coeliac disease at home, as one male participant said:

> FG7MP5: I think everybody knows somebody that has it. I have a mate that has coeliac, and I’d tell him because he’d be well interested. I’d text him about it you know, I’d get

the name of it and I'd send him a text about it. I'd pick that up for him, you know, I'd give him the name of it and tell him to try it out.

Some participants believed that an interview with a person suffering from coeliac disease should have been included in the report, this human interest would, they say, have made them pay more attention to the report.

FG4FP1: If you interviewed a young person that was a coeliac and they were telling all the things that was wrong with them, that they have to eat differently, you would listen to that.

Another criticism put forth by the focus group participants was that the report stood too much on its own, it was not linked into any other scientific or medical research and also these types of news stories about scientific discoveries were never followed up. The clip was taken from the main RTÉ evening news programme in March 2009, and the focus groups were held the following November and December. Two female participants discussed the lack of follow up.

FG6FP6: Well, I think that's the downfall of many of these news stories, they are never followed up as well, because I mean that was March

FG6FP5: That's exactly what I was thinking. Oh it was March, I haven't heard about that at all.

Participants also said that they would have liked it if the story could have contained some more information.

FG8FP7: I would like to see more on it

FG8FP10: Yes past history and what they do

FG8FP7: And how did they actually find the gene? How did they actually do it?

FG8FP10: They said they can find it but how did they find it? Is it in the DNA or were is it?

Participants in some focus groups made suggestions about graphical animations that could have been used to explain the science behind the story. The difficulty and expense of producing these animations was emphasised by FG5MP4, a producer of science television programmes.

FG5MP4: Another aspect of it is the visualisation of scientific concepts, you don't have to worry about the pictures on radio and that makes it easier to talk about nanotechnology or whatever, you know TV, you need a new picture every three seconds at least, and all those pictures have to be moving, so it's a, it's a real challenge to visualise that, and its interesting. I was on the website today of the company that did that Ida documentary and one of their big selling points was that they team up with an animation company a lot to bring everything to life, and that kind of stuff, it's great when you can do it right, but it's very expensive.

5.1.5.9 Responses to clip 2 - *Horizon* documentary

The participants in some focus groups agreed that they enjoyed the clip from the BBC *Horizon* documentary series about evolution, whereas the participants in other focus groups did not like it at all and "couldn't wait for you to switch it off".

Participants who reacted positively to the documentary clip did so because they liked the way the narrative unfolded step-by-step, and the also liked the imagery used:

> FG6FP6: The editing is beautiful.

The greatest criticism that focus group participants expressed about the *Horizon* clip was that it was over-dramatic and that the music was overpowering. A couple of participants said that some of the sequences put them in mind of "a horror or something". The music was a problem for many of the participants: "Just the music would turn me off" and:

> FG9FP3: It interrupted what the guy was trying to say even.

One participant summed it up by saying:

> FG7MP7: It's set up like a feature film, you know, with the drama and the music. The music is too overpowering and you can't, you're straining to hear what he's saying, and it can get very annoying when the balance between the narrator and the music is wrong."

Participants in some focus groups liked the narrator's voice:

> FG10FP9: The voice of the man was very easy to listen to and he tells a story very well.

The narrator's voice was criticised by participants in other focus groups for being over-dramatic, one participant compared him to the narrator for advertisements for coming attractions in the cinema. Other participants didn't like the narrator's accent:

> FG8MP2: The old English upper class accent, it's very nice to hear but it's very patronising.

What the participants considered the over-dramatic presentation style also led them to feel that the content of the documentary was less credible:

> FG9FP6: I thought it took away from what he was trying to say. I thought it made it very not believable.

and:

> FG9MP5: Well, It was presented as fact but you would wonder how much of it was actual fact and how much was, you know, personal opinion. Or a group of people's personal opinions.

The *Horizon* clip also prompted a discussion about the different elements of documentary programmes: interviews, reconstructions, narration. The participants in the younger groups in particular found interviews to be dull:

> FG4FP5: I prefer sciencey things when they act them out, like they don't just interview scientists and say like explain it, whenever they act out how it happened and stuff, it's interesting.

Some participants also criticised the subject chosen for the documentary. Evolution, they felt, had been "done to death". When asked to compare the three clips they had been shown, one participant replied: "The first and the last were so much more current as well, whereas for the other one it was really out there. I mean we've heard that so many times."

5.1.5.10 Responses to clip 3 - Royal Institution Christmas Lectures

The final stimulus that the focus groups watched was an extract from the Royal Institution Christmas lecture series. The Royal Institution Christmas lectures have been held since 1825 and have been broadcast on television every year since 1966. The lectures are aimed at young people.

The discussions about the clip from the Christmas lecture focussed mainly on the presenter, most groups agreed that the presenter was funny and engaging, "the strength of the last one was definitely the presenter". The importance of the role of presenter was emphasised by one female participant, aged 27:

> FG6FP3: I think the presenter is hugely important and that mightn't transfer well, you know, like, he's got presence, He's really good at explaining things and he's really interested and if that was Pat Kenny[22] or someone like that, you know it wouldn't be the same.

Some participants criticised the clip from the Royal Institution Christmas lectures for being too "slow-moving". Some participants felt that the lecture format was outmoded

[22] Pat Kenny is an Irish broadcaster. He currently hosts a morning programme on the independent Irish radio station Newstalk. Previously he had a 41-year career at RTÉ, presenting a morning radio programme and current affairs television programmes as well as the high-ratings *Late Late Show*.

and that they would have difficulty sustaining an interest for the duration of the entire programme. As one male participant, aged 30, said:

> FG9MP9: You see we're not really used to seeing that on television anymore, or like, you would never have a TV camera pointed at one thing for like half an hour or an hour, it's always images and different things, so it's kind of strange you know

Even within the lecture itself, some participants felt that the information was not coming at them quickly enough. One participant said that she would give up watching after a few minutes because "life's too short".

Participants reflected that young people in particular would not have the patience for the slowness of the presentation. One participant, a science communication blogger and a parent, described how his son expected information to come at him very quickly:

> FG5MP7: I have a twelve-year-old son and it's not entertainment but he will expect the information to get there a lot quicker. I mean sometimes he will ask me a science question and I will explain it to him and he's looking at me like: 'Get to the point, where are you going with this? You know, get to the point with this!" and I'm trying to give him the background to lead up to the point because I believe that telling him the point isn't going to make any sense, you know, unless I lead up to it, but they do, everything happens so much quicker, you know what I mean, like I don't want to say: 'in my day', but you know well it is like that, everything happens so much quicker, I mean from the age of six or seven playing PS3s and X-Boxes.

Some participants also criticised the content of the clip, saying it was subject that did not interest them at all, and held no relevance from them:

> FG10FP1: But it won't change my life if a computer can't tell the difference between a dog and a cat.

5.1.6 Areas of overlap/differences within and between focus groups

Focus group 1

Focus group 1 was a pre-existing group, made up of ten women (one of two all-female groups), mostly in their late thirties or early forties, studying for a Certificate in Preparatory Studies in Higher Education (CPSHE). This group was unique in that it was the only group where all the participants were parents (indeed, one of the purposes of the CPSHE course was to reintroduce the women into the workforce as they had all been at home full-time with young families for a number of years).

The communications lecturer agreed to let me to borrow her class for an afternoon. I arrived at the centre and met the women at 12.15pm just as they were going on their lunch break, I joined them for lunch which they ate sitting around one large table in the kitchen of the centre. The group was very good-humoured as they exchanged gossip and plans around the table.

After their usual 30-minute lunch break, the focus group began at 12.45pm. I rearranged the classroom so that the participants were sitting around in a circle in order to make discussion easier.

Unsurprisingly for a group of parents, the women were very concerned with science as it is taught in schools, they had this in common with focus groups 9 and 10 and indeed with the focus groups made up of school students.

Perhaps the most striking feature of this focus group, and what made their discussions stand out from the others was that they expressed more mistrust in science than the other groups, going so far as to seriously discuss conspiracy theories, and their suspicions that they were being “kept in the dark”.

Focus group 2

This was the first focus group to be held, it comprised the smallest number of participants, with just three female participants and one male participant. This was because two participants, recruited through the online forum www.boards.ie did not turn up on the day (all communication with these participants was through e-mail and private messages on boards.ie, following their no-show, for all the other focus groups I made sure to ring them to make a personal contact).

What made this group different to the others was that this group was the most critical of science, and science policy and of science television programmes.

Focus group 3

Confey Community College in Leixlip Co. Kildare was one of two school groups. They differed from the adult groups in that they watched less television, and the Confey group in particular, when they did watch television, watched more satellite channels and fewer news programmes. They spoke in the focus group about preferring to spend time on the internet than watch television, although surprisingly, in the questionnaires on media use which they filled out before the focus group, the average time spent on the internet for this group was 62 minutes each day, while the overall average for the participants for all the focus groups was 92 minutes.

Like the other school group, and the parent-participants in the adult groups, the Confey students thought about and talked about science in terms of their school studies. This group in particular were aware of the economics imperatives behind school science, and talked about how science and maths was promoted by media as school and college subjects in order to produce more scientists and engineers to support the economy.

Also like the other school group, students were keen that celebrities should present science programmes, the issue of celebrity presenters came up in adult focus groups as well, but in the adult groups the value of celebrity presenters was debated and disagreed about (particularly in focus group 10), while for the school groups it was universally agreed by the participants to be a good thing.

Also, in common with focus groups 7 and 8, the students in this focus group spoke about scientists as being somewhat removed from everyday concerns, and different to ordinary people.

Focus group 4

Focus group 4 was held with students from Coláiste na Carriage in Carrick, Co. Donegal. The session was held in the science laboratory of the school. To begin with, this was the quietest of all the focus groups and they needed more prompting than any of the other groups to get started. Like the other school group, they watched less television than the adults, but unlike the other school group (and unlike most of the adult groups with the exception of focus group 6) they talked a lot about radio, and favoured it as a medium. With respect to science, they thought and talked about it in terms of their school studies, again like the Confey school group, and again unsurprisingly for school students (even less unsurprisingly for this group as the focus group was held in the science laboratory of the school and they were asked to participate by their science teacher). Again like the Confey group they agreed that more use should be made of celebrities for presenting science television programmes.

Focus group 5

Focus group 5 comprised a science blogger, a producer of science television programmes, a regular attendee at the Alchemist Café, and five students of the MSc in science communication in Dublin City University.

In a similar way to how school students thought about science in terms of their studies, the MSc students—many of whom were recent science graduates—also thought of science in terms of their own studies. This group also, as a group with an ‘active interest in science’ differentiated between their own engagement with science television programmes and with ‘public’ engagement or how ‘your ordinary people’ deal with science, disagreeing about the amount of interest that people had in science.

This group was also very influenced by the presence of the television producer, and because of that the discussion centred much more around the mechanics of television production, the technology required to produce animated sequences, the time pressure under which television journalists work and so on. In common with almost all other groups they talked about the value or lack of value of the generic images of laboratories which are commonly used in television news reports.

Like focus group 3, this group talked about their expectations of different science programmes, and how these differed depending on what channel was broadcasting the programme.

Focus group 6

This was another ‘active’ group, made up of an education and outreach officer for a university research institute, a science communication student, a science teacher, and three laboratory scientists. It was an all-female group, although it was not intentionally so, three men who had agreed to attend did not show up to the session.

As a whole, this group was the most positive about science television programmes, they watched them regularly and enjoyed telling the group about particular episodes. Some participants cited the science programmes they had watched as children as being the reason they became interested in science. This was also the only group that were keen on specialist science magazines. Again like many other groups, this group discussed school science a lot, they were unique in that they all told of very positive experiences they had had with science in school, this was not the case for the other focus groups.

Unsurprisingly, for a group where all but one participant had at least an undergraduate degree in science, this group was very critical of the generic science images used in news reports.

Focus Group 7

Participants in focus group 7 were aged between 30 and 49 years and educated to university degree level. They were positive about the benefits of science, and like focus group 1 and focus group 9 were particularly attentive to stories about scientific research carried out in Ireland. Of all the groups, they had the strongest positive reaction to the stimulus clip of a section of RTÉ news. This group also spoke most about the enjoyment they derived from watching television, and about how the pleasure of enjoying a television programme was different to the (mostly information-gathering) ways they used other media.

Focus group 8

Participants in focus group 8 were aged over 50 years and educated to university degree level. The feature of this group that stood out was that they were the most politically engaged group. They viewed science, and scientific issues such as climate change, medical research and so on through a political lens, bringing up matters of government policy and funding for science without any prompting. Other groups discussed policy, but not in as much depth as focus group 8. This group also gave very thoughtful (and indeed reflexive) responses to the question of ‘what is science?’, and took a broader view of science than the other groups.

Focus group 9

Participants in focus group 9 were aged over between 30 and 49 years and from mixed educational backgrounds. Like other groups, they thought of science in terms of school subjects, this could be expected from this age cohort which would contain several parents. Indeed the parents in this group were very enthusiastic about the science education that their children were receiving, especially in environmental matters.

In common with other groups, participants in focus group 9 used the stereotype of the “nerdy scientist” in the discussion, and also expressed feelings of mistrust about scientific research, particularly about human nutrition. As with focus group 2, participants in this group were critical of some television coverage of science, claiming that it was often used to market science and look for funding.

Focus group 10

Participants in focus group 8 were aged over 50 years and came from mixed educational backgrounds. This group, in common with many others, initially talked about science in terms of a school subject, acknowledging how much it had changed as a subject since they were at school. They continued to discuss how much science and technology had more of an effect on their everyday lives today than when they were younger. Perhaps unsurprisingly for an ‘older’ group, they spend a lot of time discussing and comparing the kind of science television programmes that are broadcast today and the ones they watched when they were younger (such as the BBC’s Tomorrow’s World, and RTÉ’s Eamon de Buitlear’s nature programmes).

5.2 Content, television programmes

There are two main television broadcasters (terrestrial) based in Ireland—Raidió Teilifís Éireann (RTÉ) and TV3—plus cable channels specialising in sport or entertainment. The major British channels are also received in almost all of the country free-to-air, via cable or house antenna. Many other international channels (e.g. MTV, Nickelodeon, Sky) are also available on cable and satellite services. The largest broadcaster is the public service broadcaster, RTÉ, which is funded by state grant, TV licences and advertising and is controlled by a government-appointed authority. It operates three channels, RTÉ One, RTÉ Two and Teilifís na Gaeilge (TG4, which broadcasts mainly in the Irish language).

Three additional commercial television channels started up in 2006: a sports channel; a general entertainment channel, Channel 6, which has since been rebranded by its parent company TV3 as 3e; and the Dublin City Channel, a cable television channel. They have been joined by a number of other ‘city’ channels, for Cork, Galway and Waterford. Three community channels have also been licensed. In total the Broadcasting Authority of Ireland (BAI) has licensed 14 television services.

Although British television has been received via cable and more recently satellite for almost 50 years, however RTÉ has dominated broadcasting in Ireland since the 1920s and even in a more competitive market continues to do so. In terms of channel share of viewing in 2011, RTÉ One was the most popular with 23.43% of market share, followed by TV3 at 12.35% and RTÉ Two at 8.99%. The other main channels were BBC One (4.18 per cent), UTV (3.3 per cent), BBC Two (2.49 per cent), Channel 4 (2.29 per cent), TG4 (2.06 per cent) and Sky1 (1.25 per cent). The commercial channels seek advertising revenue in the Republic, making the island of Ireland in effect one media market. UTV is unique in that it has more viewers outside its franchise area of Northern Ireland, in the Republic of Ireland, than within it. This environment, which now includes many specialist sports, film and other channels offered to viewers who opt for particular satellite or other packages, means RTÉ operates in a highly competitive media market.

Fifty per cent of RTÉ’s broadcast material is domestic product, but in the case of the other Irish stations, domestic product content ranges from 27 per cent to 45 per cent. (Foley, no date). However, according to the only quantitative study of science on Irish media—an EU-funded Framework 7 project, Audio Visual Science Audiences in Europe (AVSA)—of 38 science programmes broadcast on Irish channels over five reference weeks in 2007 and 2008, the large majority of these programmes (79 per cent) were imported (Lehmkuhl et al., 2010).

RTÉ One and RTÉ Two have broadcast short (that is 4-10 programmes) series on science over the past few years. *Scope* (RTÉ Two), a science magazine programme aimed at a young audience (15-25 years) ran for four seasons of ten programmes each, from 2004-2007. Two series of *The Investigators* (of six episodes each) which focused on the work done by Irish scientists at home and abroad, were broadcast in 2007-2008. Also in 2008 RTÉ One broadcast a four-programme series, *Science Friction*, that looked at areas of science that were socially sensitive. *The Science Squad*, a magazine programme about science was launched in 2012, its second series began broadcasting in September 2013. RTÉ also broadcast two series of a childrens' science programme *The Mountain*, where two teams of children compete in a series of science-based challenges and obstacle courses, and in 2013 began to broadcast a series called *The Why Guy*, five minute programmes where experts answer science questions posed by children. RTÉ has also commissioned one-off science documentaries from independent production companies, such as *The Blood of the Irish* (about the genetic mapping of Irish people) broadcast in two parts in January 2009, *Blood of the Travellers* (about the genetic mapping of members of the Irish travelling community) broadcast in May 2011, *MND—the inside track* (about Motor Neurone Disease) first broadcast in January 2012, *Faster, Higher, Stronger* (about sports science) broadcast in July 2012, *The Heart of the Matter* (about cardiovascular disease) broadcast in March 2013 and *Aine Lawlor: Fighting Cancer*, broadcast in November 2013. Only RTÉ television broadcasts home-produced specialist programmes on science. Several channels broadcast imported programmes from BBC, National Geographic and other sources.

5.2.1 RTÉ News

RTÉ is the only Irish broadcaster to have a specialist science and technology correspondent, none of the other Irish television or radio stations have specialist units or teams working on science programmes. Among the mainly freelance science journalists in the Irish Science and Technology Journalists Association, only one or two work frequently in radio or television. The role of Science and Technology Correspondent for RTÉ News and Current Affairs was created on 4 April 2013, the managing director of RTÉ News and Current Affairs, Kevin Bakhurst said at the time:

> This is an important appointment for RTÉ News and it underlines RTÉ's renewed commitment to our coverage of science and technology. It means we will be able to cover and break a wider range of science stories and bring a specialist understanding to this important part of Irish and international news.

RTÉ News is consistently in the top twenty most watched television programmes in Ireland according to the TAM ratings (please see Appendix D for details). Watching *RTÉ News* was also mentioned by participants in focus groups as part of their everyday routine.

5.2.1.1 Content analysis of RTÉ News

In 2010, the BBC Trust commissioned a review of the accuracy and impartiality of the BBC's science coverage. Part of this review was a quantitative content analysis of BBC output in May, June and July of 2009 and 2010. The quantitative analysis was conducted by Felicity Mellor with the assistance of six coders, all graduates from

Imperial College's MSc programmes in Science Communication and Science Media Production (Mellor et al., 2011). The codes used in this research were based on those used for Mellor et al.'s (2011) content analysis. Every episode of *RTÉ Nine O'clock News* for 2011 was accessed from the www.rte.ie website, and a content analysis conducted on the science news stories. Each story was coded for 21 different attributes, such as the scientific field the story refers to, the type of news story, the overall approach of the story and so on. The following is a complete account of the definitions for the items measured and the key categories in the coding frame used for broadcast news items.

Science prominence

Science item: science (as defined below) is a central component in the item.

Alludes to science: a brief undeveloped reference to science (as defined below). Included in this category are any items which may be inferred to involve science or which may have a potential science angle, but where this has not been developed within the item beyond a brief reference, or which include explanation based on established scientific knowledge but have not met the required criteria for a science item.

No science: no reference to science; use of the word "science" or scientific terminology out of context without reference to scientific claims or activities; reference to facts which can reasonably be ascribed to general knowledge or to the standard knowledge base of professional practitioners (e.g., medical doctors, engineers).

For the purposes of coding, science was defined as:

- activities or findings from the natural sciences, the applied sciences, medical science, or mathematics;
- activities or findings which are referred to as scientific;
- references to scientific institutions (e.g., the Royal Society, research institutes, NASA);
- references to individuals who are identified as having scientific expertise either by virtue of their disciplinary base (e.g., introduced as a "biochemist", "physicist", "scientist", etc.) or by their institutional role (e.g., "Chief Medical Officer", "President of the Royal Society");
- references to individuals who are identified as being "experts", or "researchers", or equivalent, where the implied subject of their expertise is the natural sciences, the applied sciences, medical science, or mathematics;

- statements made by media professionals who are identified within the item as having a specialism in science (e.g., science journalists);
- the research and development stage of new technologies.

Not *sufficient* to define as science, unless also involving one or more of the above, were references to:

- social research, economics, criminology, and all other social sciences;
- archaeology unless pertaining to palaeontology;
- statistics, numbers or graphs;
- claims made by researchers whose expertise is in the social sciences;
- events in medical clinical practice or engineering professional practice except where presented as illustrating research in medical science or engineering science or except where involving statements about recent new knowledge or current lack of knowledge;
- health policy, climate policy, energy policy or environment policy, unless involving claims by scientists or statements about scientific findings;
- statements made by media professionals who are identified within the item as having a specialism in the environment, health or technology;
- the commercial launch of new technologies whose technical feasibility is already established;
- the economics of, or consumer or adoption issues around, new technologies;
- education issues unless explicitly referring to the science curriculum, university science departments or the need for future scientists;
- space industry news unless relating to a scientific research mission or development of a new space technology.

For example, an item about a call for action on public health may cite evidence of how certain behaviours cause ill-health. If the item attributes the call for action to a scientist, the item is coded as a *science item*. If the item attributes the call for action to a non-scientist but presents it as a response to recent research findings, it is coded as a *science item*. If the evidence is only referred to with the statement “research shows lack of exercise causes ill health” and no further reference is made to the evidential base for this or to scientists making such claims, the item is coded as *alludes to science*. If the item makes no reference at all to scientific evidence or to scientists but does make common sense statements about health and exercise, the science prominence of the item is coded as *no science*.

Scientific field

Physical sciences: all physical sciences excluding engineering and technology and climate science. Items about extra-terrestrial life are coded as physical sciences.

Life sciences: all biological sciences excluding medical science and climate science. Items about palaeontology are coded as life sciences.

Medical science & technology: all stories relating to medical developments.

Climate science & technology: all stories relating to climate change, the study of the climate, or climate mitigation technologies.

Engineering & technology: all technology development except medical technologies and climate mitigation technologies. For items about new technologies produced specifically for scientific research, if the item focuses on what the technology will be used for, this is coded as the research field it will be used in; if the item focuses on the construction or development of the technology, this is coded as the scientific field in which the technology will be used.

Mathematics: developments in mathematics research; for applications of mathematics in other scientific fields, code for the latter not as mathematics.

Mixed: stories which refer to more than one different field.

General: stories which relate to science or technology in general (e.g., some stories about science policy or science education may fall in this category).

Other: none of the above apply.

Studies relating to the environment but not referring to climate change are coded as:

life sciences if the story is about eco-systems, wildlife population surveys, impact of pollution on wildlife, GM foods, etc.;

physical sciences if the story is about atmospheric chemistry, geology, radiation levels, etc.

News event

This category is based on the story not the treatment within the item. Sub-stories within long-running stories may have different news events; all items covering sharply time-delimited stories have the same news event.

Research: ongoing or completed research; e.g., publication of a research paper.

Science policy: events concerning policy-making or implementation of policy in science or events concerning the management or conduct of scientific research.

Health policy: events concerning policy-making or implementation of policy in health. Events relating to policy over illegal drugs and substance abuse are coded as *health policy*.

Environment & energy policy: events concerning policy-making or implementation of policy regarding the environment, the climate or energy.

Natural event/accident: an accident, natural disaster or some other unplanned or uncontrolled event has occurred. Stories that involve policy responses to a natural event (e.g., a disease outbreak), are coded under the appropriate *policy* heading.

New technology: development or trial of a new technology.

Other statement by scientist: claims made by a scientist other than those relating directly to that scientist's own research or those relating to a policy event.

Other: any events not covered by the above categories.

Policy is taken as the planned actions or positions of an official body or discussions about what actions or positions an official body should take.

Reporter's beat

Coded as given in the item under the following categories:

Science

Health/medicine

Technology

Environment

Political

Home

World: any correspondent whose beat is a particular country overseas (e.g., India correspondent or Middle East editor) or whose beat is world affairs in general

Economics

Business

Regional

Other: if the beat is given but is not in the list above

Unknown

Not applicable: there is no reporter; e.g., the item is presented by the newsreader.

News contributors

These are named or unnamed individuals who speak directly to camera/mic during an item. (For online items, institutions quoted directly without reference to an individual are also included as contributors. In addition, for online items, news participants paraphrased or referred to but not quoted directly are recorded under additional categories.)

The following are not included as news contributors:

- generic references to types of people or groups;
- journalists, reporters or news presenters;
- non-human agents such as animals or machines;
- anyone speaking in clips of other media output (e.g., feature films, adverts) embedded within an item.

Contributor gender

Male

Female

Unknown: the gender of the contributor cannot be discerned.

Contributor expertise

This category seeks to identify whether or not a contributor is presented within the report as having some form of institutionally legitimated expertise, and if so, what form of expertise this is. This list is hierarchical. The categories *explicit scientific* and *implicit scientific* were included separately to facilitate coding but were combined into one *scientific* category for the purposes of analysis.

Explicit scientific: anyone who is identified within the item as a "scientist" or as belonging to a scientific discipline or who holds an office that is perceived as relating to science (e.g., Chief Medical Officer) or who explicitly refers to their own involvement in scientific research.

Implicit scientific: anyone who appears to have scientific expertise but is not explicitly identified as a scientist within the item; e.g., a contributor who has the title of professor or works at a university and who is talking about the science but has not been explicitly labelled as scientist, or a laboratory head or director of an institute who is talking about the science. Members of advisory committees whose work draws on scientific evidence should be coded as *implicit scientific* unless their scientific status is made explicit.

Clinical: a medical doctor or other healthcare provider who is not a research scientist and who speaks in their capacity as a healthcare provider or clinical practitioner. Medical doctors given the title professor and a university affiliation are coded as *scientific*.

Non-science academic: anyone who is identified within the item as being an academic or researcher in a field other than the natural sciences, medicine or engineering; e.g. a social scientist, an ethicist, etc.

Other professional expertise: anyone who speaks in a professional capacity but does not belong to any of the above categories. All those affiliated to a charity or NGO and not given an academic title are coded as *other professional*, as are all those with governmental affiliations.

Lay: someone who is either not presented as having expertise or someone whose expertise is denoted as non-scientific and non-professional (e.g., a hobbyist, a parent).

Unknown: the item implies professional expertise on the part of the speaker but gives insufficient information to identify the nature of their expertise.

Title of contributor

Dr

Professor

Other: this includes titles such as Lord, Sir, Dame, Justice, Reverend.

None: no title is given within the item or the title given is Mr, Ms, Mrs, Miss.

Where a contributor is referred to as both Professor and another title, this is coded as Professor.

Institutional affiliation of contributor

Advisory body: a body (usually of experts) set up by the government to advise on policy. The institutional affiliation of government advisors is coded as *advisory body*.

Charity/NGO: a non-governmental non-commercial organisation that is formally constituted; i.e., an organisation that is likely to have charitable status or be not-for-profit such as a patient support group or an action group or lobby group.

Religious: any religious institution.

Government/political: local or national government, or the EU Commission, and departments or units within, or attached to, these organisations; a member of a local council, a national parliament, or EU parliament other than those who belong to the government, or a group that is presented as a political party. Lords are only coded as having a *government/political* affiliation if they are either speaking as members of political parties or if they are speaking in their capacity as members of the House of Lords or members of parliamentary select committees.

Healthcare provider: the NHS, a hospital, or other institution providing healthcare. Medical schools are coded as *university*.

Industry: any commercial company, other than media organisations, or manufacturer or industry association.

International body: any international public body that operates with the sanction of member states; e.g. the UN and UN organisations, NATO, G8, the IPCC.

Media: any media company or organisation whose role is communicating to public audiences, including museums unless the museum is referred to in its capacity as a research organisation.

Military: any of the armed services.

Public body: any autonomous national public body that is funded by government but is not part of the government itself; this includes regulatory bodies, executive agencies, official watchdogs, etc. E.g., Ofcom, Schools Inspectorate, HEFA.

Research institute: a research institute other than those labelled as belonging to a university.

Scientific society: a membership or fellowship organisation representing scientists, such as the Royal Society, Institute of Physics, US National Academy, etc.

University: any higher education institution or department or institute attached to a higher education institution.

Other: an organisation that does not fit any of the above categories.

None given: no institutional affiliation is given within the item.

Cautionary comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any cautionary comments? Note that this is an assessment of the contributor’s attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as *yes* or *no*. Where speakers do not express an attitude towards scientific claims or statements made by scientists, or where no attitude could be discerned, coded as *not applicable*.

Cautionary comments are where the contributor notes some problems or limitations but does not challenge the events, findings or statements being reported on a more fundamental level. For example, for proposed new technologies, this may mean costs are posed as a problem; for research findings, the limitations of the study – small sample size, etc. – may be noted. If the contributor is ambivalent, both making supportive comments and noting limitations, this is coded as *cautionary*.

Oppositional comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any oppositional comments? Note that this is an assessment of the contributor's attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as *yes* or *no*. Where speakers do not express an attitude towards scientific claims or statements made by scientists, or no attitude could be discerned, coded as *not applicable*.

Oppositional comments are where the contributor challenges the intentions of the news source, the validity of the claims being made, the desirability of the goals aimed for, or the assumptions on which the news events are based. For example, for proposed new technologies, the contributor may reject the need for the technology or may claim that the technology brings unacceptable or unforeseen risks; for research findings, the contributor may question the theoretical framework on which the study is based.

Approach of item

What was the overall approach of the item?

Informational: the item or programme conveys information about the events or ideas presented. This may include seeking, or giving, clarifications or explanations about the events or ideas. This option applies only if neither of the other two categories applies

Questioning/investigative: the item calls news participants to account, challenges contributors' claims, or claims to uncover otherwise hidden information or activities.

Light-hearted: the item is signalled as light relief, or the reporter or interviewer appears amused by the topic of the item or by the contributors.

Tone of item

What is the overall tone of the item?

Positive: overall, the tone is upbeat with the story presented as good news, implying that the news events are to be welcomed or applauded, or the news events are presented as a significant contribution or are described with enthusiasm.

Neutral: either there is no discernable positive or negative tone, or positive and negative points are equally weighted giving a sense of a neutral report.

Negative: overall, the story is presented as bad news, implying that the news events are of concern.

Interviewer humour

Is the interviewer joking, laughing or speaking in a jocular fashion, even if only very briefly? Coded as *yes* or *no*. Coded as *not applicable* if there is no studio interview.

Interviewer aggression

This category refers to the tone or attitude of the interviewer rather than the content of what they say. Is the interviewer aggressive or dismissive in their manner towards the interviewee? Coded as *yes* or *no*. Coded as *not applicable* if there is no studio interview.

Links to website

Does the item direct the viewer/listener to the BBC website for further sources of information? Coded as *yes* or *no*.

Experimental design mentioned

Is any mention made of the experimental design through which the scientific results were obtained or the technology developed or tested? Coded as *yes* or *no*. Coded as *yes* even if the mention is very brief and superficial; for instance, if there is any mention of sample size, double-blind trials (or lack thereof), replication, statistical tests, etc.

A reference to what the scientist did is not coded as *yes* unless it gives some insight into how reliable or robust the experiment or test was.

Controversy indicated

Is there any indication that the science or technology being reported is a matter of controversy? Coded as *yes* or *no*. If no research or technology is reported in the item, coded as *not applicable*.

Controversy may be indicated by the presence of contributors with opposing views; or it may be indicated by the use of words such as “controversy”, “controversial”, “debate”, “disagreement”, “conflict”.

Uncertainty indicated

Is any reference made to science or technology being uncertain? For instance, is the science or technology being reported referred to as provisional, tentative, a pilot study, preliminary results, etc.? Are limitations of the experimental design or the feasibility of a technology mentioned, or is the hypothesis of the research study questioned? Or is any reference made to the provisional nature of science in general? Coded as *yes* or *no*. Note that since this category covers any comments about uncertainty in science in general as well as comments about any specific research being reported, *not applicable* was not an option.

Funder mentioned

Does the item explicitly state who funded the research or technology being reported? Coded as *yes* or *no*. If no research or technology is reported in the item, coded as *not applicable*.

Publication mentioned

Does the item refer to a formal print publication (already published or forthcoming) as the source of any scientific claims or findings mentioned in the item? A formal print publication might be a report from an institution such as government, a journal article, a book, etc. Blogs or other self-published material are not counted as publications. Coded as *yes* or *no*.

Peer review mentioned

Is peer review mentioned? Coded as *yes* or *no*.

Inaccuracy

Drawing on their knowledge of science, coders were asked if they were aware of any factual inaccuracies, or any statements that were materially misleading, within the item's coverage of the science. If *yes*, they gave a short free text summary of the inaccuracies as they perceived them. Any omissions, simplifications or changes in emphasis which may have been technically unsatisfactory but which were not factually incorrect and were not likely to mislead the intended audience (i.e., non-scientists) were not counted as inaccuracies.

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The aim of this content analysis is to provide evidence about how RTÉ covers science in its news programming. RTÉ has a legal obligation to impartiality extending to news and current affairs (defined in section 3 of the Broadcasting Authority (Amendment) Act 1976[23] as "including matters which are either of public controversy or the subject of

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[23] Impartiality. 3.—The Principal Act is hereby amended by the substitution of the following subsections for section 18 (1) :

"(1) Subject to subsection (1A) of this section, it shall be the duty of the Authority to ensure that—

(a) all news broadcast by it is reported and presented in an objective and impartial manner and without any expression of the Authority's own views,

(b) the broadcast treatment of current affairs, including matters which are either of public controversy or the subject of current public debate, is fair to all current public debate".) This means that according to RTE's own journalism guidelines published in October 2012:

> programme makers accept an obligation to present fairly the weight of the evidence and to report and interpret events in a manner that respects the context as well as the highlights of news and current affairs.

5.2.1.2 Summary of RTÉ content analysis

This section summarises some of the key findings of the content analysis of *RTÉ Nine O'clock News* programmes. Quantitative content analysis offers a systematic view of output. Details of the sampling method and coding, including the criteria used for selecting science items, can be found in section *4.3.3 RTÉ News—independent, accurate and impartial*, on page 115. One hundred and ten of the 365 (that is, almost one in three) *RTÉ Nine O'clock News* programmes broadcast in 2011 included at least one item about science or which alluded to science. The total number of individual stories broadcast on *RTÉ News at Nine O'clock* in 2011 was 4528, of these 110 or 2.4% contained science. This compares to 1.77% in the UK (Mellor et al., 2011) or 2.05% for France (Leon, 2008). The amount of airtime devoted to science stories is 2 hours, 59 minutes and 8 seconds, which is just under 2% of total airtime of the news programmes analysed.

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interests concerned and that the broadcast matter is presented in an objective and impartial manner and without any expression of the Authority's own views,

(c) any matter, whether written, aural or visual, and which relates to news or current affairs, including matters which are either of public controversy or the subject of current public debate, which pursuant to section 16 of this Act is published, distributed or sold by the Authority is presented by it in an objective and impartial manner.

Paragraph (b) of this subsection, in so far as it requires the Authority not to express its own views, shall not apply to any broadcast in so far as the broadcast relates to any proposal, being a proposal concerning policy as regards broadcasting, which is of public controversy or the subject of current public debate and which is being considered by the Government or the Minister.

Should it prove impracticable in a single programme to apply paragraph (b) of this subsection, two or more related broadcasts may be considered as a whole; provided that the broadcasts are transmitted within a reasonable period.

(1A) The Authority is hereby prohibited from including in any of its broadcasts or in any matter referred to in paragraph (c) of subsection (1) of this section anything which may reasonably be regarded as being likely to promote, or incite to, crime or as tending to undermine the authority of the State.

(1B) The Authority shall not, in its programmes and in the means employed to make such programmes, unreasonably encroach on the privacy of an individual.".

The news stories about science were more often positioned in the second half of the programme (77 out of 109 stories), and about one third (38 stories) were also headlined at the start of the programme. The most common categories for science stories are natural events or accidents which were the subject of 39% of the stories covered (for example, the tsunami and subsequent nuclear accident at Fukushima), or stories about new research breakthroughs (24.5%). The most common field to be reported on is medical science and technology (40.9%), followed by Engineering and Technology at 30.0%, and Life Sciences at 13.6%.

The biggest group interviewed in science news stories were (predominately male) scientists (41.1%), followed by a large number of 'Lay' contributors, that is, people presented as members of the public with no specific expertise, 20% of contributors were presented thus, this is twice the proportion of lay contributors found in a similar UK study (Mellor et al., 2011, p.3). Contributors with professional expertise other than science made up 14.4% of the stories analysed.

Just under half of science news stories include comments from more than one contributor (in addition to the journalist or presenter), and around one-fifth from more than two. About a tenth of contributors in to news stories made cautionary comments about scientific claims, such as noting limits to the applicability, reliability or relevance of results, this compares to one fifth of contributors to BBC broadcast news making cautionary comments as noted in a similar study by Mellor et al. (2011). More far-reaching critiques or oppositional comments were made by about 11.8% of contributors. Oppositional comments were usually presented in the context of controversy, rather than as the routine questioning and sceptical inquiry that are a part of science, and were made by a variety of groups, e.g. environmental organisations, businesses and patients groups.

