Field-making and sense-making:
foetal programming, risk and human reproduction

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Thesis submitted to the University of Nottingham

for the degree of Doctor of Philosophy

August 2017

Abstract

This thesis contributes to STS scholarship by providing an empirical analysis of the emergence of the field of foetal programming and of public communication surrounding this new science and its claims. Foetal programming claims that nutrition and other events occurring during the nine months of gestation as well as around conception, birth and up to the second birthday of a child's life shape the physiology of the individual and the propensity to chronic disease such as coronary heart disease or diabetes in adulthood. More recently, it has been hypothesised that propensity to illness can be passed on to children and their offspring through molecular epigenetic processes regulating gene expression, thereby shaping the health outcomes of generations to come.

Over the past decades research into foetal programming has been influencing public debates about the importance of early life for future health and about the responsibility for the health of future generations. This thesis seeks to shed light on the ways in which this field along with its risk claims have been advanced in public. It focuses on several core questions: How is foetal programming discursively constructed as a paradigm shift for understanding the origins and risk factors of adult chronic disease. What narratives and metaphors are used by the media and by scientists to communicate about this field and about new health risks associated with it? How can these narratives and metaphors contribute to framing public understanding of risk in early life?

To this end this thesis draws on discourse and metaphor analysis to explore media coverage of this research in English language news outlets, as well as interviews with scientists. It traces how communication about this field and its claims has changed over three decades of media reporting, and how this contributed to establishing this science in the public realm as a legitimate field of its own. It also demonstrates how the meanings of disease risk conveyed by metaphors and narratives were negotiated, adopted or rejected at different points in time and in different contexts, and how they were interpreted in relation to existing cultural scripts about the nature of early

development and the responsibility of mothers for the health of their children. This study also reveals the ambivalence felt by researchers on foetal programming about the ways in which their research has been communicated in public and contributes to the research on hype in science.

Acknowledgements

The research for this thesis was supported by the ESRC DTC University of Nottingham (grant number: ES/J500100/1).

I am grateful to all the scientists participating in this study for their interest, time and for sharing their invaluable insights into foetal programming research.

I want to thank my supervisors Brigitte Nerlich and Anne-Marie Kramer for their continuous guidance and encouragement.

My thanks also go to Alison Haigh, Sujatha Raman and Amal Treacher Kabesh who always offered help and advice, and I would like to thank Karen Craddock for her assistance with the transcription of the interviews.

I am also grateful for the input offered by Reiner Grundmann and Maurizio Meloni at the earlier stages of research for this thesis.

I would not have been able to conduct this research without the support of the University of Nottingham Childcare Services – a big thank you to all the staff, and in particular to Lisa and Kim for keeping our children safe and happy.

Harald and Eleonora endured the effects of early programming by maternal PhD exposure with remarkable resilience and lots of smiles. I hope the long-term effects will entail a propensity to curiosity in later life.

The role of men and fathers is often neglected in studies of foetal programming. To correct this bias, and for lots of other good reasons, my deepest thanks go to Magnus.

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Chapter 1. Introduction

1.1 Foetal programming: exploring the field in the public realm

In December 2015 England's Chief Medical Officer Professor Dame Sally Davies made headlines with the publication of a report on women's health which focused on obesity. According to Professor Davies, rising rates of obesity constituted the biggest risk not only to women's health, but also to the health of future generations (*BBC News* 2015). As reported by *The Telegraph*, obesity posed such a serious threat to the country that it 'should be treated as a national risk alongside terrorism' (Donnelly 2015). Although Davies's report made a variety of recommendations related to women's health, including contraception, menopause, prevention of cancer and incontinence, the messages linking obesity with reproduction and pregnancy attracted significant attention. Davies was quoted as saying:

> In women, obesity can affect the outcomes of any pregnancies they have and the health of any future children they may have. This is a difficult message to convey, as it risks burdening women with guilt and responsibility, but I believe that it can also empower women to take positive steps like eating more healthily and taking more exercise. (Department of Health 2015)

In this context *The Mail Online* noted that obesity rates 'were actually higher in men', but that Professor Davies was 'so concerned about women because of the complications of risks in pregnancy and the implications for their unborn children' (Borland 2015). The risks for the children, the news outlets warned, included a higher incidence of heart disease, obesity, Type 2 diabetes as well as reduced fertility in adulthood. In the media debate that ensued, various aspects of Professor Davies's report were discussed, but, intriguingly, the science underpinning Dame Sally's warning about the impact of pregnant women's health and diet on the health of future generations was not interrogated, mentioned or even named. Judging by the press coverage, the media took such messages for granted, and broadcast them nationwide, urging future mothers once again to lose weight and watch their diet.

Foetal programming[1] - the science that underpinned these warnings and the messages of Professor Davies's report (Davies 2015) - is the focus of this thesis. It aims to analyse this field and its claims from the perspective of Science and Technology Studies (STS). It also aims to add foetal programming to established discussions of emerging biotechnologies in STS, which so far have mainly focussed on a related, more fashionable field, namely epigenetics (see Pickersgill et al. 2013).

In a nutshell, foetal programming claims that nutrition and other events occurring during the nine months of gestation, as well as around conception, birth and up to the second birthday of a child's life, shape the physiological as well as cognitive and behavioural makeup of the individual. Such events shape the kind of metabolism an individual will have and 'programme' the propensity to various chronic diseases in adulthood, such as high blood pressure, cardiovascular disease, obesity and diabetes. More recently, it has been hypothesised that early life programming of health and disease might occur through epigenetic processes involved in gene expression, and that propensity to illness might even be transmitted to children and their offspring, thus shaping the health of several generations (Barker 1994, Barouki et al. 2012, Gluckman et al. 2008).

This thesis seeks to shed light on the emergence and popularisation of this research by scientists and in the media.It focuses on a science which has influenced public discourse as well as policy debates related to pregnancy and early life origins of adult chronic diseases. Such a study is important and timely, given that the claims of foetal programming about early life origins of adult chronic disease, which were first proposed three decades ago, now circulate widely in the public sphere and shape perceptions (and potentially policy) of diet, pregnancy and parenting amongst others. As they tie in with older cultural framings of women, children and health risks, they are often taken for granted, as suggested in the media vignette above.

[1] The foetal programming framework has over the years undergone many conceptual modifications and is now known as Developmental Origins of Health and Disease (DOHaD). Biomedical literature also refers to this research as the Barker hypothesis, fetal origins of health and disease, and developmental programming, among others. In this thesis I use predominantly three terms: foetal programming, DOHaD and the Barker hypothesis.

In a recent essay Shapin (2016) has noted that although science permeates our lives it is shielded from our critical sight by the taken-for-grantedness of all things scientific that we experience on an everyday basis. Contrary to common beliefs, science does not happen in secluded places, but 'is now everywhere and (…) understanding its pervasiveness is important to describing both late modern science and late modern society' (Shapin 2016: 37). Science is so firmly embedded in society that it becomes invisible, which paradoxically demonstrates how important it is 'for government, for commerce, and, not least, for our sense of self' (p. 39).

In a sense, this study attempts to 'recover the visibility' (Shapin 2016: 37) of the science of foetal programming in two ways. First, it aims to 'recover the visibility' of foetal programming in society. Since its emergence in the late 1980s, this field has been constructed and spearheaded in the public eye, both in the realm of professional science as well as in the popular media, and it has built its identity around its core claims that early life development shapes the propensity to many chronic diseases in adulthood. It has also been claimed that the foetal programming framework has brought about a paradigm shift in the medical realm and in understandings of the origins of adult chronic disease by stressing the importance of early life development for health in later life (Robinson 1992).

Proposed and promoted by Professor David Barker, an epidemiologist from the University of Southampton, the field of foetal programming, though initially controversial, came to influence public debates in the UK and elsewhere about the importance of development in the womb for health in later life, as well as health policies, such as the government programme Sure Start in the UK (Southall 2014). More recently, foetal programming has once again influenced public debates and the media coverage with the advent of research into epigenetics, which draws on ideas of early life programming of disease, as well as with the launch of the UN-backed global health movement 'The First 1,000 Days of Life' (Pentecost 2016), which has at its core claims promoted by Barker. Thus, by looking at the field of foetal programming, this thesis aims to make visible the discipline whose claims have

underpinned much of public debate about pregnancy and the importance of early life for future health outcomes.

Second, this thesis also seeks to 'recover the visibility' of foetal programming for the field of STS. It seems that STS scholarship has overlooked this discipline during the years when it was spearheaded both in the professional realm and in popular media by David Barker, as well as during the years when the claims of this science were undergoing changes and the field itself was evolving from a controversial hypothesis to an established area of research. Only recently have STS scholars started to pay attention to this research, and largely in relation to developments in the currently fashionable field of epigenetics (Ebrahim 2012, Pickersgill 2016). By exploring the field of foetal programming, this thesis seeks to fill this gap and redress what can still be perceived as a certain 'bias' in STS research 'toward studying *the bigger and harder sciences*' (Hackett et al. 2008: 6, emphasis in the original), such as genetics and genomics, and recently also epigenetics and epigenomics (see also Chapter 2).

This thesis is motivated by what has been considered important features of the STS approach to studying science, namely by the interest in the conditions of production of new knowledge and a strong empirical focus (Hedgecoe and Martin 2007: 818-822). By examining media coverage of this science as well as the interviews with scientists directly involved in foetal programming research, this thesis provides empirically-grounded insights into the conditions of knowledge production in this field. This includes insights about its emergence and its relationship with other disciplines in the current landscape of postgenomic science, as well as about the context in which its claims and its popularisation took place over the last three decades. In so doing, this thesis puts foetal programming on the map of STS investigations of new scientific fields, and it also clarifies some of the confusion that arises from the current and growing social science scholarship on foetal programming's claims, aims and social implications (see Chapter 2).

Following Shapin (2016), this thesis also assumes that science is not confined to some special spaces, but that it permeates everyday life and underpins much of

what we do, what we use - and what we hear or read in the media, for that matter. In addition, this thesis assumes, after Bucchi (1998), that science can emerge simultaneously in the professional realm and in the public sphere, and that the presence of and communication about science in the public realm – especially in the popular media - help discursively build, shape and promote new scientific fields and their claims. Therefore, the interest of this thesis lies in the exploration of discursive tools, such as narratives and metaphors that help establish and promote new fields and their claims in the public realm. By focusing on metaphors this thesis also sheds light on hopes and fears which accompany the emergence of new biotechnologies and which are often expressed in metaphorical framings in public communication of science (Petersen 2006). In exploring metaphors and other discursive tools used in the media reports and in the interviews with scientists this thesis offers a more nuanced and context specific analysis of the meanings of risk associated with foetal programming. This type of analysis can help refine understandings and interpretations of what risk in early life could entail, but is currently missing from existing scholarship on the foetal programming framework (see Chapter 2).

This thesis, entitled 'Field-making and sense-making: foetal programming, risk and human reproduction', studies the science of foetal programming. It explores the ways in which foetal programming was discursively established in the public realm as a paradigm shift or a new science of risk of adult chronic disease. It also explores the implications this might have for public understandings of risk in early life, especially pertaining to the responsibility of mothers – and parents more generally – for the health of future generations. As the title suggests, it attempts to make sense of the ways in which this field, along with its claims about early life origins of adult disease, was made, shaped and promoted in public. It also attempts to make sense of the claims about risk emerging from the conditions surrounding early development: how this risk can be interpreted in different contexts, and how its understanding has been changing with the passage of time and the growth of the field of foetal programming. Finally, this thesis also seeks to make sense of the context in which the field of foetal programming and its claims have been made and shaped by

the scientists involved in it. Methodologically, this thesis seeks to achieve this by analysing the media coverage of research into foetal programming as well as interviews with scientists.

The remainder of this introductory chapter is structured as follows. The next section provides background information about the field of foetal programming. The chapter concludes with an overview of the thesis.

1.2 Foetal programming: the field and its claims

Foetal programming is both a hypothesis and a field of scientific enquiry. The thrust of this framework is the idea that events occurring during early development might have long term consequences. As Matthew Gillman, a one-time critic and now a prominent researcher in this field, once stated: 'At first glance, it may seem implausible that your mother's exposure to stress or toxins while pregnant with you, how she fed you when you were an infant, or how fast you grew during childhood can determine your risk for chronic disease as an adult' (Gillman 2005). According to this theory, the foetus develops in interaction with its environment, and various outside stimuli, such as the amount or the kind of food reaching the womb have an impact on its growth. These stimuli can 'programme' the foetus's physical constitution, metabolic functions and propensity to illnesses in adulthood. As one of the proponents of foetal programming has claimed, everyone goes through life bearing the consequences of the earliest experiences from the womb (Nathanielsz 1996: xi). The foetal programming hypothesis as well as the the Developmental Origins of Health and Disease (DOHaD) framework– its conceptual extension and modification – are often described by their proponents as a paradigm shift in thinking about the origins of diseases (Robinson 1992, Gluckman and Hanson 2004b). Biomedical literature also refers to this research as the Barker hypothesis, fetal origins of adult disease, prenatal programming, developmental programming, metabolic programming, and so on. DOHaD is a dynamic and increasingly prominent framework within the biomedical sciences, which, over the last decade, has also developed collaborations within the field of environmental epigenetics.

Tracing the development of the field on Scopus one can see that it began to grow substantially from the mid-2000s (Figure 1)[2]. This was the time when the original hypothesis of foetal programming started to develop into a more extended framework of DOHaD, and to interact closely with another emerging field of epigenetics, a study of mechanisms involved in gene regulation (see for example Bianco-Miotto et al. 2017).

David Barker, author of the 'Barker hypothesis', and Mark Hanson and Peter Gluckman, the 'first two chairs of the DOHaD Society', are some of the most distinguished scholars associated with this field (Wadhwa et al. 2009). David Barker (1938-2013), an epidemiologist from the University of Southampon, coined and promoted the term 'foetal programming', and is also one of the most prolific authors in the field (see Figure 2).

Mark Hanson from the MRC Epidemiology Resource Centre at the University of Southampton and Peter Gluckman from the Liggins Institute in Auckland, who also serves as a Chief Science Advisor to the New Zealand Prime Minister, are some of the most prominent proponents of the concept of Developmental Origins of Health and Disease (Figure 3). Taken together, Barker, Hanson and Gluckman authored the largest number of articles on foetal programming and DOHaD, according to Scopus (Figure 4).

It should be noted that results retrieved by Scopus or by any other database are only indicative in terms of exact number of publications produced in this area. Research into early life origins of disease has been published over three decades and under many conceptual labels, including the Barker hypothesis, foetal origins of adult disease, and developmental origins of disease, which reflected the state of the art or a theoretical preference in this field at certain points in time. This is not picked up by electronic search tools, and as a result, digital databases often identify research under these labels as separate areas of scientific enquiry. For example, after conducting searches in Scopus with the key words 'the Barker hypothesis', 'foetal

[2] All figures and tables can be found in the Appendix 1.

programming', 'fetal programming' and 'developmental origins of health and disease', it turned out that Gluckman and Hanson were identified as leading scholars in DOHaD and the Barker hypothesis, but they did not feature as contributors to research into foetal programming, which is surprising, given their input into extending Barker's original framework. The search in Scopus also showed that while Barker was a leading expert in the field of foetal programming and the Barker hypothesis, he was not identified as one of the leading authors in DOHaD. These results are misleading given Barker's reputation as a pioneer who established DOHaD as a field on its own (see for example Barker J. et al. 2013).

Identifying the main papers in this area of study poses similar problems, as digital databases usually classify research into foetal programming, fetal origins of adult disease or DOHaD in separate categories. The search for the most cited papers in this area of science is further compounded by the fact that research into foetal programming and DOHaD has been of interest to other disciplines, often with only loose – if any - disciplinary and theoretical connections to DOHaD (Figure 5).

As a result, a number of scientific papers which have borrowed DOHaD concepts and applied them in other areas of study, are picked up – misleadingly - by digital databases as influential contributions to foetal programming/DOHaD literature. The examples of highly cited research into the Barker hypothesis, as retrieved by Scopus, included a paper authored by the Economics Nobel Prize Laureate James Heckman (2007), who drew on Barker's ideas in his paper on 'The economics, technology and neuroscience of human capability formation'. This paper, though influential, does not represent scholarship into the Barker hypothesis, but rather it imports its core concepts to the study of inequalities in the field of economics. Another highly cited paper retrieved in Scopus with the keyword 'developmental origins of health and disease' was Mandal and Suzuki's article on arsenic (2002), which contributes to the field of toxicology rather than to research and debates in DOHaD.

Given the above-mentioned challenges and constraints, the search in Scopus for the main papers in this field was conducted in a four-step fashion. First, the

search for highest cited publications was carried out with the keywords reflecting the commonly used names of research in this field: ‘fetal programming’, ‘foetal programming’, ‘fetal origins of adult disease’, ‘Barker hypothesis’, ‘the Barker hypothesis’, and ‘developmental origins of health and disease’. Additional searches were performed with the keywords which consisted of the names of the most prolific authors in this field, namely ‘Barker D.J.P’, ‘Hanson M.A.’, and ‘Gluckman P.D.’ The search was conducted for the period from 1986 (the year when the first paper in this field was published) and 2016. Second, the results of these digital searchers were compared and a list of publications with the highest number of citations was compiled. Third, each of the highly cited articles was separately accessed online to evaluate its connection and relevance to core debates in the field of foetal programming/DOHaD. Fourth, articles authored by scholars with identical names but with a different expertise to that of core researchers into DOHaD, as well as publications with little or no disciplinary connection or relevance to this field (such as the above-mentioned papers by Heckman, and Mandal and Suzuki) were eliminated. The resulting list (Table 1) identifies ten key papers in the field, based on the number of citations in scientific literature. Barker features here prominently as the author and co-author of eight out of ten key publications in this field.

Not only is David Barker , one of the most influential researchers in the field, he is also widely credited as the founding father of foetal programming. Barker’s role as the originator and promoter of this research is affirmed in his own scientific writings (for example Barker 2003, 2007a), as well as in numerous reviews (for example McMillen and Robinson 2005, Gluckman, Hanson and Buklijas 2011).

Most recently, Barker’s part in advancing this field was celebrated in his obituaries which were published both in leading scholarly journals, including *Nature*, *The Lancet*, *British Medical Journal* and *International Journal of Epidemiology*, as well as in popular press, including *The Guardian*, *The Times* and *The Telegraph.* The obituaries lauded Barker’s scientific achievements and emphasised his pioneer spirit. One obituary noted, for example, that ‘David Barker invented a new field of medicine’ (Lampl 2014: 187), and another suggested that Barker’s work was worthy

of a Nobel Prize and that 'we should put up a statue or name a street after him' (Olsen 2014: 3). Commemorations and appreciations of Barker's legacy also stressed his role in dissemination of the field's findings in the public realm and in popular media. As reported by *Lancet*, 'His science was important but the reason he has had so much impact is because of his missionary zeal. He really brought to the world's attention the role of early development' (Pincock 2013: 1170). As these examples illustrate, Barker was a hugely admired figure, and his role as the pioneer and populariser of DOHaD was widely acknowledged.

Both scientific papers and popular accounts situate the beginnings of the field of DOHaD in the 1980s. While investigating the geographic distribution of various diseases in England and Wales, Barker was confronted with what he considered an epidemiological puzzle. According to medical knowledge heart disease is associated with rising prosperity, but it was the poorest and not the most prosperous areas of the country that were most affected. In addition, the distribution of recent heart disease paralleled the distribution of infant mortality from the past, that is, from about the 1920s. At the beginning of the last century, as Barker argued, infant mortality occurred mainly during the first week of life and was associated with low birthweight. These findings prompted him to hypothesise that the susceptibility to heart disease later in life had its origins *in utero* and in early childhood, and they resulted from undernutrition and poor living conditions (Barker 2007a; Barker 1994; Godfrey and Barker 2000; Barker 1997).

This was a starting point for conceptual elaborations which led to theBarker hypothesis, also known as foetal programming, which suggests that undernutrition during gestation is an early origin of adult cardiac and metabolic disorders. As Barker famously stated:

> the womb may be more important than the home. (…) We are beginning to identify processes that link fetal and infant growth with cardiovascular disease. (…) These epidemiological findings point to the importance of long term programming in early life. (Barker 1990: 1111)

This was one of the earliest attestations of the term ‘programming’ by the scientist setting the agenda for this field. This term became a central concept, as well as a central metaphor, in this area of research. According to Barker, programming describes ‘the processes whereby a stimulus or insult at a sensitive or critical period of development, has lasting effect on the structure or function of the body’ (Barker 2004: 115). This definition contains another key concept and metaphor in this field, namely the ‘critical period’, which focussed on those moments in early life when the propensity to future disease was being decided.

The idea that behaviours or propensity to illness can be traced back to early development was certainly not new, and it was present in the writings of scholars preceding Barker, for example in the work of Konrad Lorenz who coined the term ‘behavioural imprinting’, as well as in the work of Anders Forsdahl and Günter Dörner who investigated the impact of early life on the incidence of chronic diseases (see Koletzko 2005b, Lynch and Smith 2005). But it was Barker whose persistence and methodological innovations gave an impetus to the emergence of a new field of study (see Gluckman et al. 2010 and 2011).

Barker elaborated on his idea of programming with studies that linked historical records of birthweight with health in later life. Barker and his team searched the country for medical data from the beginning of the 20th century and they found ledgers with information pertaining to weight at birth, as well as early growth and development of babies born in the county of Hertfordshire from 1911 onwards. Using the NHS registry, scientists were able to trace men and women born in the county, and link the data about their later health with the information about their birthweight. Some of those people were also invited to participate in what was later called the Hertfordshire cohort studies and attended clinics for health checks (Barker 2003). The follow-up of the children from this cohort indicated that the risk of death from cardiovascular disease in adulthood was related to birthweight, and was highest for men with the lowest birthweight, while men with the highest birthweight had the lowest death rate from cardiovascular disease (Barker et al. 1989, Gluckman et al.2016).

The statistical correlations between birthweight and risk of heart disease in adulthood demanded an explanation in causal terms. Barker hypothesised that during its development the foetus adapts to changing conditions, for example to a limited supply of nutrients or oxygen. If the supply crisis occurs during the 'critical period of development' of some organs or tissues, their growth can be compromised as cell division can slow down. According to Barker:

> even brief periods of undernutrition may permanently reduce the number of cells in particular organs. This is one of the mechanisms by which undernutrition may permanently change or 'program' the structure and function of the body. Other lasting 'memories' of undernutrition include changes in the distribution of cell types, hormonal feedback, metabolic activity and organ structure. (Barker 1997: 807)

Such physiological changes and an altered metabolism explain why people purportedly undernourished *in utero* experience heart disease as adults. Undernutrition in the womb is reflected in the features of the newborn's body (Barker 1997), primarily in the baby's low birthweight, but also in the body's proportions, for example in the relation between the size of the head and the rest of the body, as well as in the head and abdominal circumference*in utero* (Barker 1998).

Subsequent studies extended the importance and scope of programming caused by undernutrition: events occurring *in utero* may programme various systems and tissues, and result in insulin resistance, polycystic ovaries syndrome, impaired cholesterol metabolism, autoimmune thyroid disease and asthma (Godfrey and Barker 2000).

From its beginnings in the late 1980s research into foetal programming was focussed on the negative effects of undernutrition in early life. This started to change in the early 2000s as scientists turned to other aspects of early development, such as nutritional imbalance, and higher birthweight. As some researchers have noted:

> small birth size is not an obligatory part of the pathway leading to increased disease risk – during development many environmental factors

> (…) can induce changes in physiology and anatomy with long-term consequences. (Gluckman et al. 2007: 2)

While early research into foetal programming emphasised delayed health risks of being born small, now big babies often born to overweight and obese mothers were also considered at risk of various diseases, such as obesity and diabetes (Taylor and Poston 2007, Gillman and Poston 2012). Maternal influences, metaphorically framed as 'programming', were believed to be operating across the birthweight spectrum. Relatedly, the major shift in research activity which began from the mid-2000s onwards, manifested itself in the extension of the foetal programming framework and the emergence of Developmental Origins of Health and Disease. In addition to research on higher birth weight, now the DOHaD framework also focussed on the period of preconception and infancy, as well as on the broader implications of early life effects for the developing world (Gillman et al. 2007), including policy implications. At the same time foetal programming scholars were increasingly turning to epigenetics, the field which, it was hoped, could elucidate possible pathways through which programming in early life might operate (Gluckman and Hanson 2004a, Gluckman and Hanson 2004b, Gluckman et al.2005). The Barker hypothesis was supported by epidemiological studies based on associations between early life exposure and later health outcomes (cf. Barker 1998, Barker 2007), and it did not specify the mechanisms of programming. This, in the eyes of the critics of the foetal programming framework, undermined the credibility of this research.

Epigenetics, which generally includes 'any process that alters gene activity without changing the DNA sequence and leads to modifications that can be transmitted to daughter cells' (Weinhold 2006), seemed a good candidate to fill this gap. It is hoped that this field, which grew in prominence after the completion of the Human Genome Project (cf. Pickersgill et al. 2013) can provide a mechanistic explanation of 'how environment gets under the skin' (McEwen 2012) at the molecular level (cf. Gissis and Jablonka 2011). As Gluckman et al. have speculated, 'the environmental factor may lead to chemical modification of the DNA or

chromatin such that it is fixed in an ‘on’ or ‘off’ position. This process is referred to as epigenetic modification and may involve either DNA methylation or histone acetylation’ (Gluckman et al. 2005). It has also been claimed that the experience of exposure to adversity in early life, and the propensity to illness might be passed down through epigenetic processes to more than one generation (cf. Burdge and Lillycrop 2010: 320), although such claims are still contested (cf. Deichman 2016, Bird 2013, Heard and Martienssen 2014). As a result, foetal programming and DOHaD are sometimes considered a subfield of epigenetics (Haig 2012), especially of environmental epigenetics, and the names of these areas of research are sometimes used interchangeably.

From early on, Barker and other researchers have been consistently building their field in opposition to competing explanations of adult chronic diseases, such as genetic or lifestyle factors. The inability of the genetic and lifestyle frameworks to explain the incidence of chronic diseases indicated in Barker’s view their major conceptual weakness and marked a crisis in epidemiology and related fields, a crisis to which his hypothesis offered a solution (Barker 1998).

The early reception of the Barker hypothesis was mixed. Barker’s ideas were criticised on many grounds, including its methods and theories (Elford et al. 1991, Elford et al. 1992, Paneth and Susser 1995, Kramer and Joseph 1996, Huxley et al. 2002), and some prominent researchers even suggested that his propositions were unscientific (Susser and Levin 1999). Others have greeted Barker’s ideas with enthusiasm, with the prestigious *British Medical Journal* claiming that ’we are witnessing the beginning of one of Thomas Kuhn's "paradigm shifts"’ (Robinson 1992: 790). Despite criticism, the field started to gain wider recognition from the late 1990s onwards, when independent research based on studies of large cohorts of people from Sweden and the US supported the Barker hypothesis (Rich-Edwards et al. 1997, Leon et al. 1998). The Barker hypothesis also prompted scholars to look beyond the time of gestation in their search for the origins of chronic adult diseases. The period of developmental plasticity, that is, when the organism is particularly susceptible to environmental influences, such as nutrition, now extends from the time

around conception up to the second birthday of a child (Lucas 1994 and 1998) and comprises the period of the so-called 'the first thousand days of life' (Barker et al. 2007, Hanson et al. 2012).

Over the years the field of DOHaD grew and evolved from a contested hypothesis into an interdisciplinary field of research. As one commentator noted, after over a quarter of century of research, the field 'has of course matured, from "hypothesis" to near "orthodoxy"' (Sommer 2012: 2). DOHaD has also matured institutionally. It has its own scientific journal and professional organisation – the International Society for Developmental Origins of Health and Disease which organises a biannual world congress. A growing number of departments and research clusters in scientific institutions now operate under the banner of DOHaD, and research on early life origins of adult chronic diseases is part of professional training in many bioscientific fields, including medicine.

The foetal programming framework proved influential and inspired research both within epidemiology and beyond this field. It gave an impetus to the development of the life course approach to chronic disease or life course epidemiology (Kuh and Shlomo 2004, Kuh et al. 2003), and it features prominently in recent scholarship on evolutionary developmental biology (Gissis and Jablonka 2001, Jablonka and Lamb 2002, Jablonka 2004, Gilbert and Epel 2009). It also stimulated a new research agenda in health economics (Almond and Currie 2011). Barker's ideas have also been drawn on and promoted in the public realm by such scholars and public figures as the Nobel Prize Winners Amartya Sen and James Heckman, and the former chief economist of the International Monetary Fund Raghuran Rajan.

The impact of Barker's ideas on the policy realm is not easy to assess: while some claim the concept of DOHaD 'has gained essentially no traction within the public health community' (Gluckman et al.2016: 10), others have argued that it influenced both the debates (Smith and Kuh 1997) and understandings of the importance of early life for future health among policy makers (Smith 2013), as well

as specific policies such as the National Childcare Strategy, the Sure Start programme and the Working Families Tax Credit introduced by New Labour in the UK (Warin et al. 2011). More recently, the DOHaD concept has been recognised by the World Health Organisation and is reflected in its strategy to end childhood obesity (Gluckman et al. 2016). The idea that early life shapes future health is also at the heart of the global health movement under the banner of 'the first 1,000 days' which was launched by Hillary Clinton, and which aims to improve nutrition of mothers and children in developing countries (Hanson et al. 2012, http://www.thousanddays.org/). The concept of the 'first 1,000 days' has recently also been promoted and incorporated into research led by the National Childbirth Trust (www.nct.org.uk)

Foetal programming has had a strong presence in popular media. Research surrounding the Barker hypothesis has been the subject of several popular books (Nathanielsz 1996, Nathanielsz 1999, Nathanielsz and Vaughan 2010, Agin 2009, Gluckman and Hanson 2005, Paul 2010) and has been widely covered in the printed press, as well as on radio and television. Three decades after its emergence, the field of DOHaD continues to influence public debates about the importance of early life for health in adulthood. There is now even a Twitter hashtag #fetalprogramming that would deserve some scrutiny in future research.

1.3 Overview of the thesis

This thesis explores narratives and metaphors that helped establish the field of foetal programming as a paradigm shift and a new science of risk in the public realm, and it also studies metaphors surrounding the new risk uncovered by this field, namely the risk of adult chronic disease related to early development. In doing so, this thesis combines analysis of the media coverage of foetal programming with interviews with scientists.

The media are an important arena where 'public issues are framed, serving as the focus of intense lobbying' (Kitzinger and Willliams 2005: 731), and they are also a site where new scientific fields or approaches are built and promoted in public (Bucchi 1998). This thesis investigates three decades (1986-2016) of coverage of foetal programming in the English-language news, both in the UK press, and in other news outlets in the West (for example in the US, Canada and Australia), as well as in print media in the Global South. The media sample also includes one television programme and three episodes of a radio series on foetal programming broadcast by the *BBC* in 2011. Alongside the media coverage, this thesis also examines in-depth interviews with 22 UK-based researchers who have contributed to research and debates about this scientific field.

This thesis is structured in the following way. This Introduction is followed by a literature review in Chapter 2 which provides the background and context for this study. The literature review focuses on two sets of literatures: sociological investigations of the field of foetal programming as well as the scholarship under the banner of science and/in the media. This chapter assesses existing STS/sociological studies of foetal programming and identifies the main concerns motivating such studies as well as gaps in existing STS-inflected analyses and understandings of the field of foetal programming. This chapter also provides an overview of the themes from the field of science and/in the media which are important for this study, such as the popularisation and medialisation of science, the effect of popularisation on scientific practice, media as a site of field-making, as well as hype.

Chapter 3 discusses the research design as well as the theoretical frameworks used in this thesis. In particular, it presents Bucchi's (1998) framework of alternative routes in scientific communication and its implications for discursive studies of fields emerging in the public realm. It also presents research on metaphors in science, and it focuses on Maasen and Weingart's (2013) framework on the role of metaphors in the dynamics of knowledge. This approach is used to study changes in the meanings of the metaphors as well as in the discourses that adopt them over time and in different

context. The chapter explains how these approaches are used and combined with interviews in the thesis and describes the research methods and process.

Chapter 4 explores field-making or the ways in which the field of foetal programming was established as a new science of risk in public communication. It examines narratives and metaphors that were used by journalists as well as by scientists speaking to journalists in the media coverage spanning three decades. This chapter uses Bucchi's (1998) analytical framework to study *i)* boundary-work which helped promote foetal programming as a paradigm shift and demarcate it from the competing frameworks of lifestyle and genetic factors; *ii)* discovery stories which helped increase certainty surrounding this emerging field and legitimise it in public; *iii)* strategies of objectification and personalisation which helped render this science more concrete and familiar; *iv)* as well as discursive strategies of managing criticism in the media. This chapter also identifies an additional discursive strategy of hedging which, paradoxically, helped increase the perceived certainty of the foetal programming research and contributed to hyping this field's messages in the media. By merging the linguistic study of hedging, so far largely overlooked by STS scholars, with STS perspectives on media studies, including hyping, this thesis extends STS's ability to study how journalists and scientists manage issues around certainty and uncertainty when establishing a new field in the media.

Chapter 5 constitutes a mirror to Chapter 4, and it pursues the questions related to field-making from a different perspective by examining scientists' accounts of foetal programming. This chapter investigates the ways in which scientists used discovery narratives as well as more pragmatic tales of doing science to describe and legitimate the emergence of their field and its struggles for recognition. It also analyses boundary-work that was drawn during the interviews to demarcate what scientists perceived as legitimate or exaggerated claims which helped promote foetal programming in the public realm, and it explores scientists' views on some of the consequences of hyping messages about this field in public.

Chapter 6 returns to the media coverage, and it explores the changing meanings of new health risk through metaphor analysis, i.e. it examines the way the media made sense of the new field and the new types of risks. To achieve this, this chapter uses Maasen and Weingart's (2013) framework of metaphors and the dynamics of knowledge. This chapter focuses on three decades of media coverage of research into foetal programming both in the West, as well as in the Global South. It identifies three key metaphors of foetal programming: 'programming', 'critical periods/windows', as well as 'the first 1,000 days of life', and it explores how they emerged, how their meanings were negotiated in the media coverage and how they changed both over time as well as in different contexts. This chapter also examines discourses pertaining to responsibility for the health of future generations which accompanied metaphorical framings of foetal programming in the media.

Chapter 7 turns its attention once again to scientists, and it explores narratives and alternative metaphors that they used in the interviews to make sense of early origins of risk of adult chronic disease. This chapter presents more reflexive, nuanced and varied accounts of how risk is understood by scientists, and it explores the boundary-work carried out by researchers to present scientific accounts about early origin of risk of disease as non-judgmental and not aiming at attributing responsibility or blame for the health of future individuals. The chapter also uses the lens of the sociology of low expectations to analyse the ways in which scientists scaled down the promises made about foetal programming in public and resorted to more moderate claim-making about the potential significance of this research for society.

Chapter 8 summarises the main findings of the thesis and discusses its limitations as well as future avenues for research. It also reflects on the broader implications of this study.

Chapter 2. Literature review

2.1. Introduction

This literature review consists of two parts. The first part presents the emerging social science literature on foetal programming/DOHaD, and it discusses the issues surrounding this scientific field which have been examined by social scientists. The second part of this chapter explores sociological and STS literature on the relationship between science and the media. Given that scholarship on this topic is vast, this chapter presents an overview of several issues in this literature that are of particular interest for this thesis, such as: popularisation and medialisation of science; the effect of popularisation on scientific practice; scientists as popularisers - visible scientists and celebrity scientists; media as a site of field-making and claim-making; and last but not least the issue of hype. The discussion of these concepts provides the context and background for the empirical study of this thesis.

This thesis also draws on other sets of literatures which are important for the development of the argument for specific empirical sections. Such chapter-specific theories and concepts are introduced and situated in the context of empirical analysis in Chapters 4, 5, 6 and 7. Chapter 4 discusses boundary-work (Gieryn 1983), hedging (Lakoff 1973, Myers 1989), as well as empiricist and contingent repertoires (Gilbert and Mulkay 1984). Chapter 5 explores the norms of scientific conduct (Merton 1973), as well as the theory of scientific and social movements (Frickel and Gross 2005). Chapter 6 makes use of theories related to metaphor analysis (Pepper 1942, Lakoff 1995), and Chapter 7 briefly discusses the nascent field of the 'sociology of low expectations' (Gardner et al. 2015).

2.2. Sociological explorations of foetal programming

Although from its inception in the late 1980 the foetal programming framework sparked lively interdisciplinary debates within the biomedical community and inspired different theories linking early life experience to adult health (Leon 2004), it would be hard to find a similar level of interest in this framework within the field of

STS or social science studies of science. Scholarly literature related to foetal programming and DOHaD within STS and sociology has only just begun to emerge, and engagement with this framework has largely been inspired by recent developments in post-genomic science, in particular by the rise of the modern field of epigenetics following the completion of the Human Genome Project in 2003.

As noted in the Introduction, the last decade or so has seen an interdisciplinary *rapprochement* between the fields of foetal programming/DOHaD and some strands of epigenetic research, as it is hoped that epigenetics will shed light on potential molecular mechanisms through which early life programming operates and contributes to gene expression. Therefore, and in light of the general excitement surrounding epigenetic research (Niewöhner 2011), the term epigenetics has become fashionable (Ebrahim 2012). Even in specialist parlance it refers to research into the foetal origins of adult disease (Haig 2011) or DOHaD. This linguistic shift has proved consequential not only for the scientific and biomedical community in which the broad and popular use of the term 'epigenetics' is contested and debated (Smith 2012), but also for social scientists who are just beginning to take an interest in this arguably fashionable field and to make sense of the differences and overlaps between the DOHaD and epigenetic research. As noted by Landecker and Panofsky (2013), it is important to make such distinctions, as not all scholars in DOHaD, especially those with a background in epidemiology, use the molecular explanations of early life programming provided by epigenetic science. Consequently, some emerging STS research on epigenetics is at pains to point out conceptual distinctions, overlaps and interconnections between epigenetics and DOHaD (Richardson 2015, Kenney and Müller 2017); other recent work, however, seems to conflate or collapse the two fields (Mansfield 2017).

Much of the existing social science literature has focussed mainly on epigenetic research without giving much attention to DOHaD (for example Lock 2013, Niewöhner 2011, Pickersgill et al. 2013), and when research into foetal programming/DOHaD has featured in this social science scholarship, it has often been discussed in relation to epigenetic research, and not as a field on its own

(Landecker and Panofsky 2013). This is an important clarification, as this chapter does not review the existing social science literature on epigenetics in general. Instead, it focuses only on papers that contribute to the sociological/STS understanding of the foetal programming framework.

Despite being hailed as a paradigm shift in medicine by the *British Medical Journal* in 1992, the work by Barker and colleagues did not, at least initially, attract the attention of scholars in science studies. By contrast, medical sociologists were among the first to be drawn to the Barker hypothesis and his idea that adult chronic disease was already programmed *in utero*. In the early 1990s Barker's ideas offered a strikingly different perspective on the origins of health and disease, especially in the aftermath of the publication of the Black Report[3] which stressed social and economic inequalities as the major source of health inequalities in Britain. According to Gabe and colleagues, Barker's emphasis on biological rather than social markers was attractive to medical sociologists and scholars from related disciplines, as it allowed 'to redirect debates about health patterning and inequality away from overtly controversial social and political issues (…) and re-establish the causal primacy of individual level biological markers' (Gabe et al. 2004: 51). It seems that Barker's theory and his focus on biological processes of programming allowed researchers in medical sociology and cognate disciplines to investigate the relationship between biological *and* social factors influencing health in novel ways, not least because Barker's ideas gave an impetus to the emergence of the so-called life course approach according to which 'biological and social influences [on health] are not mutually exclusive' (Gabe et al. 2004: 52).

Over the years, there have not been many social science studies outside of medical sociology critically engaging with Barker's ideas. One exception is Darlene

[3] The Black Report, published in 1980 by the UK Department of Health, was produced by the Working Group on Inequalities in Health chaired by Sir Douglas Black. It concluded that 'there were large differentials in mortality and morbidity that favoured the higher social classes and that were not being redressed by health and social services' (Smith et al. 1990). The findings of the Black Report were at the time seen as controversial..

McNaughton who wrote a paper titled 'From the womb to the tomb: Obesity and maternal responsibility' (2011). Writing from a standpoint reminiscent of critical obesity studies, McNaughton analyses medical discourses surrounding the obesity epidemic among mothers and children in the Western world. McNaughton does not survey the Barker hypothesis and uses secondary sources to provide a fleeting mention of Barker's research. This is a starting point for a critique of what she calls 'obesity science'. In McNaughton's account, 'obesity science' of which the Barker hypothesis is purportedly a part, advances uncertain health claims about fatness, and it stigmatises (overweight) mothers for the ill-health of their children. According to McNaughton, this research affirms 'neoliberal ideas and values while at the same time rendering invisible the political economy that produces ill-health in the first place (poverty, racism, classism, sexism, etc.)' (McNaughton 2011: 187). McNaughton's take on Barker's research is starkly different from the approach of medical sociologists (see Gabe et al. 2004) who saw in it an opportunity to pursue research into health inequalities and questions related broadly to social justice. By contrast, in McNaughton's view, this research individualises risk and stigmatises women, especially from poorer backgrounds and from ethnic minorities.

More favourable accounts of the Barker hypothesis are offered by the sociologists Claudia Chaufan (2007) and Rebecca Scott Yoshizawa (2012). Speaking from the standpoint of a social justice advocate, Chaufan uses Barker's work as a starting point for an exploration of research into diabetes to argue that poverty and disadvantage in early life should be acknowledged as a source of this disease. Chaufan draws attention to the fact that the medical literature elides questions about the impact of poverty on health, concentrating instead on what (poor) individuals should do to improve their well-being. Thus, Chaufan suggests that the medical literature does not pay sufficient attention to social factors shaping health, such as lack of money and education. In this account, it seems that science can give an impetus to theorising about health inequalities and social justice, while at the same time halting such developments by focussing on individuals and their health rather than on the social structures that shape health and disease.

Rebecca Scoot Yoshizawa (2012) also uses the case of obesity (but not diabetes) research to advance the cause for social justice. Yoshizawa claims that the Barker hypothesis and its central tenet that many chronic diseases can be traced to the conditions of early development is particularly well suited to support what she calls 'the politicisation and redistribution of obesity expertise', as well as critical obesity studies which advocate justice for and end of stigmatisation of fat people. For Yoshizawa, far from being biologically reductionist, the Barker hypothesis offers a complex understanding 'that spans biology, social positionality, place and generation', and therefore should be understood as 'part of a larger paradigm shift towards complexity (…) and globality' (Yoshizawa 2012: 350). In a stark contrast to McNaughton who interprets the Barker hypothesis and similar 'obesity science' as neo-liberal tools for oppressing women, Yoshizawa sees in the Barker hypothesis an opportunity to advance a feminist agenda and to end the stigma attached to obese women:

> The Barker hypothesis therefore has the potential to support FA [Fat Acceptance] and critical obesity studies, particularly in framing obesity as an issue of social justice by suggesting that 'lifestyle' is not the only or even the best place to intervene as bodies materialize relations, times, places and conditions that are beyond our individual control or grasp. (…) Barker's advocacy for better nutrition for girls and women is a feminist and social justice-based project indeed. (…) the Barker hypothesis suggests what is needed is a society-wide consciousness of our mutual responsibility for the health of all people, shared with the non-human world that comprises the environment. (Yoshizawa 2012: 359)

In Yoshizawa's account, the Barker hypothesis has the potential to support a wide range of political causes, from the social justice agenda, to feminist issues, to the Fat Acceptance movement as well as environmental awareness.

The most sustained treatment of the Barker hypothesis in anthropologically and sociologically-minded scholarship has been offered so far by Warin and

colleagues, a research team which includes two social anthropologists, a scholar of life course health as well as a specialist in early origins of health and disease. In a series of articles (Warin et al. 2011, Warin et al. 2012, Warin et al. 2016, Warin 2015) they examined the Barker hypothesis and its reception, both in the popular realm (especially in the media), as well as in the scientific community (including the adoption of foetal programming in obesity research and epigenetics). .

The main thrust of their argument is encapsulated already in the first article published by this team, in which they trace the origins and spread of Barker's ideas using Foucault's genealogical method (Warin et al. 2011). According to Warin et al., Barker's early research, which focussed on maternal and foetal undernutrition as well as low birth weight, was grounded in interests in 'structural factors of gender inequality and low socioeconomic status' (Warin et al. 2011: 453). They suggest that the 'root causes' of disease identified by Barker were primarily derived from social circumstances. Warin et al. claim that this focus on the social causes of disease characterising the Barker hypothesis shifted from the 2000s onwards, when Barker's ideas e were adopted by scholars beyond the 'early origins' community, especially by researchers into the causes of obesity. Such research modified Barker's initial work by claiming that future health problems might stem not only from undernutrition in early life but also from overnutrition experienced in the womb.