Almost no stories included comment from independent scientists (i.e., scientists at research institutions or other scientific organisations with no connection to the research being reported). Less than ten per cent, or just nine stories, mention experimental design (e.g., sample size, whether trials are double-blind, etc.). The funder of research was mentioned in just nine stories, and a journal publication was mentioned in just two.

5.2.1.3 Detailed account of RTÉ news content analysis

5.2.1.3.1 Proportion of science in the news

One hundred and ten of the 365 (that is, almost one in three) *RTÉ Nine O'clock News* programmes broadcast in 2011 included at least one item about science or which alluded to science. The total number of individual stories broadcast on *RTÉ Nine*

O'clock News in 2011 was 4528, of these 110 or 2.4% contained science. This compares to 1.77% in the UK as found by Felicity Mellor et al.'s (2011) content analysis of the BBC's science coverage, and to 1.5% of science/technology items and 1.1% environment and natural world items found in an earlier content analysis carried out for the BBC Trust (Lewis et al., 2008, pp. 9-10), or 2.05% for France (Leon, 2008). The amount of airtime devoted to science stories was 2 hours, 59 minutes and 8 seconds, which is just under 2% of total airtime of the news programmes analysed.

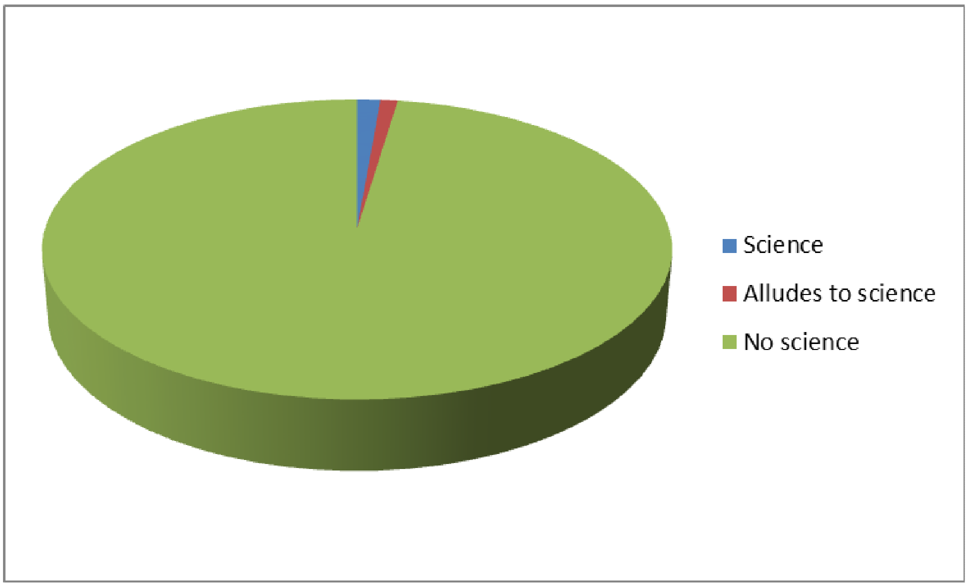

Figure 5.1 *RTÉ News stories about science or alluding to science as a proportion of all stories, please see Appendix F for full data table.*

The average duration of science stores was just over a minute and a half (98 seconds).

Out of these 110 science stories, 63 of them were coded as being science stories, that is, science is a central component in the item; and 47 stories were coded as 'alluding to science', that is, it may be inferred to involve science or may have a potential science angle, but where this has not been developed within the item beyond a brief reference, or which include explanation based on established scientific knowledge but have not met the required criteria for a science item.

Science prominence	**Frequency**	**Percent**
Science item	63	69.3
Alludes to science	47	51.7

Table 5.6 *The prominence of science in the news story.*

5.2.1.3.2 Seasonal variation in RTÉ news coverage of science

The science stories included in RTÉ News tended to cluster around specific long running issues, such as an outbreak of swine flu in January 2011, the accident at the Fukushima nuclear plant in Japan in March 2011, and the outbreak of *E. coli* in Europe in May and June of 2011. Another cluster occurred in August 2011, this was due to the traditional ‘silly season’ for news in Ireland, as Dáil Éireann[24] and the law courts are not sitting, and journalists seek out stories in other areas.

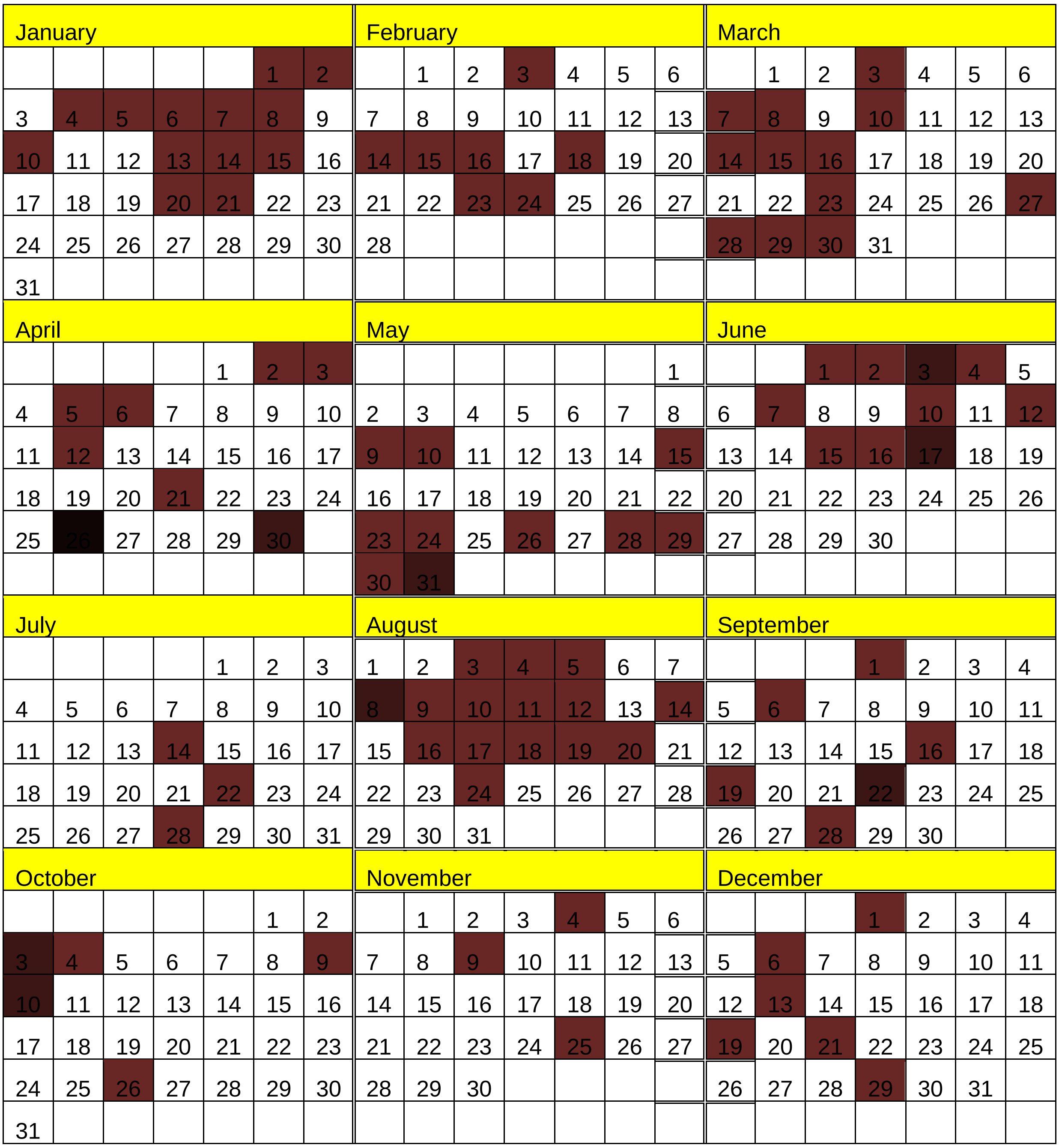

Figure 5.2 Clustering of science news stories by date

5.2.1.3.3 Positioning of science in the bulletin

[24] Dáil Éireann is the principal chamber of the Irish parliament.

As noted in section 5.2.1.3.3 Summary of RTÉ content analysis on page 172, about one third (38 stories) of the science stories in the 2011 sample were headlined at the start of the programme, but the stories themselves were most often placed in the second half of the programme (75 of 109 stories).

Three stories were the first item in the news bulletin, two concerning an outbreak of *E. coli* in Germany, and one about a volcanic ash cloud which was disrupting flights out of Ireland. Eight stories were placed second in the bulletin, half of these were about an outbreak of swine flu in January 2011.

5.2.1.3.4 Stories covered in science news

During the sample period there were three long-running stories which were frequently reported from a science angle, an outbreak of swine flu (eight stories), the nuclear accident in Fukushima (eleven stories) and an outbreak of *E. coli* in Germany (nine stories). Together, these three long running stories stories account for a quarter of the stories in the sample.

The most common field to be reported on is medical science and technology (40.9%), followed by Engineering and Technology (30.0%), and Life Sciences at (13.6%). Please see Appendix F for full data table.

Scientific field	**Frequency**	**Percent**
Physical sciences	7	6.4
Life sciences	15	13.6
Medical science & technology	45	40.9
Climate science & technology	3	2.7
Engineering & technology	33	30.0
Mathematics	1	0.9
Mixed	2	1.8
Other	4	3.6

Table 5.7 *Scientific field covered in RTÉ news. Please see the coding categories in Appendix E for a full explanation of how these fields were defined.*

5.2.1.3.5 Story focus

One of the codes used was to determine the different types of event driving the science coverage. Forty per cent of stories (41 stories) were about natural events or accidents, and almost a quarter (27 stories) about new research findings, while 5.5 per cent (6 stories) were about new technology. Please see Appendix F for full data table.

News_event	Frequency	Percent
Research	27	24.5
Science policy	2	1.8
Health policy	7	6.4
Environment & energy policy	4	3.6
Natural event/accident	41	37.3
New technology	6	5.5
Other	23	20.9

Table 5.8 *News events triggering science coverage in RTÉ broadcast news.*

There were no obvious factual inaccuracies in the sample of stories.

5.2.1.3.6 News reporters

The beat of half of the correspondents reporting on science stories was coded as 'Unknown' as it was not specified in the report, another fifteen per cent of stories did not use a correspondent at all, i.e. the entire story was told by the news anchor in the studio. Of the remaining thirty-seven stories, the reporters' beats were 'Health/medicine' (14 stories), 'Regional' (11 stories) and 'World' (4 stories). Only eight stories were by the 'Science' correspondent. Please see Appendix F for full data table.

The reason for the low representation of stories by the 'Science' correspondent was that at the time that the data was sampled, RTÉ's science correspondent role was filled by an 'Education and Science[25]' correspondent, who concentrated mainly on education stories. It was not until April 2013, with the appointment of Will Goodbody to the post of science and technology correspondent, that RTÉ had for the first time a dedicated correspondent. Another aspect worth noting is the relatively large number of stories (11) reported by 'regional' reporters, who take responsibility for stories emerging from universities and research institutes in their region.

[25] The remit of the correspondent was 'Education and Science' in line with the way the government departments were organised. From 1997 until 2010, responsibility for science was included in the remit of the Department of Education and Science, this changed in 2010 and the department was renamed the Department of Education and Skills.

Reporters beat	**Frequency**	**Percent**
Science	8	7.3
Health/medicine	14	12.7
World	4	3.6
Unknown	56	50.9
Regional	11	10.0
Not applicable	17	15.5

Table 5.9 *Reporter's beat of RTÉ news stories*

5.2.1.3.7 Characteristics of science news

I found no evidence of RTÉ news reports taking a light-hearted approach to science. Interviewers did not joke or laugh with interviewees, equally they did not question their interviewees in an aggressive or dismissive manner. They rather took an informative tone in most of the stories.

Approach of item	Frequency	Percent
Informational	85	77.3
Questioning/investigative	13	11.8
Light-hearted	12	10.9

Table 5.10 *Overall approach of news items.*

Indeed the approach of most of the items was informational (77%), with only thirteen stories (12%) approached in a questioning/investigative manner. Almost equal numbers of stories adopted a positive (42 stories) or neutral (39 stories) tone, while a quarter (29 stories)of all stories had an overall negative tone (i.e., they were reporting bad news).

Tone of item	Frequency	Percent
Positive	42	38.2
Neutral	39	35.5
Negative	29	26.4

Table 5.11 *Overall tone of news items.*

It should be noted that the tone of a report is a highly subjective measure which is difficult to apply consistently but this finding gives a rough idea of the emotional register used in these science stories.

5.2.1.3.8 Stereotypical imagery

In news items, shots of people in white coats, and glass containers full of liquids were used frequently, as were images of large complicated equipment, the precise function of which was unexplained (and by inference, unexplainable). Please see figures 5.3 and 5.4 for examples of the images used.

Figure 5.3 RTÉ News story from 9 November 2011, 'UCC develops biodegradable chewing gum'

Figure 5.4 RTÉ News story from 3 February 2011, 'Irish scientists in energy breakthrough'

Please see section *6.1.2 Othering Science—"fairly intelligent I'd say, but you know, not of this planet I'd imagine"*, on page 206 for a discussion of the focus groups' responses to these stereotypical images.

5.2.1.3.9 Expertise of news contributors

The contributors to news stories were also coded as well as the expertise attributed to them. Contributors were defined as anyone (other than the journalists and presenters presenting the items) who made any sort of linguistic utterance within a broadcast report. The RTÉ news sample included appearances by 197 different contributors. News contributors were usually introduced with on-screen credits which gave their name, title and institutional affiliation, with the reporter cueing the contributor's speech through phrases such as "scientists say" or "experts say".

Seventy of the contributors to news stories were presented within the reports as scientific experts, coded as having either explicit scientific expertise or implicit scientific expertise, and of the 'non-scientific experts', 21 were clinical experts (i.e. medical staff who were not indicated as being involved in research or given the title of professor), four were non-science academics and 36 were coded as 'other professional' (this encompasses all contributors appearing in a professional capacity who were not implied to have scientific, non-science academic or clinical expertise). Please see Appendix E for full details on how these fields were defined.

Expertise	Frequency
Explicit scientific	38
Implicit scientific	29
Clinical	21
Non-science academic	4
Other professional expertise	36
Lay	33
Unknown	9

Table 5.12 *Expertise of contributors to RTÉ news stories, please see Appendix F for full data table.*

The use of the titles “Dr” and “Professor” can imply expertise on the part of a contributor. Nineteen contributors were referred to as Professor in news stories, and forty-three as Dr.

Title	Frequency
Dr	43
Professor	19
Other	2
None	103
Not applicable	9

Table 5.13 *Titles of contributors to news stories*

Thirty-three news stories included comments from ‘lay’ people, that is, people presented as having no specialist professional knowledge of relevance to the issue. Of the thirty appearances of lay contributors in news stories, the greatest proportion (ten stories) occurs in research stories, followed by natural events and disasters (seven stories), though these stories do also include contributions from scientists, clinicians, etc.

Surveys have found that the public trusts scientists from universities more than scientists from industry or government (MORI/DTI, 2005 p. 55, also Centre for Science in the Public Interest, 2004; Critchley and Turney, 2004; Farquharson and Critchley, 2004). In this analysis, the largest proportions of contributors were affiliated to healthcare providers and international bodies and industry. The international bodies are accounted for by the long running issues of the Fukushima accident in Japan and the *E. coli* outbreak in Germany, the healthcare providers are common because there is a popular type of 'good news' story beloved of RTÉ News which reports on a new therapy or technology developed in an Irish hospital. The category of 'industry' is interesting, because it is much more common in Irish news than in comparable foreign channels, it relates to another particular type of story beloved of RTÉ, about a company developing some research or technology which promises a future bounty of jobs.

Affiliation	**Frequency**
Advisory body	1
Charity/NGO	19
Government/political	13
Healthcare provider	25
Industry	20
International body	3
Public body	19
Research institute	2
Scientific society	5
University	21
Other	5
None given	34
Not applicable	6

Table 5.14 *Institutional affiliation of contributors in RTÉ news stories. Please see Appendix F for a full data table, and Appendix E for a full description of how institutional categories were defined.*

In the sample, twenty-one contributors were affiliated to universities, just three of these were to universities outside Ireland. One significant way in which RTÉ News coverage differs to that of the BBC as analysed by Mellor at al. (2011) is in the number of contributors from business and industry. Twenty contributors were from business.. This is accounted for by the very strong focus by RTÉ on the economic benefits of science (please see section *6.2.1 It's the economy stupid* on page 217 for a discussion of the role of science as a support for the economy).

5.2.1.3.10 Gender of news contributors

The contributors to news stories were coded for gender. The findings are shown in Table 5.15 below.

Contributors	
Gender	**Frequency**
Male	118
Female	52
Contributors with scientific expertise	
Gender	**Frequency**
Male	49
Female	16
Contributors with title of 'professor'	
Gender	**Frequency**
Male	16
Female	3
Contributors with title of 'doctor'	
Gender	**Frequency**
Male	27
Female	17

Table 5.15 *Gender of contributors to news stories.*

Less than half as many women as men were contributors to RTÉ news stories. For contributors who appeared to have scientific expertise, the proportion of women was 16 out of 49. There wwere three female professors (16 male), and 17 female doctors (27 male).

5.2.1.3.1 Cautionary comments, oppositional comments, and controversy

On average, the news sample included 1.5 contributors per story. However the broadcast sample included 22 stories which included no speech from anyone other than the reporter, newsreader or presenter. These were mostly very short summary items with an average duration of 24 seconds. More than a quarter of all stories included only one contributor.

Even when multiple contributors were used, this does not necessarily imply that multiple viewpoints were aired. Perhaps most important is the stance and approach of the ‘official’ journalistic voice. Is the approach investigative or critical? Or is the story approached from a more celebratory stance? (or as Steven Rose (2004) would put it a “cheerleading” one?). It may be inappropriate to include critical comment in all science news stories, but including such comment, where well-founded, can help audiences to scrutinise and weigh up the claims being reported.

News stories in the sample were coded for ‘cautionary comments’, i.e. whether news contributors made any comments expressing caution about the interpretation of science, drawing attention, for example, to limitations in research design, or to the relevance of findings, or to factors which were not considered in the research. This code was added to the analysis to investigate whether commentators engaged in the sort of sceptical discussion which is often held up as the heart of the scientific process, as the Royal Society’s motto puts it: “*Nullius in verba*” (Take nobody’s word for it). To fulfil this Mertonian norm of scepticism would mean contributors to news stories elucidating the limitations of a piece of work or noting uncertainties that could be explored further.

News stories were also coded for ‘oppositional comments’, that is, more far reaching criticisms by contributors, for example, claims that there were fundamental flaws in the research or challenges to the assumptions on which the research was based. Such comments might come from groups opposed to the application of scientific investigation to a particular issue, but they might also come from within science where different research approaches differ fundamentally on what the key questions are or what the starting assumptions should be. These critical comments—both cautionary and oppositional—do not necessarily imply a rejection of science or an ‘anti-science’ attitude, but can constitute a normal part of scientific research and be voiced from within the mainstream scientific community.

Cautionary comments	**Frequency**	**Percent**
Yes	12	10.9
No	91	82.7
Not applicable	7	6.4

Table 5.16 *Cautionary comments made by contributors to news stories.*

Only 11% of news stories contained cautionary comments, half of these were taken up with two major events: the accident in Fukushima, where there was disagreement between Tokyo Electric and environmental groups about the extent of the radiation pollution, and the *E. coli* outbreak in Europe where there was uncertainty and disagreement about the source of contamination. There were no cautionary comments made in any of the research stories.

Just 12% of news stories sampled contained deeper criticisms or oppositional comments.

Oppositional comments	**Frequency**	**Percent**
Yes	13	11.8
No	90	81.8
Not applicable	7	6.4

Table 5.17 *Oppositional comments made by contributors to news stories.*

These oppositional comments were more likely to come from lay people, or from bodies representing lay people, such as patient organisations. However as twenty-two stories did not have a contribution from anyone other than the reporter or presenter, and some 28 stories only had one contributor, it was not unexpected that the numbers of critical and oppositional comments would be so low.

One response to the lack of cautionary or oppositional comment is that as Conrad (1999) argues, some science reporters may assume that a particular scientific finding does not require “balance” because science has already gone through a peer-review process. Professor Steve Jones, in his independent assessment of the BBC Trust review of impartiality and accuracy of the BBC’s coverage of science (2011) describes this peer review process as having faults and not guaranteeing that errors (even glaring ones) will be identified by the experts conducting the review, nevertheless, he compares it to what Churchill said of democracy, in that it is the least bad of all the systems that have been tried. Jones continues that peer review is a necessary consideration when making editorial decisions, but is not the only one. However, only two stories in the RTÉ news sample mentioned a publication, and none mentioned peer review. Questioning of science, in a routine manner, as part of the scientific method, is missing from RTÉ News, this may be because of journalistic practices or because of a reluctance on the part of scientists to criticise each other in public.

As well as cautionary or oppositional comments by contributors, news presenters can themselves note uncertainties or controversy in a story. As shown in tables 5.18 and 5.19, uncertainty was indicated in about a third of the sample, while 18 stories were coded as having some element of controversy.

Uncertainty indicated	Frequency	Percent
Yes	36	32.7
No	74	67.3

Table 5.18 *The uncertainty of the science or technology being reported.*

Controversy indicated	Frequency	Percent
Yes	18	16.4
No	76	69.1
Not applicable	16	14.5

Table 5.19 *Indications that the science or technology being reported is a matter of controversy.*

The experimental design of the research was mentioned in only nine of the stories.

Experimental design mentioned	Frequency	Percent
Yes	9	8.2
No	101	91.8

Table 5.20 *Mentions made of the experimental design through which the scientific results were obtained or the technology developed or tested.*

Also, there is evidence suggesting that the source of funding can have an influence on even the most authoritative reports of scientific findings, Ben Goldacre has written about this extensively in his 2008 best seller *Bad Science*, and the follow up *Bad Pharma* in 2012.

Funder mentioned	Frequency	Percent
Yes	11	10.0
No	57	51.8
Not applicable	42	38.2

Table 5.21 *Explicit statement of who funded the research or technology being reported.*

Just eleven of the stories in the sample mentioned the funder of the research.

5.2.1.3.2 Conclusions on RTÉ News content analysis

The proportion of news stories about science is comparable to UK (Mellor at al., 2011), and European (León 2008) studies. The main differences between UK and Irish science news stories is the greater concentration in Irish news on stories about new scientific or technological developments which will create jobs and help Ireland's ailing economy. This is reflected in a greater proportion of stories in the engineering and technology subject areas and in a greater proportion of contributors to news stories being affiliated to businesses.

The coverage of science by RTÉ news is informative but rarely investigative, and the tone tends to be celebratory, and is only rarely critical. The voices heard are mostly (male) scientists, and when other voices are heard, there is rarely any conversation or debate among scientists or between scientists and others. This presentation of science as having mainly an economic function and the small range of voices heard in science news reports gives a limited view of science, which was indeed challenged by some focus group participants. A deeper coverage of science stories including a wider range of views and debate would better serve the audience in that it could help to stimulate debate and discussion about science stories, in this way contributing to their scientific citizenship.

It is also interesting to note what is missing from news stories. There is rarely any reporting on the process of science, funding, publication or peer review.

Publication mentioned	Frequency	Percent
Yes	2	1.8
No	108	98.2

Table 5.22 *Formal print publications as the source of any scientific claims or findings mentioned in the item.*

5.2.2 Horizon

Horizon is the BBC's flagship science programme. The strand has been running since 1964. The programme was cited by focus group participants in this research as an example of a "good quality" science programme. *Horizon* has often been cited as an example of the best of BBC public service broadcasting, the Reithean 'Holy Trinity' of functions: to inform, educate and entertain.

The most interesting research about *Horizon* was carried out by Roger Silverstone in his 1985 book *Framing Science: The Making of a BBC Documentary* (surprisingly little has been done since). The core of Silverstone's study concerns the decision-making processes through which the topic of the programme was 'framed' by the programme-makers. The literature on framing defines it as the process of selecting, emphasising and interpreting a situation to promote a particular interpretation (Entman, 1993). *Horizon* was framed through the contexts through which the scientific research was to be presented, the selection of key personalities, the choice of visual images to illustrate the arguments, the locations within which the story was to be told. Silverstone reveals the extent to which the demands of the medium, combined with programme-makers judgements about the characteristics of the audience, take precedence over the requirements of scientists for detailed exposition of the problem. These media frames have been judged by some scholars to comprise the principle arena within which scientific controversies come to the attention of policy-makers and the public. The media "powerfully shape how policy issues related to science and technology controversy are defined, symbolised and ultimately resolved" (Nisbet, Brossard and Kroepsch 2003, p. 38).

The style of *Horizon* programmes has changed in recent years, moving on from a very serious, very sober exposition, which I call 'old style' for convenience, to a livelier more personalised format. The new 'personalised' format has not completely replaced the 'old style'—both formats are current today, and indeed the old style programmes have provided a socially influential and aesthetically durable form over the years.

Horizon has been criticised for concentrating too much on the spectacular, on topics that will provide stunning visuals and for not doing enough to cover current scientific issues. It has also been criticised by scientists for becoming sensationalised and dumbed down, for example by Frank Close, a theoretical physicist at the University of Oxford who mourned the passing of the higher quality programmes:

> Physicists who recall superb *Horizon* documentaries of the past …. will have been disappointed that such a marvellous project as the LHC should have been sensationalised in this way

(Close, 2007)

For this analysis, I watched recordings of *Horizon* series 48 (2011-2012). The following is a list of the episodes in that series. Descriptions of each episode as given on the BBC website is reproduced in Appendix I.

Do You See What I See?

Seeing Stars

The Nine Months That Made You

The Core

Are You Good or Evil?

Is Nuclear Power Safe?

Playing God

The Truth About Exercise

Solar Storms: The Threat to Planet Earth

Out of Control?

The Truth About Fat

Global Weirding

The Hunt for AI

Defeating Cancer

The Transit of Venus

In old style *Horizon* programmes, the narrator remains off screen, giving the impression that he (and it is almost always a 'he' in old style) is all seeing, all knowing, like the Voice of God. Dramatic imagery and language are used, for example about 'taming nature' or 'the golden age of …', The following are some excerpts taken from *Horizon,* series 48, from a number of old style episodes:

> … promises a new age in astronomy discovery [*Seeing Stars*]
>
> We're at a golden age in terms of the real discovery of the bulk of the deep earth [*The Core*]
>
> Around the world the people who are keeping the lights on are on high alert. They are facing a powerful foe. The UK's national grid is no exception [*Solar Storms*]
>
> The hope is prediction will lead to protection. The point of the weather forecast is to get the predictions of extreme events spot on [*Global Weirding*]

> Revolution in cancer treatment, the promise that one day … as simple as taking some pills [*Defeating Cancer*]

The more personalised *Horizon* style differs from this in that it uses more informal language, for example:

> Everything we learn to do, becomes automatic with practice. Getting a machine to do this is one hell of a task [*The Hunt For AI*]

Also, the narrators appear on screen and often introduce themselves as going on a journey or quest to investigate the topic at hand, making themselves ‘part of the story’:

> I’m Gabriel Westin and I’m a surgeon and a writer. I think the obesity problem has become bad enough to be called an epidemic, but it’s a puzzling one [*The Truth About Fat*]

> I’m Marcus du Sautoy, and I want to find out how close we are to creating artificial intelligence. And what that might mean for us humans. [*The Hunt for AI*]

Sometimes the presenters take the personal nature of the investigation even further, even going so far as to experiment on themselves. For example in *The Truth About Exercise*, the presenter Michael Mosely had a series of tests carried out on himself, and in *The Truth About Fat*, presenter Gabriel Weston carried out experiments on herself, measuring her appetite after fasting for twenty-four hours. This realism is a growing trend in television programmes, not just in science documentaries.

The presenters also described their personal motivations for investigating the topic (often using concern for heir families as a reason):

> I am a scientist. But I’m also a husband and a father and I want to know what’s the safest option for my family’s future, just like you [Professor Jim Al-Khalili in: *Is Nuclear Power Safe?*]

> I’m also a mother, so I’m concerned about how this explosion of obesity might affect my children, and my children’s children [Gabriel Westin in: *The Truth About Fat*]

Another device used is that the presenter finds out something in the course of making the documentary which makes it personal:

> It has altered the way I live my life, and it may alter the way you live yours [*The Truth About Exercise*]

> My enquiry into the truth about exercise has become intensely personal [*The Truth About Exercise*]

> But the latest research that I've seen has forced me to change my mind. I'm pretty shocked to discover that my assumption of a lifetime that I am the size I am because of my character is nonsense. And this new science may hold important clues for fighting the fat epidemic [*The Truth About Fat*]

As well as being personalised around the life of the narrator, the personalised *Horizon* episodes take a particular approach to the scientists featured in the programmes. Scientists are presented as struggling on a lonely quest, or alternatively as investigating a topic which has a deeply personal significance for themselves. For example:

> This is the story of one man's struggle to unravel our destiny …. To silence his critics David embarked on a world wide search. He has travelled to the four corners of the globe to find crucial evidence to back up his provocative theory, because to prove this theory, he needed to show that his ideas held true on every continent, and, for each and every one of us [*The Nine Months That Made You*]

In the case of Ranjan Yajnik, his research was presented as being motivated by his fears that he might be at risk for certain diseases himself.

> **Narrator:** Ranjan thought he too might have this unusual body composition, as he was a low birth weight baby.
>
> **Ranjan:** I was born less than five pounds, and I thought we could investigate to find out whether I was at a higher risk of diabetes. So I did this by actually studying myself and my friend. We are both same body mass index 22.3, but John has nine per cent body fat and I have 21% body fat, for same body mass index an Indian has more than twice the amount of fat than an English man has. This is a perfect example of a thin–fat Indian. [*The Nine Months That Made You*]

In *Global Weirding*, Professor Catherine Hayhoe is presented as having a personal interest in climate change as she lives in a region very much affected by changes:

> Trying to get to the bottom of this is one of the world's leading climate scientists. Professor Catherine Hayhoe has a more than academic interest in figuring out what's happening here, she lives and works in West Texas [*Global Weirding*]

But perhaps the most compelling personal motivation for scientific research was presented in *Are You Good or Evil?* where Professor Jim Fallon described how he discovered that he himself shared the neurological and genetic correlates of psychopathy:

Jim: They looked normal and I was like ‘This is fantastic’, and then I came to one and it was the last one as it turns out and it looked very abnormal, and this particular PET scan had no orbital cortex activity, it had no temporal lobe activity, this whole sort of limbic system was not functioning, and I said ‘Oh my God this is one of these killers’, and I looked at it, it’s the exact same pattern as a killer. But when I looked down at the code it was not one of the killers, it was me. It was really a shock, it was a shock but you know I tried to make it like ‘Oh, well that’s really interesting, well I’m not in jail, I haven’t killed anybody, I haven’t done any of that stuff, so at least I don’t have the genes, I don’t have, you know I just have the brain pattern so okay I felt better.

Narrator: He then did the gene tests, looking not only for the warrior gene, but for other traits like impulsivity, that make up the profile of a psychopath. Back came the results.

Jim: And again everybody had a mix of things in our family, it looked like an average sort of mix of ahm of these different genes that have to do with aggression and all sorts of behaviours, eh except now again there was this one that showed all of these high-risk genes, and it was mine. I was thinking ‘What are the odds of getting these?’ Throw the dice twenty times, come up six six, six six, six six, You know, it’s millions to one.

Narrator: Now Jim started asking himself some unsettling questions

Jim: This really became probably more serious in my mind, because you know, it’s like ‘Who am I?’ really. People with far less dangerous genetics become killers and are psychopaths, than what I had you know, I had like almost all of them.

Narrator: But the reaction from his family was to unsettle him even further.

James [son]: I knew there was always something off, It makes more sense ehm now that, it’s clear that he does have the brain and genetics of a psychopath, it all falls into place as it were. He’s got a hot head. Everything that you would want in a serial killer, he has, in a, in a fundamental way. Because I’ve been scared of him a few times.

Diane [wife]: It was surprising but it wasn’t surprising, cause he really is in a way two different people. Even though he’s been always very funny and gregarious and everything else he’s always had a stand-offish part to him, and that’s always been there. That’s always been there.

Narrator: Having heard what his family thought, Jim felt forced to be honest with himself

Jim: I have characteristics or traits, some of which are, you know, that are psychopathic yeah. I could blow off an aunt’s funeral, if I thought there was a party that day. I would just take off, and that’s not right. Uh, the thing is I know that now but I still don’t care, and so I know it, I know something’s wrong, but I still don’t care, and you know the, I don’t know how else to put that, I just, you’re in a position where ‘Oh, that’s not right, well I don’t give a shit, you know and that’s, that’s the truth.

Narrator: But Jim still had a puzzle to solve, if he had the brain and the genes of a killer, why wasn't he one? The answer is that whether genes are triggered or not will depend on what happens in your childhood. Simply having the warrior gene doesn't necessarily mean you'll be violent. [*Are You Good Or Evil?*]

Another feature of the personalised style is that it constructs the presenter as being close to the viewer, asking the kind of questions that a non-scientist 'ordinary' person would ask; having the kind of reactions that an 'ordinary' person would have. For example:

It's insane! … It's bizarre, bizarre" [*Playing God*]

Please see section *6.3.1 Ordinary Joe—rooted in the everyday* on page 225 for a discussion on how the non-scientist 'ordinary' person is constructed with respect to the scientist.

It should be noted that both old style and personalised *Horizon* episodes use the 'detective story' narrative, as these excerpts illustrate:

crucial piece of the puzzle [*Nine Months That Made You*]

…read clues in the placenta [*Nine Months That Made You*]

Thrown into space mystery which would offer clues to what was happening deep in core [*The Core*]

The narrators and contributors to the *Horizon* programmes did not—as was traditional in BBC science broadcasting—separate the content of science from the context of science. They acknowledged the influence of culture on science. For example, in the programme *The Nine Months That Made You*, there is a discussion about how studying the placenta can provide information about the health of the foetus:

Narrator: Our companion in the womb is now being given as much respect by Western science as it has always had in Saudi culture.

Dr. Sallah Al Wasoo: You cannot separate culture from science. Here for example in Saudi Arabia, towards the end of the pregnancy, we look at the placenta as if it is going to die, to bring a live baby, and for this we respect this unique organ and handle it carefully and bury it in the graveyard.

Political and economic considerations surrounding scientific problems were also acknowledged in the programmes, for example in *Fukushima: Is Nuclear Power Safe?* the presenter, Professor Jim Al-Khalili, acknowledges the complexity of the nuclear issue:

> **Al-Khalili:** And to my mind this can never be purely a scientific problem. It's indisputably tied up with economics and politics, you'll have your views and I'll have mine, but it's a debate that needs to be informed by an assessment of the scientific risks.
>
> The influence of politics and economics on nuclear power is of course nothing new, and really from the moment scientists first started to understand the power bound up inside the atom, it was inevitable that politicians would be drawn to this irresistible bounty of energy. And I think these politics have had an impact on my science, science of nuclear physics, and its attempts to find the safest way to unleash the power of the atom.

The scientists featured on *Horizon* are presented in their laboratories and also apart from their work: driving cars, walking on the beach, enjoying a family barbeque. Non-scientists did not appear very often in the *Horizon* programmes, when they did it was most commonly as medical patients, for example a woman undergoing a gastric bypass operation in *The Truth About Fat*, or as the three cancer patients undergoing treatment in *Defeating Cancer*. As the narrator in *Defeating Cancer* says: "this programme follows three people through one of the most difficult times of their lives". Although the programme *Defeating Cancer* focuses on these three 'case studies', it is the doctors, and the technology who are the real heroes, the patients are constructed as passive, complying with the instructions of the doctors and hoping for a good outcome. They are similar to the patients who Maja Horst described as possessing "an assemblage of comportment" (p. 165) in her 2007 paper about how scientific citizenship is performed with respect to gene therapy. Horst described the assemblage of comportment as patients passively co-operating with the medical team, and accepting their destinies. Their expectations of their treatment are "sound"—based on scientific methods and proven facts. Horst goes on to describe this assemblage as one in which "the relation between scientists and other actors is a one-way dissemination of knowledge" (p. 165)

The most interesting representation on non-scientists in the *Horizon* programmes is that of the biohacking citizen as portrayed in *Playing God*. The presenter Alan Rutherford goes to visit a community centre where biohacking is taking place. He is shown cultures of *E. coli* which have been made to fluoresce by adding a 'fluorescence' gene from a jelly fish. This work was carried out by "rank amateurs, people who'd never picked up pipettes before" after an hour's training.

> It's really interesting this, it's like a very community-based project, but they're doing real experimental science, and the strangest thing about it is, even though they're kids, school-aged kids here, if you just look on the shelves, this is standard lab equipment, expensive proper equipment you'd see in any hospital lab or any university lab, and it's

> just here in this kind of, it's here in this community centre, it's, it's, this is unusual, I've not seen this before.