From this moment, as Warin et al. suggest, 'there has been a simultaneous telescoping of foci away from wider social determinants of health to the individual bodies of women' (Warin et al. 2011: 456). Warin et al. imply that obesity research *sensu lato* (and not early origin research *per se*) could be responsible for emphasising individual characteristics – and the responsibility – of overweight women for their children's future health rather than focussing on social causes of health and disease. They also suggest that foetal programming scholars have not engaged with obesity research and that claims about risk related to maternal obesity originated outside the foetal programming framework. This suggestion by Warin et al. is rather surprising given that an important number of leading scholars from the 'early origins' community have been spearheading research into the impact of maternal obesity and

overnutrition *in utero* on the health of future children (Taylor and Poston 2007, Poston et al. 2016).

According to Warin et al., one of the consequences of such a hostile takeover of Barker's ideas, so to speak, by obesity researchers, is that

> obesity is no longer thought of as an embodiment of social inequalities (…) but a biomedical disease that has its origins in the interiority of individual women's bodies. This shift [from Barker's early work] or telescoping, we argue, has gone unnoticed since the 1990s. (Warin et al. 2011: 456)

In this account, obesity research in a broad sense (and not Barker's early work) constitutes the source of discourses which blame individual women for programming their unborn babies for obesity and related diseases in adulthood. Such discourses, Warin et al. claim, have become embedded in public discourses through 'the productive force of capillary power' (Warin et al. 2011: 456), or the media. Printed media have been singled out as disseminating inaccurate or biased accounts of the foetal origins hypothesis.

In a separate article 'Mothers as smoking guns: Fetal overnutrition and the reproduction of obesity' Warin et al. (2012) analyse the coverage of the fetal origins hypothesis and maternal obesity in the Australian press. They conclude that media were responsible for representing obesity in pregnancy as a crime (or as 'smoking guns') and for blaming (obese) women for the potential ill-health of their future children. The article stresses that while Barker's work 'potentially offers a way to reduce social inequalities in health by giving attention to living conditions, health, and nutrition of young women, pregnant mothers and their children', these dimensions of Barker's research are not reflected in media reports. Instead, the press

> is part of a neoliberal paradigm that aims to individualise responsibility and individualise the biocultural. In its shallow approach, it reaches into women's bodies to locate obesity as simply a matter of good or bad mothering. (Warin et al. 2012: 371)

In sum, this research positions Barker's early work and his focus on early life and undernutrition as 'non essentialist in its scope (…) and not biological determinism' (Warin 2015: 61), and most of all grounded in the preoccupation with gender and social inequalities. Warin et al. also seek to distance the Barker hypothesis from research on obesity as well as from broader implications of popularisation of ideas that overweight pregnant mother might somehow compromise the health of their future children by programming disease *in utero*. According to Warin et al., the neoliberal media are to blame for propagation of such ideas, and for focussing on individual women's bodies in search for risk factors. The claim that the media, as well as it seems some scientists, are implicated in distorting the representations of research into the fetal origins hypothesis is a current theme in all articles by Warin et al., who in this context also see 'the role for social scientists to point to slippages, for example, in how the developmental origins of obesity may be misrepresented in scientific and public discourse' (Warin et al. 2016: 69). In the work discussed above Warin et al. trace a particular kind of genealogy of Barker's work and its reception, a genealogy which recounts not only the origins and spread of the Barker hypothesis into the social and scientific realm, but also what amounts to its subsequent contamination and distortion outside the field of foetal programming.

Recent developments in the research at the intersection of DOHaD and epigenetics have attracted attention of the Harvard-based historian of science and feminist scholar Sarah Richardson. Richardson examines research conducted by two prominent researchers associated with DOHaD – an evolutionary biologist and a biological anthropologist. She sets out to explore the representations of maternal bodies that emerge from this scholarship (Richardson 2015). Richardson notes that DOHaD research increasingly draws on epigenetic explanations to account for the processes through which events in early life may influence the occurrence of chronic disease in adulthood. She also argues that with the advent of epigenetics there has been a considerable excitement in the social sciences about this new research that was seen to be less reductionist and deterministic and more holistic than the research

associated with the Human Genome Project. However, Richardson's analysis of DOHaD's research suggests that these hopeful expectations are yet to materialise.

In Richardson's view, research into DOHaD positions the maternal body as an 'epigenetic vector' or a space in which potential perturbation in early development might occur, and which results in increased risk of disease. Maternal bodies emerge from this literature as a site of potential 'epigenetics-based health intervention' (Richardson 2015: 221). In addition, DOHaD research sends conflicting messages to pregnant women who, on the one hand, are encouraged to do whatever they can to ensure the best outcomes for their foetuses. On the other hand, women are portrayed as having little influence over their offspring's health, as their own bodies are 'trapped' in the transgenerational cycle of transmission of the propensity to disease, a concept advanced by some strands of epigenetics research. This implies that a woman's physiology and propensity to illness is influenced by events from the past which shaped development and growth of her mother and grandmother. This in turn has implications for new understandings of risk and the management of disease, as it can lead to a rather fatalistic view that nothing can be done about the incidence of disease in future: 'in its focus on biochemical modifications of DNA mediated by the maternal body, epigenetic science reproduces and subtly reformulates determinist strategies and reductive methods' (Richardson 2015: 228). In contrast to the papers by Warin et al., which see the fetal origins hypothesis as an example of socially progressive, non-deterministic and non-essentialist research, Richardson suggests that DOHaD has retained features of biological determinism and that it draws on culturally embedded ideas about the vulnerability of female bodies and the need to intervene into female biology.

In a commentary 'Don't blame the mothers' published in *Nature* Richardson teamed up with social and natural scientists, including DOHaD scholars (Richardson et al. 2014), to explore issues surrounding public communication of this scientific field. In their view, the media reports on research into DOHaD and epigenetics present exaggerated and over-simplified claims which scapegoat mothers for the ill-health of their children. While such coverage highlights potentially harmful

consequences of development in the womb, which in turn increase the risk of obesity and diabetes in later life, it pays less attention to other factors influencing health outcomes, such as paternal contributions to the health of future children, family life and social environment. Healthy behaviour in pregnancy is important, but, over-simplified public messages about the dire consequences of certain kinds of diet or stress in pregnancy can lead to increased surveillance and regulation of pregnant women. Richardson and colleagues point out that not only the media, but scientists themselves have been contributing to the dissemination of over-simplified messages concerning DOHaD and epigenetics, and they urge reporters, scientists, press officers and educators to communicate research findings responsibly, as 'it will help the field to improve health without constraining women's freedom' (Richardson et al. 2014: 132).

Following the *Nature* commentary, a couple of articles at the intersection of public health and health communication (Winett et al. 2016a, Winett et al. 2016b) have been published with practical advice for scientists and science communicators on how to frame DOHaD research in the public realm to avoid 'mother-blame'. Winett and colleagues argue that certain metaphorical framings can shift the focus from women's individual responsibility for children's health to wider societal issues, for example: 'our genes listen to our environment', 'babies are record keepers of societal decisions', or 'our health is a car traveling hazardous roads' (Winett et al. 2016b: 1371). It remains to be seen if and how this advice will be used in practice, but the appearance of such research suggests that the DOHaD community is beginning to take interest in issues surrounding the public communication of this science (Müller et al. 2017).

As this discussion illustrates, the emerging social science literature on the foetal programming/DOHaD framework offers strikingly different readings of the meanings and implication of this research. While medical sociology has appreciated the focus of the Barker hypothesis on biological underpinnings of early life programming and its implications for future health, Warin and colleagues interpret foetal origins research as interested rather in social and structural factors, such as

gender inequality that subsequently lead to health inequalities. For McNaughton (2011) the Barker hypothesis is part of 'obesity science', or a research movement exaggerating health risks related to obesity and exemplifying neoliberal ideas that health falls within the responsibility of individual, especially pregnant women, and not society. Yet, Yoshizawa claims that far from oppressing women the Barker hypothesis has the potential to support not only a feminist agenda but also critical obesity research as well as environmental movements. For Warin et al., Barker's early work was sympathetic to women's issues, but the rise of obesity research and 'shallow press coverage' (Warin et al. 2011) misrepresented his ideas and led to blaming pregnant obese women in the public realm. By contrast, Richardson (2015) and Richardson et al. (2014) identify scientists, press officers as well as journalists as the source of over-simplified claims that burden pregnant women with responsibility and blame for their children's health outcomes. Finally, while Yoshizawa (2012) and Warin (2015) hail the Barker hypothesis as transcending biological reductionism and determinism, Richardson (2015) notices biological determinism inherent in this research.

That the Barker hypothesis and subsequent research that emerged from his work has inspired such diverse readings among social scientists is perhaps surprising, but the history of human, social and natural sciences provides examples of influential theories that have been interpreted in diametrically opposite ways. For instance, the work of the Scottish economist and philosopher Adam Smith has been viewed as foundational for ideas about free trade and free markets on the one hand (Sally 1998), while others have hailed it as a forerunner of egalitarianism and social democratic values (McLean 2006). In more recent years the concept of intersectionality in feminist studies (Davis 2008), and the concept of paradigm shift in the philosophy of science and science studies (Kuhn 1962) have inspired contradictory and even confusing interpretations about their meaning, scope and applicability in various areas of research, often beyond their home-disciplines (see Maasen and Weingart 2013).

It seems that some theories, sufficiently large in scope and interesting in terms of the questions they ask, can captivate the imagination of a wide range of scholars and stimulate vastly different thinking and interpretations – and the Barker hypothesis is an example of such successful scientific approaches. But in contrast to the ideas of Adam Smith or Thomas Kuhn which have prompted huge interdisciplinary literatures, the empirical and theoretical scholarship on foetal programming/DOHaD within social science, while also contradictory, is still remarkably scant. This is surprising, given that other areas of biomedical research with important human and societal ramifications, such as genetic and genomic science, have received intense attention over the past decades from social scientists who have scrutinised a plethora of questions, from the emergence of this field, to assumptions underpinning this research, to the nature of its claims and their communication in the media, the social and cultural implications of genetic science and so on (Atkinson et al. 2009).

In this context, it is somewhat baffling that similar research on the Barker hypothesis is lacking. For the time being the paucity of STS or sociologically-oriented explorations of the field of foetal programming, especially the paucity of empirical studies, makes it difficult to situate and assess the significance of this research, especially in recent years when it has been aligned with the emerging science of epigenetics. As research into foetal programming/DOHaD interacts closely with the policy realm and could have implications both in terms of health and social policies as well as social attitudes towards pregnancy and maternal responsibility for their children's health, it is crucial to address this important gap in knowledge and shed light on the field and the claims of foetal programming from the perspective of STS.

2.3. Science and/in the media

Over the last few decades the media have played a major role in debates about various developments in science and technology, and their implications for society (Nelkin 1995a; Nisbet et al. 2002). Issues related in particular to biomedicine and

biotechnology (Rödder 2009: 453) have received sustained coverage both in the printed media and on television, as demonstrated by controversies surrounding genetically modified foods (Turney 1998; Nerlich et al. 2000; Bauer 2002), cloning (Hellsten 2000; Haran et al. 2007), designer babies and embryo research (Nerlich, Johnson and Clarke 2003; Petersen et al. 2005), synthetic biology (Balmer and Herreman 2009) and more recently CRISPR technologies, or gene or genome editing (Kirksey 2016; Maben 2016).

Stories told by science about food, health and psychology have traditionally been of great interest to the public, as they address issues relevant to everyday experience (Gregory and Miller 2000: 111). At the same time the media have increasingly become the main, if not the only site from which citizens, outside of schools and universities, learn about scientific research. As Conrad has noted, 'for most people, the reality of science is what they know from the press' (Conrad 1997: 142)[4].

How much people actually learn about science from the media, and to what extent this knowledge affects their lives is still to be determined, as such studies are difficult to conduct. Some scholars claim that the effect of the media coverage on the public is considerable, while others suggest that these effects are small (Gregory and Miller 2000: 127-131). It also seems that much depends on the context or topic of science popularisation, as news concerning health scares have a direct impact on members of lay publics (Chapman et al. 2005). Nevertheless, it is reasonable to assume that 'news media messages and images constitute an important element of the public discourse (…) and are likely to influence the public's reception' of science (Petersen 2001: 1256). What is said about and by science in popular media, and how it is said, can influence public opinion as well as popular beliefs and understandings

[4] To this we can add social and online media as increasingly important channels for science communication (Trench 2014; Peters et al. 2014; Welbourne and Grant 2016). However, these new media are not the focus of this thesis: in the future more research is needed on communicating the science of foetal programming in online media.

of what science is and what it does (Nisbet 2009; Nerlich et al. 2009; Kueffer and Larson 2014).

The role of the media as a site where science is communicated and popularised has been an important field of research (Lewenstein 1995a; Bauer and Bucchi 2007; Bucchi and Trench 2008). A traditional model of science communication according to which science flows from knowledgeable scientists to an ignorant public, has been called 'the dominant view' of science popularisation (Hilgartner 1990), the 'canonical account' (Shapin 1990) or 'diffusionist model' (Cooter and Pumfrey 1994). This model tended to stress the divide between science and its popularisation as well as the importance of educating the public to gain support for science (Whitley 1985; Weingart 1998). Early studies of popular science texts were underpinned by a range of assumptions, namely that scientists were the only actors with a professional authority to speak about science; that the public was ignorant and required messages about science to be simplified to the point of being 'distorted, hyped up or dumbed down' (Myers 2003: 266); and that the transfer of scientific knowledge was unidirectional from science to society, mainly in the form of written statements (Myers 2003: 266). Popularisation of science was viewed as a a 'necessary evil', and the professional norms discouraged scholars from engaging in such activities (Sismondo 2010: 170).

Over the last few decades this so-called deficit model of science (Wynne 1991, 1995) and of science communication (based on the assumption that members of the public have a knowledge deficit that needs to be filled by science) has faced criticism (Cooter and Pumfrey 1994, Sturgis and Allum 2004; Bauer et al. 2007; Nisbet and Scheufele 2009), and science scholars have analysed aspects of science popularisation that had been overlooked. An important advance in this field of study was the realisation that science and its popularisation are not separate and that they can be considered as a continuum. According to a 'continuity' model of science communication (Cloître and Shinn 1985), the transfer of knowledge proceeds in a gradual fashion through several stages – intraspecialist, interspecialist, pedagogic and popular level – which differ from each other by degree of

specialisation/simplification of information, and by degree of certainty/uncertainty surrounding knowledge. In this view, public communication of science is understood as a 'continuation of scientific debate by other means' (Bucchi 2008: 61), or as doing science in public (Gregory and Miller 1998).

Subsequent research has shown that science popularisation is not a one-way process of knowledge transmission. As the relationship between science and the public is now considered more complex and reciprocal (Thorpe and Gregory 2010), social science and media scholars have scrutinised the ways in which increasing interactions between science and the media shape and affect not only public opinion and public understandings of science, but also science itself (see for example Lewenstein 1992; Lewenstein 1995b). In the following I provide a brief overview of the ways in which the interactions between science and mass media influence both scientists and their scientific practice.

2.3.1. Science in public: from popularisation to medialisation

Scientists' engagement with the public has a long tradition in the Western world (Gregory and Miller 1998). Engaging the public served various goals, from creating enthusiasm for science, to getting publicity, through to obtaining financial gains and achieving professional recognition, as illustrated by such cases as public demonstrations of electricity in 18th century (Schaffer 1983), advertising of scientific books and instruments in the 17/18th century London press (Wigelsworth 2010), or Pasteur's public experiment with anthrax vaccines (Bucchi 1997).

These historical insights have informed a more recent understanding of the role of science communication and popularisation which have been increasingly seen as strategic and political activities, and as an integral part of making scientific knowledge. The growing reliance of scientists on the mass media to communicate about their research should be interpreted in a wider context of the increasing significance of popular media in Western societies. According to Gregory and Miller,

‘the mass mediaserve many of the same purposes for scientists as they serve for other individuals – the promotion of a personality, idea, or cause, a few moments of fame, money and entertainment’ (Gregory and Miller 2000: 83-84).

The increasing interdependence of science and the mass media has been diagnosed as ‘medialization of science’ (Weingart 1998), or a process in which scientists engage with the media to gain prominence, win public support and eventually to get funding. Medialization is an interactive process in which both the media are more attentive to scientific issues and scientists become more attuned to the media’s specific interests and needs.

In addition to the changes in the relationship between science and the press, there is a growing pressure from funding bodies which are eager to see the impact of funded research (Martin 2011) and which expect scientists to engage with the public and the media (Holliman et al. 2009; Stilgoe et al. 2014). In contrast to previous decades when the norms of professional conduct (Merton 1973) tended to dissuade researchers from contacting the press, (Dunwoody and Ryan 1985), nowadays these norms – while not discouraging such contacts - shape expectations as to who should represent science in public and how, and what is deemed a suitable science communication (Peters 2013: 14106). Such expectationsare contradictory and rules governing how to popularise science are often used in a self-serving fashion: scientists invoke them when they want to criticise other scholars, but eschew them when they themselves communicate in public. In addition, ‘scientists who do not popularize tend to see popularisation as something that would damage their own career; however, they also think that other scientists use popularization to advance their careers’ (Gregory and Miller 2000: 82-83).

More recent research suggests that career motivations or fears are not the prime reasons for scientists to get involved in public engagement and that the decision whether to popularise science or not is influenced by the norms of their profession, or by ‘what others do’ (Poliakoff and Webb 2007: 257), It seems that the requirement to go public with scientific findings is still met with various degrees of

ambivalence among scientists (Rödder 2012), with some claiming that prominence in the media can indeed be damaging for the professional career. This is exemplified by the case of the astronomer and populariser Carl Sagan whose career suffered as a result of the perception that 'popular, visible scientists are worse academics' (Martinez-Conde 2016: 2007). On the other hand, it seems that most scholars have started to consider visibility in the media as a professional duty (Peters 2013), as they recognise the value of public funding of science. Research has also shown that contrary to assumptions that scholars shun reporters, scientists meet and talk with journalists more often than previously thought, and they tend to rate their experience with the mass media in a rather positive fashion (Peters 2013). At the same time scientists have become more savvy in their interactions with popular news outlets (Rödder 2009), and some achieve the status of 'visible' or 'celebrity' scientists.

2.3.2. From 'visible' to 'celebrity scientists'

Scientists' visibility and role in the public sphere have attracted the attention of social science and communication scholars. The pioneering work of Rae Goodell (1977) focussed on 'visible scientists', or prominent scientific figures in American public life, such as the astronomer Carl Sagan or the anthropologist Margaret Mead, who used popular media to discuss scientific problems, but also to advocate social and political issues. Goodell's 'visible scientists' mastered the skills that usually attract media attention, such as eloquence and excellent self-presentation, and worked on topics of great relevance to fears and problems of contemporary society (Weingart 1998: 870-871). .

Goodell's research has revealed that 'visible scientists' deployed various strategies of relating to the public to promote their interests and to gain influence in various domains, not necessarily related to their field of expertise. Subsequent research has suggested that scientists' influence over the media goes even further. According to Nelkin's (1995b) seminal analysis of the media coverage of science and

technology, scientists can impose their culture, values and concerns on journalists, who for their part are willing to accept 'the ideology of science as a neutral authority' (Nelkin 1995b: 163). As many scientific issues discussed in the public realm display a high level of complexity, journalists are often not able to evaluate or question scientists' claims. This leads to the situation in which scientists enjoy a considerable interpretative flexibility in addressing the public about scientific research. They can simplify or adjust their claims depending on the context, while being able to claim that journalists have distorted science in their coverage (Hilgartner 1990). They can also maintain some level of control over the meaning of their research findings that is disseminated in the press (Dunwoody 1999: 60). As a result, and unlike arts and literature, science and technology are usually shielded from criticism in the mass media, unless there occurs a crisis situation (Nelkin 1995b: 164). In general, and despite 'canonical' (Shapin 1990) views of science popularisation, science is dependent on its popularisation, as this supports its privileged status in society (Sismondo 2010: 173).

In the 20th and through to the beginning of the 21st century, science has continued to enjoy its special status and has been a major source of social authority in Western societies (Fahy and Lewenstein 2014: 84). Building on the notion of a 'visible scientist' Fahy and Lewenstein suggest an increasing tendency in the public culture 'to plaster a human face' on various ideas, including scientific ones, and to reduce complex issues to the voices and personalities of charismatic scientists. In the context of medialisation, or what Fahy and Lewenstein call 'the mediatisation of science' (ibid.: 88), where popular media outlets play an increasingly important role in setting debates about science and technology, they note a shift from 'visible' to 'celebrity scientists'. While 'visible scientists' from the mid-twentieth century onwards were prominent scientific figures who used their expertise to advocate their perspectives on various issues, 'celebrity scientists' of the 21st century are scholars whose public and private selves are merged in media representations and whose distinctive media portrayal as exceptional scholars is commodified to promote books, media broadcasts, policies and also science itself (Fahy and Lewenstein 2014: 88).

Celebrity can be understood as a genre of representation which has an important social and cognitive role to play. Celebrity scientists 'help audiences make sense of the social world' as they 'articulate and represent values and beliefs that are often implicit', and as they personify otherwise abstract ideas (Fahy and Lewenstein 2014: 88). In the media culture which focuses on individual characteristics of scientists, the process of becoming a celebrity is in Fahy and Lewenstein's view inevitable, providing that the scientist successfully engages with the media over a long period of time and manages to communicate to sufficiently large publics. This can be illustrated by the fact that some of the top scientific celebrities, including Stephen Hawking and Richard Dawkins, are often interviewed by the press not only on topics related to their expertise, but also on a wide range of non-scientific issues. Being visible in the public realm, i.e. being able to successfully engage with broader audiences, furthers scientists' presence in the media and contributes to building their celebrity status (Bucchi 2015: 244).

2.3.3. Presence in the media as marshalling of resources

Appearing in the media and popularising science, as Gregory and Miller have argued, is not only part and parcel of sharing scientific knowledge but also of making it (Gregory and Miller 2000:84). Visibility in the media can be used as a strategy to gain support not only from the public, but from the broader scientific community as well. Phillips et al. (1991) have shown that research mentioned in prominent newspapers such as *The New York Times* tended to have more citations in scientific journals. The study has illustrated that the presence of science in the media significantly increases its visibility among other specialists. These findings resonate with Hilgartner's (1990) analysis of the dominant view of popularisation which has claimed that instead of being treated as 'pollution', popularised knowledge influences the process of producing science itself, as 'scientists learn about fields outside their immediate research areas from popular accounts, and these shape their beliefs about both the content and the conduct of science' (Hilgartner 1990: 522).