Rutherford later likens biohacking to the early days of Microsoft: “in that it started in Bill Gate's garage where they were building computers from scratch in a garage, now it is this global enormous corporation.”

It could be argued that biohackers are a kind of scientific citizen, they engage with science, taking it ‘into their own hands’ without waiting for permission from any authority. They claim their own scientific citizenship. They use science as a toolkit, which can be used to answer questions about the world around. Rutherford calls what they do “DIY biology”, and they can use this to construct their DIY scientific citizenship.

The idea of science as a toolkit, which can be used to answer questions and which can be useful in everyday life was also evident in other *Horizon* programmes. For example, *The Truth about Exercise*, presented by Michael Mosely, shows how answers to everyday questions about how to live longer, better, fitter can be obtained from scientific thinking, and can be applied to everyday life.

5.2.3 My Shocking Story

My Shocking Story is a “shock doc” or “shockumentary” strand. These terms have come to refer to a particular genre of documentary which deals specifically with extreme (usually medical) issues, involves surgical procedures shown in graphic detail, and/or close up shots of bodily difference. These programmes are sensationalised, designed to shock the audience.

In the focus group discussions, ‘shock-docs’ were almost always referred to when participants were asked an open-ended question about what science programmes they watched. One documentary in particular, *Half Man Half Tree* was discussed by participants and this research explores the representations of science in *Half Man Half Tree*; it finds themes of medicalisation, voyeurism and the position of the ‘extraordinary’ person with respect to the ‘norm’.

Half Man Half Tree was produced and broadcast by the Discovery Channel as part of its *My Shocking Story* strand, and was also broadcast by Channel Five as part of their *Extraordinary People* strand. Channel Five categorise *Extraordinary People* as part of their science output—and in their 2006 strategic report, state that: “our reputation is for using emotionally compelling stories to explain scientific phenomena”. The images used in the *My Shocking Story* strand are indeed shocking, and in one case an advertising trailer for the show was the subject of complaints to the British broadcasting regulator Ofcom, the complaint being that the images shown in the trailer would be distressing for younger viewers (they were not upheld).[26]

Van Dijck (2002) argues that these medical 'shock' documentaries are a type of modern day freak[27] show, albeit transformed into a mediated spectacle for today's audiences[28]. The freak show has been defined as the objectification of people's bodies for curiosity and entertainment at the cost of their humanity (Adams 2001). Laura Backstrom (2011) raises the possibility that the rise of reality television shows featuring many of the same anomalous bodies that were displayed in freak shows means that the cultural institution of the freak show has merely changed venues from the nineteenth century sideshow to the twenty-first century television show.

The subject of *Half Man Half Tree* is Dede Kosawa, who suffers from *Epidermodysplasia verruciformis,* an extremely rare autosomal recessive genetic hereditary skin disorder characterised by abnormal susceptibility to human papillomaviruses (HPVs) of the skin. The resulting uncontrolled HPV infections result in the growth of scaly macules and papules, particularly on the hands and feet, which are similar in appearance to tree bark and branches. Koswara lives in a remote village in Indonesia and his condition has left him unable to perform basic tasks in everyday life. He is unable to earn a living in his former occupations of construction work or fishing, and had to join a travelling circus freak show to earn money.

The programme's narrative falls into three main sections: the description of Dede Kosawa's condition and the US Dr Gaspari's efforts to diagnose him and find a treatment; the story of Dede's Kosawa's involvement with the circus Shadalukh Clan;

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[26] A total of eleven viewers complained to Ofcom that the images of Dede Kosawa in the trailers might distress children and so were inappropriate for the time of broadcast.

A full account of the complaint and OfCom's ruling are available at: http://stakeholders.ofcom.org.uk/enforcement/broadcast-bulletins/obb114/

[27] Depending on the historical time period, anomalous human bodies have been referred to by various names, such as "monsters" and "curiosities". The word "freak" was used for the first time in 1847 and eventually came to be the dominant term used by both sideshow performers and the public until it fell out of favour at the turn of the twentieth century (Thomson 1996). This thesis follows the conventions of past scholarship in this area and uses the term freak to mean a culturally constructed category of different bodied people who have been publicly displayed for profit or entertainment.

[28]There is also scholarship likening the sensationalistic treatment of sexual non-conformity (Gamson 1998) and lower class people (Grindstaff 2002) by television talk shows to the freak show. The talk show uses many conventions of the historical freak show including the host as lecturer, the line-up of guests who have unusual personal issues, and the highlighting of transgressive sex and incongruous couples, and importantly, about people on display and the public examination of what are essentially private affairs (Dennett 1996). Lowney (1999) argues that modern day talk shows invoke the familiar patterns of morality and public cleansing proffered by religious revivals and the circus in the 19th century.

and a side story about a second “Treeman” Ion Toader, who lives in Romania and whose condition was treated surgically.

Like nineteenth century freak show acts which often emphasised the educational value of learning about and looking at exotic and anomalous people— thus distancing themselves from the mass entertainment commonly associated with fairs and circuses (Park and Daston, 1981, p. 23)—the *Half Man Half Tree* programme purports to provide an emotional education whereby the viewer gains tolerance and empathy by watching the stigmatised Kosawa live his life. The narration is sympathetic towards Kosawa, and constructs western scientific medicine as being his saviour, and his route to escape the circus Shadalukh Clan freak show in which he is forced to perform in to earn a meagre living to support his children.

> **Narrator:** As a single father to his two children Dede struggles to provide for them
>
> **Kosawa:** I try to be a good father to my children but I can’t give them what they need
>
> **Narrator:** His only income is to perform circus stunts with a bizarre collection of people, but with each new event the mysterious disease worsens, soon it will cover his whole body, risking his chance of death unless help can be found.

However the television programme itself constructs the Shadalukh Clan as freakish, note below an image taken from the beginning of the programme where the Clan are first introduced, they are presented in a dark room with dim red lighting and wreathed in smoke.

Figure 5.5 The Shadalukh Clan.

The Clan are very much represented as exotic, their freakishness being part of a condition which could only occur in the world of the ethnic ‘Other’. And it is only high tech Western medicine which can save these people from their disorders. In one very interesting scene, the Clan come to visit Kosawa and bring him to their next performance. As members of the Clan troop into Kosawa's house, Dr Gaspari, standing outside, greets clan members as they arrive and takes the opportunity to quickly diagnose each one, converting their freakishness into medical language, in a sense medicalizing each freak as they pass by.

> **Narrator**: Just as Dr. Gaspari prepares to end the consultation the village has some unexpected guests. Dede's circus companions have come to visit.
>
> **Dr Gaspari**: I believe the clan is arriving; the clan is a group of cohorts that are also afflicted with various conditions ahm that Dede associates with
>
> **Narrator**: He seizes the opportunity to diagnose each of the clan as they arrive.
>
> **Dr Gaspari**: [to Trembuling, a member of the clan] hello, I'm Dr. Gaspari. [To someone off screen] Van Richling's Housing neurofibromatosis. [To Nyi Jebleh, a member of the clan] Hello, I'm Dr. Gaspari, I'm Dr. Gaspari, Dr Gaspari, pleased to meet you.
>
> **Bubble Man**: How are you Dede?
>
> **Narrator**: The clan is a group of people with rare medical conditions. Dede performs with them in a city circus to try to earn a living.
>
> **Clan member**: We joke around like we do with friends. We don't look down at each other. We are the same.
>
> **Dr Gaspari**: The Bubble Man and the associate have neurofibromatosis. Each of the bubbles under the skin has a benign nerve growth that is causing the bubble to form.
>
> **Narrator**: The Clan Otis came to the village to take Dede to perform in the next show.
>
> **Dr. Gaspari**: Collectively I have not seen ehm such an unusual gathering of patients with very rare diseases. There's absolutely shared pain among the individuals for, because of their chronic skin conditions, no doubt about it.

When it comes to the circus performance that Kosawa is part of, the narrator is sharply critical, disapproving of Boi the circus manager's treatment of Kosawa, but the narrator does not acknowledge or reflect in any way that the television programme itself is also putting Kosawa on display. The narrator claims concern about the performance, but does nothing to stop it taking place, again putting salvation for Kosawa firmly in the hands of the Western Dr. Gaspari and nowhere else:

> **Announcer**: You are going to see the performance of the Shadalukh Clan. What you are about to witness may not be seen anywhere in the world. We have got some rare people.
>
> **Narrator**: We are concerned by what we are filming
>
> **Boi**: So, don't worry. It's not dangerous. You can see their faces.

> **Narrator**: The Clan looks terrified. For the final act Dede is asked to pull a two-tonne truck up a hill by his hair.
>
> **Narrator (through a translator)**: Are you worried about Dede?
>
> **Journalist**: Well. A bit worried but I trust the team.
>
> **Narrator**: the show is over, and Dede tells us he's not hurt. We were distressed by what we'd witnessed.

The freak Dede Kosawa is constructed by the television programme as passive, patiently following the doctor's instructions while also being cruelly exploited by the circus manager. He only speaks to the camera very briefly on two occasions. Medical science emerges in this construction as being of a completely 'other' world to the world of Kosawa, and of being his only hope. There is no hope to be found in his native village in Indonesia. Kosawa's scientific citizenship is constructed to be as a passive recipient of the products of scientific medicine, his role is to follow the US doctor's instructions. Viewers of the documentary are invited to share this construction of scientific citizenship—to leave unquestioned the larger issues of poverty and inequality in health care. The documentary frames the story of Kosawa from a hegemonic perspective, reinforcing stereotypes of race, culture and disability while at the same time reflecting the exhibition techniques of the freak show.

5.3 Production, programme-maker interviews

Three particular types of programmes were cited by focus group participants as examples of science on television. First, news programmes. When asked about their general television viewing habits, most participants said that they watched the news regularly (exceptions to this were the two school groups). The content analysis of *RTÉ Nine O'clock News* (the highest rated news programme in Ireland) showed that the greatest proportion of science news stories (41%) were about medical science and technology. I therefore selected the health correspondent for RTÉ News for interview. Second, focus group participants gave the examples of *Horizon* and other blue chip BBC science documentary programmes. These documentaries are an important area of study because "they represent one of the most traditional and high-prestige formats for science on television" (Haran et al., 2008). I therefore selected a documentary-maker who had worked as a producer and director for the BBC (*Horizon*, *Tomorrow's World*) and then as an independent producer making programmes for Channel 4 and Discovery. Third, focus group participants also talked about 'shock docs' such as *Half Man Half Tree (*these were probably the most animated portions of the discussions). I therefore selected a programme commissioner for factual and specialist programming employed by the Discovery Network International, this interviewee commissioned *Half Man Half Tree*.

The main aims of the interviews were to find out how the programme-makers construct their own scientific citizenship and that of their audiences, and also to investigate media routines and editorial concepts, and the production infrastructure within which programme-makers work, including, for example: the economic constraints of media organisations, the professional ideologies of journalists and other media personnel, 'news values', the editorial policies of media, the nature of the subject matter, the nature of relationships between media professionals and their sources, and the publicity practices and general media orientation of sources.

5.3.1 Documentary-maker interview

This section discusses the interview with a science documentary-maker, looking mainly at how he constructs his audience, through viewership data and other feedback, and what he sees as his duties towards his audience, and his horror of going for the "lowest common denominator".

The interviewee was already working in broadcasting part-time when he finished his PhD (in geology) in 1995. He worked as a producer and director for the BBC (*Horizon*, *Tomorrow's World*) before becoming an independent producer making programmes for Channel 4 and Discovery. In the interview, he acknowledges the influence his own science background has on his scientific work. He feels passionate about some areas of science outside his own specialism, such as space or robotics, and describes "dream projects" which he tries to get commissioned.

During the interview, the respondent talked about the idea of science communication and public understanding of science, and reported that he was saddened that efforts of the public understanding of science movement in broadcasting and other areas had not lead to a more science-engaged public, but rather that "the public has become more cynical and sceptical". He doubted that the public were more informed about science, but was certain that they were more hostile towards certain advancements in science and medicine. He reflected that the objective of a lot of science engagement has been "muddled", making it difficult to assess whether it has succeeded or not. He continued that, while, as a PR job, these efforts have failed, they may have succeeded in other ways: "because maybe people are a little more engaged and understanding of certain areas of medicine and science".

The interviewee also reflected on his own practice as a programme-maker. He does not consider himself to be an impartial programme-maker, but sees his role as a documentary maker as being inherently different to the role of a journalist "reporting the facts". He asserted that he did not like to make very sensationalist programmes, and was very critical of the approach taken by *Tomorrow's World* to the "ear on the mouse story"[29]. He did not think that the "world was ready for images like that", and the effect that it had was to do: "more damage in the field of public engagement with science, ahm, than a lot of other things and years of positive stuff." The interviewee's attitude towards sensationalism and censoring science for audiences was not completely clear cut though, as the interview continued, he reflected on his practice, asking himself: "Who am I to be censoring?"

The interviewee's relationship with the audience is mainly based on the feedback he gets about viewership. He said that he was interested in viewing figures for programmes, and described how, when he worked at the BBC, he would: "go out of my way to find out what the target audience was and what I should be doing". He described himself as quite interested in audience data and again at the BBC he would study the graphs and try to find out where the audience lay, adding that he was "quite exceptional" in doing this, as most programme-makers tended "to rely on those above you" for this information.

The interviewee also worried about the deleterious influence that the focus on viewing figures has on programme quality. He gave an example from his time in *Tomorrow's World* when viewing figures came in five-minute segments, allowing the programme-makers to see what parts of the programme prompted viewers to change the channel or switch off. One particular segment was very unpopular with viewers—a piece about a new electric cello, which was played in an Elgar duet with an acoustic cello. The response of the programme editor at the time was: "well, we're never going to put on classical instruments". As the documentary maker said:

> …. and well you think is that really how you want to run TV now? You know because that's literally lowest common denominator stuff? Why don't you just put topless dancers on if you're really kind of viewing figures, you know, forget science, so I thought it was sad really that it had gone that way but the trouble with focus groups and constant kind of audience things was that just you end up with some pap that panders to the masses which isn't necessarily what science broadcasting is about. I really feel strongly about this, I used to believe, naively I suppose, that you could reach any part of the audience with science broadcasting but you just can't. There's a part of the audience that just aren't interested and they never will be and you're never going to fix that, so forget about it, don't try chasing them the whole time and alienating the rest of

[29] An episode of the BBC series Tomorrow's World, broadcast in 1995 showed how Dr Charles Vacanti and his team at the University of Massachusetts had grown an ear from human cartilidge cells and grafted it onto a mouse. The spectacular image of the mouse with an ear on its back caused much discussion in media at the time.

> your audience by constantly trying to bring this part of the audience on side because they don't care they don't want to know.

As well as viewership figures, the interviewee also talked about receiving more direct audience feedback (e-mails, letters etc.), which was mostly complaints, "I mean you tend to only get complaints, people very rarely write in when they loved something, they're more likely to tell you it sucked and why, and why you shouldn't do it again." However, he did mention one memorable occasion when he got more satisfying audience feedback:

> The only time I got a different feeling about audience feedback was when I produced and presented the very first live webcast that the BBC had ever did, a video webcast from an eclipse from Zambia in Africa. We just broadcast it onto their service down mobile phone links, you know, we brought a lot of the equipment ourselves it was really kind of lashed together and we didn't really know if anybody had been watching anyway because this was way before YouTube, before video on the internet was popular, so we put this thing out as a one hour programme and then we logged off, signed out and logged off and logged back in from this field north of Lusaka about an hour later and there were hundreds of emails from people all over the world, from people who had just written in to say: "thank you" and that was the very very first time in my whole career in broadcasting, and it simply still the most rewarding interaction with an audience just because they'd all just been really, you know, delighted by what we'd done and they'd told us and in contrast most of the feedback we get after TV programmes is negative so it does get you down a lot of the time and you often stop reading it.

But this experience was exceptional, and indeed the interviewee reflected on his difficulties with the concept of "the audience", as:

> There's no one person you can point to and say that's my audience, the audience is very broad and it ranges from different age groups, different genders, different educational backgrounds, and all of them want different things out of their programmes, and all of them have different attitudes towards science as a subject

Despite the difficulties the interviewee admits having with conceptualising his audience, he does come up with a few audience categories, e.g. "The Sex and the City Girls": who will only watch programmes that are relevant to their own world and the "Purists" and the "Hunter Gatherers": groups that really like science and will seek it out. These groups also differ in, for example, their attitude to uncertainty, with the Purists being happy to leave questions unanswered and just explore subjects, and with the "The Sex and the City Girls" having a very "black and white view of the world" and not tolerating any uncertainty.

5.3.2 Television journalist interview

This section discusses the interview with a television journalist, his relationship with his audience and what he regards as his duties and responsibilities towards them. The interviewee specialises in health stories, and before moving to television worked for the *Irish Medical News*, a weekly newspaper for doctors and health professionals working in Ireland.

The interviewee sees part of his duty as journalist as making sure that the information being fed to his audience is accurate. He sees part of his role as keeping an eye on drug companies, as they have powerful PR machines and will try to “push coverage of expensive new drugs which may not yet have been proven effective”. He sees himself having an ethical responsibility to make sure that patients are not being used—drug companies will often link with patient groups in their attempts to get a drug approved/funded. This chimes with the literature about science journalism in section *2.12 Journalists first and science journalists second—how media constructs itself* on page 70—professionally, the media sees itself in an adversarial confrontational stance with regards to big business. Even going as far back as 1971, Tunstall, in the first major social science study of specialist journalists in the UK, noted that a key dimension of the professional ideology of journalists is to avoid that which is readily available.

The interviewee talked about how both himself and RTÉ has a duty to be educational, informative, balanced and fair. He also sees himself as having an obligation not to report (i.e. not to give in to pressure to report, again from large drugs companies) on very early stage research, as “I think it can be dangerous …. give false hope to people, if a breakthrough is actually years away”.

His relationship to the audience is built mainly through Twitter and other social media, phone calls and e-mails. These phone calls can be a source of stories and also the interviewee can act as an advocate for members of the audience, if someone rings with a problem he can tell them how to sort it, or “sometimes as well I might make a phone call, and just by doing that the problem can be sorted.”

He regards scientific “breakthrough” stories as an opportunity to provide “happy” news, and deliberately seeks them out as an antidote to the “90% of the news about misery and conflict”.

5.3.3 Programme commissioner interview

This section discusses the interview with a commissioner for factual and specialist programming employed by the Discovery Network International. This interviewee was responsible for commissioning *Half Man Half Tree*. The interview looks mainly at how the interviewee constructs the audience for *My Shocking Story* and her relationships with the individuals who are the subjects of the programmes.

The interviewee discussed the contradiction of the “tabloid” titles of the programmes in the *My Shocking Story* strand and the “sensitive” way in which the stories themselves were handled. She asserted that although the individuals who were the subject of the programmes “could be vulnerable”, the producers handled them very sensitively and felt they had a responsibility towards them not to provide false hope, and to ensure that they knew what they were letting themselves in for.

The interviewee maintained that the *My Shocking Story* strand was “objective not polemical reporting” and for this reason they were careful when choosing “experts”, that they could fairly represent their views by being articulate and concise. The research team checked this by first of all, speaking to the experts on the phone “to see how they talk and communicate”.

She considers it “absolutely essential” that the producers on the *My Shocking Story* strand have science backgrounds: “Even if the producer is a generalist, there will be people on the team with specialist skills, for example Windfall Films would have science experts in senior management, this is vital that they have these track records.” She sees her duty to the audience as being more than simply supplying them with entertainment, but makes it part of their brief to provide “further learning and education” as well. She is committed to showing how complex the science discussed in the programmes is, they do this by showing conflicts between experts:

> It's vital to us that we show differences of opinions, we do this a couple of different ways, we can bring the scientists together for a discussion or we could intercut film of them both. We do this, not to be combative, for the sake of it, but to show how complex the science is. We welcome differences of opinion.

The interviewee constructs the audience from viewership figures and audience feedback (tweets, forums etc.) Monitoring this audience response is an important element of the production of these programmes:

> During shows, and our shows go out around the world, as they premiere people tweet about them, and sometimes the experts will be actively online tweeting as well. Our research department monitors these tweets and assesses the mood of the tweets. We have other forums as well where people will give longer more considered opinions, they are watched too. Now it happens that the people on these forums can be the most extreme opinionated polarised opinions. But we do value the concerns of the audience and we respond to concerns and compliments from the viewers.

The interviewee summarised the target audience for the *My Shocking Story* strand as:

> Broadly speaking, and I can't be any more specific because information about our target audience is confidential, but broadly speaking we are going for an audience who cares about the world, we are aiming for co-viewing and for anyone in their mid-twenties onwards.

5.4 Concluding remarks on Findings

This Findings chapter gave a comprehensive account of the results of the empirical research. These findings were divided into three sections, first the reception study, which forms the heart of the empirical research for this thesis, then the analysis of the content which encompassed a detailed content analysis of the coverage of science in RTÉ news as well as an analysis of the representations of science in the BBC *Horizon* series and the *Half Man Half Tree* episode of the *My Shocking Story* strand; third, this chapter gave an account of the findings of the investigation of television production carried out, that is the three semi-structured interviews with television programme-makers.

The first section of this chapter opened with a brief description of the set-up of the focus groups and of the stimuli used. It went on to give a comprehensive description of the focus group discussions held. Focus group participants discussed the nature of science itself, their own experiences interacting with scientific topics—in school, in their work, in their communication with medical professionals, through media and so on. Focus groups discussed scientists themselves, using familiar stereotypes as shortcuts in their conversation. They talked in some detail about the motivations for making science programmes and what formats they particularly liked and disliked. Focus groups with younger participants said that they enjoyed more entertainment based formats of science programmes. In particular, the younger groups favoured celebrity presenters, while there were disagreements in the other groups about whether celebrities or actual scientific experts were best suited to presenting science programmes. Focus group participants also discussed the suitability of television as a medium for science. This first 'reception' section closed with detailed accounts of participants' responses to the individual stimuli television clips.

The second section of this chapter gave an account of the analysis of content of science television programmes. It begins by giving an overview of the television broadcasting landscape in Ireland, then goes on to describe RTÉ news and to give a detailed account of the findings of the content analysis carried out on RTÉ news. The chapter gave a full account of the proportion of science stories in news programmes, the seasonal variation in RTÉ news coverage of science, the positioning of science in new bulletins, the stories covered in science news, the focus of the science news stories, the characteristics of the news reporters, the characteristics of science news, the stereotypical images used, the expertise of news contributors, and whether any critical comment appears in the stories. The content section then goes on to give a detailed account of the representations of science in the BBC *Horizon* series and in the *Half Man Half Tree* episode of the *My Shocking Story* strand. It begins by noting the importance of *Horizon* as a blue-chip science documentary strand, and then continues with an overview of the *Horizon* season 2011-2012 studied, contrasting the 'Voice of God' old-style presentation with the newer 'personalised' style of narrating and presenting. This section goes on to give a comprehensive account of the representations of scientists in the programmes. The chapter then went on to give an account of the findings about the *Half Man Half Tree* programme. This part opens with an explanation of the shockumentary genre. This is followed by my arguments about these types of programmes being a type of freak show, and a review of the representation of the freak Dede Kosawa and his saviour Dr Kaspari.

The third section of this chapter gave an account of the three interviews carried out with television programme-makers. This section opens with an explanation of why the particular interviewees—a documentary-maker, a television journalist, and a commissioner of programmes—were chosen. It gave a thorough description of how the programme-makers think about, engage with, and construct their audiences, what editorial concepts and media routines they work with, and how their everyday routines and the infrastructure within which they work contribute to their production of science content for television programmes.

The next chapter, *6 Discussion: emerging themes from the research* on page 204 uses the accounts of the findings detailed here as data from which themes emerge, it outlines these themes and makes explicit the links between the different parts—reception, content and production—of the research.

6 Discussion: emerging themes from the research

The findings were analysed using Discourse Theoretical Analysis (DTA) as discussed in section *3.1 Using discourse analysis to examine the assemblage*, on page 78 (also please see Carpentier and De Cleen (2007) for a full discussion of the applicability of DTA to the study of media practises and discourses). DTA builds on a combination of Laclau and Mouffe's (1985) discourse theory and critical discourse analysis. Methodologically, it is based on the general principles and methods of qualitative research.

This section describes themes which emerged from the reception, content, and production research. Primary among these three elements of the study was the reception research, that is, the focus group discussions. The three main kinds of science programmes which emerged as significant from the focus group discussions were *RTÉ News*, *Horizon* episodes, and the *Half Man Half Tree* episode in the *My Shocking Story* strand. *RTÉ News* was the subject of a content analysis and I examined the *Horizon* 2011/2012 series, and the *Half Man Half Tree* episode in the *My Shocking Story* strand for representations of science. The production element again complemented the reception and content elements as interviews were held with a television journalist who specialises in stories about health and medicine, a documentary maker, who had formerly produced programmes for the BBC and is now an independent producer, and a commissioner for factual and specialist programming at Discovery Network International.

Emerging themes from the research are neither frames nor definitions but reflect representations or 'construals' each of which forms a step in a process towards the stabilisation of the concept of science on television. Each theme performs an important function in the overall public discourse on science. Nine thematic representations of the assemblages of 'science on television' emerged from the audience research, these can be further categorised into: 'constructing science', 'constructing justifications for science', 'constructing publics for science', and 'constructing (mis)trust for science'. Each of these themes is discussed in the following sections.

6.1 Constructing science

Focus group participants initially constructed science by their reflections on the epistemology of science, they placed it as an 'other', as well as reflecting on school science and on science as part of the wider culture of society. Each of these aspects of the construction of science is detailed below.

6.1.1 Epistemological issues—"I don't know if that technically counts as science but ..."

The focus group discussions began (after introductions and an explanation by the moderator of the purpose of the focus group) with the questions: "what is science?" and "what comes into your mind when you hear the word 'science'?" The participants gave a variety of answers, relating to school science, the science portrayed on media and the scientific method itself. However, these were not straightforward question and answer sessions, the questions were rather a stimulus which led to discussions about the nature of science, what the concept included and excluded, and where science began and ended. Focus group participants struggled with deciding what was science and what wasn't, using phrases such as:

> FG7FP2: Things in the paper maybe about how to spot if someone's lying or whatever, I'd read them, I don't know if that falls into the science?

> FG7FP3: I dunno if it's strictly speaking science but you know the way there's loads of programmes now about construction and architecture and buildings.

> FG5MP1: I don't know if the David Attenboroughs are classified as science

> FG5MP7: I don't know if it technically qualifies as science

The discussion in one group (participants aged over 50, well educated, mixed gender) illustrates the participants' uncertainty about the nature of science and the nature of research:

> FG6MP8: I think if you ask people 'what do they mean by science', I mean I think we're even confused, like we're totally confused by what science is.
>
> FG6FP1: Yeah
>
> FG6FP3: That's right
>
> FG6MP8: You know, I mean at the beginning we were all talking about something very very narrow right, but it's opened up now about science, so you know if we're the average, you know, what I mean, so the average person doesn't understand what science is.

It's also interesting that the participants were quite reflexive in their thinking about their own participation in the focus group, that they felt that by their participation, they were representing the "average person".

The question of how to distinguish between science and non-science, the so-called 'demarcation problem', has been described by Resnik (2000, p. 249) as "one of the most high-profile, perennial, and intractable issues in the philosophy of science". It is not merely a philosophical issue, but also has a significant bearing on practical policy questions and practical decisions. For this reason I see it as a positive part of the way in which participants are constructing their scientific citizenship that they are considering this question, that they do not see science as merely a body of knowledge, or a process of discovery but a complex, messy, and often inconclusive project, continually subject to revision.

Focus group participants also struggled with defining what a scientist was. Given the huge range of disciplines that are included in the term 'science', they found it difficult to find a single competence or quality that could describe scientists. Indeed they were critical of media portrayals of scientists as homogenous, and all of one mind, following a single trajectory of 'Science', as this quote, from a woman in her thirties aptly illustrates:

> FG7FP8: You associate science with sort of progression, you know it's constantly moving, constantly evolving, constantly learning new things and its always, if you read an article in the paper it's always "Scientists have discovered..!", like there's this big room full of scientists somewhere working away discovering these things. It covers I guess so many aspects, so many different disciplines, that it, they just call them 'scientists' whatever, but it's the idea that we're moving forward I think.

6.1.2 Othering Science—"fairly intelligent I'd say, but you know, not of this planet I'd imagine"

Participants' ideas of what scientists themselves are like agreed with common stereotypes in media of scientists being both highly intelligent and socially awkward. For example, in the focus group carried out with school students in Donegal, participants agreed that to be a scientist you needed to be "very smart" because "there's a wild lot of stuff to keep in your head, to remember". One participant also thought that to be a scientist you need to be "creative". The students also used the stereotype of the mad scientist to describe the researchers interviewed in the clips used as stimuli, for example one sixteen-year-old girl said [about the *Horizon* clip]: "There was a wee crazy scientist in it". This led to a discussion by the group about what kind of people scientists are:

> FP1: That's what I think, most people who are interested in science think, once science comes into your head you think of like crazy men with funny hairs and white coats and stuff
>
> MP2: And stuff blowing up!

FP1: Yeah.

It was not just the focus groups with younger participants that talked about ‘mad scientists’; in focus group 8, which comprised participants aged over fifty years with a high standard of education (third-level), participants also discussed the stereotypical images of science that they were familiar with from film and television:

> FG6FP1: The mad scientist in all the horror movies and also the atom bomb and all that kind of stuff.

Also, in focus group 10, which also comprised participants aged over fifty years but with mixed educational backgrounds, participants also repeated the usual constructions of scientists as socially awkward:

> FG10FP3: You know, fairly intelligent I’d say, but you know, not of this planet I’d imagine, most of the I’d say
>
> FG10FP1: Very focused I’d say and single minded
>
> FG10FP3: Yeah but not to common sense I’d imagine

It’s also worth noting the use of the word “imagine”, the participants did not have direct knowledge of scientists; they were imagining what they could be like and using media messages to help them do so. Participants in other focus groups also acknowledged the stereotypes of scientists, even using the word ‘stereotype’ without the moderator using it first. When asked what they thought of the scientists who appeared on the *Horizon* clip stimulus, the discussion went as follows:

> Moderator: what did you think of them? Some of the scientists that appeared on it?
>
> FG9MP9: They weren’t the most memorable, not memorable at all
>
> FG9MP1: Stereotypical kind of scientists
>
> Moderator: And what’s the stereotype?
>
> FG9MP1: Well just nerdy kind of
>
> [inaudible] [laughter]
>
> FG9FP10: They’re more excited, and they want you to be excited for them, like you know I think that’s why they have to make it very interesting to hold your attention because everybody isn’t going to be as excited as they are. They’re nearly like kids in a playground trying to tell you something.

However it should be noted that just because participants use stereotypes in their discussions of science; that does not mean that they ‘believe’ or ‘disbelieve’ these stereotypes, as Tessa Perkins (1978) asserts in her chapter on ‘Rethinking Stereotypes’ in the book *Ideology and Cultural Production*:

> We do not simply 'believe' or 'disbelieve' in stereotypes, since they may 'work' for us and communicate with us without our necessarily 'agreeing' with them …. They do not *necessarily* influence our behaviour/attitude/practices.
>
> Perkins, 1978, p. 2.

The most thoughtful and reflective discussions about the stereotypical images of scientists used in television programmes arose in one of the focus groups made up of participants with an active interest in science. Some participants in this group criticised the way that scientists were portrayed in media, questioning why particular "typical scientists" were chosen. As one woman, a student in the MSc in science communication in Dublin City University put it:

> FG5FP1: But the other thing I would kind of think of, I mean I do accept that point but on the other hand that camera was chosen to point at that guy, how many other scientists could they have used? And why did they pick him? That's the only thing …. Oh yeah I know just cause someone watching that their idea of scientists you know because of this, it's not only about scientists it's about what is the public's idea of scientists and it is just feeding into that now, now he probably is like that and we love characters anyway but I would just I would just wonder about it slightly.

During the same (active interest in science) focus group, another male participant, who is himself a producer of science television programmes, agreed with this criticism, noting that television programme makers have a "duty of care towards people who have given up their time and energy and put themselves forward" and that in his own practice, he was very conscious when editing a programme not to portray the scientists unfairly (this participant also noted that this "unfair" representation could lead to scientists not putting themselves forward for television interviews).

However, other participants argued that the stereotype was there for a reason, and that scientists were in fact, somewhat removed from everyday concerns of grooming etc. As a male participant, who blogs about science expressed it:

> FG5MP7: Exactly, if he is actually like that then he, okay it might be feeding the stereotype, but the stereotype is there for a reason, I mean there have been some scientists
>
> [participants talk over each other]
>
> FG5MP7: particularly when you see a drama where some scientist is portrayed like that *Back to the Future*, or something like that, apart from that when you do see the scientists I mean one of the things is that most of the really famous scientists is that they really suffer from bad hair not that I'm anyone to talk
>
> [laughter]

> FG5MP7: I mean they do, mad hair seems to be one of those things—mad hair or no hair. I mean it seems to be one of those things I can tell you about how DNA is put together I can tell you about relativity, but can't find a comb in the morning …. And that has fed the stereotype the stereotype has come from that and there are going to be scientists who feed back into it

This was picked up on by another participant, a (male) biology graduate in his twenties who was also a student in the MSc in science communication in Dublin City University:

> FG5MP8: and that's why it's interesting when you do watch a programme and the very odd time you come across a guy that doesn't look like what you think a scientist looks like, even though I'm a scientist and I'm like I don't think I look like this other guy
>
> [laughter]
>
> FG5MP8: you know and because I was watching one about back here a few years ago years ago ahm and it was quite interesting and it was basically a programme I think it was made, it was made in America, I think in the time of all these anthrax scares and they did have one guy on it and he was actually just what I was talking about, he didn't look like, he had a pony tail and leather jacket kinda like and he was, I don't know, he was just kind of refreshing to see then I suppose the, not the kind of the shirt and tie, yeah, you know, he was a bit different, you know from an everyday kinda and he was speaking about it from a ahm everyday words, I suppose when he called a bacteria badass it probably went too far but
>
> [laughter]
>
> FG5MP8: You know what I mean like. The, I suppose there are different types, of, a lot of scientists are kind of, kind of crazy and like 'Woah' and but ah they're not all like that

As well as discussions where participants mentioned stereotypical scientists, attitudes which were, indeed, very much on the surface, participants went further in their talk about scientists as being inherently different to non-scientists. For example, as one engineer in his thirties said (about the clip regarding the discovery of the gene region responsible for coeliac disease from an *RTÉ News* bulletin):

> FG4MP7: And also near the end of the report there was a ten second talk by the lead researcher and that highlights the problem I would say which is becoming more and more obvious from other sides for some reason scientists talk and think differently from other, from the rest of the population he was talking about discovering gene regions and finding particular genes, that is totally alien I would say to most people.

This was echoed by one of the Donegal group of school students, in her explanation of why she preferred the presenter of the clip from the Royal Institution Christmas lectures:

FG4MP8: She treats us like what we are, she's not saying big words in documentaries, it's like they're talking to a scientist, to another scientist and really you don't really know what they're on about.

According to some participants not being a scientist was an advantage when it came to presenting science on television, David Attenborough's programmes were frequently cited in this regard:

FG7FP2: He [David Attenborough] talks at the level in terms yet he goes into great detail you can tell his enthusiasm about things

FG7FP3: You could listen to him all night

FG7MP5: Yeah you could actually

FG7MP7: But he's not a scientist so maybe that's why it works

In another such discussion, between participants in the Kildare school focus group, the students disagreed about whether science documentaries would be better if presented by scientists or celebrities, the reason that participants gave for wanting celebrity presenters was that they wanted "someone you can relate to". Participants perceived that they would have difficulty relating to scientists because:

FG3MP5: Scientists you feel are a different—not species—but when you're watching it you want to be able to see these people are on my side you know, they can understand something else.

This attitude was taken even further by some other participants, who joked that scientists were not people at all.

Moderator: Ahm, and did you think that in general science programmes are easy to understand or

FG3MP1: Some

FG3MP2: Most of them are

FG3MP1: Yeah, most of them are, but lots of them are aimed to people so like

FG3FP3: They're like broken down and

FG3FP4: people, scientists aren't people [laughs]

[laughter]

FG3FP4: Sean!

FG3MP1: I meant they're aimed at the public and not people who are familiar with scientific shows

FG3FP3: Ok ok ok

FG3MP1: so yeah they are easy to you know

Moderator: What ahm,

FG3MP1: What did you say?

FG3FP4: [whispers] scientists aren't people!

Participants in one of the focus groups made up of people with an active interest in science reflected on how science was represented on television programmes as 'the other', and on how scientists were represented as very intelligent compared to non-scientists. As one woman in her thirties, who works in science education and outreach, said:

> FG6FP5: There was one on recently with Alan Davis from *QI* about how long a piece of string was, how long is a piece of string it, it was quite quirky because obviously he's not a scientist and he was going round visiting all these different scientists it was all about measurement really it was interesting the way it was portrayed the way the scientists were portrayed in it. Almost like they were 'super smart' a bit on the edge, like he was the dumb person who needed to be informed but then that's probably his persona on *QI* as well as a comedian.