Bucchi (2008) has pointed out that science popularisation is akin to political discourse, as it aims to address other scientists without having to pass through stages of peer review and other constraints of specialist communications. One historical example of this kind involves Albert Einstein who in 1919 ‘was able simultaneously to address different disciplinary audiences (physicists, astronomers, mathematicians) through the popular press by giving interviews and writing articles on his theory of relativity’ (Gregory and Miller 2000 quoted in Bucchi 2008: 63-64). Another case relates to the publication of James Watson’ autobiography The Double Helix (1968), which was widely interpreted as Watson’s attempt not only to promote a certain self-image, but also to recruit followers and students of the then emerging discipline of molecular biology (Yoxen 1985).. In sum, science popularisation is a valuable resource for scientists, as ‘communication with closer colleagues via the public media can reinforce allegiances and convert opponents’ by providing simplified accounts of science (Gregory and Miller 2000: 85). It appears that popularisation is beneficial for scientists at it moves knowledge into new domains (Sismondo 2010: 173). In a broader sense this and other examples suggest that ‘all writing by scientists and about science could be understood rhetorically as attempts by the scientific community to marshal resources for its own purposes’ (Lewenstein 1995: 349).

2.3.4. Media as a site of scientific field-making

As this discussion has shown, popularisation of science can feed back into the process of doing science, but it can also be used to advance a new theory or a new scientific field. That popularisation in itself can spearhead new kinds of research or a new field might sound somewhat surprising, but as Gregory and Miller have argued:

> scientists use popularization to resolve conceptual controversies because popular media communicate more quickly. (…) In a field that is poorly institutionalized (perhaps because it is new, or because of rapid or radical conceptual change, security and rewards are hard to find, and scientists may look to popularization to provide these. (…) Popularization is used

> to define the boundaries of a new field – it stakes a claim on a new domain. When a debate occurs in a field, which though established, is not fully institutionalized, some communication of ideas must inevitably take place beyond institutional boundaries. (Gregory and Miller 2000: 85-86)

The case of cold fusion is a well-studied example of attempts to advance claims about a scientific and technological revolution through interactions with the media (Lewenstein 1992, Lewenstein 1995b, Bucchi 1998). In 1989, scientists Stanley Pons and Martin Fleischmann announced at the press conference that they had successfully achieved a nuclear 'cold' fusion, that is at room temperature and with little water and electricity. The claim, which had not been backed by any scientific publication about the details of Pons and Fleishmann's experiment, sparked international controversy, both in the media and in the scientific community and ended up being refuted. At the same time, this case shed light on the role of popular media , which for a long time was the only available source of scientific information about the cold fusion experiment to scientific communities worldwide. Nowadays things are slightly different as outrageous claims are very quickly checked and deconstructed online, as for example in the recent case of the discovery of neutrinos that travelled faster than light (Nerlich 2013).

Another example pertains to the so-called Alvarez hypothesis (Alvarez et al. 1980) which claimed that the mass extinction of dinosaurs was caused by a collision of an asteroid with the earth. According to Clemens, 'the Alvarez theory offered an elegant solution to a question embedded in popular culture' (Clemens 1986: 448), as it linked the extinction of dinosaurs (a pop-science favourite) with an 'extraterrestrial' cause (extraterrestrial influences being an intellectual fashion at that time). Such features made the Alvarez hypothesis a great story, and the popular press not only promoted the hypothesis, as approximately one third of scholars involved in the subsequent debate first learned about it from popular media (Bucchi 1998: 11). It also helped direct the debate about the causes of dinosaurs' extinction (Lewenstein

1995a) and put it firmly on the map of legitimate, albeit controversial theories in several scientific fields.

These and other cases where scientists sought the attention of the media to advance new claims are what Bucchi (1998) has called 'crisis situations' and 'deviations' from well-established routes of science communication, whereby science must be first confirmed and validated by the scientific community before being disseminated in the public realm. In situations of crisis, however, when the popularised science is still emerging and weakly institutionalised, scientists can attempt to bypass channels of professional communications and use the media to speak directly to other scientists and lay publics to gain support. This way of gaining publicity and potentially legitimation for a new field is thus sought through what Bucchi has called 'alternative routes in scientific communication' (1998).

This concept is at the centre of Bucchi's theoretical framework of science communication used in this thesis (this framework will also be discussed in more depth in Chapters 3 and 4). Bucchi applied the framework of alternative routes of scientific communication in his exploration of several cases when science 'went public', which included the afore-mentioned case of cold fusion as well as the story of Pasteur's public experimentation with the anthrax vaccine, famously analysed by Latour (1988). As Bucchi argued:

> In the late 19th century, Pasteur's struggle to legitimise the anthrax vaccine and, more generally, the idea that diseases could be prevented by appropriate inoculation with the infectious agent, meant that physiologists, doctors, veterinarians and farmers had to be addressed simultaneously. This difficult task was achieved by means of a public experiment organised in 1881 on a farm, where vaccinated and non-vaccinated cattle were infected with anthrax before the eyes of hundreds of people, including French and foreign newspaper reporters, who wrote numerous detailed articles on Pasteur's success. Communication at the public level enabled the French physiologist to play down still unclear

> theoretical issues by emphasising practical ones (of great importance to some groups in his audience, e.g. farmers and politicians) such as the effectiveness and cheapness of his method. (Bucchi 2008: 63-64).

Thus, alongside the Alvarez theory, Pasteur's public experimentation with the anthrax vaccine are cases where the popularisation of science in the media contributed to its establishment as legitimate research, and to its dissemination and uptake in the scientific realm. In these cases, popularisation of research contributes not only to public claim-making about science, but also to scientific field-making in the public realm.

The questions surrounding attempts to build science in public have also attracted the attention of other scholars. For scientists, as Ten Eyck and Williment (2003) have argued, the mass media act as a tool of legitimation of their research practice and claims. However, the legitimation of science through media reporting cannot be taken for granted, as journalists, in their attempt to cover all sides of a story, often consult other actors who might present a critical view on the matter being debated. As Nowotny has put it, 'the public nature of science is no longer taken for granted. Rather, science is challenged publicly as not being public enough' (Nowotny 2005: 1). Demonstrating the relevance of science to society seems to be the key to its legitimation, and it has become a major concern for scholars keen to justify the rising costs related to their research. This suggests to Weingart et al. (2012) 'a precarious position of science in mass democracies' as well as a necessity for science to face various challenges to its legitimacy (Weingart et al. 2012: 3364).[5] This situation is currently being aggravated by the rise of false balance and fake news

[5] The claims of public science currently being under assault (for example Nowotny 2005; Nowotny et al. 2001) should be put in perspective. As Peters et al. remind us, 'In public opinion surveys, science is regularly shown to enjoy more public confidence than politics and economics. What is noteworthy about this is that the difference in the levels of trust is not primarily due to a belief that science is more competent; rather, it can be attributed to the assumption that science is independent of interests and oriented towards the common good' (Peters et al. 2008b : 13). See also Fahy and Lewenstein (2014).

in the media, for example in relation to climate science (Fahy 2017, see also Peters 2017).

In this context, Peters and colleagues have argued that medialisation of science, or orientation of science towards the mass media's needs and interests has become 'a prerequisite of its legitimation and political relevance' (Peters et al. 2008b: 71). In their study of German press coverage of epidemiology and stem cell research, Peters et al. have noted that 'a *mere mention* in the media as frequently as possible (as long as it is non-deprecating)' constitutes an important goal for scientists and PR officers employed in research institutions (Peters et al. 2008b: 81, italics in the original). Presence in the media, however meagre, is interpreted as a sign of successfully demonstrated relevance of science for society, and it is also perceived as increasing the chances of 'being noticed and taken seriously' by policy makers (Peters et al. 2008b:71).

2.3.5. Science, the media and the question of hype

As legitimation of science and chances of funding are increasingly linked with favourable media reporting, scientists develop various discursive strategies to appeal to the media (Weingart 1998). Already in the 1990s, Nelkin noted that scientists 'are becoming adept at packaging information for journalists. Like advocates in any field, they are prone to overestimate the benefit of their work and minimize its risks' (Nelkin 1995b: 163). In so doing they often rely on images, catchwords or 'promotional metaphors' - exaggerated metaphorical statements which draw on existing cultural scripts, as well as on social and cultural beliefs to create favourable representations of science (Nelkin 1994). Nelkin illustrated her argument with an analysis of the media coverage of the Human Genome Project, which was presented to the public through a variety of catchy metaphors. For example, the predictive power of genetics was conveyed through such metaphors as 'Delphic Oracle', a 'medical crystal ball', or a 'trip into the future'. The human genome was frequently referred to as the Bible, the Holy Grail or the Book of Man, while other scholars also

noted that genetic research was compared to the new frontier, a metaphor well-entrenched in the American culture, which conveyed images of heroic (white and male) scientists conquering unknown territories or looking for gold (Ceccarelli 2013). Far from being 'accidental', promotional metaphors and other rhetorical devices are deployed strategically with the view to create a certain image of science (Van Dijk 1998, Hubbard and Wald 1997). Such metaphorical framings might inadvertently misrepresent the meaning of research, overblow its importance and create inflated expectations about the future, which might mislead the public and undermine its support for science (Nelkin 1994).

Weingart (1998) has argued that the competition of science for attention in the media is one of the manifestations of the medialisation of science. Researchers, with an eye on capturing the interest of policy makers and funders, can engage in 'discursive overbidding', or such a strategic adaptation of scientific discourse to the perceived needs of the media which results in 'simplified, dramatized pronouncements and prognoses calling for immediate action which are taken up and amplified by the media' (Weingart 1998: 876). In the context of climate change debates in the press, this discursive overbidding manifested itself in catastrophic scenarios and forecasts which Weingart has called a Cassandra syndrome (1998: 873). This pattern of science-media interactions and the resulting discursive overbidding is not limited to climate change debates, and it can be detected in other policy-relevant areas of research, especially those which seek to establish themselves as independent fields:

> A small group of scientists (from different disciplines) who proclaim this danger also provide suggestions for a solution. The promise to be able to avert the threat comes with the authority of scientific expertise in a brand-new research area and is tied to the condition of needed financial support. Once this arrangement is successfully established, the scientific organizations are founded and the respective field begins its life cycle, the knowledge expands, becomes more differentiated, specialized,

> abstract and often less important for the practical arena for which it was originally recommended. (Weingart 1998: 878)

In Weingart's view, this discursive overbidding, along with other phenomena, such as the increasing role of scientists as media stars, is a symptom of of the medialisation of science, as well as ' 'an expected side phenomenon of modern mass democracies' (1998: 878). Importantly, Weingart argues that neither science nor the media should be blamed for this state-of-affairs, as both find themselves constrained by the structural and institutional realities in which they function.

By advancing the concepts of 'promotional metaphors' and 'discursive overbidding' Nelkin and Weingart were among the first scholars to draw attention to the fact that hype, or exaggerated claims surrounding science, can result from interactions between scientists and the media, and that researchers can be personally implicated in its production. This approach contrasts with some other strands of research which usually blame the media for hyping or misrepresenting research in the public realm (for example Koshland 1991). Such claims re-emerge whenever new 'breakthroughs' and advances in hot areas of research are announced and new promises about science are made in public . In the context of the media coverage of research related to the Human Genome Project in the 2000s, some commentators put the blame for 'genohype' on distorted media reporting, while it seems that 'in some circumstances the media reporting of science was surprisingly accurate and portrayed a message created by the scientific community' (Caulfield 2004: 337).

Subsequent research has shown that both journalists and scientists are implicated in the production of hype (Nerlich and Halliday 2007). Other sources of inflated claims have also been identified, such as press officers employed by universities and research institutions (Borchelt and Nielsen 2014), as well as press services of scientific journals (Franzen 2012). In a recent paper Caulfield and Condit (2012) have described a 'hype pipeline', an environment which favours and promotes exaggerated claims in science. The social forces that contribute to the 'hype pipeline' are varied, including 'the pressure to publish, the increasingly intense

commercialization agenda, the messaging emanating from research institutions, the news media and, even, the public itself' (Caulfield and Condit 2012: 209).

Caulfield and Condit argue that with so many important factors at play, it is impossible to prevent hype without changing the environment in which it thrives, a move which would require an introduction of new research-related policies. Similarly, Weingart (2017) has argued that 'because hype in science has systemic causes, the solutions need to be systemic as well' (Weingart 2017: 115). The fact that hype is a kind of aberration of science communication is beginning to be addressed by some research institutions which have started introducing new codes of conduct to counter hype (ibid.). It remains to be seen what effect such codes will have on the practice of science communication.

Although much has been written about hype in science, it seems that this topic is still quite under-researched. Weingart (2017) has identified several areas where more research is needed, such as empirical studies of particular cases of hype, the attitudes – and un/willingness of scientists to hype public messages, the actual effects of hype, including the potential to attract public attention and to affect credibility of science, and so on (see also Master and Resnik 2013). Most importantly, the question of what exactly constitutes hype and what is not is still difficult to answer. According to Weingart:

> the main criterion involved in defining hype is the illegitimacy of the conclusions it invites. (…) Only by a fine line is this sort of distortive advocacy separable from fraud (Weingart 2017: 112)

It thus seems that what is hype and what is not can be differentiated by degree rather than by kind. In this context, it is tempting to ask, following Nerlich, 'when does extravagant publicity [of hype] become fraud or deception?' (Nerlich 2013: 44). In a recent article Master and Resnik (2013) claim that hype can be captured on a

> linear scale with one end having publicity that is fully fact based with little prediction of scientific futures outside the known facts, to the

> opposite end where there are inaccurate predictions or complete exaggerations without any insight of factual support; as we move from left to right hype increases. (Master and Resnik 2013: 325)

In Master and Resnik's view then there is a cut-off point on this scale where what they call 'publicity' ceases to be a factual description of science and becomes an increasingly hyped public communication. As hype can undermine public trust in science, Master and Resnik call for more research on such issues.

In relation to this debate, Nerlich has argued that a different distinction might be helpful, namely the one between 'honest hype' and a 'politicised hype'. According to Nerlich, hype in science is unavoidable, because research is communicated in a narrative form which requires engaging and persuading the readers, be it the readers of newspapers or the readers of funding proposals. 'Honest hype' could be defined as an everyday or routine hype in which everyone engages, because it stems from the mere selection of an issue for attention of journalists or scientists – 'I select, therefore I hype' (Nerlich 2013: 45). 'Honest hype', while conveying excitement related to research, does not involve dramatisation or sensationalism. On the other hand, 'politicised' hype can be intentional in its overstating of claims and it can occur in those areas of research that have been operating in a heightened context of medialisation of science (Weingart 1998), such as climate change research, where the scientific debate is polarised between 'two rather vocal ideological camps' (Nerlich 2013: 51). In modern academia driven by the impact agenda and acceleration in the production of research outputs, 'honest hype' as well as moderation and modesty in claim-making seem to be available, as Nerlich notes, only to some not politicised areas of research like for example particle physics iNerlich 2013).

The questions of humility and modesty in science are at the centre of a recent paper on hype in epigenetic research by Martyn Pickersgill (2016). Pickersgill notes that the scientific ethos still requires researchers to communicate according to the rules of 'epistemic modesty', or moderation in claim-making and awareness about the limitations of scientific knowledge. On the other hand, the growing pressure

within the academic environment to communicate with immodesty and immoderation means that scientists have simultaneously to operate within two conflicting regimes of scientific praxis: the regime of epistemic modesty and the regime of the epistemic ostentatiousness. According to Pickersgill, epistemic ostentatiousness is

> a rather more flamboyant display of scientific knowledge that while not deceitful nevertheless presents the 'best side' of research and of researchers to a range of audiences. Part of being a 'responsible' scientist, it seems, is to know when, in both public and professional forums, to adopt the appropriate register of modesty and ostentation – a trick that relates to the wider scientific consensus on the epistemic domain in question. (Pickersgill 2016: 198-199)

This means that hype can be identified mainly in the context (lay or professional) in which claims are being madeand understood as a marker of scientific 'dissensus' (Pickersgill 2016: 199) on specific questions that are being hyped.

Hype has also been an important focus of research within the field of the sociology of expectations (Brown and Michael 2003, Brown 2003, Borup et al. 2006). Much of this literature analyses the role of expectations for the development and shaping of biotechnological areas of innovation. In this research, expectations, as well as promises and inflated claims, are considered as 'fundamentally generative' (Borup et al. 2006: 285): they inform various activities related to the development of new biotechnologies, they work as a tool of legitimation for research and innovation, and they attract interest and investors. In this account, biotechnologies of the future are discursively created in the present 'through contested claims and counterclaims over its potential' (Brown et al. 2000: 5). Expectations, promises and hype are then performative, as they constitute 'wishful enactments of a desired future' (Borup et al. 2006: 286). On the other hand, if the extravagant promises remain unfulfilled, hype can be damaging for 'credibilities and reputations' (Brown 2003: 17). Despite the reputational damage looming large in case of unrealised promises, hype is difficult to pin down as the 'communities of promise are constantly presented with the difficulty

of judging the veracity of future claims' (Brown 2003: 17). It is also difficult to avoid, as hype seems to be part and parcel of the process of imagining the future (Franklin 2001).

Kitzinger and Williams's (2005) work on the embryo stem cell debate in the UK is an example of empirically grounded research on what hype is and how it works. In their article Kitzinger and Williams have analysed how competing visions of futures, both utopian and dystopian, were mobilised by proponents and opponents of embryo stem cell research in the media. In this context, the concept of 'hope' invoked in relation to embryonic stem cells performed rhetorical functions and mobilised visions of future breakthroughs and cures for the sick. At the same time, the claims that adult stem cells could be used for similar research were dismissed in the press as 'just hope' or exaggerated hopes. Thus, in the media debate hype about the potential of embryonic stem cells was used alongside anti-hype which downplayed the usefulness of adult stem research. Both hype and anti-hype had a performative role as they were used to legitimise and de-legitimise particular strands of research by pointing to competing visions of futures.

In subsequent research Kitzinger (2008) has explored the issue of hype in the case of Woo-Suk Hwang, a South Korean scientist, who claimed to have performed the first cloning of human embryonic stem cells. The announcement of his achievement in *Science* sparked an international furore as well as speculations about future cures for many diseases. The hopes about imminent cures were dashed, when after an investigation, Hwang admitted to fraud. Kitzinger has explored how the UK press initially used Hwang's breakthroughs to paint a positive and hopeful image of stem cell research, and how after the discovery of scientific fraud, the proponents of this research sought to save hope related to this science by performing careful boundary-work which demarcated hopeful and legitimate kinds of stem cell research from those cases in which 'the hype has gone too far' (Kitzinger 2008: 426). In this context Kitzinger has noted that the concept of hype is

> an excessively simplistic way of characterizing the complex processes involved in the creation, management and repair of hope. It is a blunt

> instrument which fails to address the shifting alliances and oppositions evident as key protagonists compete to assert different versions of hope. (Kitzinger 2008: 432)

Hence, accusations of hype can be understood as attempts to de-legitimise competing visions of the future or to scapegoat the media for inflating science-related claims, while saving the reputation of scientists and policy makers. Most importantly, as Kitzinger has argued, going beyond the accusations of hype allows to examine 'complex processes involved in the creation, management and repair of hope' which occur over longer periods of time (Kitzinger 2008: 417).

As this discussion has shown, there are numerous tensions in the scholarship pertaining to hype in science. There are clearly definitional issues, and while hype can be identified with a high degree of confidence in cases of fraud, in other cases it could be a matter of degree (Weingart 2017, Nerlich 2013). Defining hype remains elusive (Brown 2003), and this makes it, as Kitzinger (2008) claims, a problematic analytical category, since it lumps together complex processes of creating and managing expectations in science. According to the sociology of expectations (Brown and Michael 2003, Borup et al. 2006) hype has a performative function as it mobilises scientists and various other actors around a particular research agenda, but it can also be seen as a tool for marshalling resources (Weingart 1998), and as a kind of PR exercise which aims to create a favourable, though exaggerated, account of science's potential and achievements (Nelkin 1994). Some scholars consider that (at least some degree of) hype is inevitable as it is inextricably linked to the creative processes of imagining the future (Franklin 2001), or, as Nerlich (2013) has noted, it stems from the narrative forms of science communication. Accusations of hype have also attracted scholarly attention, and they can be interpreted as markers of a scientific 'dissensus' (Pickersgill 2016), or as a rhetorical tool which, along with what has been called 'anti-hype' (Kitzinger and Williams 2005), can be used to de-legitimise competing approaches to science (Kitzinger 2008).

At the same time there is a strong sense in the literature discussed above that 'bad' hype, in the guise of what Jasanoff (2003) has called 'the technologies of

hubris' should be avoided in the realm of science and public policy. In this context the calls for more humility (Jasanoff 2003) in science coincide with sober realisation that modesty and moderation may not or no longer be available options in many areas of research (Nerlich 2013), and that the new norms of modern academia expect scientists to communicate both with ostentatiousness and modesty (Pickersgill 2016), posing real ethical dilemmas to scientists and communicators. Finally, it is not clear whether hype undermines trust in science and the credibility of scientists – while the sociology of expectations claims that hype presents such a danger, Nerlich (2013) argues that this is not certain and that much depends on what is defined as 'hype', 'trust' and so on. In any case, as Weingart (2017) has noted, more research is needed on the conditions which favour the incidence of hype and the impact of hype on science's credibility and reputation.

2.4. Conclusions

This chapter has outlined two key sets of literature which provide the background and context for this thesis. First, it has homed in on the emerging sociologically-oriented scholarship on foetal programming, and second, it has provided an overview of themes grounded in the sociological studies under the rubric of science and/in the media.

This literature review suggests that there is a considerable gap in STS scholarship on the foetal programming framework, both with respect to empirical studies and theoretical conceptualisations. The existing studies of foetal programming have given scant attention to the issues of knowledge production in this field, despite the fact that such questions are a major concern in STS scholarship. In the literature surveyed in this chapter only one article critically analyses the claims or the context of the production of claims from the field of foetal programming/DOHaD (Richardson 2015) in the tradition of STS or science studies. One study (Warin et al. 2012) offers an analysis of the coverage of research into foetal programming in the Australian press. The majority of existing studies are primarily concerned with the (assumed or (un)desirable) societal consequences of

this research, primarily in terms of social justice, health and gender inequalities, as well as social and cultural attitudes towards pregnancy and early life. Most recent publications (Richardson et al 2014, Winett et al. 2016a) point to the need for responsible public communication about foetal programming/DOHaD which should avoid both exaggeration and oversimplification of scientific claims as well as blaming pregnant women for the health outcomes of their children. The majority of the literature discussed in this chapter does not provide an in-depth analysis of the foetal programming framework, but it offers varied and often contradictory views on what this field is, what it says and what it means for society. There is then a clear need for more empirically-grounded studies of this emerging science. This thesis seeks to fill this important gap and shed light on this field's assumptions, claims and significance in the current landscape of post-genomic sciences.

This chapter has also provided an overview of the STS/sociological literature under the rubric of science and/in the media. It has focussed on several issues concerning the impact of the changing nature of the relationship between science and the media on the scientific practice and scientists themselves. Engaging with the mass media, once discouraged, is now increasingly expected, especially from scientists working in publicly funded institutions which are under pressure to demonstrate impact, and to legitimate the high cost of science brought upon the taxpayers.

As this literature overview has shown, science popularisation is not merely an exercise of disseminating simplified knowledge to lay audiences. It is an important resource for gaining the support of tax payers, funders and policy makers, to attract followers and allies in the professional realm, to build a personal reputation as a public expert or a 'visible scientist', as well as to establish and promote new theories or fields of research. Thus, science popularisation, far from being a one-way knowledge transfer, feeds back into the research process and what I have called in this thesis 'field-building'. It also changes the norms of scientific conduct in the public realm, including the norms of public communication of science. In this context, the issue of hype has attracted sustained attention from social scientists, who

have analysed various kinds of rhetorical work performed by inflated claims in the public realm. They have also pointed out several areas in which more research is needed, including into the conditions which promote the incidence of hype and its potential effects on the sciences and their publics. This thesis seeks to contribute novel empirical findings, as well as novel theoretical insights, to the STS and sociological literature on these issues.

Chapter 3. Research design: theoretical approaches and methods

3.1. Introduction

This chapter outlines the design of this thesis, including the theoretical approaches and the methods used to carry out the empirical research. The first section of the chapter outlines discursive studies and metaphor analysis within Science and Technology Studies. It is followed by the second section which discusses theoretical approaches adopted for this thesis: i) Bucchi's framework of discursive studies of science communication, ii) Maasen and Weingart's framework of metaphor analysis, iii) as well as qualitative interviewing and mixed methods research which is underpinned by Collins' concept of 'alien science'. The third part of the chapter focuses on the research process, and it provides more detail on the methods of the media and interview analysis, sampling strategies and ethical considerations. The chapter then concludes.

3.2. Discourse and metaphor studies in STS

The research for this thesis is situated within the field of Science and Technology Studies (STS), a heterogeneous area of scholarship concerned with 'creating an integrative understanding for the origins, dynamics, and consequences of science and technology' (Hackett et al. 2008: 1). While there has been a long debate and disagreement about the intellectual boundaries, theoretical coherence as well as the scope of this field of research (Jasanoff 1999: 59), what studies in STS seem to have in common is

> an empirical focus, an interest in the content of scientific and technological developments rather than just their application, an awareness of the political implications of such work, and how it challenges conventional authority. (Hedgecoe and Martin 2008: 818)

To put it simply, STS is primarily interested in the ways in which knowledge is created (Roosth and Silbey 2009). Similarly, Sismondo defined STS as the field that 'looks to how the things it studies are constructed' (Sismondo 2008: 13), thus drawing attention to what he called 'the metaphor of construction' and the strong tradition of social constructionism (Berger and Luckmann 1966) that underpins much of STS research. The implications of adopting this school of thought for STS is that science and technology are considered as social, active and 'not themselves natural', which means that they do not stem directly from nature, but are constructed or produced by human effort (Sismondo 2008: 14). Within the field of STS, the idea of social construction was applied to the analysis of various aspects of science, from the construction of data and phenomena which are studied by science, through the construction of methods and epistemologies, to the construction of facts and artefacts, and to the construction of boundaries of disciplines which are produced discursively (Sismondo 2008).

While STS has traditionally drawn on diverse research methods (Pickersgill 2013), studies of the rhetoric and discourse of science occupy an important place within this field. Some of the canonical studies in this field conducted by Gilbert and Mulkay (1984), Gieryn (1983), Myers (1990), and even the ethnographic work of Latour and Woolgar (1986) are all interested in the ways in which scientific arguments, facts and theories are constructed with the help of rhetorical tools. On this view, science is not a 'special' domain that should be studied separately or in a different fashion from other areas of social life. Instead, science and its discourse can be analysed 'just as any other literary form (…) through its language, genre, style and rhetorical structure' (Hackett et al. 2008: 317), as well as through discursive devices such as boundary-work and paradoxes (Bucchi 1998) and metaphors (Boyd 1993).

Metaphor analysis has proved a particularly fruitful area of research in STS and STS-inflected scholarship in which metaphors are often seen as truth-making devices 'essential to every aspect of science' (T. Brown 2003: 15), as cognitive devices enabling research and communication about science (Lakoff and Johnson

1999), or as vehicles for world-views (Pepper 1942) or ideologies (Haraway 1989) reflecting assumptions and preoccupations of a given time (Sismondo 2010).

Metaphors are conceptual devices which 'help us understand an abstract or inherently unstructured subject matter in terms of a more concrete, more highly structured subject matter' (Nerlich et al. 2002: 3). They allow us to map older, or more familiar domains called source domains onto less familiar source domains (Stelmach and Nerlich 2015). Therefore, metaphors, as Hellsten notes, 'have an important role to play in making sense of the world – and in communicating these views' (Hellsten 2002: 2-3). Metaphors are essential not only in science, but also in science communication where they 'enhance insight and understanding and foster memorableness of science-related material' (Whaley 2010: 478-479). They have proved crucial for scientists, science writers and journalists as they go about their task of communicating about scientific findings in public, especially in the media, as illustrated by a vast social science scholarship on genetic research (e.g. Nelkin and Lindee 1995, Condit 1999, Kay 2000), cloning (Nerlich and Clarke 2003, Haran et al. 2007) or synthetic biology (Hellsten and Nerlich 2011).

In the context of genetic and genomic research, for several decades metaphors such as 'code', 'blueprint', 'book', or 'map' have shaped scientific research as well as public understandings of what genes are and what role they play in determining physical and behavioural traits, as well as the propensity to illness (cf. Keller 2000, Keller 2002, Nerlich and Dingwall 2003). However, after the completion of the Human Genome Project (HGP), the metaphorical landscape of postgenomic sciences has started to change (Nerlich and Hellsten 2004, Nerlich and Hellsten 2009). This shift was triggered by the reaction to the outcomes of the HGP, which revealed that the genome functioned in more complicated ways than expected. As a result, the HGP did not bring about much-anticipated cures for various illnesses, from Alzheimer's disease to cancer, neither did it yield answers to fundamental questions about the nature of (human) life (Nerlich and Hellsten 2004). There have been calls to rethink the use of such genetic metaphors as 'books', 'codes' and 'blueprints' which were perceived as too deterministic and no longer adequate or

accurate to convey the complexity of processes studied by postgenomic sciences (cf. Avise 2001, Porta 2003, , Pigliucci 2010).

Have these calls had any effect on the ways in which advances in biosciences and biotechnologies are being talked about? iseA recent study of the media coverage of epigenetics, a field related to foetal programming and DOHaD, indicates that grand narratives (Lyotard 1979) and grand metaphors associated with genomics, such as the book of life, have given way to a plethora of smaller metaphors that are being used to convey core messages about epigenetics. These include such metaphors as electric 'switches', as well as 'marks', 'tags' and 'labels' on the genome (Stelmach and Nerlich 2015).

The field of foetal programming/DOHaD itself has recently come to the fore of postgenomic and medical science with claims about the paradigmatic nature of this research (Robinson 1992). Research in this field shifts attention away from genes to processes of early development, which, it is hoped, will explain the emergence of chronic adult disease (Barker 1998, Gluckman and Hanson 2004a). Alongside these claims, a new conceptual toolkit and new metaphors have been developed. There includes references to foetal (Barker 1998), nutritional (Lucas 1991), or perinatal (Plagemann 2005) programming, or critical windows (Bateson 1979) in the DOHaD literature. However, within STS there are currently no studies of metaphors or metaphorical framings that are used to conduct research in DOHaD and promote it in public..

Discourse and rhetorical studies, including metaphor analysis are particularly well-suited to the research questions of this thesis. They can shed light on the issues of persuasion, as, in order to thrive, science needs to convince various audiences about its claims and recruit followers. At the same time close analysis of texts can uncover meanings and assumptions underpinning science and elucidate 'what people believe and how they believe it' (Sismondo 2010: 156). In addition, the forcus of STS studies of scientific discourses extends beyond the realm of scientific writings

published in specialist journals or books to other sites of knowledge production, such as popular science books, media articles or policy documents, which are now also included in such investigations (Pickersgill 2013: 32, see also Nelkin 2001 and Bucchi 1998). This thesis draws on this research tradition in STS to study narratives and metaphors used in public communication about this science, and the next section outlines the theoretical and methodological approaches that underlie the design and methods of this thesis.

3.3. Theoretical approaches

The focus of this thesis lies in the study of public communication surrounding the emergence of foetal programming and its claims about early life origins of disease risk. To this end it combines three theoretical approaches. First, Bucchi's (1998) framework of alternative routes in scientific communication is used to investigate how the field of foetal programming was established in the media as a legitimate field of its own through the use of discursive devices. Second, Maasen and Weingart (2013) framework of metaphors and the dynamics of knowledge is used to study what metaphors related to early life disease risk were deployed in the media and how they changed over time and different contexts. Third, Collins's concept of 'alien science' is drawn upon in this thesis and it underpins the decision to use a mixed method approach. Thus this project combines media analysis with qualitative interviewing which helps gain access to scientists' views and understandings related to the emergence and risk claims of their field. In what follows I discuss these three approaches in more detail.

3.3.1. Bucchi and discursive studies of emerging fields

The core idea underpinning Bucchi's (1998) framework of alternative routes in scientific communications is that scientists can seek public support and turn to the media to legitimise their research and to build a new field of research. This turn to the public, or what Bucchi calls a 'deviation to the public' can happen in a situation of crisis which cannot be resolved within the scientific community, and when new boundaries of science are at stake. According to Bucchi, 'as long as a discipline has

not yet been recognised as such (and therefore until it is granted authority and prestige), it is essential for researchers to prove the relevance of their work for society at large' and to arouse 'its interest in their work' (1998: 15-16). The process of seeking public support, recruiting followers and creating a scientific field in the public sphere entails various types of discursive strategies which seek to demarcate the new field from its competitors, build its legitimacy, increase certainty surrounding the emerging research, manage criticism from opponents as well as render the science less abstract and more familiar. These features of Bucchi's framework as well as its focus on discursive strategies make it particularly well-suited for studying the emergence of foetal programming in the public realm.

One of the discursive strategies of field-making identified by Bucchi is boundary-work (Gieryn 1983). In public boundary-work is deployed with a view to positioning the new research as a scientific and legitimate area of enquiry, to differentiate the new field from its competitors, and to draw disciplinary boundaries around the new paradigm and demarcate its own area of expertise. Boundary-work can be achieved by using paradoxes or metaphors, although in the case of the media coverage of foetal programming, this thesis also analyses other discursive tools such as defamiliarisation, which does not feature in Bucchi's framework and which is discussed in Chapter 4.

Presenting new research as a break-through or a paradigm shift in the public realm often entails stripping away ambiguities and uncertainties from science communication and bolstering the robustness of its findings. This is achieved through the strategies of what Bucchi calls 'certainty-building' which involves discovery narratives or stories about the things discovered by the emerging field. Such stories often rely on what Brannigan (1981) called folk theories of scientific discoveries. These theories usually explain the emergence of science or a theory by telling stories of a scientific genius, or, alternatively, of a 'cultural maturation' of a scientific field which inevitably lead to a discovery. As Mulkay has suggested, such folk theories not only account for why or how a discovery happened, but they also add some contextual information which makes it easier to interpret the discovery in a specific

discourse (Mulkay 1985:197). Discovery narratives are also crucial as they demonstrate the new field's achievements and relevance and thus increase the degree of certainty and credibility associated with the new science.

In this thesis I also explore another certainty-building strategy, namely hedges and hedging. Importantly, hedging was not included in Bucchi's field-building framework, but this study has identified it as an important strategy for promoting a new field in the public realm, a strategy which links up with Bucchi's focus on certainty-building and sheds new light on this process. Although previous research has explored, for example, different types of statements conferring differing degrees of certainty/uncertainty in scientific discourse (Latour and Woolgar 1986), hedging as a certainty-building strategy has so far not been analysed in any depth in science studies. Previous research by Kitzinger (2008) referenced the fact that certain linguistic markers like ''can' or 'could' were employed much more often than more uncertain terms such as 'may' or 'might'' to almost unnoticeably hype research into therapeutic cloning (see Kitzinger 2008: 421). However, this existing research does not systematically engage with the literature on hedges and hedging which have been studied by linguists for a long time. Thie linguistic approach provides the basis for the analysis in Chapter 4 of this thesis. In that chapter I will show how this neglected literature can be used to complement STS studies on hype and certainty-building by showing that linguistic markers known as 'hedges', such as the modal verbs 'may' or 'might' (but there are many more) can be used to, paradoxically, project certainty for a field where uncertainty still prevails.

'Objectification' is another discursive strategy of field-making in public which is studied in this thesis and which draws on Bucchi's framework. This concept, which Bucchi borrows from Moscovici's (1961, 1984) theory of social representation. denotes processes of transformations in the representations of a scientific theory. Such transformations occur when science travels into the public and social realm, or, as in the case of research discussed in this thesis, when it is covered in the media. What objectification seeks to achieve is to make abstract and complex science more real, relevant and anchored in everyday experience. When science is

communicated in the public realm, objectification is usually achieved through personalisation, or 'identification of theories and results with the faces and the names of visible scientists' (Bucchi 1998: 125-126). One of the effects of this personalisation is the media's focus on various attributes of the scientist, for example on his personal appearance or achievements (*ibid.*: 126).

Bucchi also draws attention to discursive strategies that aim to manage public criticism which can be levelled at emerging fields by its critics. In doing so Bucchi draws on the seminal work of Goffman's (1959) *Presentation of self in everyday life* to emphasise the staged character of communicating science in public (see also Hilgartner 2000). While the mundane activities of science production and negotiation, for example in laboratories, can be conceptualised as happening backstage, communicating science in popular media can be thought of as happening frontstage, where 'a polished, objectified, linear and persuasive story' of science is being told (Bucchi 2014: 124). When applied to science communication, Goffman's metaphor of public performance has another advantage, as it makes it possible to explain why these persuasive stories or carefully staged performances are sometimes disturbed: it is when some events or elements of the backstage, where scientific criticism abound and the 'dirty laundry' of science is washed, are exposed frontstage to the public. These exposures usually involve controversies and debates surrounding a particular scientific claim disseminated to the public or the emergence and popularisation of a particular paradigm. Bucchi suggests that addressing such 'backstage exposure' or managing criticism from opponents may rely on the use of contingent repertoires (Gilbert and Mulkay 1984) which aim to dismiss criticism by presenting it as influenced by non-scientific factors, such as circumstances, personal idiosyncrasies etc.

As this discussion has shown, Bucchi's framework allows to explore the uses of various discursive devices that are deployed in the process of building a scientific field in public. The flexibility of this approach has also enabled me to look beyond the range of discursive devices identified in his framework and to explore other ways of field-making, such as hedging and defamiliarisation.

3.3.2. Maasen and Weingart: metaphors in context

This thesis, and especially Chapter 6 aims to explore which metaphors were developed in the field of foetal programming and how they were used to communicate about research. In addition, this thesis aims to study whether there were any changes in the meanings conveyed by these metaphors at various points in time or in different contexts. Finally, it seeks to analyse the implications of these metaphorical framings for the public understanding of early life. These questions are explored with the help of Maasen and Weingart's (2013) framework of metaphors and the dynamics of knowledge.

According to Maasen and Weingart (2013) metaphors can be understood as communicative tools that offer common ground for debate (Hellsten 2002). They can connect various discourses and act like boundary objects (Star and Griesemer 1989), in the sense that they 'are both flexible enough to adapt to novel situations, and robust enough to maintain identifiable structures' (Hellsten and Nerlich 2008). At the same time the nomadic nature of metaphors means that they are taken up by and interact with various discourses in multiple ways over time. Eventually, both the metaphors and discourses which adopt them acquire new shades of meaning. AsMaasen and Weingart claim, 'this is what the metaphor analysis is about. It looks for both the locally specific processing of metaphors and the ways in which they – gradually – produce (heterogeneous sets of) meanings across various (types of) discourses for a given period of time' (Maasen and Weingart 2013: 3-4).

The aim of such metaphor analysis is ambitious, as it 'attempts to surface nothing less than the anatomy of the grand phenomena in the changing world of knowledge, be it paradigm shifts, the emergence of a new *Zeitgeist*, or the rise and fall of general world views' *(ibid.:* 4*)*. Maasen and Weingart (2013) have applied their framework of metaphors as tools of knowledge transfer in a study of the terms 'struggle for existence', 'paradigm', and 'chaos'. They have shown that the metaphors gradually changed meanings and shaped discourses in which they appeared along their travels from one context to another.

This thesis shares Maasen and Weingart's belief that such metaphor analysis can help explore the emergence of a new *Zeitgeis*t in relation to the formation of new scientific fields or discoveries. However, it does not claim to be exhaustive, to present the totality of metaphors in the media coverage and to 'surface the anatomy' of a new paradigm emerging in the press. Instead, it aims to capture and illustrate how metaphors and metaphorical framings used in the coverage of foetal programming create new, diverse as well as time- and context-specific meanings and understandings related to the field of foetal programming and its claim that origins of many adult diseases can be traced back to early life.

Maasen and Weingart's approach directs attention to changes in meanings of metaphors that occur over time and in different contexts. Their framework can thus be adopted for the study of the media coverage of research into foetal programming both over longer time frames (as in this thesis) and in different geographical locations (i.e. based on media reports produced both in the West and the Global South). In addition, this approach also helps uncover the changing discourses that adopt metaphors and which subsequently also modify the meanings they carry. All these characteristics make Maasen and Weingart's framework of metaphors and dynamics of knowledge a very suitable approach for my study.

3.3.3. Collins and alien science: qualitative interviews and mixing methods

The concept of 'alien science' was coined by Collins (1999) to highlight the pitfalls of sociological studies of science which produce such accounts of a field or facts that may look unrecognizable to the concerned scientific community. The risk of producing an 'alien science' arises when sociologists seek for example to chart the origins and spread of a new discipline by relying on a single set of sources, such as the scientific literature or media reports, and without engaging with the members of a scientific community. This means that sociologists may not have access to specific interpretations and tacit knowledge of the scientific community in question, which

might in turn lead to problematic representations of science (Collins 2001). Such problematic or 'alien' accounts of science eschew uncertainties, focus on inflated claims, and do not do justice to a range of more nuanced views expressed by members of the scientific community (Hedgecoe 2006, Pickersgill 2016).

This thesis aims to avoid producing an 'alien science' description of foetal programming that might not be recognisable to scientists working in this field. It strives to achieve this by critically engaging with these scientists' perspectives on major developments surrounding the emergence of their discipline. Such developments are related to the politics and practice of establishing a new field and to the difficulties and pitfalls of communicating about this field in the public realm, especially in the context of a changing media and science landscape, where new scientific fields jostle for attention, credibility and legitimacy. To this end this thesis relies not only on one type of sources, such as media reports on foetal programming, but also on qualitative interviews with scientists.

Interviewing, or gathering information through conversation is a powerful research method which relies on a 'basic mode of inquiry' (Seidman 2013: 8). The assumption underlying this mode of getting information is that human beings have a capacity to convey their experience through language, and that understanding how they use language can help understanding their behaviour (*ibid.*). Qualitative in-depth interviews are particularly useful for shedding light on 'how people think and act in everyday life' (Haimes 2002: 106). According to Brinkmann and Kvale:

> The qualitative research interview attempts to understand the world from the subjects' points of view, to unfold the meaning of their experiences, to uncover their lived world prior to scientific explanations. (Brinkmann and Kvale 2015: 3)

Semi-structured interviews were chosen as the interviewing method for this thesis, as they allow to gainan understanding of how some groups of people – in this case scientists - talk about a specific issue. Semi-structured interviews follow an

interview guide, or a list of questions which are prepared in advance, and which are put forward to all the participants in the study. This type of interviews is particularly suitable for projects in which specific issues for consideration and investigation are already identified and can be structured in a coherent strategy. The guide or schema of asking specific questions is adopted for all the interviews, however the interviewer can follow some new or unexpected topics that emerge spontaneously during the conversation. This approach allows to gather reliable and comparable data and is flexible enough to capture information that was not anticipated and can prove useful (Qualitative Research Guidelines Project online).

In qualitative studies interviews can be used as stand-alone methods or combined with other research methods, and this strategy is called a mixed methods approach. This thesis adopts mixed methods approach, and in particular it draws on a 'mixed data analysis' (Small 2011), as it analyses both interviews with scientists and media coverage. 'Mixing methods' has been a growing trend in social sciences, and the decision to combine different kinds of data or analytical techniques is usually justified on the grounds of ensuring either complementarity or confirmation. In the case of a complementary design, like the one adopted in this thesis, scholars tend to make sure that their findings are not derived from one kind of data. According to Small:

> Researchers have used complementary designs when they are reluctant to limit the kind of knowledge gained to that which a type of data can produce. The core assumption is that any given types of data can produce only a given kind of knowledge. (Small 2011: 64)

This thesis combines media and interview analysis with the aim of achieving complementarity rather than confirmation or refutation of findings. That is, the use of two kinds of data does not seek to achieve triangulation by demonstrating whether what is reported in the media is confirmed by scientists or not. Instead, this thesis seeks to gain a richer understanding of the issues surrounding the emergence and claim-making of foetal programming by using a wider range of sources.