In this example, Alan Davis stands in for the naïve public, for the 'ordinary' person, who is constructed in opposition to the "super smart" scientists. This simple dichotomy was used by participants to describe the difference between science and everyday life—between scientists and ordinary people. As one man in his forties put it:

> FG8MP5: You've got the two sides, you've got the scientist and you've got the ordinary Joe Soap like myself.

In a focus group comprising participants aged between 30 and 49 years of age, educated to university degree level, one female participant, a neuroscientist[30] in her thirties, made the distinction between people in her own circle of friends who were scientists or "non-science", these two separate groups would have different kinds of conversations about science. She declared that the clip from *RTÉ News* about coeliac disease would be of no interest to her "non-science" friends:

> FG7FP6: Like, it's the kind of thing you would talk to your friends down the pub about, I wouldn't say to my non-science friends about the gene story, they wouldn't care, whereas the other thing I would.

This idea of the ordinary man in opposition to the scientist is explored further in the section about constructing publics for science (please see section *6.3.1 Ordinary Joe—rooted in the everyday* on page 225).

[30] Scientists were not specifically recruited for this focus group; however, one of the participants recruited happened to be a scientist.

Another notion which emerged from the focus group discussions was the idea that scientists themselves bear some of the responsibility for this ‘othering’ of science, this representation of science as special and distinct from other professions is similar to Hornig’s (1990) findings about the representation of science as ‘sacred’ and to this author’s similar findings about the Voice of God style of some of the BBC *Horizon* episodes (see 5.2.2 *Horizon*, p. 185). Focus group participants, again in one of the focus groups made up of participants with an active interest in science, got into a debate about the accuracy of representations of science on television, FG5MP7, who is a blogger about science, argued that scientists were too particular about how science is represented:

> Yeah, this is something that somebody said to me; there’s a lot of programmes where people portray lawyers, or you know any other type of you know, whether it’s a drama, or whether it’s a news programme where they portray these other people they don’t get, he used the word ‘precious’ when we do, I mean science people we go ‘Oh you can’t be showing somebody in *CSI* getting results like that, but they have things happening in dramas about lawyers and things happen that are completely unrealistic but they don’t get precious about it, but we seem to be the only people who go ‘well, you know, we want everybody to know about science, but we want you to know the way we want you to know; we don’t want you to be able to figure it out for yourself’.

6.1.3 School science: “physics, chemistry, biology, that’s the three isn’t it?”

When asked what came to mind when they thought of science, the first reaction of many participants was to refer to the science they had studied in school. Science in senior cycle secondary school in Ireland is divided into three subjects: physics, chemistry and biology. Many participants gave the answer “biology, chemistry and physics”, when asked to about science, that is, the three science subjects they studied in school.

> FG9FP6: Physics is a bit you know way out, you know from the three things you did in school physics would have been the one that was whoa, biology would be the favourite I would say among most people

Participants who studied science at third level also first of all thought of science in these terms, for example FG4MP3, who undertook a degree in biology:

> FG4MP3: Because when I think of science I just think of what I’ve done because I’ve spent four years doing biology so I just think of biology basically that kind of thing I think I’ve had kind of I suppose a bit of an influence on my siblings my sisters know that I do microbiology and maybe a small part of me that I don’t know that’s what they’ve picked

> up as well ehm but I don't know how much of an influence I've been in that case but science in general a kind of different perspective.

Some participants described very positive experiences of learning science in school, often citing particular teachers that influenced them:

> FG6FP4: Actually one of the things that interested me in science in the beginning was actually my teacher and for weird reasons like she was glamorous and stuff like that and I know that sounds weird doesn't it? And you know it was kind of it was a very structured class as opposed to actually being the content itself which is kind of worrying I suppose but you know its funny when you have a like a kinda positive influence in a classroom it kinda you kinda get a desire into it then.

The 'certainty' of school science was also attractive for some participants:

> FG6FP5: I have to say when I was in school that I used to like that there was a right answer and a wrong answer. I used to get very annoyed in English when you'd write an essay and the teacher would go "Not exactly what I had in mind" Well, it was what I had in mind. With science then you either got the answer right or you got it wrong and you got effort marks and all sorts of things so I quite liked that.

> FG1FP1: I loved science. It would have been one of my better subjects at school.

Although this was countered by the negative experiences of other participants with science, mainly complaining that science was too theoretical, and not enough attention was paid to the practical aspects of it, as these school students from Kildare put it:

> FG3MP5: I think its kind of how it's taught sometimes you kind of have a negative view of it. I mean our science teacher wasn't really good in the first three years of school. No, I'm just saying the truth you know if the teacher sort of will affect you it sort of turns you away from the subject more.

> FG3MP1: You think when you go to secondary school you're going to do loads of experiments but you don't, you don't do anything
>
> FG3MP2: If you did more practical stuff you might have a bit more interest.

This heavy theoretical emphasis in school science at second level was contrasted—by the same group—with the more fun practical nature of science that they had enjoyed as younger children:

> FG3MP8: It was kind of more interesting as a child now it's too...
>
> FG3FP3: Because you have to learn it
>
> FG3MP8: Yeah, the novelty because you didn't do science in school as a child

The concentration on school science was not limited to the focus groups held with school students. In a focus group held with women studying for a Certificate in Preparatory Studies in Higher Education (CPSHE), an access course run by Letterkenny Institute of Technology, participants recalled their experiences of science in school, where, as young women, they were discouraged from choosing science subjects.

Older participants also—in common with school students—criticised the way science was taught in school, and the lack of practical work:

> FG9MP9: But also I mean this has probably nothing got to do with today's topic, but like in schools, the way science is taught in schools is probably a real turn-off as well.
>
> Moderator: What is it about it that's a turn-off?
>
> FG9MP8: Well, like it's there, it's not always an accessible subject for people you know, like a lot of the teachers that are there probably are [inaudible] inspiring, maybe they stick to the textbooks kind of these days, I don't know
>
> FG1FP4: I think as well when we were in school and we did our science experiments, and most of our science experiments were done on paper, they weren't actually done with the bubbly stuff, you might do—I don't remember but you might have…

However, many focus group participants—particularly those who had children currently going through the educational system—discussed the major changes that have taken place in school science, acknowledging how science as taught today, was much more connected with everyday life:

> FG10FP1: The whole area of environmental science, they're so much more aware now, where you know it wasn't, when we were in school that would never have been part of what we were taught in science. Then kids in primary school, science is on the curriculum now, it's taught, it's part of everyday life to them really, whereas in our day it was just you know lab work and books.

Also, in the focus group discussions, participants talked about the way their and their children's perception of science had changed since they were at school. They attributed this in part to the science television programmes which they watched:

> FG8FP9: Science years ago when we were in school was very difficult—if you liked science you were you know—but now you know with these programmes I'd say more people would now be into it, you know science because like forensics and people didn't think about any of that years ago, so I think these channels are brilliant because it opens up
>
> FG8MP4: Knowledge.

FG8FP9: Knowledge, exactly.

6.1.4 Science as part of culture

These new areas of science which have been opened up—like the environment or forensics—were advanced by focus group participants as “part of culture”. They also included scientific imagery and language used in advertising in this assessment:

> FG8FP1: In advertising, I mean they’re trying to sell stuff, it’s being used a bit in that context to fob us off all these actimels and all these probiotics and they’ve introduced a whole load of scientific words into their language
>
> FG8FP9: You’d have to have the dictionary out for it
>
> [laughter]
>
> FG8FP1: Yeah, it’s really selling you stuff, ‘this is good for you’ using science

Science as part of culture was also cited in its use in decision making, e.g.:

> FG6FP6: But then again I think there is an awful lot everything from advertising to a scientific approach to policy-making, all those kind of things where science comes in again I think.

6.1.5 Conclusions on constructing science

Focus group participants struggled with deciding what science was—about the nature of science and the nature of research. I argue that this is a positive part of the way in which participants construct their scientific citizenship, they are thoughtful in their consideration of the question, and also reflexive about their position and role in taking part in the focus groups. Participants do not see science as merely a body of knowledge, or a process of discovery but acknowledge that science is a complex, messy, and often inconclusive project, continually subject to revision. Although focus group participants played around with stereotypical images of science and scientists, and with the idea of science as other, they were ready to tackle complex epistemological issues, and indeed showed themselves capable and willing to take on scientific citizenship, to participate in decision making about scientific issues in society.

Participants discussed their experiences of science in school, and at third level where applicable, talking about what aspects of science they found interesting as school subjects. They described how their positive or negative experiences of science in school influenced their attitude towards it in later life, although many of the parents in the groups talked about how curricula had changed and how their children were having a very different experience of school science. School science, though important, did not have the degree of influence that de Cheveigné and Véron (1996) found in their reception research about science television programmes in France. de Cheveigné and Véron found that interviewees and focus group participants' readings of science programmes on television depended mainly on two things: the legitimacy accorded to television as a source of knowledge, and the type of memories left by their school experience, memories of school influenced the appreciation by participants of the limits of their own knowledge and of their capacity to learn and understand science.

Focus group participants played around with common stereotypes of scientists being both highly intelligent and socially awkward, but also challenged these same stereotypes, criticising how scientists were sometimes portrayed on television. However, they did construct scientists as being inherently different to non-scientists, in the "alien" language they used and their "way of thinking". This simple dichotomy between scientists and non-scientists was used by participants to describe the difference between science and everyday life. This representation of arcane science as special and distinct from other professions is similar to Hornig's (1990) findings about the representation of science as 'sacred' in the *Nova* television series, similar to my own findings about the 'Voice of God' style of some *Horizon* programmes, and Trench's analysis of Irish media coverage of science as remote (2007, p. 138), and difficult for society to engage with (2009). The discourse theme of science as 'other', competes with the discourse of ‘science as part of culture’, where focus group participants constructed areas of science such as forensics or the environment as opening up, and along with scientific imagery and language—used for example in television advertising—as “being everywhere now”.

6.2 Constructing justifications for science

Focus group participants, in their discussions of what science was, and whether they believed it to be important or relevant to them, justified the value of science overwhelmingly in economic terms, chiming with the economic discourse in *RTÉ News* examined in this research, and indeed in Trench’s earlier (2007) review of Irish media representations of science. The other discourse theme which ‘justified science’ was the idea of science (particular medical science) helping people. In these focus groups, the discussions of science helping people centred around Western scientific medicine as being the saviour of people with unusual medical conditions as portrayed in shock docs or shockumentaries such as the *Half Man Half Tree* programme in the *My Shocking Story* strand. Both of these discourse themes are explored in detail in the following sections.

6.2.1 It’s the economy stupid[31]

In the focus group discussions, one of the overarching themes was that of the economy, and how science functions as part of that economy, particularly in terms of its employment and expenditure aspects. Focus group participants in the main saw the central function of science as supporting the economy and creating jobs.

Participants in the focus groups discussed the potential of scientific research for creating employment; in one focus group held with women studying for a Certificate in Preparatory Studies in Higher Education (CPSHE), an access course run by Letterkenny Institute of Technology, participants talked about the jobs that could be created by spinoffs from research into nanotechnology, jokingly calling them “nanojobs!”

These focus group conversations about the economic impact of science follow the media’s lead. Thirteen out of a total of 112 stories about science on RTÉ Nine O’clock news in 2011 were about new research and emphasised the commercial applications of the research. Indeed, the economic value of science was emphasised by one of the

[31] In 1992, US Democratic Party campaign strategist James Carville coined a slight variation of the phrase “it’s the economy, stupid.” At that time, Carville was attempting to emphasise the importance of the struggling economy in then-candidate Bill Clinton’s 1992 presidential campaign. Although originally intended for an internal audience of campaign workers, the phrase became a de facto slogan for the entire campaign.

interviewees for this research, a television journalist who specialises in health and medicine stories (please see section ***Error! Reference source not found. Error! Reference source not found.***, on page **Error! Bookmark not defined.**), who called it “a big thing”. The crisis in the economy is probably the most pressing issue for Ireland today, and because of these economic problems news stories which refer to it are particularly salient. Stories about scientific research which could lead to economic growth and employment are ‘good news’ stories. Such stories frequently use images of people working in laboratories as a backdrop when reporting on the high tech jobs which will arrive. Stories about breakthroughs in research are framed in terms of the possible (and hoped for) future economic benefits. Science is presented as a saviour of Ireland’s broken economy—a way out of the mess—particularly when a commercial application of a new technology can be sold. For example, on 16 March 2011, *RTÉ News* reported on a “Dublin-based company which employs just a handful of people says it’s amazed and overjoyed after being bought by the video sharing website YouTube for a non-disclosed sum”. The report includes an interview with the CEO of the now successful company, in which he says: “We’re overjoyed that we will be seen to be ehm at the top of our field in that way and ehm yeah, it’s just fantastic,” and concludes with an interview with Joe Morley, Manager of the Guinness Enterprise Centre:

> I think it’s a great message of hope for each of the 60 companies who are here, these guys are working day in day out ehm sweating away to make their businesses work and this just proves that they can do it. You don’t have to be big if you’ve got a great product with great technology. You can grab the attention of one of the biggest companies in the world.

Focus group participants felt very positively towards these types of stories, and in fact many said that they would like to see more of them, and a more in-depth treatment of such stories. For example, in a focus group made up of participants aged thirty to forty nine years of age of mixed educational backgrounds, one male participant said:

> FG9MP9: I was going to say it would be good to see programmes also about you know how there’s new types of businesses and new types of companies coming along to kind of cope with the environmental challenges that are out there. The ESB announced jobs today to set up divisions that are going to equip homes with like sun panels and gave people advice on how to change theirs. There’s loads of green companies and wind farms and all those kind of things so you know it’s good to see programmes about those as well you know.

There was very little criticism of this restricted view of the role of scientific research, either in *RTÉ News* or in the focus group conversations; focus group participants limited themselves to criticising the lack of efficacy of particular policies rather than questioning the underlying premise behind them. Even with environmental stories, solutions for climate change are consistently presented as technological/scientific/business e.g. windmills, etc., never as a slowing (indeed, stopping) of economic growth and production.

Participants in one focus group were very critical of university science courses “jumping on the *CSI* bandwagon” to promote their science courses. One male participant in his thirties, for example, criticised the Dublin City University forensic science course because of the number of students dropping out after their first year, as the course did not match their expectations. He was also critical of the lack of a career path for forensic scientists:

> FG4MP5: …. and also the fact that there’s no jobs in it that’s the other side of it, you know, I mean there’s something like only two hundred forensic labs in the world or something, you know so it’s, there’s no chance.

Other participants, who lived in a rural area in Donegal, worried about whether new technology would actually take away jobs rather than create new ones (Focus Group 1).

However, in spite of criticism by focus group participants of particular methods used by policy makers to promote science, they did not question the value of science in economic terms. The ‘economy’ discourse overwhelms all other discourses current in wider Irish society, and so too the ‘economic benefit’ discourse overwhelms all other discourses with regard to science. The primacy of the economic discourse in the focus group participants’ minds is illustrated here by one male participant (from Dublin, in his forties), whose television-viewing habits have changed since the beginning of the recession:

> FG10MP4: I suppose the way the country’s in turmoil, I find I don’t like missing the news, I like to get to see the news and any, if there’s anything else follow-up, if there’s going to be any programmes or debates on generally, I’m not very politically minded, but in the present climate, so I just ehm, I just want to keep up-to-date.

Even the younger groups (two of the focus groups conducted were with school students aged around 16 or 17 years), who tended to think of science mainly in terms of school and examinations, talked about science and maths being promoted by media as school and college subjects in order to produce more scientists and engineers to support the economy.

> FG3MP5: They’re all aimed at trying to get you interested
>
> Moderator: They’re all aimed at what?
>
> FG3MP5: They’re all aimed at trying to get you interested in science

FG3FP4: Trying to get people interested in science

FG3MP5: Because people have lost interest

FG3MP1: Yeah they, they make it sort of for different ages

Moderator: Mmmm

FG3MP1: But still, for

FG3MP5: and science courses are, not as many people are doing science courses[32] or mathematical courses anymore, so they're kinda trying to spring sorta life into science again

Moderator: Yeah yeah

Moderator: So you think that's the motivation behind the production of these programmes?

FG3MP5: Could be yeah. Sometimes they're just, especially like ah, a certain incentive nearly you know if you do this course you know you'll be learning about interesting stuff like this

Moderator: Mmmm

FG3MP5: Cause like at the moment you know, well like science courses, not as many people would do them you know cause there's no real incentive to do it

Two focus groups had as their stimuli clip an episode of the RTÉ series *The Investigators* about nanotechnology. *The Investigators* is an Irish-produced programme, and concentrates on work done by Irish scientists at home and abroad.

Scientific research is represented in the programme as progress, and as extremely competitive, and Ireland is very much portrayed as a strong competitor, for example:

> Basically these R and D efforts are a type of horserace, we start off with many possibilities, at the moment its being whittled down to 2 or 3 and Mike is among one of those last possibilities
>
> [Professor John Boland]

> As the race for the next breakthrough in computer technology reaches its conclusion, the scientific and commercial communities are watching closely to see who will reach the finishing line first.

[32] Since the focus groups were conducted there has actually been a significant rise in the number of college applicants who chose science and engineering courses as their first preference. In 2009, 3911 applicants (6.7% of all applicants) chose science as their first preference, in 2013, this had increased to 4570 (7.5% of all applicants), this is an increase of 16.9% over the five years. In 2009, 2309 applicants (3.9% of all applicants) chose engineering as their first preference, in 2013, this has increased to 2813 (4.6% of all applicants), this is an increase of 21.8% over the five years (Patterson and Harvey, 2013).

[Narrator]

> There's an international race on at the forefront of computer technology and the winner will be credited with literally revolutionising the industry one of the frontrunners in the field is Professor Mike Coey in Trinity College Dublin.

[Narrator]

Further examples of the way that science as progress and as a competition are represented in the programme are given in section 5.1 *Reception analysis, focus groups* on page 121.

Focus group participants recognised these themes, and were sceptical of the programme because it was so ardently in support of nanotechnology research. They described the programme as “very one-sided”. They saw it as an advertisement, a marketing tool, rather than as a balanced documentary. Again, they saw the role of science as a contributor to the economy as a major theme in the programme.

The participants of focus group 2, held in Dublin were particularly critical of the themes of economy and competition in The Investigators programme. As noted in section 5.1.4 Focus group 2 on page 131, participants variously described it as "a party political broadcast", a "marketing tool" and a very Utopian view of science", they also criticised the lack of detailed information in the programme.

The focus group participants’ emphasis on economy in their conversations follows the media’s lead, and, indeed the media emphasis on economic, employment and expenditure aspects of science strategy in turn follows the government’s lead. The Irish government has committed itself to the pursuit of a ‘knowledge-based economy’. The *Strategy for Science, Technology and Innovation 2006-13* (Government of Ireland, 2006) has among its aims that:

> Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture.

Media coverage of science forms part of this policy. The Report and Recommendations of the Task Force on the Physical Sciences (2002) was critical of Irish media, observing that they had a low level of interest and expertise in covering science, instead coverage was led by public relations activities, ‘good news’ stories and: “PR-led items that make limited demands on editorial resources and are easy for the mainstream media to handle.” The report recommended that a significant cultural shift in attitudes be brought about to improve communication between the scientific community, the media and the public. To achieve this, government agencies, such as the Environmental Protection Association (EPA), Teagasc, and Science Foundation Ireland (SFI) have sponsored science series on RTÉ such as *The Investigators* and *The Science Squad*. However, the focus group discussions suggest that the sponsored programmes lack subtlety, and that a more nuanced, balanced account of scientific research is required to engage audiences.

Government-funded science awareness programmes such as Discover Science and Engineering, also have a labour market focus: they target school students in an effort to boost the numbers of students taking science and engineering subjects at second-level and thus ensure an abundant supply of scientifically and technically qualified graduates. Trench (2007, p. 140) terms this a highly instrumentalist view of public awareness of science which “chimes with the view of scientific knowledge that underlies Irish policy for the knowledge society: knowledge is especially valued if it can be turned to innovation in the economy.” This restricted view of the role of science, filters out from government policies to media representations to societal discourses, leaving little room for public engagement with the priorities and purposes of research or with its social, philosophical and ethical implications.

6.2.2 Western scientific medicine: the only hope for the freak

Van Dijck (2002) argues that the shock doc or shockumentary uses the language of medicine and science to justify their interest in documenting the lives of those considered different; and that this documentary style is firmly rooted in the nineteenth-century freak show: “The live freak show never really disappeared, but took on a new cloak; it evolved into medical documentary, the appeal of which is based, to a large extent, on the convergence of medical and media techniques” (p. 538). As Guy Debord (1977) posits, contemporary Western culture is a “society of the spectacle”, implying that all modes of knowledge are subject to the constraints of electronic mediation. The ‘Shockumentary’ both reflects and constructs specific norms and values about ‘deviant bodies’ in our common culture. Medical interventions ‘normalise’ their bodies and lives.

In the focus group discussions, ‘shock-docs’ were almost always referred to when participants were asked an open-ended question about what science programmes they watched.

During a focus group held with second-level school students in Donegal, participants were asked to name science programmes, or programmes with science in them. After naming *Doctors* and *Dr Phil* and other medical advice programmes, one sixteen-year-old girl named *The Jerry Springer Show*. When asked where the science was in *The Jerry Springer Show*, she responded: “Well, there’s a woman, there’s a bouncer on it that only has from her waist up…she has no legs”.

This seemingly strange association of science and disability is puzzling until one considers the number of science documentaries which focus on medical interventions on people with unusual disabilities or medical conditions. These shock docs or shockumentaries were cited by focus group participants as programmes they watched frequently. Participants in the focus groups discussed their guilt and awkwardness at watching these programmes, but were at the same time fascinated by them. As one woman in her fifties from Dublin put it:

> FG6FP3: You're drawn into, it's horrible and I know I did watch, and I know I'm laughing about it, but it's unreal, the saddest thing I ever saw, these poor people, it was horrible.

This discomfort when faced with disability was summed explained by the Australian philosopher Elizabeth Grosz:

> The freak is an object of simultaneous horror and fascination because the freak is an ambiguous being whose existence imperils categories and oppositions dominant in social life'
>
> (Grosz, 1996, p. 56)

Attempts have been made to control this ambiguity, Michel Foucault (1973) has extensively argued how, in the course of the eighteenth and especially the nineteenth century, medical explanations increasingly accounted for all sorts of deviations in appearance and behaviour. However this medicalisation of disability and difference did not cause the disappearance of the freak show, but rather changed its character as public attention shifted from the freak to the surgeon. The medical profession's effort to 'save' the freak, rather than the freak himself, became the centre of attention. Also scientific and medical technology takes on a heroic character in the television representations of these efforts. In these programmes, the dominant Western ideal of superior technology and socio-medical justice is sharply pitted against the technological and social backwardness of the non-Western world. Television programmes use the language of medicine and science to justify their interest in documenting the lives of those considered different.

According to Van Dijck (2002), the appeal of the televised medical documentary is based, to a large extent, on the convergence of medical and media techniques. The French philosopher Guy Debord (1977) suggests that an important characteristic of the mediated spectacle is that various formats and genres—like information, entertainment, and promotion—have coalesced. Debord continues that contemporary Western culture is a 'society of the spectacle', implying that all modes of knowledge are subject to the constraints of electronic mediation.

As well as guilt and fascination, the focus groups had a variety of other responses to the shockumentary form. The shockumentary is repeated so often, and has become so sensationalist, so over-the-top, that its shock value has deflated itself, and focus group participants are no longer shocked, they enjoy it from a stance that is merely ironic, ludic and humorous**.** Hartley (2010) calls this sort of playful use of media for “silly citizenship”.

6.2.3 Conclusions on constructing justifications for science

First of all, the ‘economic benefit’ discourse overwhelms all other discourses with regard to the role and purpose of science, this discourse theme was present in RTÉ News reports about science and in the (sponsored) science documentary programme *The Investigators*. This theme was uncritically accepted by the participants in all the focus groups apart from Focus Group 2, where participants were sceptical of the programme because it was so ardently in support of nanotechnology research, they described the programme as “very one-sided”. However, in the main, the focus group participants’ emphasis on economy in their conversations chimes with media coverage of science, which in turn follows government emphasis on economic, employment and expenditure aspects of science. This is in common with Andy Stirling’s (2008) description of the situation in the UK, where ‘innovation’ is justified simply by reference to a general “pro innovation” position, and technological innovation is portrayed without qualification as self-evidently good (HM Treasury 2004). The ways in which context, purpose, and power shape the outcomes of technology choice are thereby downplayed and tacitly denied. Transparency, accessibility, accountability, and agency are correspondingly diminished.

Regarding the other ‘justification’ for science which emerged as a theme from the data, the idea of Western scientific medicine as being the saviour of people with unusual medical conditions as portrayed in shock docs or shockumentaries, it may appear on the surface that attitudes to disability are regressing to a nineteenth century view of anomalous bodies as freakish. However, focus group participants were playful in their constructions of the freak. I view this as a positive development, in that participants were challenging the hegemonic perspective of the programme, and engaging in what Hartley (2010) calls a (silly) citizenly manner with the science.

6.3 Constructing publics for science

This section describes how focus group participants construct ‘publics for science’ and by doing this, construct their own identities in relation to science. The literature review examined the ethno-epistemic assemblage of science by looking at how individual elements of the assemblage: ‘science’, ‘policy-makers’ and ‘media’ construct both themselves and other parts of the assemblage.The following completes this process by looking at how the other main element of the assemblage, the ‘public’, constructs itself, examining how focus group participants construct their identities with respect to science, by looking at the two main discourse themes about publics for science, which I have called ‘Ordinary Joe’ and ‘Bright Young Things’. Ordinary Joe is a non-scientist, who is constructed in relation to scientists, whereas the Bright Young Things are the young people presented, particularly in RTÉ News bulletins, and by focus group participants who are parents, as confident in engaging with science and providing ‘hope for the future’.

6.3.1 Ordinary Joe—rooted in the everyday

Participants described the “ordinary man” “the man in the street”, “the ordinary Joe Soap”, “Joe Bloggs”. They identified with this Ordinary Joe, using him as a taken-for-granted signifier of all that is everyday and commonplace. The constructions of ‘Ordinary Joe’ and ‘The Scientist’ are particularly interesting as one is constructed relative to the other. Whereas The Scientist is very dedicated to, and very focused on research, Ordinary Joe, while aware of science, is mainly concerned with the everyday routines of working, commuting, cooking, caring for children, and so on. The subject position of Ordinary Joe is defined through his relation with science.

> FG10MP5: You’ve got the two sides, you’ve got the scientist and you’ve got the ordinary Joe Soap like myself …
>
> Male, Dublin, thirties, FG10

Carpentier and Resmann (2011) argue that the concept of ordinary people plays a significant role in our sociodiscursive realm as a category to capture social differences.

There was a crucial difference in the way that Ordinary Joe was constructed by the focus group participants in the ‘ordinary’ focus groups and in the ‘active interest in science’ focus groups. The active group discussed Ordinary Joe as having no interest in science, and considered it the duty of scientific institutions and policymakers to change this.

> FG5MP7: I think when most people get out and start working, unless they’re working in a science related field, like your ordinary people, and you ask them about science, they’ve no interest because it doesn’t affect any part of their lives until there’s a controversy that builds up.
>
> Male, 40s, active group

> FG4FP6: If you brought in eight people off the street and show that to them you know that have no interest in science.
>
> Female, 20s active group

Whereas the ‘ordinary’ group considered themselves interested in science which they deemed relevant to themselves; and also considered themselves more than capable of discussing it and engaging with big ideas about the societal implications of scientific development.

> FG1FP3: But if you heard of that as a medical application, it’s fabulous, a camera so small it can image your whole body you don’t have to go into a scanning device, but if you’re looking at it as a military development it seems sinister. I think technology has advanced beyond our moral concepts of what’s right and what’s wrong. You know, it’s outstripped it, it’s science fiction off the telly becoming real.
>
> Female, forties, Donegal

Ordinary Joe is rooted in the everyday, in the routines needed to maintain his existence. This everyday life has been styled as being different from the exceptional, the sublime, the extraordinary; Bennett and Watson (2002, p. x) describe everyday life being depicted: “as ordinary in the sense that it is not imbued with any special religious, ritual or magical significance”. Lefebvre (1958, p. 97), explained everyday life in opposition to “exceptional” or “superior” activities such as dreams, art, philosophy, or politics. Lefebvre (1988) also, however, distinguished between the everyday (le quotidien) and everydayness (la quotidiennité), emphasising the critical, political, and emancipatory potential of the everyday as the site where social change resides. Roberts (2006) summarised Lefebvre’s (1988) position as follows: “The everyday is that social or experimental space in which the relations between technology and cognition, art and labour are configured and brought to critical consciousness” (p. 13). It is not “simply the expression of dominant social relations, but the very place where critical thinking and action begins” (Roberts, 2006, p. 38).

There is also the argument that everyday life is a term deployed by intellectuals to describe a non-intellectual relationship to the world. The feminist writer Rita Felski (2000) summarises that for Lukas and Heidegger, for example, the everyday is synonymous with an inauthentic, grey, aesthetically impoverished existence. Lefebvre views it with more ambivalence; everyday life is a sign of current social degradation under capitalism, but it is also connected to bodily and affective rhythms and hence retains a Utopian impulse. More recently, for some scholars in cultural studies, history, and related fields, everyday life has emerged as an alternative to theory and an arena of authentic experience. Faced with a legitimation crisis about the value and purpose of humanities scholarship, intellectuals have often found an alibi in the turn to the ordinary.

Felski (2000) also describes everyday life as an inherently secular and democratic concept. Secular because it conveys the sense of a world leached of transcendence;

the everyday is everyday because it is no longer connected to the miraculous, the magical or the sacred; democratic because it recognises the dominant shared reality of a mundane, material embeddedness in the world. Everyone, from Einstein to the smallest child, eats, drinks and sleeps, everyone is embedded in the quotidian.

Carpentier and Resmann (2011) bring to these conceptions of the everyday and ordinary the idea that the main significance of the ordinary is that it is defined through its articulation with everyday (authentic) experiences. It is this 'everyday-ness' that distinguishes Ordinary Joe, positioning him as possessing authenticity and spontaneity, in opposition to the position of The Scientist, who possesses expert knowledge but is perceived to be lacking in common sense. Even Lefebvre himself proposes that the 'everyday' is vital and authentic, active and original (he places this 'everyday' in opposition to 'everyday life'—life under capitalism, life in 'the bureaucratic society of controlled consumption' [Lefebvre 1984, p. 68]). Livingstone and Lunt in their 2004 book: *Talk on Television: Audience Participation and Public Debate* describe the 'laity' as being constructed as authentic, and again this construction is in opposition to experts (p. 99).

The following quote illustrates how focus group participants constructed Ordinary Joe as authentic. To put it in context, participants were discussing a programme they had watched on the Discovery Channel about the damage that frogs were doing to the environment in Northern Australia. Both scientists and farmers and local people were trying to solve this problem, each in their own way:

> FG10MP5: … and in both cases with the bees and particularly with the frogs the scientists were busy working away trying to get a formula whereas the farmers and everybody else were out at night time with their lamps catching them and taking them back and they actually found the easiest way to kill the frogs was to throw them into freezers and then when they put them into the freezer they took them out say a couple of days later and then they were fit to make this ahm [clicks fingers] propene?
>
> Male, forties, Dublin

Focus group participants constructed Ordinary Joe—and thus themselves—in opposition to The Scientist. Ordinary Joe was perceived as lacking precise knowledge and expertise about science but nevertheless as possessing authentic everyday skills grounded in experience, and as having the entitlement to engage with and participate in science. Participants were confident about their own abilities with respect to science.

This gives us a positive view of the possibilities of scientific citizenship. This scientific citizenship forming part of what John Hartley (1999, p. 179) terms DIY citizenship, the idea that 'citizenship' is no longer just a matter of a social contract between state and citizen, no longer even a matter of acculturation to the heritage of a given community; but rather a choice people can make for themselves.

Hartley argues that individuals use television audienceship as a training ground to learn the “difficult trick of ‘suiting yourself’, as it were, while remaining locked in to various actual and virtual, social and semiotic communities” (p. 178). Audiences work together with texts—and by extension with the producers of texts—to make sense of their identities as citizens in what Brants (1998, p. 176) calls ‘co-citizenship’. Jones (2006) takes this further, arguing that the contribution of the media to the construction of the self as a political being is not just about furnishing information; there is a central role also for, “symbols, myths, metaphors and other significations. Media provide schema or mental maps to chart the political reality” (Jones, 2006, p. 368). He asks, “From where do we obtain the reservoir of images and voices, heroes and villains, sayings and slogans that we draw upon in making sense of politics and how are they involved in the creation of a political reality?” (ibid., p. 369).

The ‘personalised’ style of the *Horizon* documentaries discussed elsewhere in this thesis (please see section *5.2.2 Horizon* on page185), can contribute to this co-citizenship of science, as it constructs science as a toolkit, to be used by ‘ordinary’ people to improve their everyday lives.

The focus group participants were positive about their identity as Ordinary Joe, it was part of how they constructed their own DIY scientific citizenship, without privileging science over other aspects of culture, by using their formal education, workplace experience, political views, and media use in a—somewhat messy—assemblage that allows them to negotiate the world around them. This gives us a positive view of the possibilities of scientific citizenship. This scientific citizenship forming part of what John Hartley (1999, p. 179) terms DIY citizenship, the idea that ‘citizenship’ is no longer just a matter of a social contract between state and citizen, no longer even a matter of acculturation to the heritage of a given community; but rather a choice people can make for themselves.

6.3.2 Bright Young Things—cheerleading for the “innovation generation”

Science stories on *RTÉ News* often concentrate on young people, interviewing second or third level students who have won competitions (for example, an interview with Alexander Amini, the winner of the BT Young Scientist competition 2011 on *RTÉ News* of 14 January 2011, or with the team of students from Sligo Institute of Technology who won the Microsoft Imagine Cup 14 July 2011). These young people are presented as bringing “hope for the future”. This theme is closely related to the ‘economy’ theme, as these young people will hopefully commercialise their scientific skills to pull Ireland out of recession.

This theme of young people being the hope for the future was echoed in the focus group discussions, with parents in particular talking about how their children were very comfortable with science, and about how children were much more scientifically and environmentally aware than they were at that age, and about how they viewed science as not just a school subject but as part of everyday life.

For example, one father of two (in his forties) said:

> FG8MP4: You never really realise what's out there now, I suppose looking at it now, I suppose looking at it now it's far more interesting it's playing a bigger role day to day the things we do even talking to our kids, my ten-year-old knows compared to what I knew, it's just incredible, it's absolutely incredible, all the stuff, it's not just wildlife, it's say on chemistry and all this stuff, he's aware of all these chemicals and kind of stuff and you know the bigger picture, the bigger picture.

Another 66-year-old man who used to work in Dublin Zoo spoke about how the understanding of science had changed over the years and how young people had a different —and broader—understanding of science than older people.

> FG8MP8: That's why to go back to the Young Scientists[33] exhibition, I've been at a few of them over the years because we have a stand there, it has brought to the kids, and the kids, now know now when I was growing up, now know that its investigating cows milk or investigating tractors that that is all part of science so it's a broader subject and I think the younger generation understand everything more.

Changes to the science curriculum were viewed very positively by focus group participants, in particular, the education surrounding the environment, which was cited by a number of parents:

> FG10FP1: The whole area of environmental science, they're so much more aware now, where you know it wasn't, when we were in school that would never have been part of what we were taught in science. Then kids in primary school, science is on the curriculum now, it's taught, it's part of everyday life to them really, whereas in our day it was just you know lab work and books.

> FG7MP3: I think people in general are much more aware of the environment than they were even say ten years ago. Even the children in school, it something that's on everybodys' mind and I suppose the environment itself is a link to all, you know, every science.

[33] The BT Young Scientist and Technology Exhibition is an annual competition held every January since 1965 in Dublin. Currently sponsored by BT Ireland, its intention is to encourage interest in science in secondary and primary schools.

FG9FP10: Because the kids are interested now, they all want the green flags for school and they're interested in getting all these things, so they could explain just a little bit more.

FG5FP1: I'd have to disagree a little bit because I have a daughter and I know when you say science to kids of primary school age they think it's the greatest thing since sliced bread.

Focus group participants affirmed that as well as school science, their children also enjoyed watching television programmes about science, in particular citing the Discovery channel, and programmes with an entertainment format, such as *Mythbusters* or *Brainiacs*:

FG1FP1: They watch *Brainiacs* and the Discovery Channel.

FG1FP4: Yeah they like them, it brings it to their level.

FG2FP3: I know I'm listening to my kids they're all on the Discovery channels

FG10MP4: *Mythbusters* yeah, that's very good like, that's very interesting

FG10MP5: It makes good fun out of it

FG10MP4: Yeah

FG10MP5: But you're getting a bit of knowledge out of it as well, for kids and that, it's quite interesting

FG10MP1: *Mythbusters*, yeah, the kids are interested in that

FG8MP6: There's one, I think it's on the Discovery Channel called *Brainiacs*, all the children love that because there's certain things out there regarding science and it either proves it or dispels it and I've actually seen my boys watch that.

The focus group participants also discussed other science events and shows that their children were interested in, for example a show about forensic science held in Dublin city centre, and activities for children held at the Science Gallery "with match boxes and bubbles and stuff like that".

The focus groups comprising participants with an active interest in science discussed, at length, how best to engage children with science, emphasising the need to 'get them when they're young'. For example, this woman in her thirties, a laboratory scientist and a recent graduate of the MSc in Science Communication in Dublin City University said:

> FG6FP2: You want to target, like science interest is continually waning all the time and people going on to, talk about numbers in science courses declining all the time so you kinda have to get children at a young age to be interested in science, maybe by doing a kids programme, I remember another question in that book I had was why is there sand in a desert? And you know little, really weird things that you'd never think about and you're there, as a kind when it's all explained with pictures like why is the sky blue? There's loads of really good ones, so maybe that's why I was interested in science even because it was quirky little questions that they answer, that are interesting.

However both parents and the students who took part in the two school focus groups noted a disconnect between science at primary level and second level, and that the science learning they had to do for second-level deadened their enthusiasm for the subject, or as one participant put it: "kills ambition and curiosity". As noted in section 6.1.3 School science: "physics, chemistry, biology, that's the three isn't it?" on page 212, participants in the Kildare school focus group recounted that they had found science to be much more interesting when they were younger (i.e. at primary school).

All of the focus group participants were positive about childrens' engagement with science and thought that it had value. I argue that this new way of teaching and learning science at school, of putting science in context for society—showing its value for example for health and the environment, helps participants in their dealings with science, giving them an opportunity to deal with science as an activity relating to them, thereby contributing to their scientific citizenship.

6.3.3 Conclusions on constructing publics for science

Focus group participants used the construction of Ordinary Joe in the same way they used stereotypes of typical 'nerdy' scientists—as a way to talk about science. It may seem like a simplistic dichotomy between Ordinary Joe and The Scientist, but participants didn't use it that way, like stereotypes which are not really believed or disbelieved. Ordinary Joe is useful but in his rootedness in the everyday and his authentic knowledge and experience, participants did in fact construct Ordinary Joe as being capable of engaging with science.

The discussions surrounding the Bright Young Things theme are more concerning. In this construction of science as something to be engaged with by young people, older publics (i.e. adults) can feel left out of the loop. I call for an expansion of government thinking about science in the public—this discourse of Bright Young Things for science has after all filtered from government policies about engaging young people with science (again for the sake of the economy)—to include adults and older publics, and to expand the focus of science and society out from solely economic considerations to include wider societal concerns about scientific research and development.

6.4 Constructing (mis)trust in science

Forty out of the 109 science stories broadcast *on RTÉ Nine O'clock News* in 2011 described some degree of risk to the public. The topics covered in these stories included the 2011 Japanese tsunami and the accident at the Fukushima nuclear power plant, an outbreak of *E. coli* in Germany, an increase in the number of new cases of swine flu in Ireland, and the release of a report recording an unprecedented fall in the ozone levels around the Artic due to a combination of the CFCs interacting with the very cold winter in the stratosphere.

These kinds of stories contribute to what British sociologist Anthony Giddens calls the 'risk society', "a society increasingly preoccupied with the future (and also with safety), which generates the notion of risk" (Giddens 1998, p. 27). The German sociologist Ulrich Beck on the other hand defines the risk as:

> a systematic way of dealing with hazards and insecurities induced and introduced by modernisation itself. Risks, as opposed to older dangers, are consequences which relate to the threatening force of modernisation and to its globalisation of doubt. They are politically reflexive.
>
> (Beck 1992, p. 21).

Risks no longer take traditional or natural forms; instead, they derive from decisions deliberately made by humans, often for the sake of technology and advancement (Leiss no date). According to Beck's concept of world risk society, chemical, radioactive, and biological risks are commonly distributed and organised by political means (as noted by political scientist John Dryzek 1996). These risks know no political or geographical boundaries.

This risk society means that scientific expertise is not always considered valid or legitimate. Science is an essential resource for decision-making, however, many scholars of science and technology agree that scientific experts need to justify their knowledge claims to much wider communities to regain public trust and legitimacy (Funtowicz and Ravetz 1993; Irwin 1995; Nowotny, Scott, and Gibbons 2002; Fischer 2005; Leach, Scoones, and Wynne 2007).

Flicker (2008) asserts that the public image of science and scientists reflects ambivalence between trust and mistrust towards science, between faith in progress and fear of the uncontrollable effects of science on society or the planet. The focus group discussions in this research give some examples of participants' lack of trust in scientific expertise. One female participant expressed it as "I think nowadays, we're much more suspicious about stuff". This distrust of scientific knowledge is as posited by Beck (1992) and Giddens (1992) as informed by disputes between scientific specialists, the inconsistency of their truth claims and the overall overload of information. In the focus groups, many participants cited their bewilderment when confronted by conflicting reports from experts, particularly in the field of medical and nutritional science. For example, this woman in her thirties, a laboratory scientist and a recent graduate of the MSc in Science Communication in Dublin City University said:

> FG6FP2: Or else now ridiculous you know you know like its better there was one lately that if you drink loads its good for your heart, even if it was in excess it would still be good for your heart, they are often contradicting stories as well, so you never know whether to trust them or not.

And a male IT engineer in his thirties, said:

> FG5MP5: they say this week: 'Apples give you cancer', next week it's 'Apples prevent you from getting cancer', next week it's 'If you don't eat apples and you do eat them you'll still get cancer' and you know, so you'd question that.

Focus group participants described how they figured out the relative credibility of the different science stories that they watched on television, for example, one participant, a woman in her late twenties, noted that "It's more credible when it's associated with a university".

This lack of trust extended from scientists and scientific institutions to policy makers and government, who were not trusted to be competent, as is illustrated in this quote from a woman in her forties from Donegal, who had doubts about future scientific employment in Ireland (going by an example she gave of past performance):

> FG1FP3: …you had several factories in Ireland dealing with that, a friend of my daughter's did science in college and she ended up working for a good few years with one such company. Now, typical Ireland—since the technology became dated and the thing closed up, they shipped it off somewhere else.

6.4.1 Trusting media

Focus group participants also discussed how they did not just feel a lack of trust in science, but were also wary of media, and that media coverage of science contributed to their lack of trust. As one woman, a student in the MSc in science communication in Dublin City University put it:

> FG5FP1: Well yes I think it is a bad thing, there's a lot about science, and can we trust science, and science comes up in the news so much as controversies, and so the seed is sown that you can't trust science, because they're not at all mad, they can't do the thing in 45 seconds, ehm you know, I mean I don't know, I just think if you're if you're

> going to put yourself out there, and try and be, you know science in society and all that, well let's start with getting the facts right, and I understand that the mechanics of TV don't let, and all that, I'm just saying there's an awful lot presenting itself in skewed ways.

Focus group participants arranged the media sources that they used into hierarchies of trust, with some more trusted than others. Wikipedia often came in at the bottom of the pile:

> FG8MP6: I don't trust Wikipedia, when I go to it I treat it with caution you know because it's like lightning, you say it's something that everyone can add to.

> FG5MP9: Another place is by the way on the internet, you have to be careful about what you're reading, you could go to Wikipedia and they'll say 'citation needed' so that means, well, it hasn't been validated, so if you went somewhere maybe with *Time* magazine, ok, they've researched properly, but you'd want to be checking up the source of the information or even from magazines.

One male participant in his fifties recalled a hoax that had been played through Wikipedia:

> FG10MP6: They'd go on the Wikipedia and they'd, I can't remember the fella, he was well known, a famous person, and they put false, this guy had put false, totally false information you know, that he won a fecking award for piano playing at this age
>
> [laughter]
>
> And all this total rubbish and it appeared in two newspapers, I think one of them was *The Guardian* and the other was *The Telegraph*, and the guys were sacked actually the two journalists.

Participants also discussed the decline in the quality and credibility of newspapers:

> FG5FP1: Look at what happened to newspapers. Newspapers started doing that, and you know there's so little in them now, and you don't trust them, and people are very, and you know they're a media form that's struggling with its audience, and what it should do.

Particpants made distinctions between the quality and credibility of satellite and non-satellite television channels. Many participants observed that they "know what they're going to get" on each particular channel. With regards to the actual programmes, science programmes produced by the BBC were deemed the most trustworthy, particularly nature programmes presented by David Attenborough and the *Horizon* strand of documentaries, which were described by one man in his twenties—a student of the MSc in Science Communication and a devotee of *Horizon*—as "the most credible, without question".

As well as the channel that the programme was broadcast on, participants also discussed how the presentation of the programme could affect how they perceived its credibility; for example, an overly dramatic presentation style such as that used in the stimulus clip from the *Horizon* programme *The Missing Link* appeared to negatively affect the programme's trustworthiness:

> FG7FP6: I thought it took away from what he was trying to say. I thought it made it very not believable.

Some participants also showed themselves to be aware of the sources and sponsorship of television programmes about science, and how this affected their credibility:

> FG5FP6: If you see an environmental programme sponsored by Shell that's a good indication that
>
> [laughter]

This awareness of 'who is behind the science' also extended to research that participants would initiate on the internet, for example this women talked about the "interested parties" which she came across (and was sceptical of):

> FG10FP1: Even if I follow stuff up you don't even have to watch a programme on the internet, you kind of follow stuff up, it's a bad thing sometimes because the information it's not always correct, it's the way you go but even stuff about various drugs, tests, illnesses just stuff that's very relevant even stuff about food and products that we're all using and I think a lot especially the investigative stuff challenges that scientific way and it also challenges the interested parties a bit on informs us about who the interested parties are. Some science seems pure for the want of a word and then you find it's Unilever or something that's behind it.

The burgeoning of the *CSI* franchise was also held by some participants as a reason to be wary of television science, in that the franchise has changed expectations of forensic science, making results appear instantaneously and with complete certainty:

> FG10MP6: A lot of those *CSI*s, I just don't look at them to be honest with you, where you can get on the likes of the, what I might call the more normal science ehm documentaries saying this is how we got to there, you know, this is where we started, this is how we got to there, where this was now the solving of the crime, as opposed to everything falling into place that you get in the TV programme say, I think that, those programmes have nearly ruined forensic science as a credible science.

The lack of trust that the focus group participants showed in the media can be linked to a global trend. Public trust in the press as a social institution has declined over the past few decades (Izard, 1985; Kiousis, 2001). In the US, the Pew Research Center reports that the number of Americans who believed NBC News ''all or most of the time'' which was 32% in 1989 had dropped to 23% by 2008 (Pew, 2008). Another (earlier) Pew study found that a large majority of respondents believed that news media were open to manipulation by external sources, with 75% agreeing that news organisations are "often influenced by powerful people and organisations" (Pew, 2013, p. 5).

Indeed, the dangers of the influence of pharmaceutical companies in particular was emphasised by the television journalist in an interview for this research (please see section ***Error! Reference source not found. Error! Reference source not found.***, on page **Error! Bookmark not defined.**). The television journalist said in the interview that he sees part of his duty as journalist as keeping an eye on large pharmaceutical companies, as they have powerful PR machines and try to push coverage of expensive new drugs which may not yet have been proven effective. Focus group participants were also wary of big business, and in this context saw science as being a watchdog for the population. For example, this focus group participant, a man in his forties with two children, worried about big business' effects on the environment and public health:

> FG8MP4: The frogs. The same thing, the same thing in the water with the tiger fish and the lion fish that's coming and killing everything and as well as that it's just the prime predator that's in the oceans now it's causing havoc and like that you wouldn't even know about it and then there's a seaweed too that's taking all the, so you know there's all these things happening and there's scientists there trying to work out something that would be eco-friendly that they could put in that would counteract kind of put a balance again and I think that's one thing the scientists are trying to do is to make a balance of everything when its chemicals or medicines or trying to bring a balance that will go. If it was left to all the producers, the Kellogg's and the Nestlés of this world, they'd just be ploughing out the sugar and the salt and the whatever the god knows what, if there wasn't a cap on or someone actually watching to say, you know there's been an objection or something on the news that you'd hear.

Scholarship has been carried out about the relative credibility of different media for science. Major and Atwood (1997) found that television credibility did not decline in comparison to newspaper credibility when predicted natural disasters failed to occur, hinting that opinions of television credibility may be more stable than newspaper credibility perceptions. Newhagen and Nass (1989) speculated that the discrepancy in credibility ratings is partially fuelled by the alternative standards people use to evaluate television news as opposed to newspapers. People are inclined to judge the individual journalists who deliver the news on television by themselves, but they assess the entire institution of the newspaper when judging print media. Therefore, opinions of television should be more favourable because survey respondents ally news anchors to television credibility, in contrast to the nameless institution they link with newspaper credibility.

Focus group participants also acknowledged the time pressure under which television journalists worked, and how this affected the credibility of the news reports. In a discussion about the *RTÉ News* stimulus clip, one woman in her twenties, an MSc student at Dublin City University said:

> FG5FP6: You'd expect them to have done their research and to know what they're talking about specifically about that. But the news, you know that you're getting something that's only broken that day that they only had a maximum twenty four hours to get their stuff together if they're lucky, they might only have two hours getting off to Trinity before the news has to break or just send it directly over without even going back to the office.

This doubt about the veracity of what participants viewed on television affected how they perceived programmes. As one participant put it, in a discussion about the *Horizon* stimulus clip viewed in the focus group:

> FG7MP5: Well, It was presented as fact but you would wonder how much of it was actual fact and how much was, you know, personal opinion. Or a group of people's personal opinions.

Other participants expressed their lack of trust in the facticity of television programmes:

> FG4MP4: Always when you watch stuff like that on TV you're kinda, like, well I don't really know if it's true or not

> FP6: You'd watch it, but I don't know if you know believe it all. I don't think so.

Note that this lack of trust did not mean that participants did not watch the programmes, but it did affect how they perceived them. As far back as 1964, Westley and Severin differentiated between perceptions of media credibility and media preference. In other words, people did not always feel their most preferred medium was the most credible. Some participants said that they actively challenged the programmes that they watched, reading them in an oppositional manner:

> FG6FP7: I would have watched it, but it would be more to challenge it than—even as it was I was challenging it, because at the end of the day if you do believe in evolution in the between hand as they're changing you know you can't just go well: one day you're going around as a fish and the next day you're a person, you know what happens them when they're doing that? Just, just I don't buy into it.

6.4.2 Ontological uncertainties—"I'm all about the conspiracy theories"

For some participants, particularly in the focus group carried out with women studying for a Certificate in Preparatory Studies in Higher Education (CPSHE) in Donegal, their mistrust went further, as one woman in her late thirties put it: “I’m all about the conspiracy theories”. This was picked up by other participants, as the following interaction shows:

> FG1FP5: I don’t think we’re aware of half of what’s going on, I think we’re just kinda kept in the dark here.
>
> FG1FP6: We might be better off not knowing.
>
> FG1FP5: It’s advanced a lot more than what we know; they’re not keeping us informed.

Stef Aupers (2012) has written about this ‘conspiracy culture’ which he posits is a radical and generalised manifestation of distrust that is embedded in the cultural logic of modernity, and ultimately produced by processes of modernisation.

Traditionally, conspiracy theorists (or the ‘paranoid style’ in US politics) have been dismissed as pathological (Hofstader, 1965; Pipes 1997) in accordance with Freudian thinking of the ‘paranoid personality’, or as “the poor person’s cognitive mapping in the postmodern age” (Jameson 1991, p. 356), or as indicating “moral panic” (Knight 2000, p. 8). These accounts obstruct a disinterested empirical study of conspiracy culture as a culture in its own right, after all, it is not the role of the historical and cultural sciences to determine whether the existence of cultural phenomena are worth while (Weber, 1948 [1919] p. 145).

Narratives of conspiracies permeate popular culture, films like *The Matrix* play with the paranoid assumption that social reality is an illusion. Historically, conspiracy theories can be traced back to the Christian crusades in the Early Middle Ages and theories about Jews and secret societies of Templars, Rosicrucians, Illuminati and Freemasons (Pipes, 1997), however, conspiracy culture has evolved over the last decades from a deviant, exotic phenomenon to a mainstream narrative that has spread through the media and is increasingly normalised, institutionalised and commercialised (e.g. Birchall, 2002; Goldberg, 2001). Knight (2000) writes about a transition from “secure paranoia” to “insecure paranoia”:

> For the post-1960s generation, [paranoia has] become more an expression of inexhaustible suspicion and uncertainty than a dogmatic form of scaremongering”
>
> (Knight, 2000, p. 75)

and

> popular conspiracism has mutated from an obsession with a fixed enemy to a generalised suspicion about conspiring forces …. to a far more insecure version of conspiracy-infused anxiety which plunges everything into an infinite regress of suspicion’ (2000, p. 4).

Aupers (2012) traces this insecure paranoia to a radical delegitimisation of objective scientific knowledge through constructivist accounts of knowledge and postmodern theory—(Bauman, 1987; Foucault, 1970 [1966]), which have increasingly permeated everyday life (e.g. Giddens, 1992: p. 21; Van Zoonen, 2012). Empirical studies demonstrate that there is growing scepticism among Western citizens about scientific authorities, the knowledge they produce and the (technical) solutions they propose. This distrust of scientific knowledge is informed by disputes between scientific specialists, the inconsistency of their truth claims and the overall overload of information (e.g. Beck, 1992; Giddens, 1992).

Tradition, Anthony Giddens argued, provided a stable sense of reality since it communicated that "the world is as it is because it is as it should be" (1992, p. 48). Max Weber (1996 [1930]) developed a broad, historical–sociological perspective: the erosion of tradition and increased dominance of functional- or goal-oriented rationality in different institutional domains since the sixteenth century, is, he argued, a Faustian bargain. It provides modern humankind with probably the most effective way of governance in history but, from a humanistic perspective, its proliferation in bureaucracy, science, the economy and technology becomes irrational. Once institutionalised, Weber points out, these subsystems obey their own rational laws and have their own internal dynamic. Because of this, modern individuals experience these systems more and more as autonomous external forces on which they have no influence. Basically, this autonomisation of rationalised social systems is the reason why Weber wrote about western society as an alienating, suffocating '*stahlhartes Gehäuse'* or 'iron cage' (1996 [1930]). And social systems continue to become yet more opaque and autonomous as under the influence of globalisation, they are disembedded from time and space and present themselves as increasingly evasive (Giddens, 1992). This alienation from economic, bureaucratic and technological systems gives rise to ontological insecurity, which contributes to the plausibility of conspiracy theories about what is 'really' going on behind the scenes. In this way, conspiracy theories are cultural responses to these developments—they are strategies to rationalise anxieties by developing explicable accounts for seemingly inexplicable forces. Jameson (1991, p. 38) characterises these conspiracy theories as operating as 'cognitive maps' to represent systems that have become much too complex to represent, or even to "think the impossible totality of the contemporary world system".

6.4.3 Conclusions on constructing (mis)trust in science

Some focus group participants disclosed strong feelings of mistrust in science, indeed, in authority more generally, and claimed to be sceptical about what they watched on television. However, one aspect of this research that is worth noting is that as Kitzinger

(1999, p. 18) observed, the effort by focus group participants to deconstruct media messages and develop a critical reading in a research setting does not necessarily mean that participants reject these messages when conveyed via the media on a day-to-day level. It was sometimes only when invited to do so, within the research setting, that people challenged attitudes or facts conveyed by the media which they had previously accepted without question. Evidence of critical readings from organised research sessions should not be unproblematically extrapolated to routine media–audience encounters. This is particularly apt in discourses of trust.

So what does it mean for people to live in a risk society? What does it mean to mistrust scientific authority? Leiss (no date) claims that those affected by risks are likely to mobilise politically, even to a global scale, and this mobilisation can increase democratisation through active participation, citizens are sceptical of authority, no longer accepting decisions at face-value, and thus creating a more active and vibrant community, comprising citizens who participate and engage with debates over scientific subjects.

The issue then becomes the willingness of scientists and governments to participate in debates with publics. Brian Wynne’s (1996) influential case studies about Cumbrian sheep farmers embody this concern. One particular farmer had conflicting identities based on networks that connect him to workers in the Sellafield plant; these workers do not wish to have the plant blamed for the radiation exposure, and to more distant farmers, who see the plant as partly to blame. The more distant farmers mistrust the official view that evidence for radiation contamination is from the more recent Chernobyl accident, and they suspect instead that for years the government and industry have not been telling the truth about contamination from the nearby Sellafield plant. Wynne found that the opinion of this farmer was at least partly conditioned by (conflicting) social identities and relations, and that the farmer was quite reflexive about the social basis of his opinion. In sharp contrast to this, Wynne argues that the official knowledge of state and industry tends to cut itself off from such reflexive self-understanding. Indeed, he finds reflexivity to be inversely related to power, and he turns the public deficit model of scientific expertise on its head by drawing attention to the reflexivity deficits among scientists and governments. I agree with Wynne’s suggestion that the lack of reflexivity of institutions generates public mistrust in science, and I call for scientists to open up their debates from technical issues of risk assessment to “the proper ends and purposes of knowledge” (Wynne, 2007, p. 219).

7 Conclusions, implications, recommendations

Citizens interact with science through the mass media, and particularly television, as part of the routine of daily life. This thesis examined scientific citizenship by looking at how publics use science on television as part of an ethno-epistemic assemblage that informs their everyday actions. Television fits into this assemblage because television-viewing practices are embedded in everyday life; meaning that local contexts of text–reader interaction are a salient part of ethno-epistemic assemblages.

This research examined how viewers' engagement with television contributes to their scientific citizenship. Specifically, it looked at how focus group participants use television when constructing their citizenship for themselves. Quantitative and qualitative analysis techniques explored how scientific citizenship is constructed not just by publics but also by television programme-makers and within the content of television science itself. The analysis addresses the research questions relating to scientific citizenship through a production, content and reception analysis of science on television, incorporating programme-maker interviews, a content analysis of television news and an analysis of the representations of science in documentary programmes as well as focus groups with audiences for science on television.

This concluding chapter, gives a brief overview of all the emergent themes from these data, before looking at how ideas of scientific citizenship work across the themes and drawing conclusions about what these themes mean for citizens. It then outlines the implications this might have for wider society and for government policy regarding science communication and scientific citizenship. Based on this I make recommendations for a more reflexive governance of science, and with regards to television, for a more interactive and personalised style of science programming that challenges scientists and programme-makers to enter into a dialogue with their audiences.

Within this thesis, I examined science on television predominantly from a social constructivist perspective. As an epistemological stance, constructivism asserts that as individuals assign meaning to the world around them, they construct reality (Appleton and King, 2002). From a constructivist perspective, meaning is not something that lies dormant within objects just waiting to be discovered, but rather is created as individuals interact with and interpret these objects (Crotty 1998). Social reality cannot be discovered: it does not exist prior to its social invention. Social constructivist and discourse theorists comprehend the production and construction of social realities and truths through the study of the role of language. Discourses are thus: "practices that systematically form the objects of which they speak … Discourses are not about objects; they do not identify objects, they constitute them and in the practice of doing so conceal their own invention" (Foucault, 1972, p. 49).

In society, different discourses, each representing a particular way of talking about and understanding the social world, constantly struggle with one another to try to achieve hegemony (Jorgensen and Phillips, p. 7), that is, to fix the meanings of language in their own particular way. Hegemony then, can be understood as the dominance of one particular perspective over alternatives; conflicts disappear and give way to an 'objectivity', where one perspective is naturalised and consensus prevails. Gramsci (1991) assigns a degree of agency to all social groups in the production and negotiation of meaning. Stuart Hall and the media group at the Centre for Contemporary Cultural Studies (CCCS) also put forward the idea of agency of social groups, particularly media audiences. They draw attention to the complexity of media representation (Hall et al., 1980). According to Hall's 'encoding/decoding' theory, recipients are able to interpret or 'decode' messages by codes other than the code which was 'encoded' in the text, i.e. they resist the ideology.

At times, our social practices can appear so natural that we can hardly see that there could be alternatives. For instance, we are so accustomed to the understanding and treatment of children as a group with distinctive characteristics, separate from adults that we treat the discourse about children as natural. But just a few hundred years ago, children were, to a much greater degree, seen and treated as 'small adults' (Aries, 1962).

In her overview of social constructivism, Vivien Burr, in her book *Introduction to Social Constructionism* (1995), observed that a social constructionist position could not be identified by any one particular feature, but rather by a somewhat loose group of approaches characterised by their critical stance toward taken-for-granted knowledge, historical and cultural specificity, and the key assumptions that knowledge is fabricated through daily interactions between people and that knowledge and social action go together.

One of the key theoretical concepts that I have used in this research is the idea of the ethno-epistemic assemblage, and the thesis is an examination of the ethno-epistemic assemblage of science on television. This approach fits with Burr's characterisation of a social constructivist approach in that television viewing practices are embedded in everyday life, and that in the local contexts of text–reader interaction, knowledge is constructed in a local context, with local cultural conditions.

7.1 Ethno-epistemic assemblage

This research has found that the assemblage surrounding audience meaning-making about science on television is composed of different types of knowledge, both scientific and non-scientific. Audiences found out about science from television programmes, which are the focus of this thesis, but focus group participants also talked about their experiences of science elsewhere. They discussed their own experiences of science in school, and the parents in the groups talked about their children's experiences of learning science. They used these experiences to understand and talk about how their perceptions of science had changed over the years since they were at school. Constructing science as subject learned in school was a sub-theme in the discourse analysis, discussed in section *6.1.3 School science: "physics, chemistry, biology, that's the three isn't it?"* on page 212.

As well as formal science education, participants also talked about their experiences of more informal science outreach events and activities. They mentioned visiting the Science Gallery in Dublin, and one participant described going to a "stand-up mathematician" during Maths Week[34], which she recounted as being hilarious, but which enabled her to better understand statistics and to be more critical about how scientific research is represented in media. Another focus group participant, a 66-year-old man who worked in Dublin Zoo until his retirement, spoke about how working at a stand at the Young Scientists exhibition had changed his understanding of science, making him see that it was a broader area than he had previously thought.

As well as this formal and informal engagement with 'official' science, participants also used their direct experiences with, for example medicine, to help them make meaning of science. One participant, in responding to a stimulus clip from RTÉ news about a new method being developed by researchers in Queen's University, Belfast for combating antibiotic-resistant superbugs such as MRSA, recalled how his father suffered from the condition. Another participant described how she could see how the technologies surrounding maternity care had developed in between giving birth to her first child in 1980 and her last in 1995.

Participants noted how they would chat about science programmes with family or work colleagues—in response to a stimulus clip one participant said that if he saw a story about coeliac disease on the news, he would let his friend (who is coeliac) know about it: "I'd get the name of it and I'd send him a text about it. I'd pick that up for him, you

[34] Maths Week Ireland promotes awareness, appreciation and understanding of maths through events and activities every October. It is a partnership of over 50 universities, institutes of technology, colleges, museums, libraries, visitors centres, and professional bodies and is Co-ordinated by the Centre for the Advancement of Learning of Maths, Science and Technology (CALMAST), Waterford Institute of Technology.

know, I'd give him the name of it and tell him to try it out." Media representations of science were generally found to stimulate interest and discussion among focus group participants.

Participants also discussed the place of science in wider society, and the impacts (particularly economic) that it has. The concept of the ethno-epistemic assemblage is a useful heuristic tool because it allows analysis of these situated knowledges and resources and allows analysis of how focus group participants construct themselves as 'scientific citizens' through their talk.

The assemblage is co-constructed with the above actants, in particular, this research concentrated on the 'circuit of mass communication' related to the assemblage, and looked at the production, content and most particularly the reception of the television science content detailed above.

7.2 Addressing the research questions

Each of the research questions outlined in section *1.1 Introducing the research questions*, on page 1 was addressed in this thesis. To begin with, the main research question was:

> How do the meanings that users make of science content on television contribute to their scientific citizenship?

In order to answer this question, science content on television was examined through the three main kinds of science programmes emerged as important from the focus groups: *RTE News*, *Horizon* episodes, and the *Half Man Half Tree* episode in the *My Shocking Story* strand. Both the science content and discourse themes found in these programmes were investigated. Precisely, this examination of content asked the following specific questions:

> What science, and in what amounts, is broadcast in television news in Ireland?
>
> Why is science presented by *RTÉ News* in this way?
>
> How is science represented in the two science documentary series *Horizon* and *My Shocking Story*?
>
> Why is science represented in this way in the in the two science documentary series *Horizon* and *My Shocking Story*?

The content analysis carried out on RTÉ News found that the Ireland is comparable to the UK and France[35] in the proportion of science news stories broadcast on television.

[35] The only European countries for which data is available.

Just 2.4% of news stories broadcast on RTÉ in 2011 were about a scientific topic or alluded to science in some way. As noted in section 5.2.1.2 Summary of RTÉ content analysis on page 169, this is comparable to the Uk at 1.77% (Mellor et al., 2011); and to France at 2.05% (Leon, 2008).Typical stories were about a risk to the population, such as an outbreak of swine flu or *E. coli*, in fact just over half (53%) of the science stories analysed were about a public risk. Stories about new scientific research, what one television journalist (who was interviewed as part of this research) called "breakthrough stories", are typically about Irish research and mention the hoped-for economic benefits of the research (the exceptions to this were stories about new research carried out by NASA in the US, and the story about the first successful full face transplant carried out in the USA). This strong emphasis on the economic benefits of science reflects Irish Government policy in their commitment to a knowledge economy, which dates back to the 1995 Report of the Science, Technology and Innovation Advisory Council, and has been maintained through the current economic crisis.

The coverage of science by RTÉ news is informative but rarely investigative, perhaps because as Conrad (1999) argues, some science reporters may assume that a particular scientific finding does not require "balance" because science has already gone through a peer-review process. The tone of the coverage tends to be celebratory, and is only very rarely critical. 'Scientific' images are frequently used, white laboratory coats and beakers of liquids being a convenient shorthand for science. It is also interesting to note what is missing from news stories; there is rarely any reporting on the process of science, funding, publication or peer review. The voices heard in science news stories are mostly male scientists (the ratio is 2.3 : 1 male : female). There is no conversation or debate shown, either between scientists, or among scientists and others, such as NGOs, patient advocacy groups or other stakeholders.

The analysis of the *Horizon* episodes showed that science is represented in two main ways, reflected in the style of presentation, the first: which I call 'old style' for convenience, is a very serious and very sober exposition, where the narrator remains off screen in the conventional documentary mode, taking in the 'Voice of God'; the second, I call 'personalised' where presenters themselves are scientists, often introducing themselves as going on a quest to investigate the topic at hand, implying to viewers the very personal nature of this journey. The 'personalised' presenter is frequently constructed as being close to the viewer and despite his/her scientific expertise (in one particular area), asks the kind of questions a lay audience would ask, and has the kind of reactions that an 'ordinary' person would have.

The credibility of these presenters is vitally important. Previous research indicates that audiences often use the credibility of the messenger as a heuristic—or quick information shortcut—for deciding whether to accept communicative messages (Eagly and Chaiken, 1993; Petty and Cacioppo, 1986). For example, as Malka et al. (2009) found, the level of concern about climate change can depend on the extent to which citizens trust what scientists say about the environment.

Non-scientists, when they are shown at all, are represented as being passive, for example, patiently waiting for the doctors to decide on their cancer treatment. One notable exception to this is the biohackers appearing on the *Playing God* programme about the new scientific field of synthetic biology. This is probably the most interesting representation on non-scientists in the *Horizon* programmes. Biohackers arguably come closest to the ideal of the scientific citizen. They engage with science, taking it 'into their own hands' without waiting for permission from any authority. They claim their own scientific citizenship using science as a toolkit, which can be used to answer questions about the world around. The presenter Adam Rutherford calls what they do "DIY biology", and they can use this to construct their DIY scientific citizenship.

The analysis of the *Half Man Half Tree* programme in the *My Shocking Story* strand showed that science, in particular Western scientific medicine, was represented as the (only) saviour of people with unusual medical conditions. The freak[36] Dede Kosawa was constructed as passive, patiently following the doctor's instructions while also being cruelly exploited by the circus manager. Kosawa only speaks to the camera very briefly on two occasions. He is a passive recipient of the products of scientific medicine and his role is to follow the US doctor's instructions. His position and conduct is similar to the patients described by Maja Horst as possessing "an assemblage of comportment" (Horst, 2007, p. 165) in her analysis about how scientific citizenship is performed with respect to gene therapy. Horst described the assemblage of comportment as patients passively co-operating with the medical team, and accepting their destinies. Their expectations of their treatment are "sound"—based on scientific methods and proven facts. Horst goes on to describe this assemblage as one in which "the relation between scientists and other actors is a one-way dissemination of knowledge" (p. 165)

[36] Depending on the historical time period, anomalous human bodies have been referred to by various names, such as "monsters" and "curiosities". The word "freak" was used for the first time in 1847 and eventually came to be the dominant term used by both sideshow performers and the public until it fell out of favour at the turn of the twentieth century (Thomson 1996). This thesis follows the conventions of past scholarship in this area and uses the term freak to mean a culturally constructed category of different bodied people who have been publicly displayed for profit or entertainment.

The Clan, with whom Dede Kosawa performs his freakishness, are very much represented as exotic, their freakishness being part of a condition that could only occur in the world of the ethnic 'Other'. And only high tech Western medicine can save the Clan members from their disorders. Dr. Anthony Gaspari, chief of dermatology at the University of Maryland Medical Center medicalises the freaks, thus converting freakishness into something that can be diagnosed, categorised and treated. Gaspari speaks confidently (and compassionately) in comparison with the almost silent Kosawa. Indeed experts for documentaries are chosen in part specifically because they are articulate, in the interview with the programme commissioner, she revealed that one of the first things the research team does when beginning to put together an idea for a programme is to ensure that the experts chosen are articulate and concise, they do this firstly by speaking to the experts on the phone: "to see how they talk and communicate".

Next, the focus group discussions were examined in order to find the participants' responses to science on television and identify the main discourse themes in the focus groups. The themes can be categorised into four subsets:

- constructing science,
- constructing justifications for science,
- constructing publics for science and
- constructing (mis)trust in science.

7.2.1 Constructing science

With respect to the 'Constructing science' theme, focus group participants struggled with deciding what science was—both in relation to the nature of science and the nature of scientific research. Participants were thoughtful in their consideration of the question, and reflexive about their position and role in taking part in the focus groups. Participants did not see science as merely a body of knowledge, or a process of discovery but acknowledged that science is a complex, messy, and often inconclusive project, continually subject to revision. Although focus group participants played around with stereotypical images of science and scientists, and with the idea of science as 'other', they also challenged these stereotypes, and showed themselves to be ready to tackle complex epistemological issues. One example of this was the woman in her thirties who joked about media stories which always began with the words 'Scientists have discovered', her response to this being a joking disbelief, "like, there's this big room full of scientists working away discovering these things". Indeed participants showed themselves to be capable and willing to take on scientific citizenship, to participate in decision-making about scientific issues in society.

7.2.2 Constructing justifications for science

With respect to the ‘Constructing justifications for science’ theme the focus group participants placed emphasis on the role of science as a support for economic development in their conversations, which chimes with media coverage of science, which in turn follows government emphasis on economic, employment and expenditure aspects of science. This economic discourse overwhelmed all the other discourses about the roles and purposes of science in society. Focus group participants also discussed science (particularly medical science) as helping people, in particular seemingly hopeless cases, such as Dede Kosawa in the programme *Half Man Half Tree*.

7.2.3 Constructing publics for science

With respect to the ‘Constructing publics for science’ theme, the focus group participants used the construction of ‘Ordinary Joe’ in the same way they used stereotypical images of science and scientists—as a way to talk about science. Ordinary Joe, with his rootedness in the everyday and his authentic knowledge and experience, was constructed as capable and willing to engage with science. Participants also constructed ‘Bright Young Things’ (or responded to the televised representations of Bright Young Things—particularly in RTÉ News) as young people presented as confident in engaging with science and providing ‘hope for the future’

7.2.4 Constructing (mis)trust in science

With respect to the ‘Constructing (mis)trust in science’ theme, the focus group participants discussed their lack of trust in scientific and other institutions, for example government and media. Participants talked about how they worked out hierarchies of trustworthiness among different kinds of scientists—for example university scientists versus industrial scientists—and among various media sources—for example BBC news versus Wikipedia. Some participants brought their mistrust to extremes, using conspiracy theories to understand the world, reflecting the ‘conspiracy culture’ which Aupers (2012) posits is a radical and generalised manifestation of distrust embedded in the cultural logic of modernity, and ultimately produced by processes of modernisation.

7.3 Observations on scientific citizenship working across themes

Academic and science communication circles place a high value on dialogue models of public engagement with science, but despite this the television representations of science examined in this thesis almost all continue to work on a top-down deficit mode of communication. Science is represented as ‘other’, arcane and difficult for ordinary people to engage with—and its main function is the support of the economy and the creation of employment.

Focus group participants joined in these constructions of science, talking about science being a support for the economy and playing around with the idea that scientists conformed with common stereotypes available from media—stereotypes of scientists being both highly intelligent and socially awkward. Participants constructed the scientists as ‘other’, separate and apart from the rest of the population.