The benefit of combining the analysis of media coverage with the interview analysis lies in the fact that interviews enrich the empirical data. They ground questions related to foetal programming in scientists' professional understandings and practices, and provide access to meanings and interpretations that could not be gleaned from the media analysis alone. In their accounts of foetal programming both the scientists and the media (supported by scientists) foreground and background various issues surrounding this field. However, by analysing what scientists say in the interviews for this study, what they say in the media, and how journalists report on what is being said, this thesis can capture a wider variety of emerging issues related to field-making and claim-making, as well as the broader contexts in which these issues appear. This in turn makes it possible to provide additional layers of interpretation of the questions surrounding the emergence and development of foetal programming, and it reduces the risk of producing alien accounts of this field.

3.4 Media analysis

3.4.1. Media sample: rationale

Decisions about sampling strategies shape not only the analytical process but also the outcomes of the analysis. A key feature of sampling in qualitative studies is that

> 'researchers usually work with *small* samples (…) nested in their context and studied in-depth – unlike quantitative researchers, who aim for large numbers (…) and seek statistical significance'. (Miles and Huberman 1994: 27, italics in the original)

Similarly, Macnamara notes that the process of constructing the sample for qualitative research of media coverage 'is not required to meet statistically valid formulae of quantitative analysis' as 'random or even representative methods of sampling may not capture the issues or themes which are the subject of qualitative analysis' (Mancamara 2005: 17-18). Rather than being concerned with the question

of ‘representativeness’, the sampling strategy for qualitative research should be underpinned by conceptual and theoretical questions which guide research design (ibid.).

The proposition that sampling should be aligned with research questions and objectives of the study means that

> ‘There is no one best sampling strategy because which is best will depend on the context in which researchers are working and the nature of their research objective(s). (…) the biggest questions all researchers need to ask themselves are what they want to accomplish and what they want to know. The appropriate sampling strategy will follow from that.’ (Palys 2008: 697)

Different sampling strategies can be combined within the same study with the view to ‘yield rich results’ (Macnamara 2005: 18) and to ‘cover a spectrum of positions and perspectives in relation to the phenomena one is studying’(Palys 2008: 697). One such combination suggested by Miles and Huberman (1994) involves a selection of *i)* typical or representative examples, as well as *ii)* those that contradict or oppose the representative ones and *iii)* those that are exceptional or ‘deviant’. Such a combined approach, which is also called ‘maximum variation sampling’ (Palys 2008), helps identify a wider range of perspectives, and by providing examples of both patterns and exceptions it ‘allows exploration of discourse at various points within the range’ (Macnamara 2005: 18). While this type of combined sampling strategy in qualitative research provides insights into broad patterns and recurring themes, it ‘should not (…) be treated as *statistically* representative’, as attributing numbers to particular data or results could be ‘misleading’ (Kitzinger, et al. 2008b: 8, italics in the original).

The purpose of the media analysis for this study is to examine a variety of discursive strategies and tools, such as metaphors and narratives, that were used to promote the field of foetal programming in public from its inception to the present day. The sampling strategy reflects these research objectives as it focusses on the

collection of a wide range of media items that appeared in the public realm over a long stretch of time. The sample is broad, as it aims to identify and analyse typical examples of the media coverage, but it also allows to highlight those that are contradictory or exceptional. In this sense, and following Kitzinger et al. (2008b), the research sample should not be understood as *statistically* representative, and no statistical or quantitative claims are being made on the basis of the data analysed for this study.

The sample draws on three types of media materials: *i)* transcripts of three episodes of the *BBC Radio 4* series on foetal programming, *ii)* a transcript of the *BBC Horizon* TV programme on this research, all broadcast in August 2011, as well as *iii)* i) English-language newspaper articles published during the period of 1986-2016.

The rationale underpinning the inclusion of the *BBC Radio 4* and *BBC Horizon* transcripts in the sample is that these shows were produced by a prestigious national broadcaster and subsequently became a discussion point in the print media. On an empirical level, the transcripts offered a wealth of material as both the TV and the radio programmes on foetal programming attempted to summarise several decades of research in this field. This made the *BBC* coverage particularly suitable for this study, as it showcased various strands of research into foetal programming which developed over time. The analysis was limited to the spoken/transcribed texts and did not focus on audio and visual aspects of the *BBC* coverage.

The news articles included in the sample were published between 1986 (the year in which the first scientific article in the field of foetal programming was published) and 2016. The vast majority of these articles (305) were identified with the help of the digital news archive Nexis R, and additional five articles were identified by a Google search. The latter appeared in prominent media outlets, such as *Time Magazine, New York Times, The Economist* and *Discover Magazine* and *BBC News Online*. As Gans (1979) has argued, elite media, such as *New York Times* play an agenda-setting role in defining what is newsworthy and constitute an important point of reference not only for other media outlets, but also for other

actors, such as various stakeholders and policymakers. The inclusion of five high-profile media articles (two in-depth feature stories, two opinion pieces, and one long article authored by Barker himself) in the sample was important, not least since some of them were quoted frequently in other media.

The main bulk of media articles in the sample was retrieved by Nexis R. The search in the digital archive was broad as it targeted English-language news articles published in print media around the world. As a result, the search returned articles published in a great number of countries, such as the UK, US, Canada, Australia or New Zealand – all of which are countries which host long-standing and prominent research centres on foetal programming/DOHaD. The search also retrieved articles published for example in Bangladesh, Pakistan, Yemen or Nigeria – all of which are countries where the concepts of DOHaD and 'the first 1000 days' have just begun to be discussed in the media. This analysis attempts to identify whether the great diversity of these countries is or is not reflected in the ways in which research about foetal programming is communicated. In other words, this analysis seeks to find out what kind of message about foetal programming is disseminated and what implications this might have for the understanding of this research in different contexts. Given the limited number of articles in the sample this analysis does not claim to offer general or statistical insights on how research is covered worldwide, but it can offer snapshots of how different meanings are generated depending on the topic and/or the context.

As noted earlier, in addition to being broad, the sample also includes media coverage spanning three decades of foetal programming research. By exploring long timeframes in the media coverage this thesis aims to capture patterns as well as variations and exceptions in the reporting, including variations in metaphorical framings and narratives, which could not be identified in shorter timescales. Taking a long view on the media coverage is a useful strategy in qualitative research, and it was deployed for example by Ten Eyck and Williment (2003) to investigate thirty years of national newspaper coverage of biotechnology and genetic issues. In that

study analysing media coverage over time helped uncover various framings that were used in the processes of legitimation of these scientific fields.

More recently Hulme and colleagues (2018) analysed the changes in framing of climate change issues in *Science* and *Nature* editorials published over the last fifty years. This sampling strategy allowed Hulme and colleagues to trace both recurring patterns and variations in framings over time as well as variations in framings between these two prestigious journals. These examples suggest that analysing media coverage over longer periods can be useful in studies of a single scientific issue or a single scientific field - such as this study of foetal programming – as focusing on longer timescales in coverage may help retrieve and collect a wider range of media items for the sample.

As noted earlier on, sampling strategies can vary considerably across studies, as they are designed to match the topic, research questions and aims of research projects. While research for this thesis uses broad samples to study developments related to one scientific framework (foetal programming) over a long period (three decades), it is possible to use shorter timescales for studies of a single scientific discipline, especially if research in this field is fashionable, fast-paced, and attracting considerable media attention. An example of such a field is stem cell research in the first half of 2000s analysed by Kitzinger (2008). Kitzinger examined rhetorical strategies in the media coverage of this field from about 2000, when stem cell research was starting to gain high-profile status, up until the years of 2005-6, which marked a serious reputational damage to stem cell research caused by allegations of scientific fraud. Though the timescale of the sample was relatively short, it was rich in data as dramatic event which occurred over this period triggered a wide range of both positive and negative media reports. Thus, the nature of the topic of this study (the rise and fall of stem cell research in the media) allowed the author to adopt a different sampling strategy (broad sample over short period of time), which yielded relevant and interesting data and results.

Yet another sampling strategy – and different research questions and aims – were at the heart of the study by Sumner et al. (2016) of the media coverage of

health-related science. Sumner and colleagues sought to trace the sources of exaggerations and caveats in press reports, and to this end they compared media coverage of health research with the original scientific articles and the associated press articles issued by scientific journals. The topic of media coverage analysed by Sumner et al. was broadly defined as health-related and with 'with possible relevance to human health, psychology or neuroscience' (2016: 3). Health-related news is a popular topic in the press reports of science (Gregory and Miller 2000) and appears in the media on a daily basis. The fact that the topic of science coverage was broadly defined and included multiple areas of scientific research meant that the sample could rely on a short timeframe of just one year of 2011 and still include a high number of news items with the associated original articles and press releases. In addition, the focus of that study was on tracing possible variation in scientific claims across different kinds of scientific writings, and not in tracing variation over longer timescale, which would have suggested a different sampling strategy. This example shows that a specific research question (the relationship between news coverage and press releases) as well as a broad definition of the topic of the media coverage (health-related news) shaped the research design of this study and influenced the choice of a short timeframe of the media analysis (one year of coverage) as well as the selection of the material for the analysis (broad sample of news articles, press releases and associated scientific papers).

3.4.2. Media sample: composition

The largest component of the media sample for this thesis included press coverage of foetal programming. The search for the relevant news items was conducted in the Nexis R digital archive for the period between 1 January 1986 and 1

February 2016. The following settings were used: All English Language News, high similarity and excluding websites and newswires. I used several keywords which reflect the changing names of the field, as well as the changing concepts at the core of this research, such as *i)*'foetal programming OR fetal programming' (n=179), *ii)*'fetal origins hypothesis' (n=30), *iii)* 'Developmental Origins of Health and Disease (n=87), and *iv)*'the first 1000 days of life' (n=68). I also used the keyword *v)* 'Professor David Barker' (n=189) which refers to the epidemiologist credited as a founding father of this field. This keyword p helped identify articles about this field from its inception, i.e. in the late 1980s and early 1990s when it did not yet have a name.

I also conducted a separate search in Nexis R to retrieve articles from high-profile media outlets such as *Newsweek* and *Vogue* which were published over the same period, but which were not identified by previous searches. In this case I chose the following settings: All English Language News, more sources – *Newsweek* or *Vogue,* high similarity and excluding websites and newswires. The keywords for this search were the following: *i)* 'foetal programming OR fetal programming' (n=5), *ii)* 'fetal origins (n=1) and *iii)* 'David Barker (n=7). The last two keywords were chosen as searches in *Newsweek* and *Vogue* with the previously used keywords'Professor David Barker' and 'fetal origins hypothesis' did not return any results.

In total, the Nexis searches retrieved 566 articles. There was a considerable overlap between data sets, as the same articles could be retrieved with two different keywords, for example 'Professor David Barker' and 'foetal programming'. The searches also retrieved irrelevant pieces, for example articles related to other professors called David Barker, or reports on applications of foetal programming research in animal husbandry. The latter were subsequently excluded from the dataset, as research for this thesis is concerned with foetal programming and human – and not animal – reproduction. After reviewing the set of 566 articles retrieved by Nexis and removing 261 duplicates and irrelevant pieces, I identified a corpus of media articles consisting of 305 articles (Professor David Barker n= 137, David Barker n=5, foetal/fetal programming n=67, fetal origins hypothesis n=23, fetal

origins n=1, Developmental Origins of Health and Disease n=29, the first 1000 days of life n=43). To this corpus I added five other news items which did not feature in Nexis, but which appeared in *Time Magazine, New York Times, The Economist, Discover Magazine* and *BBCBBC News Online* (a full list of all media sources can be found in the Appendix 2).

The two remaining components of the sample - the *BBC* radio and TV shows on foetal programming - were retrieved from the *BBC* websites, and their spoken content was transcribed.

BBCRadio 4BBC

Given the very fine-grained, almost tooth-combing, search strategies and the fact that many articles had to be eliminated because they were duplicates or irrelevant, it is virtually impossible to provide a numerically based graph of the ups and downs of media coverage. However, keeping these provisos in mind, one can provide a graph representing the raw numbers derived from searching NexisR on a high similarity setting, using the search terms 'Professor David Barker' OR 'fetal programming' OR fetal origins hypothesis' OR 'developmental origins of health and disease' OR 'the first 1000 days of life' (Figure 6). As one can see, this graph follows the contours of that provided for Chapter 1 based on scientific publications captured by Scopus (Figure 1), showing that the press tracked the development of the field with considerable interest.

This interest was often stoked by Barker, who was not averse to self-promotion. The newspaper coverage was often driven by various media events, such as press conferences organised to announce research findings, to inform about scientific conferences and public talks, to report about ongoing studies and their anticipated outcomes, or to help promote scientific or popular books on foetal programming. In the printed press this field of research was covered mainly in science reports of various lengths, but also in other types of journalistic texts such as feature stories, interviews, media profiles of Barker, as well as, in 2013, Professor Barker's obituaries. In addition, in the summer of 2011 *BBC Radio 4* and *BBC*

Horizon broadcast high-profile programmes on foetal programming featuring Professor Barker and other prominent researchers in this field. These programmes sparked a lot of interest, as they were advertised in advance in the printed press and subsequently discussed by journalists.

3.4.3 Media sample: limitations

This study has some limitations. Although the set of 300 sources, including news articles complemented by the transcripts of one TV show and three radio episodes provides a wealth of material for qualitative analysis, the findings of this study should be viewed as illustrative rather than exhaustive, not least given various limitations of the Nexis database, as highlighted by Deacon (2007). The limitations relevant for this study stem from the fact that Nexis database is incomplete - for example, some important articles about foetal programming may be missing from the media archive as various UK newspapers started to be digitised at different points in time, i.e. some in the mid-1980s (*The Guardian* and *The Times*), while others from early 1990s *(Daily Mail* and *The Observer*), or early 2000s (*The Star* and *Daily Telegraph*) (Deacon 2007). This might indicate that certain media sources, such as *The Guardian* or *The Times*, might be overrepresented in the sample to the detriment of news from the *Daily Telegraph*, although it is difficult to predict what kinds of implications this might have for the analysis. In addition, English-language articles from many prominent media outlets, such as *Time Magazine* and *The Economist*, are not available through Nexis.

Another limitation of this dataset is related to a limited sensitivity of keywords which are better suited to identify things (such as people or places) rather than themes in the database (Deacon 2007: 7). This means that various articles covering research on foetal programming are missing from the sample as they do not contain any of the specific keywords chosen for the digital search. This stems from the fact that journalists and science popularisers tend to avoid technical language and often skip scientific terms to make their articles more accessible to the lay public. I

have found instances of articles on foetal programming which did not feature in Nexis as they did not contain specific terms, for example a piece from *The New York Times*, as well as articles from *Daily Mail*. This shows that the findings of this analysis are better viewed as illustrative rather than comprehensive of the entire media coverage of this scientific field.

Finally, this analysis can only shed light on the ways in which media report on foetal programming – it cannot provide information about how various publics perceive and understand the implications of research in this field. To explore these issues more audience research would be needed.

3.5. Analytical process: thematic analysis

In order to explore how the media reported on the emergence and claims of foetal programming, I drew on thematic analysis in the first instance to identify the main topics and issues that appeared in the public communication of this field. This method is used for 'identifying and interpreting patterns of meaning across qualitative data' (Clarke and Braun 2014). Thematic analysis is a useful tool to illuminate various processes of social construction, notably the production of meaning (Joffe and Yardley 2004, Braun and Clarke 2006), and it is one of the most popular methods for analysing textual newspaper data (Joffe 2012). It has also been used frequently in the context of media coverage of scientific research, and a recent example includes an analysis of early human development in the press (O'Connor and Joffe 2013). Thematic analysis is thus particularly well-suited to the purposes of the present study.

The thematic analysis of the media sample proceeded in an iterative fashion. The whole sample was read and annotated several times to identify major themes in the coverage pertaining to three areas: representations of foetal programming as a scientific field, representations of claims of risk, as well as the social implications of a new understanding of early origins of disease risk. The coding of the sample was discussed with the supervisors, and a part of the codes was compared and analysed to

ensure a degree of reliability of the analysis. The coding frame that was developed for this purpose was partly inductive and grounded in the content of the analysed texts (Joffe 2012) on foetal programming, but also informed by theoretical debates in social science studies of the biosciences, medicine and reproduction. For example, it included a major theme 'descriptions of foetal programming', which consisted of different sub-codes. These could refer to foetal programming as a scientific discipline and to claims of a paradigm shift, to foetal programming as a biological phenomenon related to future health risk, or to foetal programming understood as an active/passive process with the implications for framing the responsibility for health of future generations. The latter code draws on the literature on maternal blame (for example Lupton 1999, 2013) and it was introduced to gauge whether agency and/or responsibility for programming in early life can be attributed to some specific actors (the pregnant woman, the foetus, the environment, etc.). The thematic analysis was the first step towards the identification of metaphors, which are discussed in the following section.

3.6 Analytical process: metaphor analysis

As mentioned in the previous section, thematic analysis of the media text constituted the first step in the analysis which aimed to identify themes related to research questions of this thesis. In the second step, the analysis zoomed on particular themes to find out how they were metaphorically framed. Identifying a metaphor is not an easy task, as 'any word can be a metaphor if its context makes it such and if the speaker intends it as such (Charteris-Black 2004: 35). The problem of identification is compounded by the fact that while scientists might consider some words as neutral and non-metaphorical technical terms, journalists and other people not working in a given scientific field may regard them as a metaphor (Stelmach and Nerlich 2015: 203).

I adopted Charteris-Black's (2004) critical metaphor analysis which follows three steps: *identification*, *interpretation* and *explanation*. I read and re-read the entire media sample and identified candidate metaphors. The metaphors were

identified and extracted 'manually', that is without the use of any software. To decide whether the candidate metaphor was indeed a metaphor, I examined whether it was used in a literal sense or metaphorically (Praglejazz Group 2007). The second step of the critical metaphor analysis involved the interpretation of the metaphor, or the identification of 'the type of social relations that are constructed through them' (Charteris-Black 2004: 35). The third step of the analysis - the metaphor explanation - explores textual meaning of the metaphor and whether it is interrelated with other metaphors in a given context (*ibid.*). While preparing some elements of this analysis for a joint conference presentation, both the student and the supervisor (Professor Brigitte Nerlich) coded a part of the corpus (i.e. articles retrieved with the keywords 'foetal programming' and 'Professor David Barker'), they discussed metaphors that they had extracted and compared notes. There was a strong overlap in the coders' extraction of metaphors. Finally, the uses of a metaphor at different points in time and in different contexts were compared and analysed to identify potential changes in meaning.

3.7. Interviews with scientists

3.7.1. Interviews: sampling strategy

The selection of the participants for this study was underpinned by the strategy of purposeful sampling in which 'researchers intentionally select (or recruit) participants who have experienced the central phenomenon or the key concept being explored in the study' (Creswell and Plano Clark 2011). This type of sampling helps access information which is both rich and relevant for the issue under research (Palinkas et al. 2015).

I interviewed twenty-two scholars based at leading research institutions in England. All of them had worked on issues related to foetal programming/DOHaD, and most of them indicated this framework as their major area of expertise on their online research profiles. The participants were drawn from a list of potential respondents that I had prepared after reviewing relevant scientific literature in foetal programming. As the fieldwork progressed, this list was constantly up-dated and

other scholars were also asked to participate. The scientists were contacted by emails, approached at conferences or recruited through snowballing or personal recommendation. In each case a formal email with a request to participate alongside details of this study were sent to them prior to the interview.

One of the key issues encountered in purposeful sampling is the availability of research subjects and their willingness to participate in the study (Palinkas et al. 2015). Not all the scholars who had initially agreed to take part were able to participate in my research. This was due to various reasons, including illness, change of plans or time constraints on the part of potential participants, as well as difficulties that I experienced in obtaining permission to access NHS premises on which one of the scientists was working. Nevertheless, I sought to draw on the principle of maximal variation in my sampling strategy (Creswell and Plano Clark 2011: 174). This means that I sought to include female and male researchers at various career stages to ensure a wider range of perspectives. In total, I contacted forty scientists (twenty-four men and sixteen women), out of which eighteen (ten women and eight men) were not interviewed for this project. Out of twenty-two scientists who agreed to participate and were interviewed, six were women and sixteen were men. (

In terms of professional ranks, twelve out of twenty-two participants were very senior researchers, five were at an intermediate to senior stage of their career, and five were at an early to intermediate stage, including one PhD-student. Some of them had engaged with debates or research on foetal programming for most of their careers – for example, some had done their PhD or post-doctoral research on foetal programming or they were already independent researchers at the time when the Barker hypothesis was being advanced. Others had developed an interest in this field more recently or along with other research specialisms. The majority of participants, especially at the professorial level, were key players who had shaped and made significant contributions to the field and enjoyed an international reputation. At the time of the interviews all but two participants were actively involved in research and debates related to foetal programming, while one had left the field, and another was considering leaving it to pursue other research interests.

The participants' areas of expertise ranged from developmental biology, physiology, and nutritional sciences to epigenetics/genomics and epidemiology. In addition, four participants had medical training, including two neonatologists, one paediatrician and one obstetrician. The largest part of the fieldwork was carried out in 2014, with three additional interviews conducted in 2015/2016 and one in 2017.

3.7.2. Interviews: structure and analytical process

The interviews were semi-structured and informed by my analysis of the scientific literature as well as media reports on foetal programming. The questions related broadly to three sets of issues: 1) the development of their field of research and their involvement in it; 2) the scientists' understandings and interpretations of issues related to health risks emerging in early life; and finally 3) the social and ethical implications of their research for new health advice or interventions, as well as for public understanding of early life, including representations of foetal programming in the media and focus on pregnant women's behaviours. To some extent, the interviews were tailored to specific participants, as they were preceded by an intensive period of preparation during which I analysed each participant's published scholarship and identified the topics and questions which were most relevant for my thesis and improved my understanding of the field of foetal programming.

The interviews typically began with questions about the participants' intellectual trajectory and their involvement in research and debates related to foetal programming. Then the conversations proceeded in different directions, depending on the scientists' time, interests and dispositions, and they also focused on topics which were not included in the original interview guide, but were, as my interviewees felt, important for understanding the issues under discussion. All but one interview were conducted face-to-face (and one on the phone), and lasted between 45 minutes to over 90 minutes. The interviews were recorded using digital voice recorders and were subsequently transcribed.

The analytical process of studying the interviews did not start once the recordings were transcribed, as it underpinned the design and the strategy of conducting interviews with the scientists. Continuous reflection on the data shaped subsequent conversations with other participants.

After transcription, the interviews were anonymised and details which could identify the respondents were removed from the texts. The interviews were then analysed thematically, and the coding frame that was developed took into account both the content of the interviews as well as coding frames used in the media analysis. To some extent, the coding frames developed for the interviews mirrored those developed for the media text, but there were some substantial differences, for example codes related to exaggerated claims or hype were developed only for the interviews as they emerged only after the conversations with scientists.