The role of science as a support of the economy is the most dominant relationship that works across the discourse themes. The value of the economic benefits which science can create is one of the ‘justifications for science’ described in section *6.2 Constructing justifications for science* on page 217. The construction of ‘Bright Young Things’ as a public for science—that is, enthusiastic, scientifically educated school and university students—contains the hope that these bright youngsters will innovate their way out of the current Irish economic crisis. Even when focus group participants talk about science as a school subject, the purpose of learning science is constructed as economic, as perhaps a path to a better job, and indeed as a career choice being supported by government policy (for example, the government-funded science awareness programme Discover Science and Engineering, focuses on the labour market: it principally targets school students in an effort to boost the numbers of students taking science and engineering subjects at school and university and thus ensure a plentiful supply of scientifically and technically qualified graduates.) However, the representations of the ‘Bright Young Things’ dealing with science can be limiting for a more general scientific citizenship (for older duller things), in that science is represented as being something specifically aimed at young people, and by extension beyond the ken of older publics.

But, there were some exceptions to these general representations of science. In the *Playing God* episode of *Horizon*, rather than maintaining the sacredness of science by portraying scientists as special and distinct from other professions (as was the case for *Nova* according to Hornig’s excellent 1990 critique of the series), the programme shows “rank amateurs, people who'd never picked up pipettes before” after an hour’s training producing cultures of *E. coli* which have been made to fluoresce by adding a 'fluorescence' gene from a jelly fish.

These 'biohackers' engage with science, taking it 'into their own hands' without waiting for permission from any authority. Adam Rutherford, the presenter of the *Horizon* programme calls what they do "DIY biology", and they can use this to construct their DIY scientific citizenship. It could be argued that biohackers come close to the ideal of the scientific citizen, however, as noted by Alessandro Delfanti, in his 2013 book *Biohackers: The politics of open science*, these are still very early days for biohacking, it is still in the preliminary phases of the development of a possibly broader and stronger movement. In many cases citizen biology consists of very elementary scientific practices, and community labs are often poorly equipped and cannot be compared to corporate or academic labs. While over the last few years citizen biology has benefited from the spreading of more open source hardware for biological research and from an increased circulation of knowledge within communities, DIYbio activities often consist of basic practices such as DNA extraction or bacteria isolation with household tools and products (for example using a kitchen centrifuge, detergent and a few other easily available chemicals to create a buffer solution and extract DNA from strawberries).

Delfanti asserts also that in some cases, media attention has overstated and mythologised biohacking, and that citizen biology is—for the present anyway—not so much a site of research and innovation but rather of political, artistic and educational experimentation (Delfanti, p. 115). However, even in these early days, and in this 'experimentation phase' the biohacking network DIYbio[37] has also established dialogues and relationships with universities, private companies, media and the US government, and raised concerns of security and safety among biologists, ethicists and government agencies (Schmidt 2008). Biohackers, in their very active practice, claim their own scientific citizenship, it may be impractical for the citizenry at large to engage in biohacking activites, but it does serve as an interesting model for what is possible.

There were also some exceptions to the acceptance by focus group participants of the (limited) constructions of science represented on television. Care should be taken not to celebrate these resistances per se without first examining them. One interesting exception was in the response of Focus Group 2 to *The Nano Revolution* episode of *The Investigators*. This programme had very strong themes of the progress of science as a competition, and Ireland as a major player in this competition, however, focus

[37]DIYbio (Do-It-Yourself Biology), a network of amateur biologists that in many ways is related to the traditions, myths and practices of computer hackers and who even share physical spaces with computer hackers (they set up wet labs for citizen biology in hacker spaces).

group participants responded very critically to these themes, describing the programme as “very one-sided”, and as being “like a party political broadcast” and “a marketing tool” and lacking detailed information. The participants recognised the very specific agenda of the programme, and used it to make up their own minds about the content. The audience were sophisticated in their understanding and use of the media (television), the television programme makers—and in this case particularly the sponsors—need to also become more sophisticated in their understanding of their audiences/publics, and produce programmes that are worthy of them, that encourage a dialogue about science rather than the ‘hard-sell’ of *The Investigators*.

The focus group held in Donegal with a group of ten women studying for an institute of technology access course produced another exception. Participants spoke about how very mistrustful they were of science, commenting that “they’re not keeping us informed” and that they were being “kept in the dark”, one participant went as far as to allow to believing in conspiracy theories. Stef Aupers (2012) describes this ‘conspiracy culture’, which he posits is a radical and generalised manifestation of distrust that is embedded in the cultural logic of modernity, and ultimately produced by processes of modernisation. In this milieu, science is not only othered and separated from the common everyday culture, but is so complex and opaque that individuals reach for conspiracy theories to use as ‘cognitive maps’ to represent these systems that have become much too complex to represent. As Jameson (1991) posits in *Postmodernism, Or the Cultural Logic of Late Capitalism*: “conspiracy theory (and its garish narrative manifestations) must be seen as a degraded attempt—through the figuration of advanced technology—to think the impossible totality of the contemporary world system.”

Another exception was the way focus group participants dealt with the representation of science in the shockumentaries such as *My Shocking Story*. Rather than uncritically accepting the construction of western scientific medicine as the saviour of the passive freak, focus group participants responded to the programme in a variety of ways, some unexpected. As well as guilt and fascination, focus group participants responded to the programmes with humour and enjoyed it from a playful ironic stance. One participant, a male IT engineer in his thirties, joked: “It’s always *Half Man Half Something*, I want to see one that’s called *Half Man Half Apple Tart!”* Ludic responses to television constructions of scientific medicine as the saviour of the freak at least challenge the hegemonic perspective of the television programmes.

These readings, from the fears of the conspiracy theorist and to the ludic responses to the freak show, were the only means by which the focus group participants resisted the dominant hegemonic framing of science as ‘other’ and as an economic powerhouse as represented in media coverage; coverage which in turn reflects Irish government science strategy.

However, while focus group participants deconstructed programmes in these ways, it does not necessarily mean that they rejected the framing of the programmes. As David Morley wrote in his study of audiences for BBC's *Nationwide* in the eighties:

> In fact, the recognition of 'preferring' mechanisms is widespread in the groups and combines with either acceptance or rejection of the encoded preferred reading; the awareness of the construction by no means entails the rejection of what is constructed.
>
> (Morley, 2005, p. 272)

Although television programmes are just one element of the assemblage that participants use to make sense of science, they are a key element, holding a privileged place because of the special trust placed in them by audiences. In the main, the participants' emphasis on economy in their conversations chimes with media coverage of science, which in turn follows government emphasis on economic, employment and expenditure aspects of science.

Trench (2007) calls this a "highly instrumentalist view of public awareness of science" and it fits with the view of scientific knowledge that underlies Irish policy for the knowledge society: "knowledge is especially valued if it can be turned to innovation in the economy" (ibid: p. 140). This means that discourses about science construct it in a very restricted manner, and there is little space for citizens to engage with the priorities and purposes of scientific research or with its social, philosophical and ethical implications. Citizens play a very limited role in this construction of science, their job is to support science, marvel at the wonders it has wrought, and encourage their children to study it. Media coverage of science, because of its celebratory (even cheerleading) tone, and its emphasis on the economic functions of science, are reinforcing the low public and political participation in scientific issues in society.

However, science does not have to be represented in this way. Television programmes could take their lead from the 'personalised' *Horizon* episodes. Here science is represented as a toolkit, which is useful in everyday life and can be used to answer questions about the world around us. Bringing science 'down to earth' in this manner should make it easier for citizens to engage with it. The following section gives more detailed recommendations for using television to contribute to scientific citizenship.

7.4 Some recommendations

This section makes some recommendations about how scientists, scientific institutions and broadcasters can remove the limitations to how scientific citizenship is constructed, And how citizens can make best use of the resources available to them to construct their own scientific citizenship. Rather than constructing science as ‘other’, scientists and the scientific institutions within which they operate need to be more open and transparent in their work. As a first step, they need to get involved in public debates concerning scientific issues, and engage with publics at a deeper level than mere communication of scientific facts. Television is the most trusted source for scientific information in Ireland (Eurobarometer 2007), therefore programme-makers could take advantage of this trust to stimulate debate about scientific issues.

Alan Irwin recognises the need for the discussion of science and democracy to move “from the level of sloganizing to an important focus for both social scientific and practical investigation and experimentation” (2001, p. 16). Indeed Irwin proposes that there is an academic and policy need: “to move beyond the mere advocacy of scientific democracy and towards a more considered treatment of the possible forms of such democracy and their implications for the wider publics” (Ibid, p. 4). After all, scientists are also citizens, and it is in this role that they can best engage with publics, as scientific co-citizens. Scientific institutions such as universities and research bodies could include in their education and outreach bodies, processes that engender dialogue with citizens and give citizens the opportunity to be involved and contribute to research decisions from the beginning of the research process.

Focus group participants are already negotiating their scientific citizenship through talk, scientists and policy-makers need to join these discussions, because science, and its consequences, does not begin and end at the laboratory bench.

As for broadcasters, this research suggests room for a public journalism ethos in their coverage of scientific issues, emphasising the relationship between the practice of journalism and the democratic work of citizens in a self-governing republic. Journalists are ideally suited to help constitute vital publics to deliberate complex issues and engage in collective problem-solving activities. Critical comment on science is a crucial aspect of this public journalism, and television, in conjunction with other digital media platforms, can become a forum for scientists to hold an interactive dialogue with citizens. Public journalism can set out to help members of the public come to see themselves as citizens, as Nichols et al. (2006) recommend. Thus, citizens are made more accountable for grappling with the full complexity of issues and become true participants in civil society rather than mere spectators of it.

In his Reith lecture on *The Scientific Citizen* in 2010, Martin Rees called for more “scientific commentators and critics, such as the best scientific journalists, because they in fact have a network that spreads across different subjects and they can calibrate the quality of work in different fields” (2010, p. 23). I join him in seeing a role for ‘critics of science’ and go further in calling for a more investigative and critical science journalism. A critical approach to reporting science news and making science documentaries would mean assessing the value and validity of the scientific work, highlighting its strengths but also bringing attention to any weaknesses or flaws. Indeed this criticism, this sceptical attitude, is a Mertonian norm, held up as being at the heart of the scientific process, indeed, the motto of the Royal Society is “*Nullius in verba”*—Take nobody’s word for it. This scepticism at the heart of science should also be at the heart of science reporting and programme making.

Critical science journalism should encompass some degree of investigative journalism. For example, mainstream news has not covered scientific fraud to the extent it is reported in specialist scientific media. When such stories do reach newsrooms, they are represented as misconduct committed mainly by individuals who have lost—or never had—a scientific ethos. Thus the problem remains at the level of the individual, rather than with the institutional practices within science that favour misconduct. Accounts of scientific fraud are therefore ripe material for scandals: “The public impression of scientific deviance is based on a few individual cases, dramatized by the media with generous doses of human tragedy and failure” (Fuchs and Westervelt, 1996).

More criticism/critique of science and of its purposes would also expand discussion beyond the purely economic. But how can television do this? One way would be for programme-makers to follow the example of the personalised *Horizon* programmes. Presenting science as a toolkit for everyday life can open out the conversation about science. In news bulletins, the problem with showing questioning, criticism, and opposition to scientific research is invariably presented by programme makers, and acknowledged by focus group participants, as a lack of time allotted for the bulletin. The national broadcaster RTÉ’s recent appointment of a science and technology correspondent should help, but there is the danger that in reporting on such a specialised area, the correspondent can get too close to his sources and become solely a promoter, or as Steven Rose would put it, a cheerleader, for science. Television news producers/journalists could provide more critique of science by making more use of other media at their disposal, especially internet and social media. The internet has not yet reached its potential as a media tool for science communication, and could be used to show extended podcasts of interviews, to link to more information and background and to host discussion forums. In this way, the DIY scientific citizens would have more resources to discuss science, and construct their own scientific citizenships. The same goes for television documentaries which could use online resources to extend and deepen the engagement of their audiences. In this research, the programme-maker interviewees all claimed a commitment to public service broadcasting. However, this paternal model of public service broadcasting, envisioned in the US PBS as “a public affairs philosophy focused on transforming television viewers into active citizens” envisions citizens to be, as Laurie Oullette (1999) terms it: “loyal to discursive requirements of professionalism, reason, civility and detached objectivity—so that becoming a ‘good citizen’ also meant acquiescing to the expertise, cultural capital and behavioral proscriptions of a higher authority” (p. 63). What is needed for scientific citizenship to happen, is more ‘public journalism’ rather than this paternal system of public service journalism.

But what about television audiences themselves? What recommendation can be made for them? How can individuals make the best use of the resources available to them to construct their own scientific citizenship?

This thesis has argued that citizens construct and shape their identities by talk, that talk is constitutive of publics and thus vital for democracy. Indeed, according to Peter Dahlgren, there is a kind of common sense view that holds that ‘talk is a good thing’, historically associated with the formation of public opinion. “By talking to each other, citizens shape their opinions and this generates a collective will, that then has some sort of impact on policy” (Dahlgren, 2002, p. 10).

Democratic talk broadens the scope of political communication beyond that envisioned by neo-liberal democrats, who treat speech much as they do other market commodities. Barber argues that within neo-liberal theory the dominant functions of talk in democratic societies are the articulation of interests among competitive individuals seeking to satisfy their self-interests through markets, and persuasion aimed at convincing others of the legitimacy of one’s own interests (Barber 1984, p. 179-180). The remaining functions of political talk, undervalued or ignored by neo-liberal theorists, are essential to participatory democratic communication. Barber offers the following taxonomy of the various functions of civic talk:

1. The articulation of interests among competitive individuals.

2. Persuasion aimed at convincing others of the legitimacy of their interests.

3. Agenda setting as the grassroots formulation of issues and concerns.

4. Exploring mutuality in feeling, experience or thought.

5. Affiliation and affection through the development of empathy for others.

6. Maintaining autonomy by repeatedly re-examining one’s beliefs and convictions.

7. Witness and self-expression through the expression of opinions, dissent and opposition.

8. Reformulation and reconceptualisation or the reshaping of political definitions and values.

9. Community building through the creation of public citizens who recognise common interests and common goods.

It is the ninth function above—that of community building—that is at issue here, and I argue that public talk about television is in itself a political action. The 'citizenliness' of engaging with media is not a new idea, indeed, reading the morning newspaper was judged by Hegel in the nineteenth century to be a responsibility of the modern subject, and by Benedict Anderson in the twentieth to be constitutive of citizenship (Hartley et al., 2013). For scientific citizenship, I again turn to Barber, who argues that it is ordinary talk rather than deep expertise that is required for citizenship. Even if citizens' interaction may be wanting in terms of deep knowledge and well thought out opinions, it is crucial for maintaining a sense of collective civic identity and for generating a collective will. Citizen engagement is fundamental for democracy and it begins with talk. The looseness, open-endedness of everyday talk, its creativity, potential for empathy and affective elements are indispensable for the vitality of democratic politics (Barber, 1984). This is in line with Nick Couldry's (2006) concept of achieving a 'feel' for citizenship to describe how informal mediated talk allows people to take account of their everyday experiences and be motivated by their interests and to strengthen their orientation to issues of shared concern.

7.5 Contribution to knowledge

This study makes an original contribution to research by presenting findings from an analysis of audience discourses about science on television—a valuable source of material neglected in research to date. It reveals four discourse themes relating to science on television in circulation among the focus groups, interviews with programme-makers and within television programmes themselves. These were identified as: 'Constructing science,' 'Constructing justifications for science,' 'Constructing publics for science,' and 'Constructing (mis)trust in science'.

The key contribution to knowledge is found in the interdisciplinary nature of this research. It uses concepts from different disciplines including science communication and the sociology of science, so that explorations of one perspective illuminate others. For example ideas of knowledge production in an ethno-epistemic assemblage as well as ideas about media audience reception theory join together to form an assessment of how audiences use science on television as part of how they construct their scientific citizenship. This research also makes the connection between scientific citizenship and the (cultural studies) idea of DIY citizenship that people can construct for themselves.

This is the first audience research carried out in Ireland about science on television. Ireland is unique in terms of science as it is a modern economy but with an under developed science culture, and very pro-science government policies. Also, in terms of television programmes about science, Ireland is in an interesting position, in that Irish television channels do not produce many science programmes, but most of the population have access to British television, with its strong tradition of science programming.

The study highlights the value of discourse theoretical analysis for focus group discussions for explaining perceptions and lived experiences of television audiences.

7.6 Reflections on marrying the concepts of the circuit of mass communication and ethno-epistemic assemblages

As discussed above the key contribution to knowledge that this dissertation makes is the interdisciplinary nature of the research, in particular, the marrying of the concepts of the circuit of mass communication and ethno-epistemic assemblages. Indeed, the interdisciplinary nature of this research, as well as being the key contribution, was also the most challenging feature of the research.

Seipel (2005) defines interdisciplinarity as integration of knowledge, concepts or techniques of several disciplines that helps to create new knowledge or a deeper understanding. The knowledge, concepts, methods and approaches of several disciplines that are compared, combined and applied in such a manner should result in deeper understanding of television science audiences. In this case, the research result was greater than if knowledge of the separate disciplines was applied. Interdisciplinarity is also often linked to creativity; for example, Conway suggests that “at its best and most creative, interdisciplinarity produces insights that were previously not perceived by the individual disciplines working alone” (Conway 1995, cited in Shove and Wouters, 2006). Also, much research has shown that the most creative thinkers are those people who can make links between different areas of study. For example Ken Robinson, in his book *Out of Our Minds: Learning to be Creative* says: “Creativity depends on interactions between feeling and thinking, and across different disciplinary boundaries and fields of ideas” (Robinson, 2011, p. 200).

An interdisciplinary approach was necessary for this research because the topic being studied—audiences for television science—addresses several disciplines at the same time. In terms of media studies they are media audiences, in terms of science communication they are scientific citizens and so on. Indeed the relationships between these elements are so complex, ambiguous and uncertain that they require an integrated, interdisciplinary approach.

I found that one of the primary challenges of an interdisciplinary approach is that the language and methodological approaches of each discipline differs. As a researcher, I was concerned that my understanding of each individual discipline was not robust enough, in particular the specific language used, because although some terms are common to several disciplines, they may have different meanings in each. However, as the research progressed, I found that the advantages of an interdisciplinary approach outweighed my concerns about a lack of deep understanding of any one discipline, and indeed that the breadth of the research became a valuable strength. To research the subject of the study, audiences for science television, in appropriate depth, I needed to combine theories and methodologies in interdisciplinary ways. I was also encouraged by my own experience. I hold a BSc in mathematics and physics, and worked for fifteen years as a technical writer. In my experience in industry, I found that interdisciplinarity is the default mode of operation. Products were developed by specialists in electronics, software, website design, sales and marketing and so on, all co-operatively working together. Specialists had to learn the needs and language of different team members, as well as a bit about their disciplines in order to develop successful products. In the industry I worked in, interdisciplinarity is not considered a choice, but rather an absolute necessity, and that has coloured my attitude towards interdisciplinarity in this research.

Interdisciplinarity itself has a dual nature: instrumental and innovative. Instrumental interdisciplinary can be described as a process, that is, a way to solve, analyse and explore complex issues (for example, science and society problems). Innovative interdisciplinarity, on the other hand, results in the reorganisation of a discipline and creation of new knowledge. This research began with the intention to use interdisciplinarity solely in an instrumental manner. The intention was to use concepts such as the circuit of mass communication and ethno-epistemic assemblages as instruments to explore audiences for science television. The research achieved this, but I also found that the interdisciplinary approach opened out my thinking about the topic. Thinking about the circuit of mass communication made me regard ethno-epistemic assemblages differently, looking not just the television but at the wider context in which the television was being watched and discussed, that is, it allowed me to integrate knowledge and methods from different disciplines, using a real synthesis of approaches.

7.7 Recommendations for further study

The study could be extended to include drama. As noted by Kitzinger (2010): “fiction is a potential avenue for enabling discussion about social context and can allow for upstream engagement (public consideration of an outcome before it has happened)” (ibid: p. 84). Considering the research literature about representations of science in film and television drama, a dramatic portrayal of science or scientists would provide further valuable material to use as a stimulus for focus groups as well as interviews with producers of dramas with strong science content.

As audiences are using online sources more and more for their news, it is essential to extend the content analysis of news to web sources, especially as online news is not under the same pressure of space and time as television news. A particular research question could investigate if digital content producers are making use of the opportunities for extended interviews, more detail and deeper engagement with audiences.

Future research could look also at what discussions are happening at specific moments in terms of web sources of science news and discussion, between scientists, citizens, and programme-makers on social media fora and how these discussions could potentially be developed.

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Appendix A—Programme maker interviews

Questions for producers, editors and journalists of RTÉ television news programmes

Tell me about the last science story you covered.

What's your daily routine?

What are your sources? [universities? Galileo? journals?]

How many sources do you usually use for a science story?

Do you use high-level scientists, e.g. managers of teams or directors of institutes, as sources?

Do you use scientists directly involved in research as sources?

Do you use policy-makers as sources?

Do you use non-governmental organisations, e.g. environmentalists, as sources?

Do you use sources that may disagree with each other?

What is most important to you when producing a science programme?

How important is it to you to present scientific information that helps the audience to act as informed citizens?

Have you any science background/training yourself?

Do any/many of your colleagues have a science background/training?

Do you think this makes a difference in the way you cover science?

Do you like science stories?

What would encourage you to do science stories?

What would put you off doing science stories?

How do you deal with explaining the background science of a complex science story?

Does your programme have a website?

How do you use the programme's website?

Do you get feedback from your audience?

What do your audiences think of science stories?

What do you think about the way science news is covered by your channel?

Should more science stories be covered?

What could your channel do to improve coverage of science?

What is the future of science stories in news?

Is the coverage of science news getting better or worse?

Appendix B—Questions for producers and editors of specialist science programmes

Tell me about the last programme you made.

Where do the initial ideas for a programme come from?

How do you research the science content?

How do you find your sources?

How do you find participants? (universities, scientists, interested lay people?)

Do you use high-level scientists, e.g. managers of teams or directors of institutes, as sources?

Do you use scientists directly involved in research as sources?

Do you use policy-makers as sources?

Do you use non-governmental organisations, e.g. environmentalists, as sources?

Do you use sources that may disagree with each other?

What is most important to you when producing a science programme?

How important is it to you to present scientific information that helps the audience to act as informed citizens?

Have you any science background/training yourself?

Do any/many of your colleagues have a science background/training?

Do you think this makes a difference in the way you cover science?

How do you deal with explaining the background science of a complex science story?

Does your programme have a website?

How do you use the programme's website?

What is your target audience? (e.g. young people, science-educated etc.)

Do you get feedback from your audience?

What do your audiences think of science stories?

What do you think about the way specialist science programmes are done on your channel?

Should more specialist science programmes be broadcast?

What could your channel do to improve specialist science programmes?

What is the future of specialist science programmes?

Is the broadcasting of specialist science programmes getting better or worse?

Appendix C—Focus group discussion guide

I'd like to begin by going around the room and getting everybody to introduce themselves and tell me what sort of television they usually watch.

Prompts:

Name, age, children, job or occupation, qualifications or training, favourite leisure activities or hobbies and the kind of television usually watched.

THEME 1 - General (attitudes towards science and science programs)

The objective in this section is to investigate:

(a) participants' perceptions of science and science programs

(b) where these perceptions come from

1.1 What comes into your mind when you think of the word 'science'?

Spontaneous reactions.

1.2 What comes into your mind when you think of 'science programs'?

Spontaneous reactions.

Probes:

Definitions of a science program given by the respondents.

Naming of some existing programmes that fall within this category

Positive or negative connotations of science programs.

Expression of interest/attraction or of lack of interest.

1.3 Tell me about a science programme you watched recently

Spontaneous reactions

Probes:

Recall of the topic, the main issues covered, the participants, the format, etc.

Assessment of the programme in terms of interest, credibility, comprehensibility, etc.

1.4 What prompts your interest in science?

Spontaneous reactions.

1.5 What features of science interest you are most interested in / do you particularly like?

1.6 What do you think of science on television compared to radio, newspapers, magazines or the internet?

Spontaneous reactions

Probes:

Interest, quality and credibility of scientific information on television

1.7 Where would you go in search of science related information? (which medium?)

THEME 2 (Responses to the stimuli)

The objective in this section is to get participants to respond to stimuli clips from television programmes.

Presentation of first programme clip

<<SHOW PROGRAMME CLIP 1>>

2.1 What did you think of that?

Spontaneous reactions

Probes:

Overall reactions to contents – subjects dealt with, structure

Reactions to the different sections i.e. novelty (or not) of the information, interest, credibility, intended audience

Overall reactions to the clip's form: genre, presentation, language.

Does this program respond to the need for information on this science topic?

Overall judgements: appealing or not, clear or not, straightforward or complex…

2.2 If you switched on the TV and this clip was on would you keep watching?

Spontaneous reactions

Probes:

Justifications for watching or not

2.3 Could it be improved?

Spontaneous reactions

Probes

Content, structure, format, style of presentation, duration, persons involved, etc.

2.4 In what programs would expect to see a clip like this?

Spontaneous reactions

Presentation of second programme clip

<<SHOW PROGRAMME CLIP 2>>

2.5 What did you think of that?

Spontaneous reactions

Probes:

Overall reactions to contents – subjects dealt with, structure

Reactions to the different sections i.e. novelty (or not) of the information, interest, credibility, intended audience

Overall reactions to the clip's form: genre, presentation, language.

Does this program respond to the need for information on this science topic?

Overall judgements: appealing or not, clear or not, straightforward or complex…

2.6 If you switched on the TV and this clip was on would you keep watching?

Spontaneous reactions

Probes:

Justifications for watching or not

2.7 Could it be improved?

Spontaneous reactions

Probes

Content, structure, format, style of presentation, duration, persons involved, etc.

2.8 In what programs would expect to see a clip like this?

Spontaneous reactions

Presentation of third programme clip

<<SHOW PROGRAMME CLIP 3>>

2.9 What did you think of that?

Spontaneous reactions

Probes:

Overall reactions to contents – subjects dealt with, structure

Reactions to the different sections i.e. novelty (or not) of the information, interest, credibility, intended audience

Overall reactions to the clip's form: genre, presentation, language.

Does this program respond to the need for information on this science topic?

Overall judgements: appealing or not, clear or not, straightforward or complex…

2.10 If you switched on the TV and this clip was on would you keep watching?

Spontaneous reactions

Probes:

Justifications for watching or not

2.11 Could it be improved?

Spontaneous reactions

Probes

Content, structure, format, style of presentation, duration, persons involved, etc.

2.12 In what programs would expect to see a clip like this?

Spontaneous reactions

2.13 If the three programs were scheduled at the same time which one would you prefer to watch?

Spontaneous reactions

Probe i.e. Rating scale

Which features of the stimuli do you like or dislike?

Appendix D—Top 20 Programmes, Jan - Dec 2011

Rank and programme	**AV TVR**	**AV 000's**	**AV Share**
1. *The Late Late Toy Show*	35.03	1195.3	65.19%
2. *Eurovision Song Contest*	29.96	1016.5	63.08%
3. *All Ireland Senior Football Final*	28.2	962.3	70.30%
4. *The Frontline Leader's Debate*	27.44	935	59.13%
5. *Mrs Brown's Boys Christmas Special*	24.9	849.6	48.72%
6. *The Late Late Show*	24.53	835.9	56.62%
7. *Mrs Brown's Boys*	24.43	832.5	52.04%
8. *Prime Time Leader's Debate*	23.16	789.2	49.80%
9. *The Rose of Tralee*	22.61	767.2	53.16%
10. *RTÉ News: Nine O'Clock*	22.56	769	44.15%
11. *All Ireland Senior Hurling Final*	22.44	765.8	65.06%
12. *The Frontline*	22.36	763	47.45%
13. *RTÉ News: Six One*	21.89	745.9	59.97%
14. *Fair City*	21.08	718.3	45.43%
15. *The All Ireland Talent Show*	20.55	700.4	44.09%
16. *Queen Elizabeth II in Ireland*	20.55	697.2	47.35%
17. *Coronation Street (TV3)*	20.36	693.7	39.58%
18. *Prime Time Investigates*	20.35	690.3	44.04%
19. *The Secret Millionaire*	19.34	659.9	42.82%
20. *Love / Hate*	19.27	657.6	41.32%

Source: Nielsen Television Audience Measurement / Arianna

Based on National, ROI Commercial Channels, January - December 2011, Consolidated

Averaging: Any day, Any Time, Best Episode

Minimum Programme Duration: 15 minutes

Rank and programme	AV TVR	AV 000's	AV Share
1. *The Late Late Toy Show*	33.53	1119.2	63.26%
2. *Euro 2012: Republic of Ireland v Croatia*	31.62	1072.5	66.48%
3. *Love/Hate*	28.75	956.5	57.53%
4. *The Late Late Show*	28.63	971.1	67.72%
5. *Mrs Brown's Boys Christmas Special*	27.63	919.2	44.79%
6. *All-Ireland Football Final*	25.50	892.4	70.89%
7. *Mrs Brown's Boys*	23.52	782.6	47.98%
8. *All-Ireland Hurling Final*	23.26	814.2	68.52%
9. *RTÉ News: Nine O'clock*	21.46	730.8	41.92%
10. *London 2012 Olympics*	19.54	662.7	63.75%
11. *Eurovision Song Contest*	19.42	658.6	50.43%
12. *Raw*	19.37	659.7	37.12%
13. *The Voice of Ireland - Results*	19.17	652.6	43.15%
14. *The Voice of Ireland*	19.05	648.6	41.42%
15. *The Rose of Tralee*	18.94	642.6	42.80%
16. *RTÉ News: Six One*	18.79	639.7	51.11%
17. *Coronation Street* (TV3)	18.75	638.3	39.98%
18. *Operation Transformation*	18.16	618.4	41.05%
19. *Fair City*	17.78	605.3	37.90%
20. *MND - The Inside Track*	17.55	597.7	37.83%

Source: Nielsen Television Audience Measurement / Arianna

Based on National, ROI Commercial Channels, January - December 2012, Consolidated

Averaging: Any day, Any Time, Best Episode

Minimum Programme Duration: 15 mins

Appendix E—Coding for RTE News

Science prominence

Science item: science (as defined below) is a central component in the item.

Alludes to science: a brief undeveloped reference to science (as defined below). Included in this category are any items which may be inferred to involve science or which may have a potential science angle, but where this has not been developed within the item beyond a brief reference, or which include explanation based on established scientific knowledge but have not met the required criteria for a science item.

No science: no reference to science; use of the word “science” or scientific terminology out of context without reference to scientific claims or activities; reference to facts which can reasonably be ascribed to general knowledge or to the standard knowledge base of professional practitioners (e.g., medical doctors, engineers).

For the purposes of coding, science was defined as:

− activities or findings from the natural sciences, the applied sciences, medical science, or mathematics;

− activities or findings which are referred to as scientific;

− references to scientific institutions (e.g., the Royal Society, research institutes, NASA);

− references to individuals who are identified as having scientific expertise either by virtue of their disciplinary base (e.g., introduced as a “biochemist”, “physicist”, “scientist”, etc.) or by their institutional role (e.g., “Chief Medical Officer”, “President of the Royal Society”);

− references to individuals who are identified as being “experts”, or “researchers”, or equivalent, where the implied subject of their expertise is the natural sciences, the applied sciences, medical science, or mathematics;

− statements made by media professionals who are identified within the item as having a specialism in science (e.g., science journalists);

− the research and development stage of new technologies.

Not *sufficient* to define as science, unless also involving one or more of the above, were references to:

− social research, economics, criminology, and all other social sciences;

− archaeology unless pertaining to palaeontology;

− statistics, numbers or graphs;

− claims made by researchers whose expertise is in the social sciences;

− events in medical clinical practice or engineering professional practice except where presented as illustrating research in medical science or engineering science or except where involving statements about recent new knowledge or current lack of knowledge;

− health policy, climate policy, energy policy or environment policy, unless involving claims by scientists or statements about scientific findings;

− statements made by media professionals who are identified within the item as having a specialism in the environment, health or technology;

− the commercial launch of new technologies whose technical feasibility is already established;

− the economics of, or consumer or adoption issues around, new technologies;

− education issues unless explicitly referring to the science curriculum, university science departments or the need for future scientists;

− space industry news unless relating to a scientific research mission or development of a new space technology.

For example, an item about a call for action on public health may cite evidence of how certain behaviours cause ill-health. If the item attributes the call for action to a scientist, the item is coded as a *science item.* If the item attributes the call for action to a non-scientist but presents it as a response to recent research findings, it is coded as a *science item*. If the evidence is only referred to with the statement “research shows lack of exercise causes ill health” and no further reference is made to the evidential base for this or to scientists making such claims, the item is coded as *alludes to science*. If the item makes no reference at all to scientific evidence or to scientists but does make commonsense statements about health and exercise, the science prominence of the item is coded as *no science*.

Scientific field

Physical sciences: all physical sciences excluding engineering and technology and climate science. Items about extra-terrestrial life are coded as physical sciences.

Life sciences: all biological sciences excluding medical science and climate science. Items about palaeontology are coded as life sciences.

Medical science & technology: all stories relating to medical developments.

Climate science & technology: all stories relating to climate change, the study of the climate, or climate mitigation technologies.

Engineering & technology: all technology development except medical technologies and climate mitigation technologies. For items about new technologies produced specifically for scientific research, if the item focuses on what the technology will be used for, this is coded as the research field it will be used in; if the item focuses on the construction or development of the technology, this is coded as the scientific field in which the technology will be used.

Mathematics: developments in mathematics research; for applications of mathematics in other scientific fields, code for the latter not as mathematics.

Mixed: stories which refer to more than one different field.

General: stories which relate to science or technology in general (e.g., some stories about science policy or science education may fall in this category).

Other: none of the above apply.

Studies relating to the environment but not referring to climate change are coded as:

− life sciences if the story is about eco-systems, wildlife population surveys, impact of pollution on wildlife, GM foods, etc.;

− physical sciences if the story is about atmospheric chemistry, geology, radiation levels, etc.

News event

This category is based on the story not the treatment within the item. Sub-stories within long-running stories may have different news events; all items covering sharply time-delimited stories have the same news event.

Research: ongoing or completed research; e.g., publication of a research paper.

Science policy: events concerning policy-making or implementation of policy in science or events concerning the management or conduct of scientific research.

Health policy: events concerning policy-making or implementation of policy in health. Events relating to policy over illegal drugs and substance abuse are coded as *health policy*.

Environment & energy policy: events concerning policy-making or implementation of policy regarding the environment, the climate or energy.

Natural event/accident: an accident, natural disaster or some other unplanned or uncontrolled event has occurred. Stories that involve policy responses to a natural event (e.g., a disease outbreak), are coded under the appropriate *policy* heading.

New technology: development or trial of a new technology.

Other statement by scientist: claims made by a scientist other than those relating directly to that scientist's own research or those relating to a policy event.

Other: any events not covered by the above categories.

Policy is taken as the planned actions or positions of an official body or discussions about what actions or positions an official body should take.

Reporter's beat

Coded as given in the item under the following categories:

Science

Health/medicine

Technology

Environment

Political

Home

World: any correspondent whose beat is a particular country overseas (e.g., India correspondent or Middle East editor) or whose beat is world affairs in general

Economics

Business

Other: if the beat is given but is not in the list above

Unknown

Not applicable: there is no reporter; e.g., the item is presented by the newsreader.

If the reporter's specialism is not stated in the item, the beat is coded from the list below or, if not listed below, coded as Unknown.

David Shukman: environment

Fergus Walsh: health/medical

Jonathan Amos: science

Pallab Ghosh: science

Richard Black: environment

Roger Harrabin: environment

Rory Cellan-Jones: technology

Sarah Mukherjee: environment

Susan Watts: science

Tom Feilden: science

Victoria Gill: science

News contributors

These are named or unnamed individuals who speak directly to camera/mic during an item. (For online items, institutions quoted directly without reference to an individual are also included as contributors. In addition, for online items, news participants paraphrased or referred to but not quoted directly are recorded under additional categories.)

The following are not included as news contributors:

− generic references to types of people or groups;

− journalists, reporters or news presenters;

− non-human agents such as animals or machines;

− anyone speaking in clips of other media output (e.g., feature films, adverts) embedded within an item.

Contributor gender

Male

Female

Unknown: the gender of the contributor cannot be discerned.

Contributor expertise

This category seeks to identify whether or not a contributor is presented within the report as having some form of institutionally legitimated expertise, and if so, what form of expertise this is. This list is hierarchical. The categories *explicit scientific* and *implicit scientific* were included separately to facilitate coding but were combined into one *scientific* category for the purposes of analysis.

Explicit scientific: anyone who is identified within the item as a “scientist” or as belonging to a scientific discipline or who holds an office that is perceived as relating to science (e.g., Chief Medical Officer) or who explicitly refers to their own involvement in scientific research.

Implicit scientific: anyone who appears to have scientific expertise but is not explicitly identified as a scientist within the item; e.g., a contributor who has the title of professor or works at a university and who is talking about the science but has not been explicitly labelled as scientist, or a laboratory head or director of an institute who is talking about the science. Members of advisory committees whose work draws on scientific evidence should be coded as ***implicit scientific*** unless their scientific status is made explicit.

Clinical: a medical doctor or other healthcare provider who is not a research scientist and who speaks in their capacity as a healthcare provider or clinical practitioner. Medical doctors given the title professor and a university affiliation are coded as *scientific*.

Non-science academic: anyone who is identified within the item as being an academic or researcher in a field other than the natural sciences, medicine or engineering; e.g. a social scientist, an ethicist, etc.

Other professional expertise: anyone who speaks in a professional capacity but does not belong to any of the above categories. All those affiliated to a charity or NGO and not given an academic title are coded as *other professional*, as are all those with governmental affiliations.