3.7.3. Interviews: ethical issues

Prior to the start of the fieldwork, this project underwent a research ethics review and was approved by the ethics committee of the School of Sociology and Social Policy at the University of Nottingham. The research design of this study observed the Research Code of Conduct guidelines of the University of Nottingham and took into account a number of relevant ethical issues.

I sought to obtain informed consent from all participants of this study. The emails with the invitation to take part in this research that I sent to all respondents contained an information sheet outlining the purpose of this study as well as contact details of my supervisors, the School's Research Officer and myself, and the participants were encouraged to get in touch if they had any additional questions. All the interviews began with a description of the design and purpose of my study, and the participants were always asked whether they needed any additional information pertaining to this research. As stipulated by the Participant Consent Form, the participants were informed about their right to withdraw from the interview and from

the study without having to give any reason. They were also informed that extracts from the interviews can be anonymously quoted.

All the participants were given the option to speak on or off the record, i.e. with or without anonymity, and some of the high-profile researchers were happy to be identified as participating in this project. As the fieldwork progressed and given the nature of networks in this rather small scientific field, it became clear that t revealing the identity of some scholars could lead to the identification of others who wished to remain anonymous. As a result, and after discussions with supervisors and other ethics experts, all the names, quotes and information used in this thesis were anonymised to grant maximum anonymity for those who wished it.

In doing so, this thesis seeks to avoid an accidental or deductive disclosure (Kaiser 2009) of the identity of participants, which poses a challenge to researchers studying small populations or close-knit communities (see Ellis 1995), including small scientific fields. Anonymisation of data for this study covered several types of information (Saunders et al. 2015), and included removing the names of the researchers and replacing them with randomly allocated numbers, as well as concealing their institutional affiliation, gender, specialism and other details which could potentially identify them. A common problem associated with anonymisation is that it removes potentially interesting details and context in which fieldwork occurred. Depending on the type of issues under study, removing some kinds of information can have an impact on the interpretation of data, and – if anonymisation is extensive - it can amount to 'white-washing' the data and compromising its quality and integrity. To illustrate this point Parry and Mauthner cite the example of qualitative studies of the work-family interface in which 'the withdrawal of information about employment history, status and family composition would limit the usefulness of the data' (Parry and Mauthner 2004: 144). Hence, as Saunders et al. have noted (2015), anonymisation is not a straightforward process of removing common identifiers, such as names of people and places, but rather it is a balancing act in which both anonymity of participants as well as integrity of data should be

carefully considered. These considerations guided my analysis and anonymisation of the interviews with scientists, and I sought to ensure anonymity of participants while preserving the richness of the material gathered during fieldwork.

When analysing the data, I found that responses to my questions ran along rather similar lines regarding for example stories and appraisals of David Barker, claims made about health risks, and so on. There were some differences between researchers at an early to medium stage of the career and senior scholars, as the latter often presented perspectives on various developments in the field, and they reflected on its history as well as on the avenues for future research. There were no other deep differences in responses that could be attributed to participants' professional specialisms, gender or institutional affiliation. On the whole no claims can be made about relevant differences between participants' responses that would warrant going beyond the strict anonymity promised to some of the participants and then extended for consistency to the whole group.

Similar strategies of anonymisation have been adopted in other studies of science and scientific fields. For example, in their analyses of media representations and of experiences of women in science Kitzinger and colleagues extended anonymity to all research participants, even though some were happy to be identified. In addition, Kitzinger and colleagues chose not to attribute quotes to participants' ID numbers 'in order to avoid 'jigsaw identification' with other quotes presented in other reports about our research' (Kitzinger et al. 2008a: 23, see also Kitzinger et al. 2008b).

In recent STS studies of epigenetics which drew on interviews with researchers in this field Pickersgill (2016) and Tolwinski (2013) also anonymised the interview data, though to varying degrees. The only information about the participants that could be gleaned from Pickersgill's paper is that these were 'full professors across five research-orientated universities' in the UK (Pickersgill 2016: 188). Other potential identifiers such as specialism within the field of epigenetics, or gender were concealed in this paper (although the pronoun 'he' was sometimes used

in a reference to an interviewed scientist). Despite this rather high degree of anonymisation Pickersgill's study provided a rich and interesting account of the ways in which scientists conceptualised various contentious issues within their field.

Tolwinski's paper on epigenetics also drew on anonymised interviews from which the names of participants were removed and replaced by alphabetical codes, but it offered more information about their specialism, career stage/rank, as well gender and country of work (participants were recruited from the USA, Canada, Australia and the UK). It also hinted at some institutions and conferences where participants were recruited, although such information was not attributed to participants or quotes. In this case, too, despite the anonymisation of the interview data Tolwinski's study offered a nuanced account of a range of interpretations of developments in epigenetics as seen by specialists in this field. As the above-mentioned cases suggest, anonymisation of data does not necessarily lead to impoverished accounts or skewed understanding of research, as not all contextual information that has been removed has an actual bearing on the ways in which data can be read. Much here depends on the topic and research questions of the study.

The data collected for this research are securely stored both physically and electronically – they are password protected. As required by the research code of conduct of the School of Sociology and Social Policy, the data will be stored for seven years, and destroyed after that period.

3.8 Conclusions

This chapter has outlined the research design, theoretical approaches and methods used in this study. It has situated the thesis within the tradition of the constructivist school of thought in the field of STS and then it presented the rationale for studying discursive features and metaphors in the media coverage as well as for using interviews. This chapter has explained the decision to adopt a mixed methods approach, and it has presented the case for combining the analysis of media coverage with the interview analysis to avoid representing foetal programming as an

‘alien science’ (Collins 1999). This chapter has also discussed the ways in which this study was executed as well as ethical issues related to the research process.

Chapter 4. Making sense of a new scientific field: Narratives and metaphors of foetal programming in English-language news

4.1 Introduction

Science, at least in popular imagination, is done behind laboratory doors where its knowledge and claims are born out of hours of experiments (LaFollette 1990). However, much of science happens outside laboratories and is done in offices, libraries, at conferences (David 2005), and, increasingly, in public arenas such as the media (Peters et al. 2008b). Press reports and interviews (Nelkin 1995b), radio and television broadcast (LaFollette 2009), but also blogs (Jarreau and Porter 2017) and tweets (Pearce et al. 2014) are the means by which journalists and scientists not only communicate about scientific findings, but also do science in public (Gregory and Miller 2000). Media, as Weingart (1998) and Bucchi (1998) among others, have argued, are the channels through which scientists themselves seek publicity, recruit allies, attract the attention of funders, as well as build and legitimate new fields of scientific enquiry.

The focus of this chapter is on the ways in which the media helped establish and legitimate the new scientific field of foetal programming in the public realm. It explores three decades of media coverage of foetal programming research to ask the following questions:

- How is foetal programming discursively constructed as a new field and approach to understanding the origins of and risk factors for adult chronic disease?

More specifically, this chapter asks:

- What narratives, metaphors, and other discursive tools are used in popular media to represent this field as a new science of risk?
- What implications do these representations have for public understandings of the role of science and for public understandings of risk in early life?

In doing so, this chapter draws on Bucchi's framework of alternative routes in scientific communications (see also Chapters 2 and 3), according to which scientists may turn to the public when they attempt to establish 'a new theoretical tradition (a shift of paradigm)' (Bucchi 1998: 17). In this sense, the turn of science to the media is not merely an exercise in science popularisation, but it contributes to establishing scientific facts and fields (p. 11) and constitutes an important part of scientific practices and discourses (p. 21). It also means that this approach is oriented towards the study of language, especially towards the analysis of discursive tools which help represent science as persuasive, objective and unambiguous.

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Bucchi identifies several strategies through which this discursive science-building is achieved. First, the strategy of boundary-work seeks to demarcate the new field from other competing disciplines, and it also aims to protect and defend the reputation of the new science in the face of criticism – a situation which Bucchi calls 'backstage exposure'. Second, the strategy of 'certainty-building' aims to remove ambiguity that might potentially surround science by telling stories of discoveries and 'aha' moments. These stories seek to justify and legitimate scientific research by drawing on well-entrenched cultural schemata, for example of a scientific 'genius'. Third, the process of 'objectification' seeks to make science more real, concrete, and relevant. This might involve 'personalisation', or identification of science with a concrete person or group of people. . This chapter explores the ways in which these field-building strategies were deployed in the media, and it pays particular attention

to the discursive tools used to this end, including narratives, metaphors, paradoxes, hedging and defamiliarisation.

This chapter is structured as follows. First, it analyses the boundary-work that was carried out in the media coverage to demarcate foetal programming from other competing approaches and to position it as a field of its own. Second, it focuses on the discursive means of increasing certainty about this field and discusses hedging the claims of early life health risks as well as narratives of scientific discoveries. Third, it deals with objectification, or efforts to make science more concrete and relevant by personifying it, and it analyses media representations of Barker as the human face of foetal programming. Fourth, it examines the potential risks of backstage exposure, or risk of dragging scientific disputes into the public realm. This section explores the media coverage of debates and criticism of foetal programming and its implications for the successful establishment of this field in the public realm. The chapter concludes with a discussion of the findings.

4.2 Boundary-work

Boundary-work, as proposed by Gieryn (1983, 1995, 1999), consists of a range of rhetorical devices which are used to demarcate the boundaries of science from non-science or from other competing fields and to confer authority to the proponents of the new approach (Riesch 2010). In that sense, boundary-work is an essential discursive strategy which is deployed to build credibility of science and to make a space for it (Gieryn 1999) in the crowded marketplace of scientific approaches. It also helps to defend science in a situation of contestation by defining some types of science as legitimate and others as unacceptable (Addison 2016). Gieryn drew on the metaphor of drawing boundaries of science to suggest that boundary-work amounts to mapping out science, or to representing it rhetorically as a territory on a map with clearly defined borders, landscapes, landmarks and neighbours (Gieryn 1999: 6-12). Such rhetorical maps exist not only to establish a new field – they are also 'drawn or talked to help us find our way around' (Gieryn 1999: 7), or to make sense of what a particular science is, what it does and how it relates to other scientific disciplines.

Doing boundary-work, as Bucchi (1998) argued, is also part and parcel of building a new scientific approach in public arenas, including the media. In the press coverage, boundary-work can operate on various levels, and it may be deployed to trace boundaries i) between science and non-science, ii) between competing approaches, and also iii) around emerging paradigms (*ibid.*). As Gieryn (1999) noted, there are multiple ways of creating cultural space for science, and the strategies involved in boundary-work show a fair amount of flexibility and arbitrariness (Lamont and Molnár 2002) in interpreting, for example what is a new science and how it is different from other approaches. In the media coverage of foetal programming boundary-work was achieved through various means, such as metaphors, paradoxes, anchoring and other discursive devices. It will be demonstrated that these discursive tools helped to put foetal programming on the scientific map, so to speak, and to establish it as a legitimate field of research.

4.2.1 Making space for new science: between genes and lifestyle

The first press articles in my sample date from the late 1980s and early 1990s, and they simply reported on stand-alone studies conducted by Barker and his team, as the field of foetal programming as such did not yet exist. However, as early as 1991 the press started referring to this research as a 'theory' or 'the newest theory' that might be able to find new causes of risk for adult diseases in early development:

> People who were small as babies are at higher risk of developing diabetes later, a Medical Research Council study has found. According to the researchers' theory, poor nutrition during the mother's pregnancy and during infancy means that the pancreas is unable to cope with the metabolic strain caused by affluent eating in later life.' (*The Independent* 25/10/1991);
>
> [T]he newest theory suggests that while diet is indeed important in heart disease, it is what our mothers eat during pregnancy and what they give

> us to eat in the first year of life that really matters. (*The Times* 28/05/1992);

and:

> Fatter babies make fitter adults. Heart disease: the girth of a theory. (*Daily Mail* 10/12/1993)

This was the first step in the process of boundary-work, and during the years that followed Barker's research started to be described in the press not only as a theory but also as an independent area of scientific enquiry, 'a burgeoning new field of research' (*Yukon News* 06/12/2002), or 'a new field of medicine'(*The West Australian* 03/11/ 2007). This shift in the media coverage is suggestive of successful boundary-work which allowed the framing of foetal programming as breaking new ground and promoted a novel field of scientific enquiry. But boundary-work was also used in the media to differentiate foetal programming from other competing frameworks and to demarcate boundaries of its own scientific competence and authority.

Trying to differentiate itself from competing approaches is an important part of field-building, and every emerging discipline needs to establish 'a cohesive self-identity and collective project', which can be achieved by defining its 'epistemological other' (Somers and Gibson 1994: 1). This was also true of foetal programming. Lifestyle and genetic explanations of chronic diseases in adulthood played the role of foetal programming's 'epistemological others', and the boundary-work carried out in the media coverage sought to demarcate foetal programming from these competing approaches. Looking at the ways in which genetic and lifestyle frameworks were discursively demarcated from foetal programming can shed light on foetal programming as an emerging field. This is because boundary-work, as Gieryn suggested, works like a literary device known as a foil. A foil provides a contrast or background to the main protagonist, and, to use Gieryn's own analogy of a detective story, 'just as readers come to know Holmes better through contrasts to his foil Watson, so does the public better learn about 'science' through

contrasts' to other competing scientific approaches' (Gieryn 1983: 791). Thus, claims about what foetal programming *is not* can provide crucial insights into what this field *claims to be*.

The media coverage of foetal programming challenged the genetic and lifestyle explanations of such adult diseases as coronary heart disease or diabetes, and it allowed the proponents of foetal programming to advocate a new aetiology of these ailments. In their view, the origins of these diseases were located not in faulty genes or bad lifestyle choices, but in events which occurred in early life and even before conception. The first media article on this research in my sample already contained this kind of boundary-work, and it featured Barker challenging the lifestyle framework with the following quote:

> To reduce deaths from heart disease in men society should promote the health and growth of young girls. (…) Instead of always looking at the fatty diets of middle-aged men we should pay more attention to the next generation's mothers. (*The Times* 23/05/1988)

In this account, the cause of heart attacks of middle-aged men lies not in their unhealthy diets, but rather in the conditions which shaped health and growth of their mothers, and which in turn influenced their sons' development in the womb. While this sort of framing turns attention away from adult lifestyle factors and focuses on the biological processes of reproduction, early development and growth, at the same time such boundary-work does something else, too, namely it establishes a causal relationship between the state of young women's health and heart conditions suffered by middle-aged males. Such an attribution of causality makes it possible to imagine that the health of young girls and women should be monitored for the benefit of other members of society, especially middle-aged men, who in the 1980s were believed to be affected by heart conditions more than other groups in the population[6] (see also Legato and Colman 2000, Riska 2000). In this way, foetal programming was positioned as a field whose focus was not on investigating 'the fatty diets of middle-

[6] Dr Marianne Legato, personal communication.

aged men' or the usual epidemiological 'triad of lifestyle naughtiness' such as smoking, drinking and overeating (Smith 2005), but rather on providing a link between health in later life and the health and nutritional status of the previous generation of mothers.

Claims that adult lifestyle factors cannot account for the occurrence of adult chronic diseases were accompanied by similar claims about genetic factors. As an Australian newspaper warned a few years later:

> Forget about genes and the dangers of hedonistic lifestyles. Instead, worry about what happened to you in the womb (*Sydney Morning Herald* 29/10/1994).

It is noteworthy that after the start of the Human Genome Project in 1990, the public discourse often framed genes as the most important factors in health and illness. Advising the readers to 'forget about genes' at that time was then a highly provocative claim. Over the years the suggestion that the search for origins of chronic diseases in adulthood should focus on the processes of reproduction and development rather than on adult life style or genes, was repeated in the media reporting, for example:

> Our health in later life is not simply a matter of genes and lifestyle, but is intimately linked to what happened to us in our mother's womb (*The Guardian* 10/03/1998);

or:

> It seems that the nine months spent in the womb may have a more lasting impact on your life than either your genes or lifestyle (*The Times* 20/08/2011).

Messages about the differences between foetal programming and its scientific competitors appeared in the press at various points over almost three decades of reporting. This suggests that for new entrants in the scientific arena the

game of boundary-work and credibility building is a long-term task, especially if rival approaches, such as life style and genetic frameworks are well established and enjoy high levels of prestige

All in all, boundary-work in the press coverage not only succeeded in presenting foetal programming as an independent field competing with lifestyle and genetic approaches. It also suggested that it offered better theories and explanations of how adult chronic disease arises. Professor Peter Nathanielsz, one of the most prominent proponents of foetal programming in the US, explained in a *Newsweek* article that:

> 'Programming … is equally if not more important than our genes in determining how we perform mentally and physically'. (*Newsweek* 27/09/1999)

Although in this example the contribution of programming and genetic factors to adult health outcomes was not represented in terms of statistical estimates, the article nevertheless speculated that programming could be 'more important' than genes for shaping the individual's future health performance. Similar discursive tactics were adopted in other journalistic pieces, which tended to frame the contribution of genes and lifestyle as 'small', while that of foetal programming as 'major' or 'most important'. For example, according to the press, the lifestyle approach was not able to fully account for the incidence of adult chronic disease as it explained 'only in small part why one person gets a heart attack and another person does not' (*The Ottawa Citizen* 30/06/1999). By contrast, as early as 1989 the Australian press reported that:

> Whilst cigarette smoking, diet and exercise are important, development in early childhood could be the major controlling factor in determining the risk of death from heart disease. (*The Advertiser* 29/06/1989);

and:

> (…) how well a baby grows and matures in the womb and during infancy has a major impact on adult health. (*The Daily Telegraph* 30/07/2002)

The influence of early life on adult health and disease was framed here as so great that it could outweigh the impact of smoking, diet and physical activity. This and other striking claims appeared in the press at various points in time across my sample. For example, early development, especially the time spent in the womb, was represented as a period which defined the rest of an individual's life. In Barker's words:

> 'We need to be much more focused on what happens in pregnancy. (…) You are marked forever by what happens in the womb.' '?The most important day of your life is not conception, it's the next nine months.' (*Sydney Morning Herald* 29/10/1994)

In the same vein, a press article claimed that:

> … the first 1,000 days of life - from the moment of conception to a child's second birthday - are the most important indicators of determining how healthy and happy your kids are later on in life. (…) 'So what you have on your 1,000th day is what you will ever have' [Barker said]. (*Irish Independent* 21/09 2011)

Boundary-work in the media produced representations of the Barker hypothesis as an independent field competing with the genetic and lifestyle frameworks. As a result, development in the womb was framed as more important than inherited genes or adult lifestyle choices, and the field of foetal programming was described as offering better theories than its rival approaches. At the same time, boundary-work sought to challenge the importance of the genetic and lifestyle factors, and the next sections explore this issue in more detail

4.2.2 Countering lifestyle explanations

In the press boundary-work sought not only to contrast foetal programming with its competitors, but to present it as somewhat superior to genetic and lifestyle explanations. This involved highlighting the purported shortcomings of these approaches and the gaps in knowledge that they were unable to address. The strategy of countering the claims of the competitors was particularly striking in the case of lifestyle explanations of chronic adult diseases, and it often relied on the use of the rhetorical figure of a paradox.

Paradoxesare important means of communicating science to various publics (Bucchi 1998: 27). In the history of science there have been numerous instances when paradoxes, such as for example Schrödinger's cat, which could be simultaneously dead and alive, captivated attention of both scientists and lay audiences. A paradox is 'a statement that goes against general accepted opinion' (p. 27) and it exploits the feeling of surprise by challenging received wisdom. In popular scientific texts paradoxes are not always veridical or 'true', that is, they can rely on some seemingly contradictory premises and be simply apparent paradoxes. Indeed, as Jacobi (1986) has shown, many of the paradoxes used in science popularisation are apparent ones. Such apparent paradoxes (*paradoxismes* in French) are discursive devices whose aim is to create a surprising image to persuade the reader (Jacobi 1986:18-19). In science communication paradoxes entice curiosity by emphasising contradictions, and thus they can help an audience to gain a new understanding of an old problem by reframing it in terms of new and surprising ideas (Bucchi 1998: 30). But, as rhetoricians Fahnestock and Secor (1991) have argued, what makes the use of paradox particularly appealing is its ability to create an 'impression of discovery', to enhance the 'intellectual content of the argument', but also to demonstrate that the people using the paradox are clever (Fahnestock and Secor 1991: 88).

These features of the paradox made it a useful tool in demonstrating the purported shortcomings of the lifestyle paradigm and superiority of foetal programming's novel – and surprising - explanations. The lifestyle factors framework was often represented as mainstream, but ultimately as inexact or even

misleading. This view was promoted by leading researchers in the field of foetal programming, for example by David Barker who was quoted as saying that:

> 'Lifestyle only goes a small way to explaining why one person gets heart disease and another doesn't,' he [Barker] says. 'Many people with healthy lifestyles still have heart problems. Most of the development in our bodies, including organs such as the heart, lungs and kidneys takes place before we're born' (*The Express* 20/05/2003).

Here the media exploited the paradox which challenged the lifestyle framework's reputation and assumptions, namely that healthy lifestyle protected from heart disease and could predict or explain individual health outcomes. According to this coverage, not only was the predictive power of the lifestyle paradigm weak: the usefulness of lifestyle interventions to protect health of populations was also questioned, as 'many people with healthy lifestyles still have heart problems'. The conundrum posed by this paradoxical statement is resolved by claims that the time spent in the womb seemed to be more important for later health outcomes than adult lifestyle choices. Similar rhetorical strategies were also deployed in other press articles, (for example in *The Herald*, 24/12/1993).

To summarise, in these accounts good lifestyle choices do not protect against disease, a paradox which was used to undermine the claims of the lifestyle factors framework. But even more surprisingly, some media coverage drew on another paradox which suggested that bad lifestyle choices do not necessarily lead to chronic disease. As Professor Keith Thornburg, a prominent foetal programming scholar explained on a radio programme:

> We tend to think about people getting disease as adults based on their lifestyle. They lay around and watch television too much, they drink too much, or they eat too much steak and we blame all of their disease on that. Those things are actually correlated with disease, but what we are only now coming to realise is that vulnerability for disease is determined in the womb, so some people are quite resistant to those effects,

> especially high fat diet for example and they don't get disease and that's because they aren't vulnerable. (*BBC Radio 4* 2011)

Here the stereotypical image of 'couch potatoes' is used to marshal a claim that contrary to the lifestyle framework's assumptions about the harmful effects of bad diet and lack of physical activity, not everybody indulging in such behaviour suffers from chronic disease. This is because – as foetal programming argues - of the way in which those people's development in the womb took place, making some vulnerable and others resilient to the effects of high fat diets and lack of exercise. This paradox was used here to illustrate the failures of the lifestyle framework to adequately explain incidence of chronic disease in adulthood and to suggest that foetal programming offers a new and convincing solution to its rival's shortcomings.