Lay: someone who is either not presented as having expertise or someone whose expertise is denoted as non-scientific and non-professional (e.g., a hobbyist, a parent).

Unknown: the item implies professional expertise on the part of the speaker but gives insufficient information to identify the nature of their expertise.

Title of contributor

Dr

Professor

Other: this includes titles such as Lord, Sir, Dame, Justice, Reverend.

None: no title is given within the item or the title given is Mr, Ms, Mrs, Miss.

Where a contributor is referred to as both Professor and another title, this is coded as Professor.

Institutional affiliation of contributor

Advisory body: a body (usually of experts) set up by the government to advise on policy. The institutional affiliation of government advisors is coded as *advisory body*.

Charity/NGO: a non-governmental non-commercial organisation that is formally constituted; i.e., an organisation that is likely to have charitable status or be not-for-profit such as a patient support group or an action group or lobby group.

Religious: any religious institution.

Government/political: local or national government, or the EU Commission, and departments or units within, or attached to, these organisations; a member of a local council, a national parliament, or EU parliament other than those who belong to the government, or a group that is presented as a political party. Lords are only coded as having a *government/political* affiliation if they are either speaking as members of political parties or if they are speaking in their capacity as members of the House of Lords or members of parliamentary select committees.

Healthcare provider: the NHS, a hospital, or other institution providing healthcare. Medical schools are coded as *university*.

Industry: any commercial company, other than media organisations, or manufacturer or industry association.

International body: any international public body that operates with the sanction of member states; e.g. the UN and UN organisations, NATO, G8, the IPCC.

Media: any media company or organisation whose role is communicating to public audiences, including museums unless the museum is referred to in its capacity as a research organisation.

Military: any of the armed services.

Public body: any autonomous national public body that is funded by government but is not part of the government itself; this includes regulatory bodies, executive agencies, official watchdogs, etc. E.g., Ofcom, Schools Inspectorate, HEFA.

Research institute: a research institute other than those labelled as belonging to a university.

Scientific society: a membership or fellowship organisation representing scientists, such as the Royal Society, Institute of Physics, US National Academy, etc.

University: any higher education institution or department or institute attached to a higher education institution.

Other: an organisation that does not fit any of the above categories.

None given: no institutional affiliation is given within the item.

Cautionary comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any cautionary comments? Note that this is an assessment of the contributor's attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as ***yes*** or ***no***. Where speakers do not express an attitude towards scientific claims or statements made by scientists, or where no attitude could be discerned, coded as ***not applicable***.

Cautionary comments are where the contributor notes some problems or limitations but does not challenge the events, findings or statements being reported on a more fundamental level. For example, for proposed new technologies, this may mean costs are posed as a problem; for research findings, the limitations of the study – small sample size, etc. – may be noted. If the contributor is ambivalent, both making supportive comments and noting limitations, this is coded as cautionary.

Oppositional comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any oppositional comments? Note that this is an assessment of the contributor's attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as ***yes*** or ***no.*** Where speakers do not express an attitude towards scientific claims or statements made by scientists, or no attitude could be discerned, coded as ***not applicable***.

Oppositional comments are where the contributor challenges the intentions of the news source, the validity of the claims being made, the desirability of the goals aimed for, or the assumptions on which the news events are based. For example, for proposed new technologies, the contributor may reject the need for the technology or may claim that the technology brings unacceptable or unforeseen risks; for research findings, the contributor may question the theoretical framework on which the study is based.

Approach of item

What was the overall approach of the item?

Informational: the item or programme conveys information about the events or ideas presented. This may include seeking, or giving, clarifications or explanations about the events or ideas. This option applies only if neither of the other two categories applies.

Questioning/investigative: the item calls news participants to account, challenges contributors' claims, or claims to uncover otherwise hidden information or activities.

Light-hearted: the item is signalled as light relief, or the reporter or interviewer appears amused by the topic of the item or by the contributors.

Tone of item

What is the overall tone of the item?

Positive: overall, the tone is upbeat with the story presented as good news, implying that the news events are to be welcomed or applauded, or the news events are presented as a significant contribution or are described with enthusiasm.

Neutral: either there is no discernable positive or negative tone, or positive and negative points are equally weighted giving a sense of a neutral report.

Negative: overall, the story is presented as bad news, implying that the news events are of concern.

Interviewer humour

Is the interviewer joking, laughing or speaking in a jocular fashion, even if only very briefly? Coded as ***yes*** or ***no***. Coded as ***not applicable*** if there is no studio interview.

Interviewer aggression

This category refers to the tone or attitude of the interviewer rather than the content of what they say. Is the interviewer aggressive or dismissive in their manner towards the interviewee? Coded as ***yes*** or ***no.*** Coded as ***not applicable*** if there is no studio interview.

Links to website

Does the item direct the viewer/listener to a website for further sources of information? Coded as **yes** or **no**.

Experimental design mentioned

Is any mention made of the experimental design through which the scientific results were obtained or the technology developed or tested? Coded as ***yes*** or ***no***. Coded as *yes* even if the mention is very brief and superficial; for instance, if there is any mention of sample size, double-blind trials (or lack thereof), replication, statistical tests, etc.

A reference to what the scientist did is not coded as yes unless it gives some insight into how reliable or robust the experiment or test was.

Controversy indicated

Is there any indication that the science or technology being reported is a matter of controversy? Coded as ***yes*** or ***no***. If no research or technology is reported in the item, coded as ***not applicable***.

Controversy may be indicated by the presence of contributors with opposing views; or it may be indicated by the use of words such as "controversy", "controversial", "debate", "disagreement", "conflict".

Uncertainty indicated

Is any reference made to science or technology being uncertain? For instance, is the science or technology being reported referred to as provisional, tentative, a pilot study, preliminary results, etc.? Are limitations of the experimental design or the feasibility of a technology mentioned, or is the hypothesis of the research study questioned? Or is any reference made to the provisional nature of science in general? Coded as ***yes*** or ***no***. Note that since this category covers any comments about uncertainty in science in general as well as comments about any specific research being reported, ***not applicable*** was not an option.

Funder mentioned

Does the item explicitly state who funded the research or technology being reported? Coded as ***yes*** or ***no***. If no research or technology is reported in the item, coded as ***not applicable***.

Publication mentioned

Does the item refer to a formal print publication (already published or forthcoming) as the source of any scientific claims or findings mentioned in the item? A formal print publication might be a report from an institution such as government, a journal article, a book, etc. Blogs or other self-published material are not counted as publications. Coded as ***yes*** or ***no***.

Peer review mentioned

Is peer review mentioned? Coded as ***yes*** or ***no***.

Inaccuracy

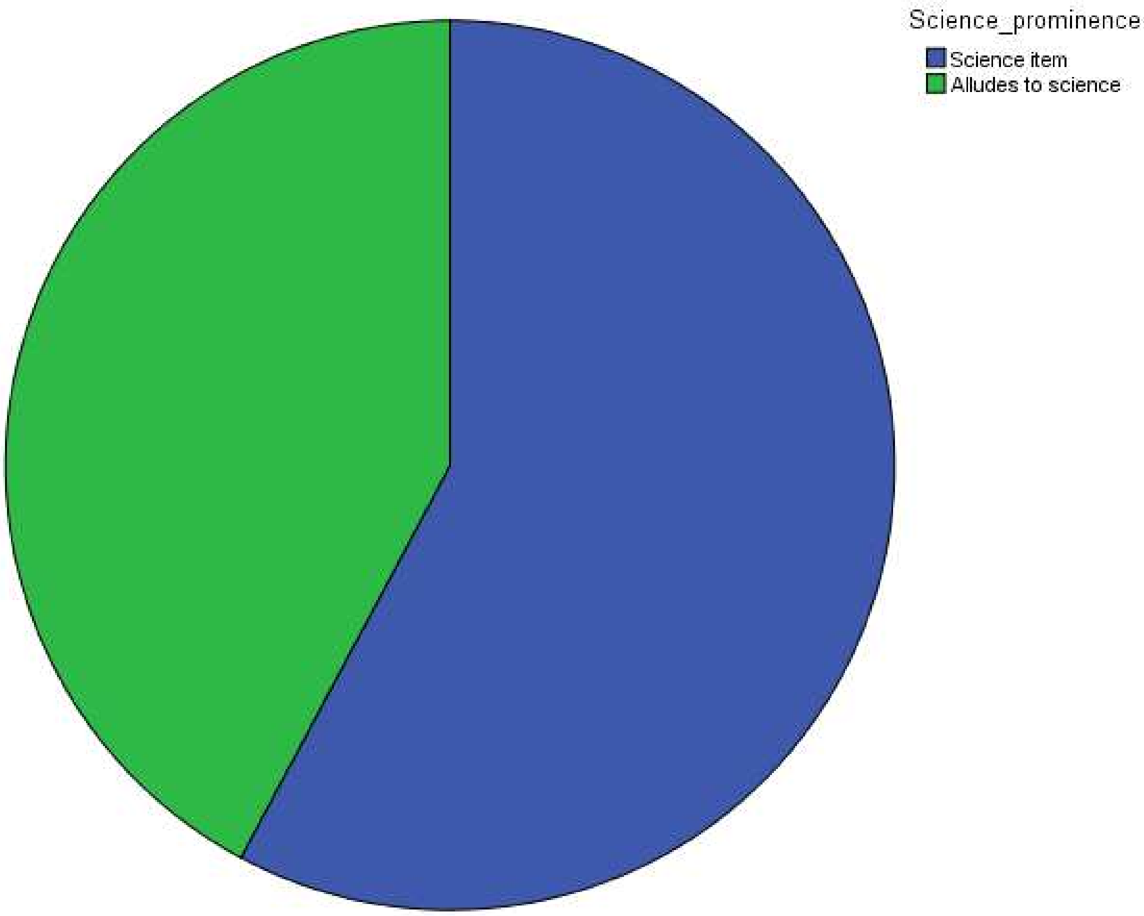
Drawing on their knowledge of science, coders were asked if they were aware of any factual inaccuracies, or any statements that were materially misleading, within the item's coverage of the science. If ***yes***, they gave a short free text summary of the inaccuracies as they perceived them. Any omissions, simplifications or changes in emphasis which may have been technically unsatisfactory but which were not factually incorrect and were not likely to mislead the intended audience (i.e., non-scientists) were not counted as inaccuracies.

Appendix F—Detailed findings of content analysis of RTE Nine O'clock News

Science prominence

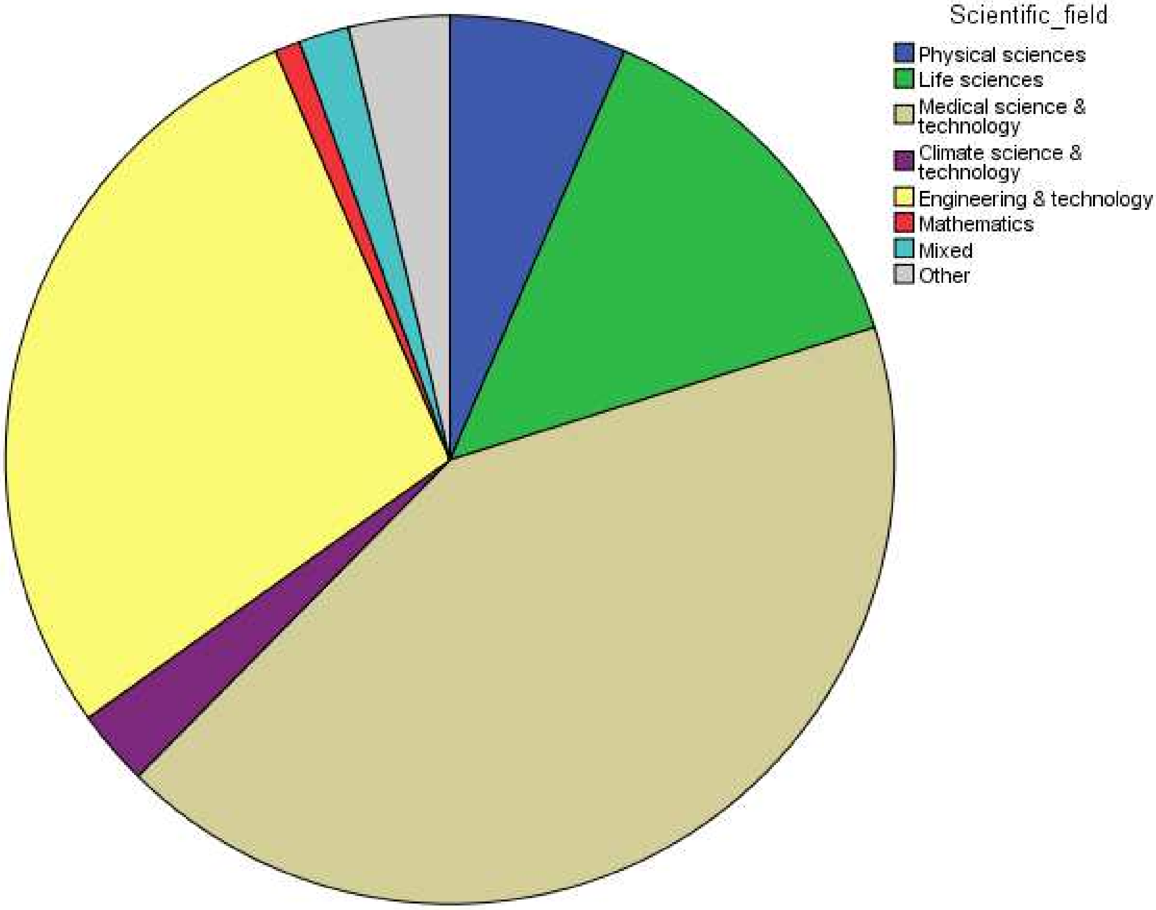
This code describes whether the item is a science item, i.e. science is a central component in the item or whether it alludes to science, i.e.: it may be inferred to involve science or which may have a potential science angle, but where this has not been developed within the item beyond a brief reference, or which include explanation based on established scientific knowledge but have not met the required criteria for a science item.

Science_prominence	**Frequency**	**Percent**
Science item	63	57.3
Alludes to science	47	42.7



Scientific field

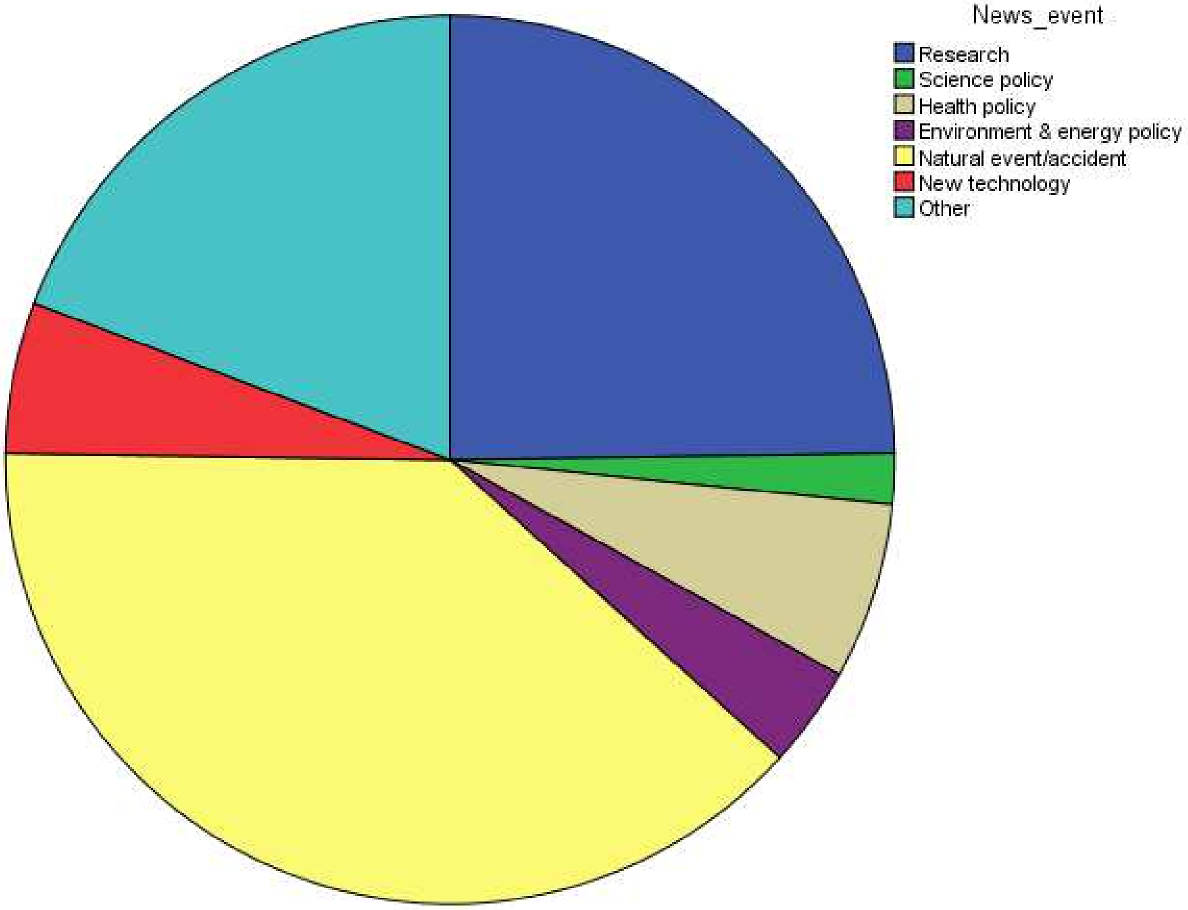
Scientific field	Frequency	Percent
Physical sciences	7	6.4
Life sciences	15	13.6
Medical science & technology	45	40.9
Climate science & technology	3	2.7
Engineering & technology	33	30.0
Mathematics	1	0.9
Mixed	2	1.8
Other	4	3.6



News event

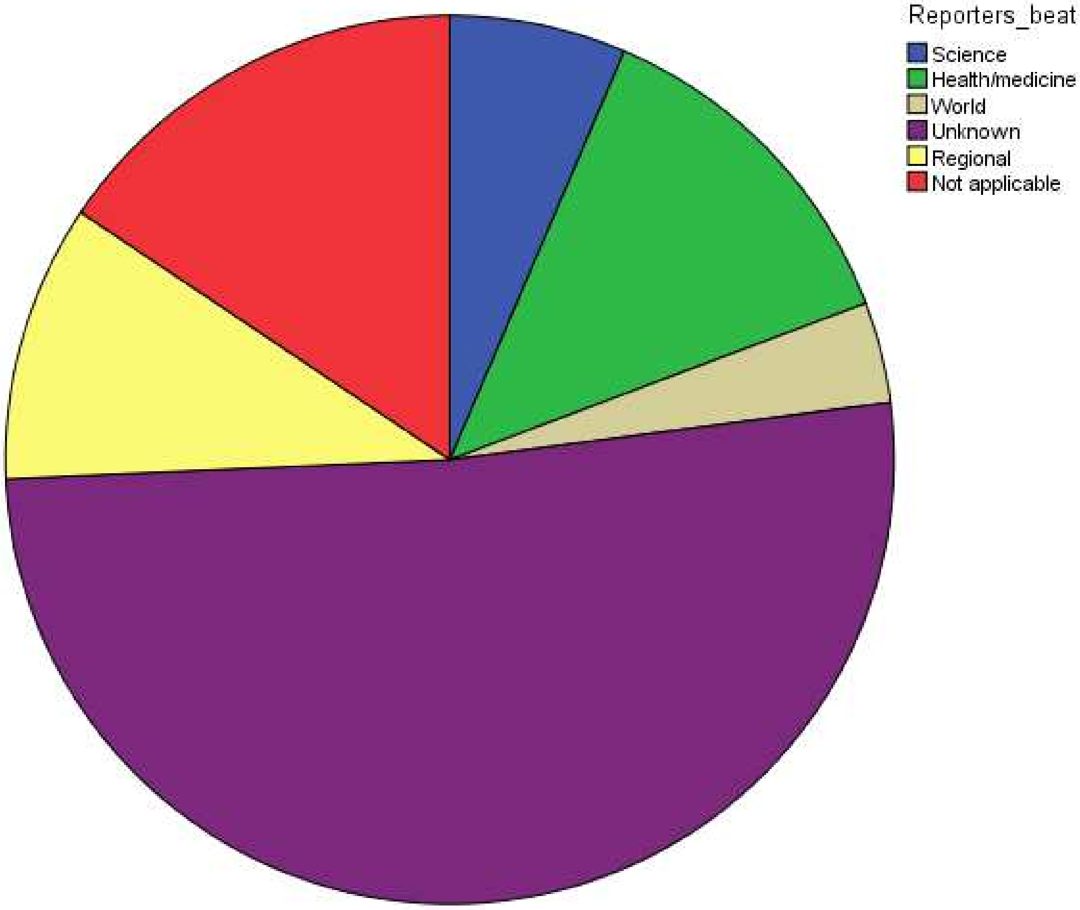
This category is based on the story not the treatment within the item. Sub-stories within long-running stories may have different news events; all items covering sharply time-delimited stories have the same news event.

News_event	Frequency	Percent
Research	27	24.5
Science policy	2	1.8
Health policy	7	6.4
Environment & energy policy	4	3.6
Natural event/accident	41	37.3
New technology	6	5.5
Other	23	20.9



Reporters beat

Reporters_beat	Frequency	Percent
Science	8	7.3
Health/medicine	14	12.7
World	4	3.6
Unknown	56	50.9
Regional	11	10.0
Not applicable	17	15.5



Gender of contributors

Gender	Frequency
Male	118
Female	52

Expertise of contributors

Expertise	Frequency
Explicit scientific	38
Implicit scientific	29
Clinical	21
Non-science academic	4
Other professional expertise	36
Lay	33
Unknown	9

Title of contributors

Title	Frequency
Dr	43
Professor	19
Other	2
None	103
Not applicable	9

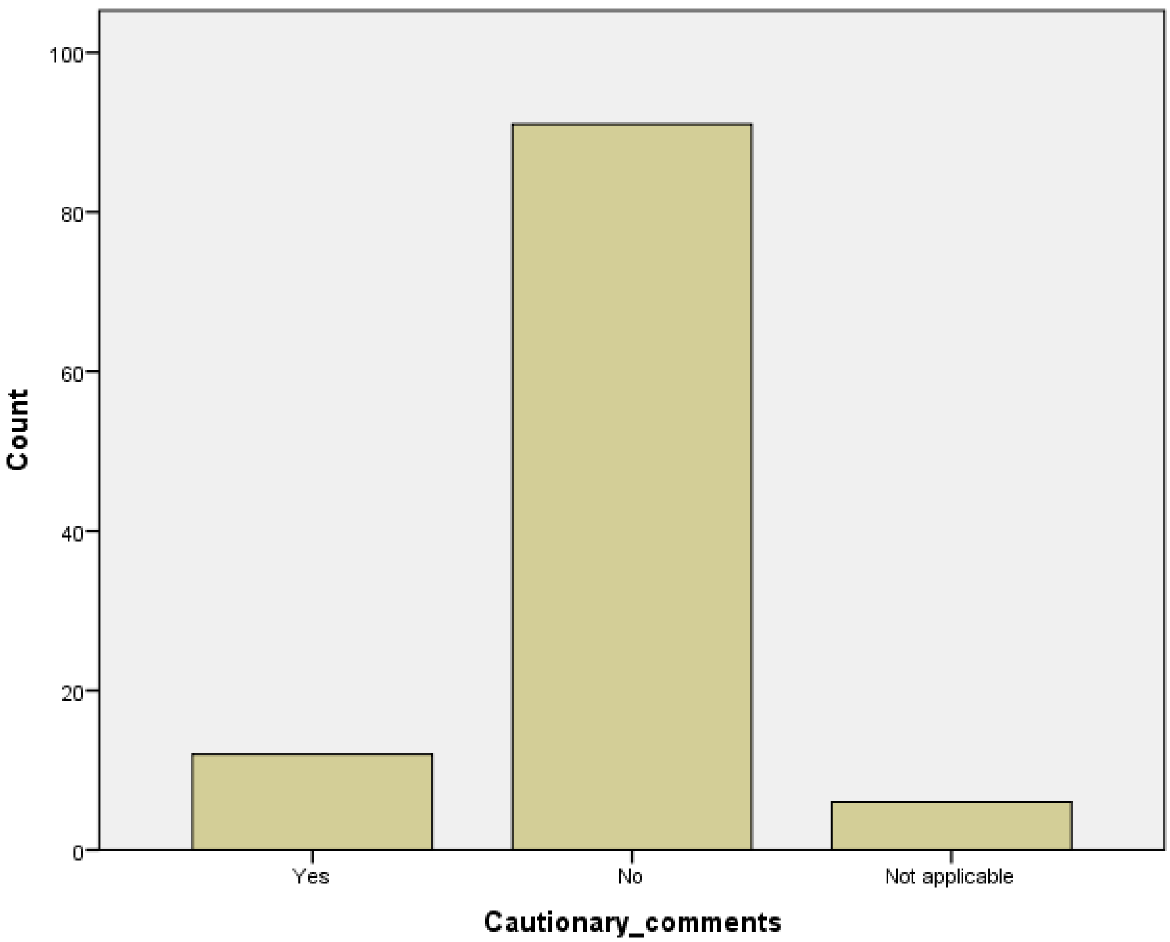
Affiliation of contributors

Affiliation	Frequency
Advisory body	1
Charity/NGO	19
Government/political	13
Healthcare provider	25
Industry	20
International body	3
Public body	19
Research institute	2
Scientific society	5
University	21
Other	5
None given	34
Not applicable	6

Cautionary comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any cautionary comments? Note that this is an assessment of the contributor's attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as ***yes*** or ***no***. Where speakers do not express an attitude towards scientific claims or statements made by scientists, or where no attitude could be discerned, coded as ***not applicable***.

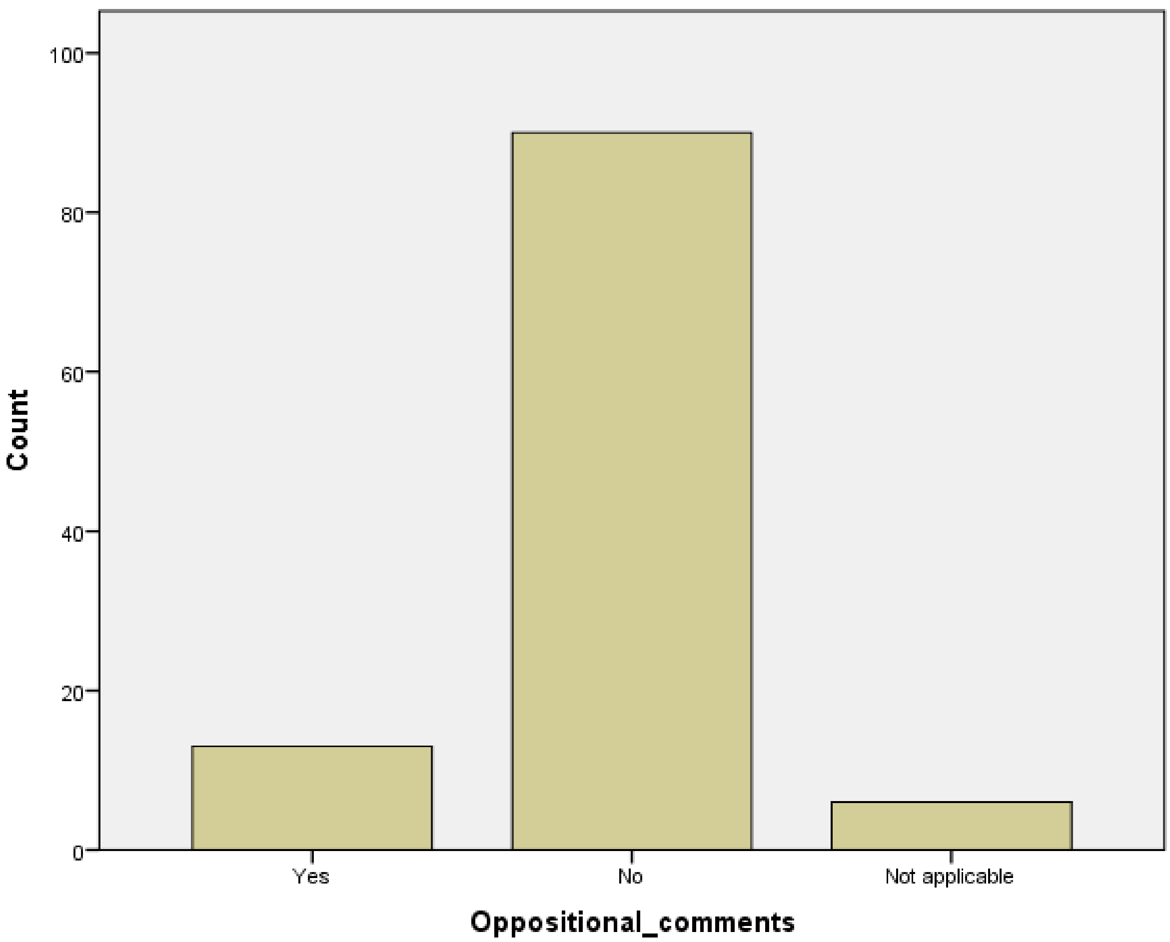
Cautionary comments	Frequency	Percent
Yes	12	10.9
No	91	82.7
Not applicable	7	6.4



Oppositional comments

Where speakers express an attitude towards scientific claims or statements made by scientists, does the contributor make any oppositional comments? Note that this is an assessment of the contributor's attitude to the claim being made, not an assessment of their attitude towards science in general. Coded as ***yes*** or ***no.*** Where speakers do not express an attitude towards scientific claims or statements made by scientists, or no attitude could be discerned, coded as ***not applicable***.

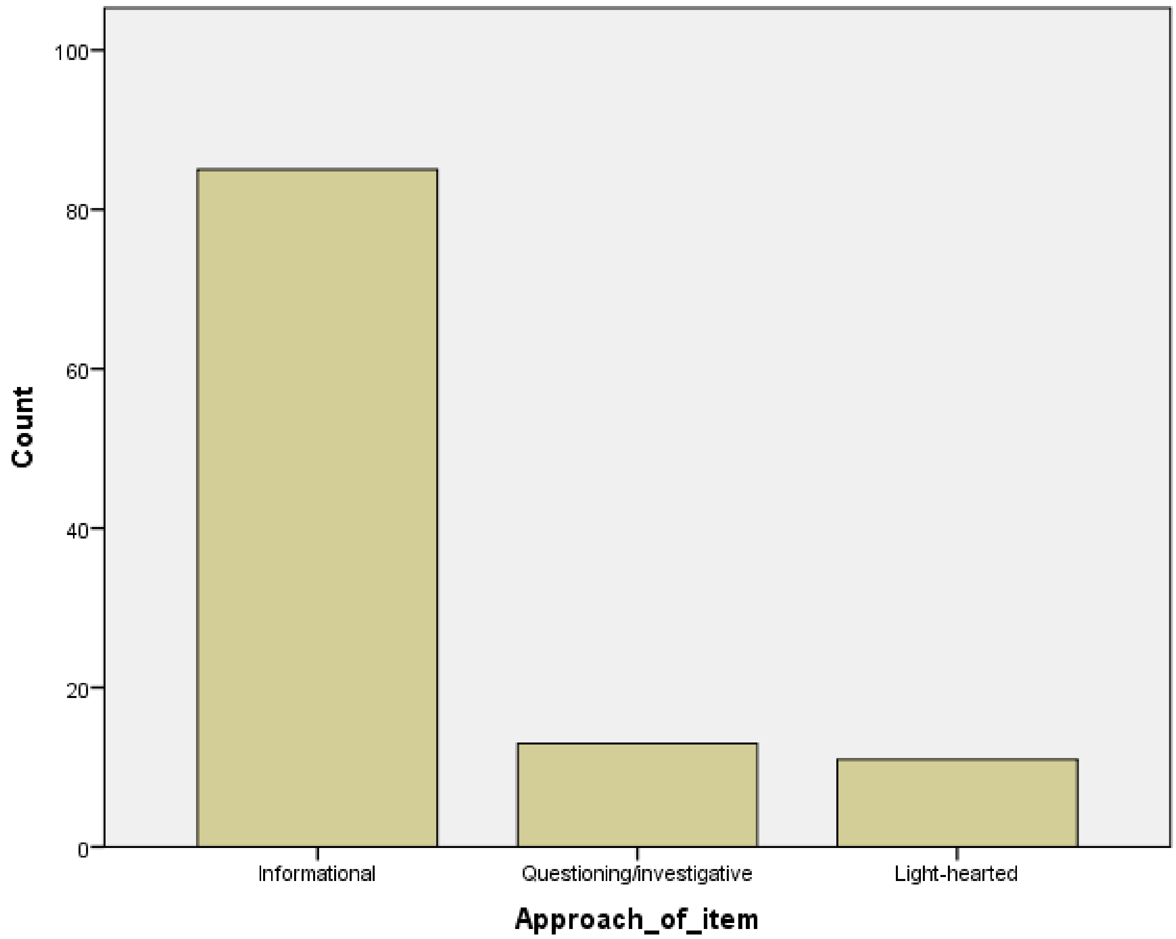
Oppositional comments	Frequency	Percent
Yes	13	11.8
No	90	81.8
Not applicable	7	6.4



Approach of item

The overall approach of the item.

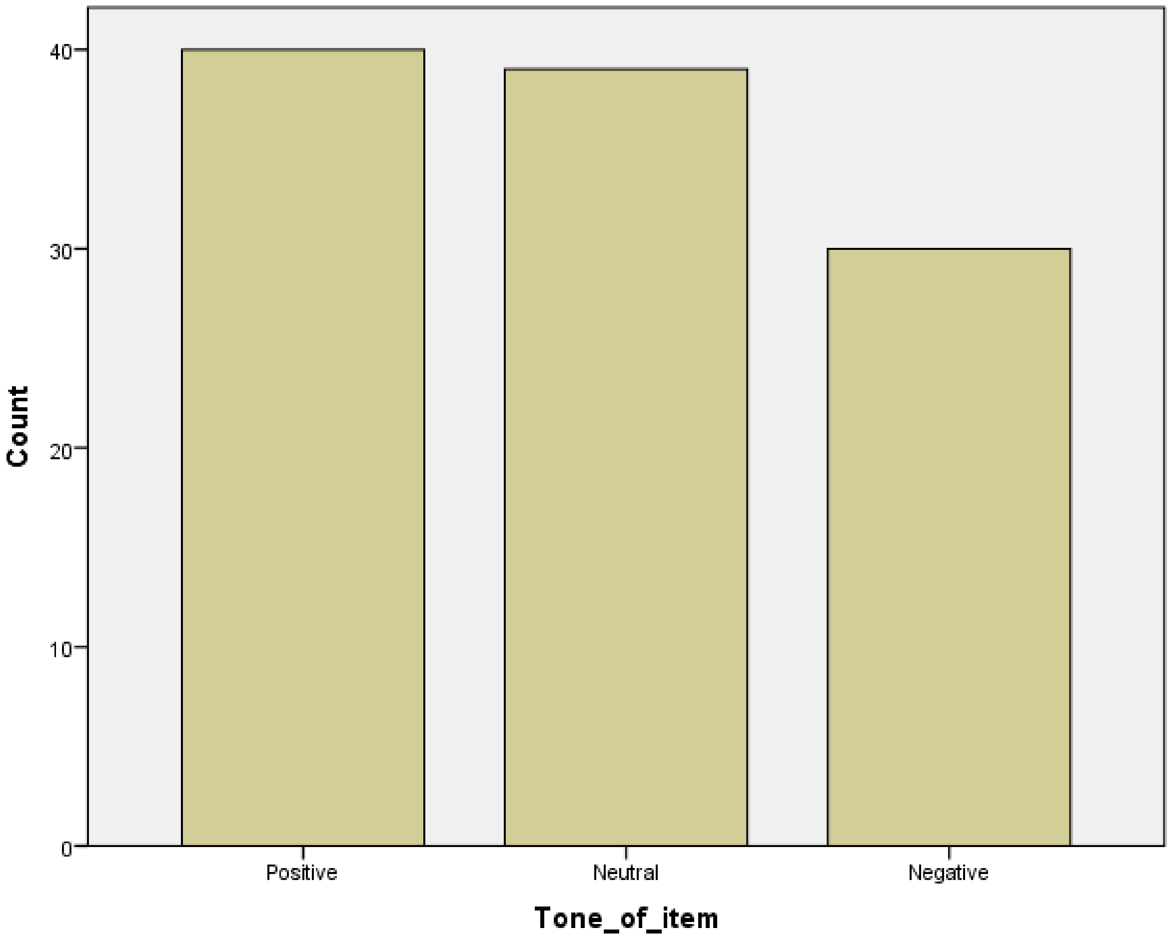
Approach of item	Frequency	Percent
Informational	85	77.3
Questioning/investigative	13	11.8
Light-hearted	12	10.9



Tone of item

The overall tone of the item.

Tone_of_item	**Frequency**	**Percent**
Positive	42	38.2
Neutral	39	35.5
Negative	29	26.4



Interviewer humour

Is the interviewer joking, laughing or speaking in a jocular fashion, even if only very briefly? Coded as ***yes*** or ***no***. Coded as ***not applicable*** if there is no studio interview.

Interviewer_humour	**Frequency**	**Percent**
Yes	0	0
No	0	0
Not applicable	109	100

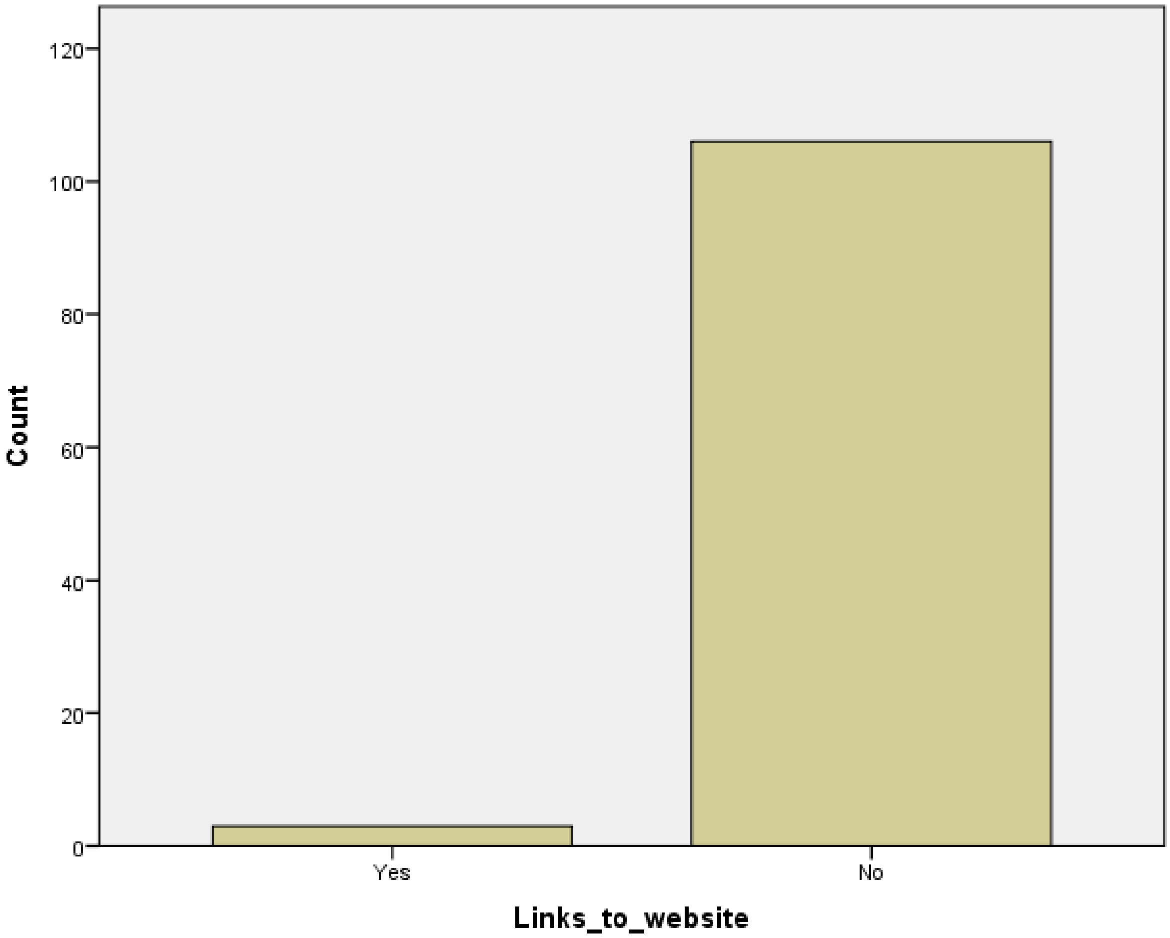
Interviewer aggression

This category refers to the tone or attitude of the interviewer rather than the content of what they say. Is the interviewer aggressive or dismissive in their manner towards the interviewee? Coded as ***yes*** or ***no.*** Coded as ***not applicable*** if there is no studio interview.

Interviewer_aggression	**Frequency**	**Percent**
Yes	0	0
No	0	0
Not applicable	109	100

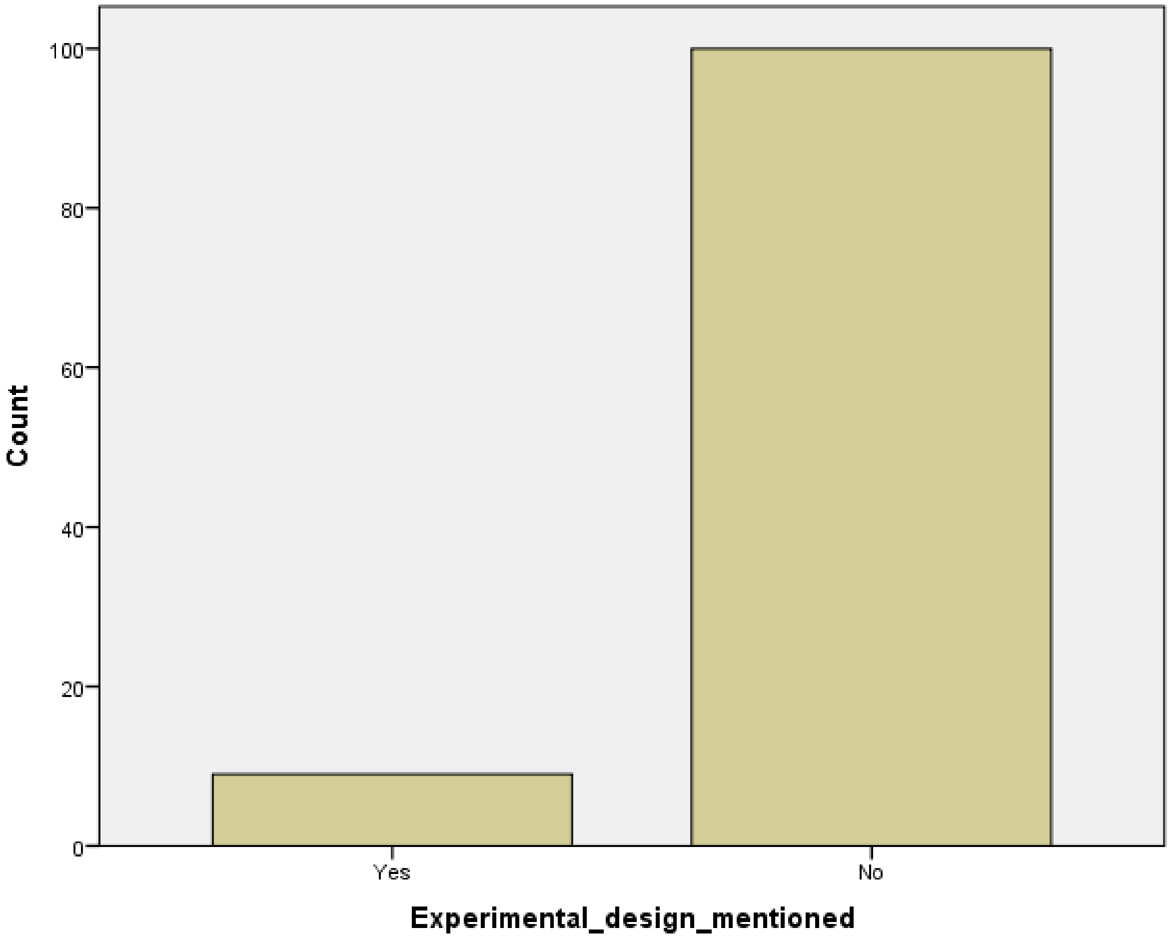
Links to website

Links_to_website	Frequency	Percent
Yes	4	3.6
No	106	96.4



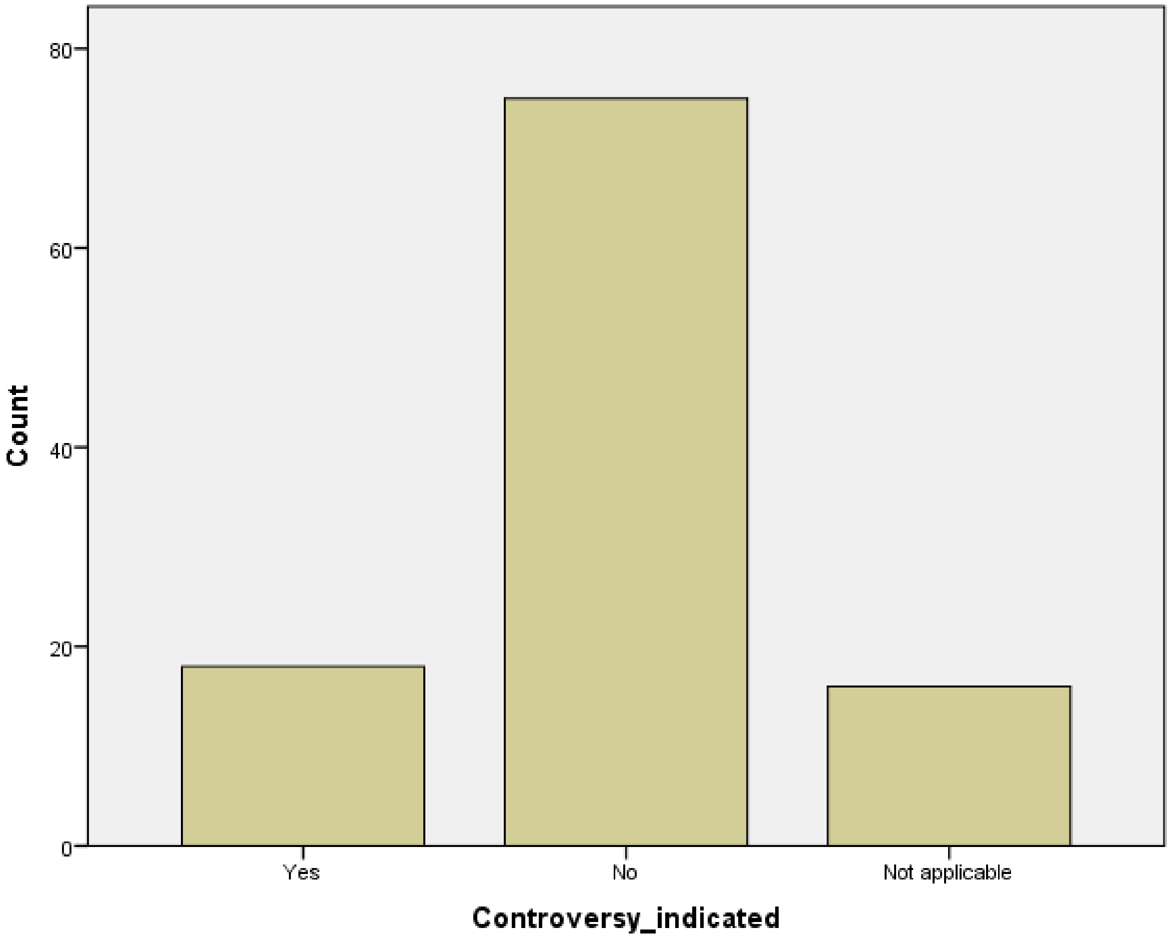
Experimental design mentioned

Experimental design mentioned	Frequency	Percent
Yes	9	8.2
No	101	91.8



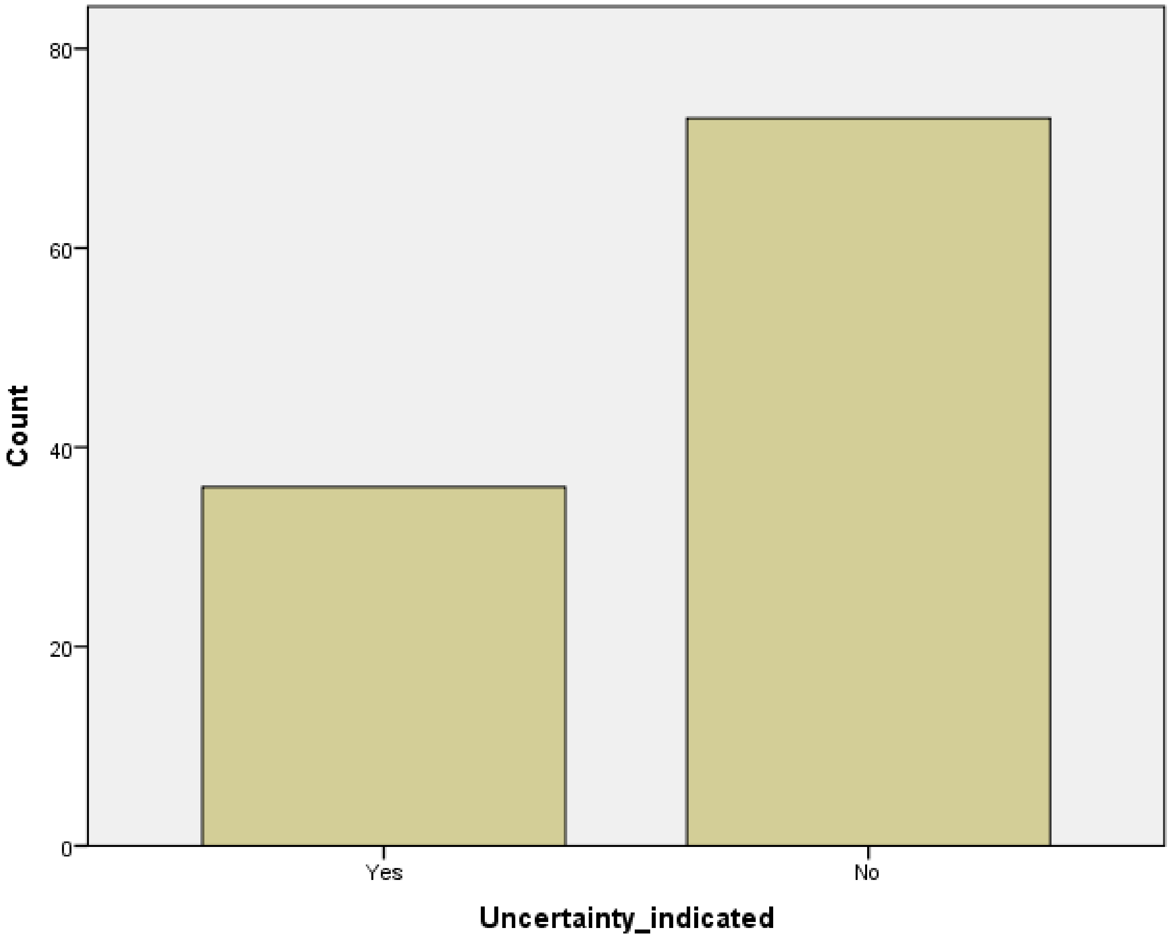
Controversy indicated

Controversy indicated	Frequency	Percent
Yes	18	16.4
No	76	69.1
Not applicable	16	14.5



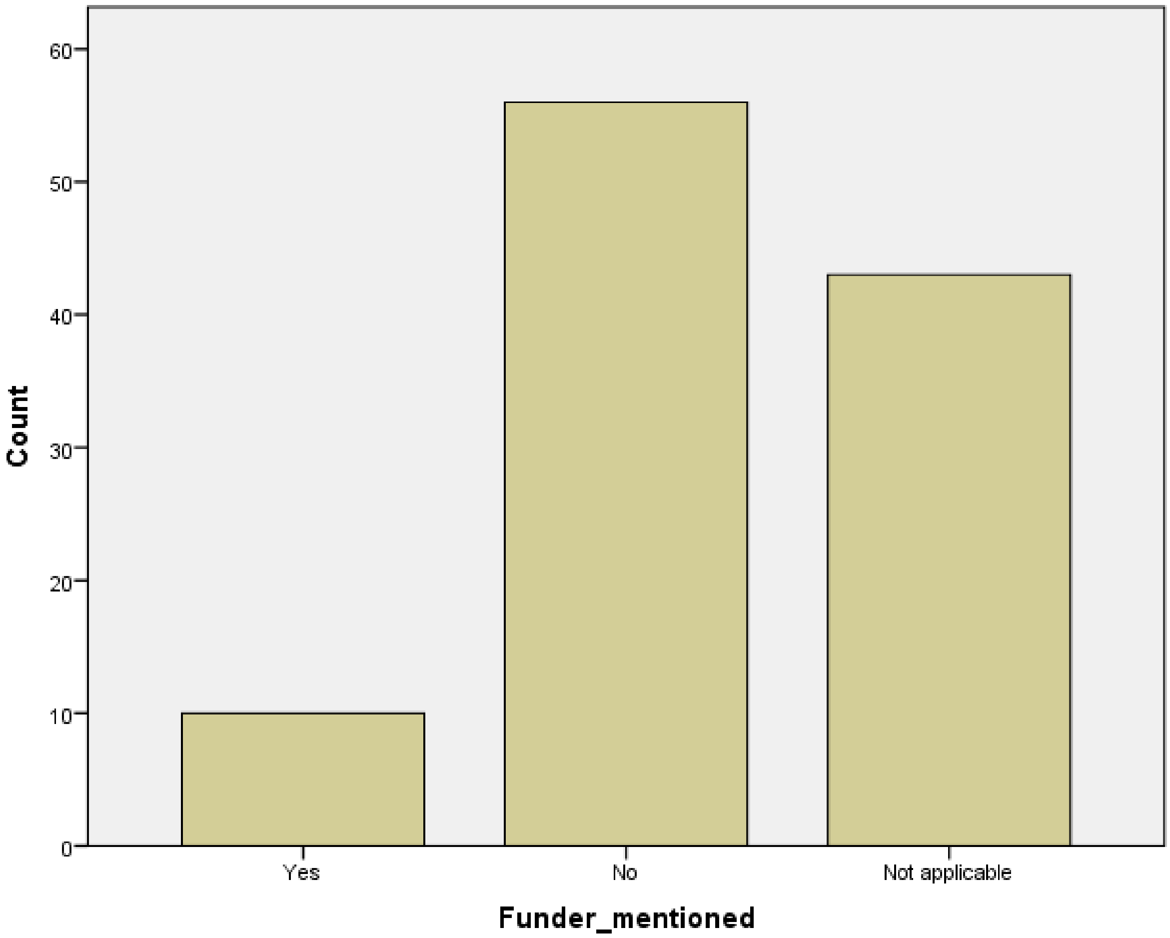
Uncertainty indicated

Uncertainty indicated	Frequency	Percent
Yes	36	32.7
No	74	67.3



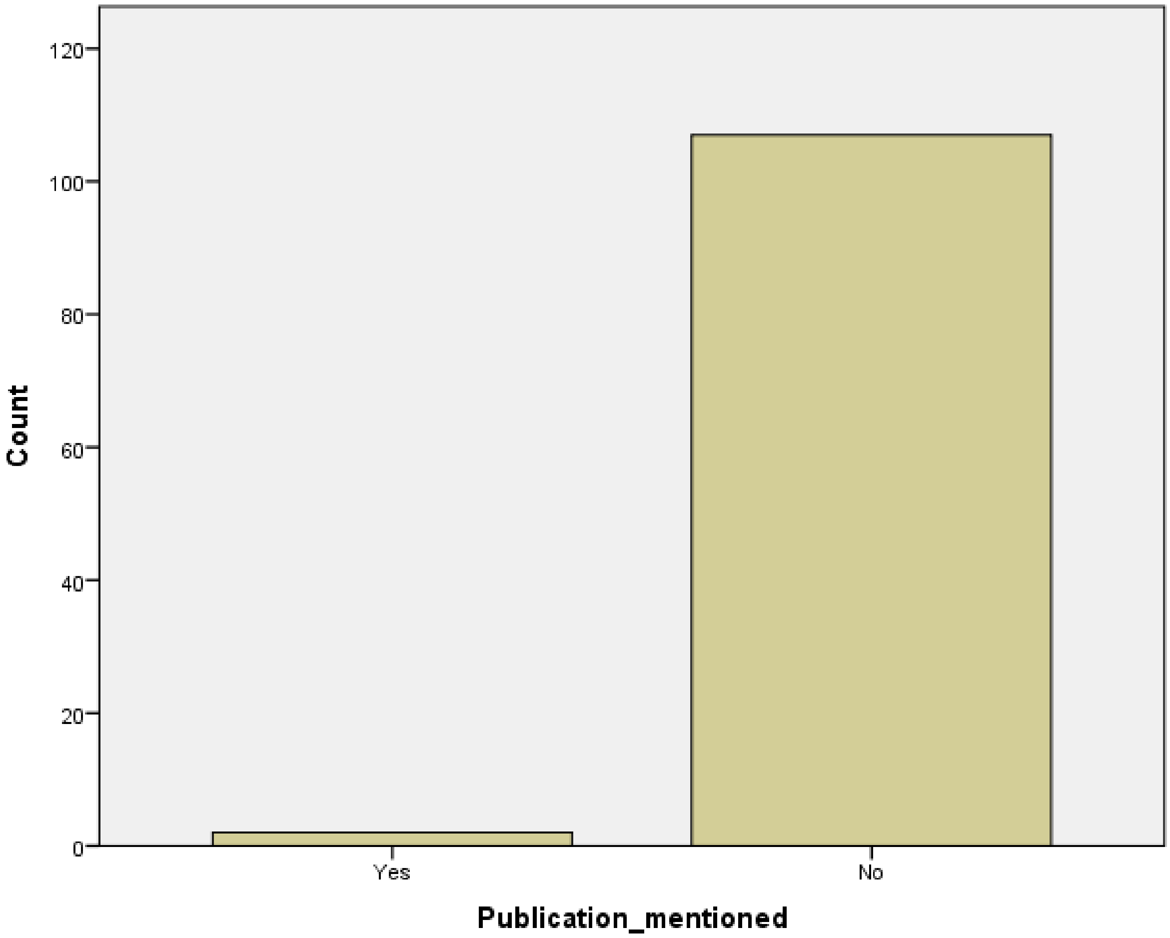
Funder mentioned

Funder_mentioned	Frequency	Percent
Yes	10	10.0
No	57	51.8
Not applicable	42	38.2



Publication mentioned

Publication_mentioned	Frequency	Percent
Yes	2	1.8
No	108	98.2



Peer review mentioned

Peer review mentioned	Frequency	Percent
Yes	0	0
No	109	100

Inaccuracy

Inaccuracy	Frequency	Percent
Yes	0	0
No	109	100

Appendix G—Horizon ratings

Week ended	Horizon title	Place	Millions
14 August 2011	Do you see what I see?	20	1.49
21 August 2011	Seeing Stars	25	1.49
28 August 2011	The nine months that made you	21	1.52
4 September 2011	The core	14	1.69
11 September 2011	Are you good or evil?	27	1.49
4 March 2012	The truth about exercise	4	2.9
11 March 2012	Solar storms	24	1.82
18 March 2012	Out of control	23	1.75
25 March 2012	The truth about fat	6	2.19
1 April 2012	Global weirding	11	1.61
10 June 2012	Transit of Venus	5	2.11

Appendix H—Summary of focus groups' media use

Group 3

This group was held in Confey Community College in Leixlip, Co. Kildare. It comprised nine participants, four female and five male.

Eight participants were aged 16, one was aged 17

Summary of Group 3 reported media use	
Television	
Average time spent watching television	100 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, BBC1, Channel 4
Most popular television programmes (watched frequently by at least three participants)	N/A
Radio	
Average time spent listening to the radio	28 minutes
Most popular radio stations (if listened to regularly by at least three participants)	N/A
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
Newspapers	
Average time spent reading newspapers (in minutes)	11 minutes
Most popular newspaper (if read by at least three participants)	N/A
Popular newspaper science sections / magazines (if read by at least three	N/A
Internet	
Average time spent on internet	62 minutes
Number of participants who download science podcasts / webcasts	1

Group 4

This focus group was held in Coláiste na Carriage, Carrick, Co. Donegal. Participants knew each other beforehand. The group comprised four female participants and five male participants. All participants were aged 16 years.

Summary of Group 4 Reported Media Use	
Television	
Average time spent watching television	100 minutes
Most popular channels (watched by more than three participants)	RTE1, RTE2, BBC1, Channel 4
Most popular television programmes (watched frequently by at least three participants)	N/A
Radio	
Average time spent listening to the radio	28 minutes
Most popular radio stations (if listened to regularly by at least three participants)	N/A
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
Newspapers	
Average time spent reading newspapers (in minutes)	11 minutes
Most popular newspaper (if read by at least three participants)	N/A
Popular newspaper science sections / magazines (if read by at least three	N/A
Internet	
Average time spent on internet	62 minutes
Number of participants who download science podcasts / webcasts	1

Group 5 - Active

This focus group was held in Dublin City University. Participants for this group were recruited because of their active interest in science. Participants were scientists, science teachers, worked as science communicators (either professionally or on an amateur basis), regular attendees of the Alchemist Café or Science Gallery. The group comprised three female participants and five male participants, ranging in age from 22 to 42.

SUMMARY OF GROUP 5 REPORTED MEDIA USE	
TELEVISION	
Average time spent watching television	116 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, TV3, BBC1, BBC2, Channel 4, ITV
Most popular television programmes (watched frequently by at least three participants)	Horizon
RADIO	
Average time spent listening to the radio	41 minutes
Most popular radio stations (if listened to regularly by at least three participants)	RTÉ radio 1, Today FM Newstalk
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
NEWSPAPERS	
Average time spent reading newspapers	46 minutes
Most popular newspaper (if read by at least three participants)	Irish Times
Popular newspaper science sections / magazines (if read by at least three	Irish Times
INTERNET	
Average time spent on internet	167 minutes
Number of participants who download science podcasts / webcasts	6

Group 6 – Active

This focus group was held in Dublin City University. Participants for this group were recruited because of their active interest in science. Participants were scientists, science teachers, worked as science communicators (either professionally or on an amateur basis), regular attendees of the Alchemist Café or Science Gallery. The group comprised six female participants.

SUMMARY OF GROUP 6 REPORTED MEDIA USE	
TELEVISION	
Average time spent watching television	99 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, BBC1
Most popular television programmes (watched frequently by at least three participants)	N./A
RADIO	
Average time spent listening to the radio	138 minutes
Most popular radio stations (if listened to regularly by at least three participants)	Today FM, RTÉ Radio One
Most popular radio programmes (if listened to frequently by at least three participants)	N/A
NEWSPAPERS	
Average time spent reading newspapers (in minutes)	31 minutes
Most popular newspaper (if read by at least three participants)	The Irish Times
Popular newspaper science sections / magazines (if read by at least three	The Irish Times
INTERNET	
Average time spent on internet	148 minutes
Number of participants who download science podcasts / webcasts	5

Group 7 – Aged 30-49

This focus group was held in Dublin City University. Participants in this group were aged between 30 and 49 years and educated to university degree. The group comprised five female participants and four male participants.

SUMMARY OF GROUP 7 REPORTED MEDIA USE	
TELEVISION	
Average time spent watching television	108 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, BBC1, BBC2, Channel 4, TV3, ITV
Most popular television programmes (watched frequently by at least three participants)	Surgeons, Horizon, Eco Eye, Megastructures
RADIO	
Average time spent listening to the radio	88
Most popular radio stations (if listened to regularly by at least three participants)	RTÉ Radio 1, Today FM, 2FM
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
NEWSPAPERS	
Average time spent reading newspapers (in minutes)	33
Most popular newspaper (if read by at least three participants)	Irish Times, Evening Herald
Popular newspaper science sections / magazines (if read by at least three	Irish Times
INTERNET	
Average time spent on internet	74 minutes
Number of participants who download science podcasts / webcasts	5

Group 8 – Aged 50+

This focus group was held in Dublin City University. Participants in this group were aged 50+ years and educated to university degree. The group comprised five female participants and five male participants.

SUMMARY OF GROUP 8 REPORTED MEDIA USE	
TELEVISION	
Average time spent watching television	148 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, TV3, BBC1, BBC2, Channel 4, ITV
Most popular television programmes (watched frequently by at least three participants)	Eco Eye, Horizon, Megastructures, Naked Science, Science Shack, Surgeons
RADIO	
Average time spent listening to the radio	93 minutes
Most popular radio stations (if listened to regularly by at least three participants)	RTÉ Radio 1, Lyric FM, 98FM
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild, Mind Matters, Icons of Irish Science
NEWSPAPERS	
Average time spent reading newspapers (in minutes)	63 minutes
Most popular newspaper (if read by at least three participants)	Irish Independent, Irish Times
Popular newspaper science sections / magazines (if read by at least three	Irish Times
INTERNET	
Average time spent on internet	51 minutes
Number of participants who download science podcasts / webcasts	4

Group 9

This focus group was held in Dublin City University. Participants had mixed educational backgrounds, and were aged between 30 and 49 years. The group comprised five female participants and four male participants.

SUMMARY OF GROUP 9 REPORTED MEDIA USE	
TELEVISION	
Average time spent watching television	156 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, TV3, BBC1, Channel 4, ITV
Most popular television programmes (watched frequently by at least three participants)	Horizon, Megastructures
RADIO	
Average time spent listening to the radio	99 minutes
Most popular radio stations (if listened to regularly by at least three participants)	Today FM, RTÉ Radio One, 98FM
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
NEWSPAPERS	
Average time spent reading newspapers	44 minutes
Most popular newspaper (if read by at least three participants)	Evening Herald, Irish Independent, Irish Times
Popular newspaper science sections / magazines (if read by at least three	N/A
INTERNET	
Average time spent on internet	93 minutes
Number of participants who download science podcasts / webcasts	0

Group 10

This focus group was held in Dublin City University. Participants had mixed educational backgrounds, and were aged 50+ years. The group comprised five female participants and five male participants.

Summary of Group 10 Reported Media Use	
Television	
Average time spent watching television	155 minutes
Most popular channels (watched by more than three participants)	RTÉ1, RTÉ2, TV3, BBC1, BBC2, Channel 4
Most popular television programmes (watched frequently by at least three participants)	Families in trouble, Horizon, Megastructures, Naked Science, Storm Force, Surgeons
Radio	
Average time spent listening to the radio	102
Most popular radio stations (if listened to regularly by at least three participants)	RTÉ Radio 1, 2FM, Newstalk
Most popular radio programmes (if listened to frequently by at least three participants)	Mooney Goes Wild
Newspapers	
Average time spent reading newspapers (in minutes)	32
Most popular newspaper (if read by at least three participants)	Irish Times, Irish Independent
Popular newspaper science sections / magazines (if read by at least three	Irish Times
Internet	
Average time spent on internet	73 minutes
Number of participants who download science podcasts / webcasts	5

Appendix I—Descriptions of Horizon episodes from series 48 (2011/2012)

The following is a list of the episodes of Horizon series 48 (2011-2012) together with the descriptions of each episode given on the BBC website http://www.bbc.co.uk/programmes/b006mgxf/episodes/guide#b013c8kd

Do You See What I See?

Roses are red, violets are blue but according to the latest understanding these colours are really an illusion. One that you create yourself.

Horizon reveals a surprising truth about how we all see the world. You may think a rose is red, the sky is blue and the grass is green, but it now seems that the colours you see may not always be the same as the colours I see. Your age, sex and even mood can affect how you experience colours.

Scientists have unlocked the hidden power that colours can have over your life—how red can make you a winner, how blue makes time speed up, and more.

Seeing Stars

Around the world, a new generation of astronomers are hunting for the most mysterious objects in the universe. Young stars, black holes, even other forms of life.

They have created a dazzling new set of super-telescopes that promise to rewrite the story of the heavens.

This film follows the men and women who are pushing the limits of science and engineering in some of the most extreme environments on earth. But most strikingly of all, no-one really knows what they will find out there.

The Nine Months That Made You

Horizon explores the secrets of what makes a long, healthy and happy life. It turns out that a time you can't remember—the nine months you spend in the womb—could have more lasting effects on you today than your lifestyle or genes. It is one of the most powerful and provocative new ideas in human science, and it was pioneered by a British scientist, Professor David Barker. His theory has inspired a field of study that is revealing how our time in the womb could affect your health, personality, and even the lives of your children.

The Core

For centuries we have dreamt of reaching the centre of the Earth. Now scientists are uncovering a bizarre and alien world that lies 4,000 miles beneath our feet, unlike anything we know on the surface. It is a planet buried within the planet we know, where storms rage within a sea of white-hot metal and a giant forest of crystals make up a metal core the size of the Moon.

Horizon follows scientists who are conducting experiments to recreate this core within their own laboratories, with surprising results.

Are You Good or Evil?

What makes us good or evil? It's a simple but deeply unsettling question. One that scientists are now starting to answer.

Horizon meets the researchers who have studied some of the most terrifying people behind bars - psychopathic killers.

But there was a shock in store for one of these scientists, Professor Jim Fallon, when he discovered that he had the profile of a psychopath. And the reason he didn't turn out to be a killer holds important lessons for all of us.

We meet the scientist who believes he has found the moral molecule and the man who is using this new understanding to rewrite our ideas of crime and punishment.

Is Nuclear Power Safe?

Six months after the explosions at the Fukushima nuclear plant and the release of radiation there, Professor Jim Al-Khalili sets out to discover whether nuclear power is safe.

He begins in Japan, where he meets some of the tens of thousands of people who have been evacuated from the exclusion zone. He travels to an abandoned village just outside the zone to witness a nuclear clean-up operation.

Jim draws on the latest scientific findings from Japan and from the previous explosion at Chernobyl to understand how dangerous the release of radiation is likely to be and what that means for our trust in nuclear power.

Playing God

Adam Rutherford meets a new creature created by American scientists—the spider-goat. It is part goat, part spider, and its milk can be used to create artificial spider's web.

It is part of a new field of research, synthetic biology, with a radical aim: to break down nature into spare parts so that we can rebuild it however we please.

This technology is already being used to make bio-diesel to power cars. Other researchers are looking at how we might, one day, control human emotions by sending 'biological machines' into our brains.

The Truth About Exercise

Like many, Michael Mosley wants to get fitter and healthier but can't face hours on the treadmill or trips to the gym. Help may be at hand.

He uncovers the surprising new research which suggests many of us could benefit from just three minutes of high intensity exercise a week.

He discovers the hidden power of simple activities like walking and fidgeting, and finds out why some of us don't respond to exercise at all.

Using himself as a guinea pig, Michael uncovers the revealing new research about exercise, that has the power to make us all live longer and healthier lives.

Solar Storms: The Threat to Planet Earth

There is a new kind of weather to worry about, and it comes from our nearest star.

Scientists are expecting a fit of violent activity on the sun which will propel billions of tonnes of superheated gas and pulses of energy towards our planet. They have the power to close down our modern technological civilisation - e.g. in 1989, a solar storm cut off the power to the Canadian city of Quebec.

Horizon meets the space weathermen who are trying to predict what is coming our way, and organisations like the National Grid, who are preparing for the impending solar storms.

Out of Control?

We all like to think we are in control of our lives - of what we feel and what we think. But scientists are now discovering this is often simply an illusion.

Surprising experiments are revealing that what you think you do and what you actually do can be very different. Your unconscious mind is often calling the shots, influencing the decisions you make, from what you eat to who you fall in love with. If you think you are really in control of your life, you may have to think again.

The Truth About Fat

Surgeon Gabriel Weston discovers the surprising truth about why so many people are piling on the pounds, and how to fight the fat epidemic.

She discovers the hidden battles of hormones that control people's appetites, and sees the latest surgery that fundamentally changes what a patient wants to eat by altering how their brains work.

Gabriel is shocked to find out that when it comes to being overweight, it is not always your fault you are fat.

Global Weirding

Something weird seems to be happening to our weather - it appears to be getting more extreme.

In the past few years we have shivered through two record-breaking cold winters and parts of the country have experienced intense droughts and torrential floods. It is a pattern that appears to be playing out across the globe. Hurricane chasers are recording bigger storms and in Texas, record-breaking rain has been followed by record-breaking drought.

Horizon follows the scientists who are trying to understand what's been happening to our weather and investigates if these extremes are a taste of what is to come.

The Hunt for AI

Marcus Du Sautoy wants to find out how close we are to creating machines that can think like us: robots or computers that have artificial intelligence.

His journey takes him to a strange and bizarre world where AI is now taking shape.

Marcus meets two robots who are developing their own private language, and attempts to communicate to them. He discovers how a super computer beat humans at one of the toughest quiz shows on the planet, Jeopardy. And finds out if machines can have creativity and intuition like us.

Marcus is worried that if machines can think like us, then he will be out of business. But his conclusion is that AI machines may surprise us with their own distinct way of thinking.

Defeating Cancer

Over the past year, Horizon has been behind the scenes at one of Britain's leading cancer hospitals, the Royal Marsden in London.

The film follows Rosemary, Phil and Ray as they undergo remarkable new treatments - from a billion pound genetically targeted drug designed to fight a type of skin cancer, to advanced robotic surgery.

We witness the breakthroughs in surgery and in scientific research that are offering new hope and helping to defeat a disease that more than one in three of us will develop at some stage of our lives.

The Transit of Venus

Liz Bonnin presents a Horizon special about a rare and beautiful event in our solar system, one that we should all be able to see for ourselves - the transit of Venus across the face of the sun. It will start just before midnight of the 5th of June, and won't happen again for more than a century.

Liz is joined by Lucie Green and Helen Czerski to show why the transit is such a remarkable event - transforming our understanding of our own solar system as well as helping scientists hunt for alien life on distant planets, hundreds of light years away.