In some instances, in the attempt to counter the lifestyle factors explanations of chronic disease, the same paradox was used, albeit with a tweak: instead of focusing on some anonymous 'couch potatoes', the paradox zoomed on the image of one individual – a fictional Uncle Charlie - whose life seemed to contradict the basic tenets of the lifestyle, and also of genetic explanations. As Barker argued:

> 'American epidemiology has gone off on a boil, gone off to rooms filled with paper and no patients,' he [Barker] says. 'Everyone has an Uncle Charlie who lived a grand life, drank, ate up a storm, and died at 100, while another guy lived a blameless life and died of coronary heart disease at 45. We can't blame everything on genes and go to sleep, because genes don't quite explain it either.' (*Discover Magazine* 01/12/2002)

This kind of paradox proved popular in other high-profile media, such as the *BBC Horizon* broadcast (2011) and *The Times* which claimed that:

> Optimum conditions before, during and after birth will not make you immune to other inherited risk factors or the ravaging effects of old age,

> but they may explain why everyone knows an Uncle Ernie who smoked and drank and lived to 100. (*The Times* 16/08/2011)

In these examples, the persuasive power of the paradox calls on the personal experience and speaks to the common sense of the lay audience – as 'everyone has an Uncle Charlie' (*Discover Magazine* 01/12/2002) or 'everyone knows an Uncle Ernie' (*The Times* 16/08/2011) – which is encouraged to observe and reflect on the limited merits of a healthy lifestyle. In this sense, this paradox draws on powerful social imaginary of health outliers, or, as Smith has described them 'people, who survive to a ripe old age despite transgressing every code of healthy living' (Smith 2011: 538)[7]. In the so-called lay epidemiology, a cultural system of theorising about health, illness and death, such cases are usually explained as due to luck, because these people's 'individual constitution' allowed them to enjoy themselves and remain alive' (Davison et al. 1991: 16). While drawing on such lay understanding of illness, the paradox of Uncle Charlie offers a new and surprising explanation for it, namely that not luck but resilience acquired in the womb may have shielded Charlie from bad effects of smoke and drink throughout his life. Countering lifestyle factors claims by proposing a new and more persuasive aetiology of adult disease thus contributed to the legitimation and demarcation of new boundaries between foetal programming and other scientific disciplines in the public realm.

4.2.3 Challenging genetic explanations

A similar strategy of drawing boundaries between disciplines was deployed in the case of the genetic paradigm. Explanations of adult chronic diseases which made use of genetic factors were also challenged, albeit in a slightly different fashion from lifestyle factors. While countering the claims of the latter relied heavily on

[7] For a discussion whether this or similar cases represent a paradox and constitute a failure of explaining disease in epidemiology see Smith (2011).

paradoxes, various metaphorical framings were used to challenge gene-focussed explanations of chronic adult diseases. At the same time, many of the press articles tended not to discount genetic research *per se*, but rather they de-emphasised the importance of genes as primary source for determining disease. For example, as Professor Keith Thornburg argued:

> 'So the genes an individual inherits from parents and environmental factors like how much they drink or whether they smoke will always be made to determinate of how long someone lives and the sort of illnesses that they are likely to develop. But their ability to shrug off such insults, their resilience to disease, is decided by events that occur in their first thousand days [of life].' (*BBC Radio 4* 2011)

Professor Peter Nathanielsz made a similar point in a cover story published in *Newsweek* over a decade earlier:

> 'The new science of fetal programming suggests that we may have gone overboard in ascribing traits to genes.' (*Newsweek* 27/09/1999)

Thus, the media coverage seemed to suggest that while the genetic framework was important forunderstanding disease, it was also somewhat overrated, as events occurring in the womb determined an individual's resilience to chronic disease in adulthood. This ambivalence was particularly noticeable in the metaphorical framings that were used to describe the genetic research, especially in the years leading up to the completion of the Human Genome Project (1990-2003). For example, the media claimed that:

> While the genetic juggernaut has mesmerised many scientists, and the remainder have become submerged in scrutinising our bad habits (…), a group of British scientists have been trying for 10 years to tell the world that a vital period of life has been ignored with major implications for preventing (…) [chronic] conditions (*The Independent* 19/01/1997);

or:

> A decade ago, the 'Barker hypothesis' was almost unknown, drowned out by the thunder of excitement over the genetics revolution. (*Discover Magazine* 01/12/2002)

In these accounts, genetic and genomic research is metaphorically represented as 'juggernaut', a word which according to the Oxford Dictionary online designates a 'huge, powerful and overwhelming force'. Genetic and genomic research is framed either as a powerful paradigm or alternatively as an overwhelming force which 'has mesmerized many scientists', thus eclipsing other important issues such as 'a vital period of [early] life'. In the second quote, genetic research is framed as 'genetic revolution' accompanied by a 'thunder of excitement' which 'drowned out' other competing frameworks, such as the 'Barker hypothesis'. In both examples, the genetic research is metaphorically framed as an overwhelming force or a revolution which seems to compromise the scientists' sense of hearing or sight. This makes it difficult for other approaches to be seen and for their claims to be heard. This image of genetics and genomics as hegemonic science was further promoted by Barker who according to *The New Yorker* 'made disparaging asides about the 'dismal failure' of genetic research to explain chronic disease' and was quoted as saying:

> 'Genes are not Stalinist dictators,' he [Barker] said. 'They live in a democracy, and what they do is conditioned by what else is going on around them.' (*The New Yorker* 19/11/2007)

Here the metaphor of Stalinist dictators living in a democracy is used by Barker to dispel the notion that genes could be the primary source of disease. This metaphor shifts attention from genes to environmental factors which are referred to here as 'what else is going on around them [genes]'. But it is also possible to read the metaphor of a 'dictator' as applying to the genetic and genomic research which may have been perceived as occupying the centre-stage of biomedical sciences for decades and not abiding to the rules of democracy by muting scientific debate.

As this analysis has shown, the merits of the genetic and genomic paradigm were usually not directly discounted, as was the case with the lifestyle factors

explanations. However, the status and the usefulness of the genetic approach were regularly challenged, and this was often achieved with the help of metaphors which framed genetics as a hegemonic science hindering the advance of early life explanations of adult chronic disease. At the same time, the media coverage represented foetal programming as better placed than genetic or genomic science to account for why some people get disease and others do not. After all, in Barker's words 'genes are yesterday, this [foetal programming] is tomorrow's science' (*The Independent* 19/01/1997).

The media constituted an important public arena where new boundaries between disciplines were negotiated to establish the emerging science of foetal programming. This involved the use of metaphors and paradoxes which were employed to encroach on the disciplinary expertise of the lifestyle and genetic factors explanations and to discursively make space for the new player in the field.

4.2.4 Drawing the boundaries around the field

The media coverage of foetal programming also drew on boundary-work to trace boundaries around this field and to demarcate it as an independent area of research. This was achieved with the help of various discursive devices which sought to make sense of this new field by anchoring it in the existing understandings and ways of talking about health and disease.

Anchoring is a term coined by Moscovici (1988), and it refers to 'the process of making something unfamiliar understandable by linking it to something familiar' (Jaspal et al. 2012: 385). Anchoring a new idea or object usually involves comparing it with or situating it within an existing stock of other objects and ideas specific in a given culture or social group (Jaspal et al. 2014).

In the case of foetal programming, the process of anchoring this new topic in the press involved situating it within common sense assumptions about human nature and within lay understandings of why people fall ill. To this end the media used

clichés - or rhetorical devices which by their virtue of carrying well-known messages and meanings (Cuddon 2014) were able to situate foetal programming in a familiar context. For example, clichés about binary oppositions such as genes versus lifestyle or nature versus nurture were deployed to introduce and to anchor the topic of foetal programming in the press. But since the familiarity of the messages carried by the clichés makes them somewhat uninspiring if not boring, in the press the clichés were subsequently reframed in a surprising fashion by means of a literary technique called defamiliarisation or estrangement. As Cuddon notes:

> To 'defamiliarize' is to make fresh, new, strange, different what is familiar and known. Through defamiliarization the writer modifies the reader's habitual perceptions. (Cuddon 2014)

In addition, through uncovering surprising aspects of familiar objects and ideas, defamiliarisation stimulates intellectual pleasure and a sense of discovery (Newton 1997), a feature which made it a suitable discursive device for building credibility and legitimacy of foetal programming which claimed to discover new roots of adult chronic disease.

Thus, in the press the Barker hypothesis was rendered both as familiar - thanks to clichés, and at the same time as fresh and surprising - thanks to defamiliarisation. This discursive strategy helped to introduce this field to the public, to make sense of it in relation to the already known facts and to appreciate its novel and pioneering claims. For example, some journalists and scientists talking to the media attempted to present foetal programming as an alternative to genetic and lifestyle explanations, or a solution which goes beyond the usual binary oppositions. According to *The Weekend Australian*:

> Disease is caused by the interaction between the genes you receive from your parents and the lifestyle you choose. (…) But a new field of research proposes a third factor in the equation: that the environment in the womb can influence the foetus's development, restricting the baby's growth and leaving them at greater risk of diseases such as hypertension,

> heart disease and diabetes when they grow up. (*The Weekend Australian* 01/07/2000)

Here development in the womb, which is the key focus of foetal programming, is framed as a 'third factor in the equation' in addition to genes and lifestyle, as it offers a new explanation of the occurrence of chronic diseases in adulthood. In addition, a cover article from *Time* referred to foetal programming as 'a third pathway' (*Time* 10/2010), and a similar framing of the 'third factor' appeared in *The New York Times* (02/10/2010).

In other journalistic pieces, foetal programming/DOHaD was discursively positioned as a solution to the eternal debate about nature (understood as genes) versus nurture (understood as lifestyle or environment). This framing appeared especially in those articles which discussed foetal programming in the context of recent advances in epigenetics, the field which, it is hoped, will identify a mechanism through which programming in the womb might be operating. *The Sunday Times* quoted Phil Hanlon, professor of public health at Glasgow University who said that:

> 'There has long been a debate about nature versus nurture and what is being suggested now is nature via nurture - that genes are turned on and off by a set of environmental factors.' (*The Sunday Times* 02/072006)

The Economist argued that:

> The long-vaunted distinction between nature and nurture is therefore 'outdated and unhelpful', says Janet Curie of Princeton University's Centre for Health and Child Wellbeing. Poor nurture during pregnancy can worsen the hand that nature has dealt. (*The Economist* 04/04/2015)

The suggestion is that foetal programming might provide a better explanation of adult disease and transcend the old and unproductive debate of nature versus nurture, or of genes versus lifestyle. This and the previous examples show that the boundary-work of drawing the lines around foetal programming as a separate field involved anchoring it in the cliché of the 'nature versus nurture' debate and

subsequently defamilarising it – or reframing it in a new way as ‘a third way’, or ‘nature via nurture’.

Such a way of presenting an emerging field was an effective way of enhancing the impression that foetal programming was driving science forward by transcending the usual binary opposition of genes and environment. This rhetorical strategy also drew on a stereotypical toolkit of science communication according to which ‘science is (…) portrayed (…) as a solution to intractable dilemmas, a means of achieving certainty in an uncertain world, a way (…) to rebuild comfortable images of progress’ (Nelkin 1990: 45). Framing foetal programming as a solution to an old and seemingly intractable problem of ‘nature versus nurture’ suggested that science can and should progress by focusing on development in the womb.

4.2.5 Breaking with the past, starting a revolution

While some articles attempted to define foetal programming as a scientific field with the help of familiar anchors, others tried to position it as an innovative approach which breaks with the past. This was expressed in the idiom of ‘conventional knowledge’ or ‘conventional explanations’ which was used to denote the kind of knowledge that foetal programming was challenging. This type of framing appeared in early coverage and was used across a range of media. For example, one article argued that:

> (…) conventional explanations of heart attack risk had concentrated too much on diet, smoking, and lack of exercise, a conference was told yesterday. Professor David Barker (…) said (…) that predisposition to heart disease was determined even before birth. (*Herald* 14/11/1992);

and:

> It's a theory that has turned conventional medical wisdom on its head. (*Daily Record* 22/08/2011)

More broadly, the press coverage suggested that foetal programming was radically changing the understanding of how humans grow and develop, and of the consequences this may have in the future.

Some news articles and broadcasts went as far as to argue that foetal programming constituted a revolution or a paradigm shift in biomedical sciences. Such claims first appeared as early as in 1992, when the consensus about Barker's research had not yet been reached and the field was fighting for recognition. According to a piece published by *The Times*:

> (…) Barker has come up with a new theory which (…) could revolutionise our view, not only of heart disease, but of other degenerative diseases as well. (…) The possibility is, as Roger Robinson, an editor of the *British Medical Journal*, wrote in a recent editorial, that we may be witnessing what the historian of science Thomas Kuhn called ''a paradigm shift'', when an old theory is replaced wholesale by a new one better able to explain the facts. Such events happen rarely in science, but the confusion over heart disease is so complete that the subject is ready for a revolution. (*The Times* 06/06/1992)

Since the publication of Kuhn's (1996) seminal book on scientific revolutions in 1962, the term 'paradigm' or 'paradigm shift' has been widely adopted across disciplines. However, its meaning remains vague, not least because throughout his book Kuhn himself used it at least in twenty-one different ways (Masterman 1970). The many, often confusing, interpretations (Morgan 1980) of Kuhn's 'paradigm' have led some scholars to argue that this term can be understood as a metaphor (Maasen and Weingart 2013) whose meaning depends on its context of use. Significantly, in the quote above, the term 'paradigm' is used not as a cliché or a metaphor, but as an explicit reference to Kuhn's work who claimed that a paradigm consists of 'universally recognized scientific achievements that, for a time, provide model problems and solutions for a community of practitioners' (Kuhn 1996: x).

Claims about a paradigmatic or revolutionary character of Barker's work appeared in various media in the UK, Australia, or US. Paradigm shift became almost synonymous with revolution. For example, an article from the Australian press claimed that: 'A revolutionary new view of many common diseases is emerging' (*Sydney Morning Herald* 19/01/1998), while according to the American edition of *Newsweek*:

> 'It is no exaggeration to call these findings a revolution in the making. (…) Two years ago, no one was even thinking about this', says Dr. Matthew Gillman of Harvard Medical School. 'But now what we are seeing is nothing short of a new paradigm in public health' [says Dr Matthew Gillman]. (*Newsweek* 27/09/1999)

This view was also promoted by Annie Murphy Paul, a journalist and author of *Origins: How the nine months before birth shape the rest of our lives,* a popular book on foetal programming. In her cover story for *Time Magazine* Paul claimed that:

> 'Research on fetal origins (…) is prompting a revolutionary shift in thinking about where human qualities come from and when they begin to develop. It's turning pregnancy into a scientific frontier' (*Time* 10/2010).

One of the most prominent assertions of the paradigmatic nature of this research was made by Professor Caroline Fall, a leading scholar into foetal programming, who in *The BBC Horizon* film said that:

> The whole idea was extremely controversial. It blew me away, actually. It was an incredible idea, a real paradigm shift (*BBC Horizon* 2011).

Claims of a paradigm shift, scientific revolutions and breakthroughs in the press have long attracted attention from media and social science scholars. They have been interpreted in various fashions, for example as a sign of lazy journalism (see Arney 2017), or as a well-entrenched feature of journalistic writing. Dunwoody (2014) has argued that science journalists tend to 'hang their stories' on traditional

news pegs, such as timeliness, controversy and novelty, and claims of scientific revolutions seem to fulfil all of these criteria. According to Nelkin (1990), claims of scientific revolutions should not be taken at face value as they belong to a stereotypical imagery of science reporting, alongside the claims that science is akin to frontier or warfare. But she has also argued that scientists themselves are complicit in propagating such aggressive imagery – and even in propagating hype.

These and similar claims of breakthroughs have also been investigated through the lens of the sociology of expectations. Brown and Michael (2003) have argued that claims and promises about the future constitute essential steps to mobilise support for a new field. Many such claims might still be wildly optimistic and promote myths of what science and technology do and what they actually achieve (Nightingale and Martin 2004). However, as noted by scholars in the rhetoric of science, radical claims keep being made even when there is a significant time lag between promises and their (hoped for) implementation. Such radical statements should not necessarily be interpreted as promoting myths, but rather as sustaining an emerging field, or keeping a dream of a scientific revolution alive. This kind of 'preservative' rhetoric of revolution

> insures[s] that epistemic judgements are maintained in the marketplace of ideas where they may be subjected to the scrutiny of others . (...) [rhetoric] keeps alive ideas whose time has not yet come,' for technical or other reasons. (Cherwitz and Hikins 1986: 98 quoted in Zagacki and Keith 1992: 68)

Hence the promises of a paradigm shift, frontier science and scientific revolution caused by foetal programming do not necessarily have to be examined and evaluated against the background of this field's achievements or consensus whether it is a paradigm shift (or not). Rather, such claims can be understood as discursive land grabbing, so to speak, or an attempt to demarcate a scientific territory even when the facts or recognition do not yet catch up with reality. In addition, claims of

a paradigm shift can be repeated over long period of time to promote, sustain and strengthen the field's standing among other disciplines and in the public realm.

4.2.6 Framing science as religion

Alongside the claims of paradigm shifts and scientific revolutions, other discursive strategies were used in the media to represent foetal programming as a new and exciting idea capable of galvanising support and recruit followers. As a result, both in the printed and audio-visual media foetal programming was metaphorically framed as akin to religion or quasi-religious belief.

Framing science as a belief or religion is not new. According to Locke (1992) Watson and Crick consciously used the concept of belief as well as religious vocabulary and imagery while advancing their new ideas about the Central Dogma. While in the context of molecular biology of the 1950s, the choice of the term 'dogma' was, as Locke argues, a kind of provocation directed by Crick at this science's opponents – especially religiously motivated vitalists, in Locke's view even contemporary 'materialistic science is not without its own religious overtones' (Locke 1992: 50). Already in the 1960s religious imagery surrounding genetics spread into popular accounts of this science, and it helped construct the study of genes 'as a spiritual and moral issue' (Dijck 1998: 45).

The use of religious imagery and metaphors has also been explored in the context of climate change debates. As Nerlich (2010) and Jaspal et al. (2012) have shown, framing science as religion is a device often used to delegitimate science – in the past creationists used it to discredit the theory of evolution, and more recently climate denialists have been resorting to a similar strategy to delegitimise climate science. Nerlich's analysis (2010) of online 'climategate' debate has identified an overall conceptual metaphor 'science is religion', as well as metaphorical expressions which were used by so-called climate sceptics to frame scientific theories proposed by mainstream climate science as 'dogma', 'myth' or 'gospel'; scientific consensus as 'orthodoxy' or 'singing from the same hymn sheet'; and

scientists as ‘believers’, ‘prophets’, ‘evangelists’ or the ‘converted iluminati’. In the climategate debate, these metaphors have been used to paint a highly negative portrait of climate science and scientists by attributing to them intransigence of thought, rigidity, ignoring scientific evidence and so on.

Thus, framing science as religion can solicit positive and noble connotations (as in the case of genetics), as well as negative ones (as in the climate change debate). As the following analysis will show, the media coverage of foetal programming followed these two well-established patterns of communicating science in public. In my sample, the media coverage in which the Barker hypothesis was framed as religion or belief exploited rather positive imagery of this science. For example, the high-profile *BBC 2 Horizon* television programme ‘The Nine Months that Made You’ featured Professor Yajnik, a prominent researcher in foetal programming, who explained the Barker hypothesis in the following fashion:

> So David's idea that part of your destiny was sealed before you are born was difficult to understand for Westerners, but not for me. As an Indian, I believed that what happened in your earlier life, what your parents did, actually had a bearing on what happens to you in your life. This is the theory of karma. (*BBC Horizon* 2011)

Here the Barker hypothesis is framed as karma, a religious theory that allowed Professor Yajnik to grasp the significance of foetal programming and events from the past for adult health in the future. This was not the only example of religious framing in my sample. In the media scientific opinions expressed by proponents of foetal programming were also framed as ’belief’, for example:

> Researchers in the UK now believe that the first 1,000 days of life - from the moment of conception to a child's second birthday - are the most important indicators of determining how healthy and happy your kids are later on in life. (*Irish Independent* 21/09/2011)

In addition to framing foetal programming as 'religion' or 'belief', the media also referred to Barker's research as 'heretical' (*The New Yorker* 19/11/ 2007) or 'heresy' (*The Times* 20/11/2004). At times, the press made use of a whole web of religious metaphors. For example, Mark Porter, a medical doctor and an author of *BBC Radio 4* episodes on foetal programming, described this field in the following way:

> 'I first met one of the pioneers of this theory, Professor David Barker, an epidemiologist at the University of Southampton, while working on a new series for *Radio 4* - The First 1,000 Days: A Legacy for Life - and came away a convert. His enthusiasm is infectious and while verging on the evangelical he is no maverick loner. Over the past few months I have spoken with researchers from a range of disciplines, including cardiology, obstetrics, paediatrics, rheumatology and genetics, and they are all singing from the same hymn sheet' (*The Times* 16/08/ 2011).

Here a range of interconnected religious metaphors such as 'evangelical', 'convert', and 'singing from the same hymn sheet' was deployed to create an impression that foetal programming was a scientific underdog, so to speak, pioneering new ideas, fighting for recognition and striving to spread the word – or being 'evangelical ' (the fact that has also been referred to as 'missionary zeal in Barker's obituaries; see Chapter 1 and Pincock 2013). This last feature, that is the evangelism or this field's efforts to recruit followers, was particularly salient in the instances where some past or current opponents of foetal programming were presented in the media as 'sceptics', or 'detractors', while some current researchers in the field, including such prominent figures as Professor Yajnik, Dr Janet Rich-Edwards and Dr Matthew Gillman, were introduced in the media as 'converts'. As a feature story in *The New Yorker* argued:

> One of the most significant events in the life history of a scientific idea occurs when its detractors become adherents. A Danish researcher, Allan Vaag, told me that he 'really did not believe in this theory' until 1997; that was the year he discovered, in a study of identical twins, that diagnoses of type 2 diabetes were more common for the twin who had a lower birth weight. Janet Rich-Edwards, a Harvard Medical School epidemiologist (…) 'set out to prove that Barker was totally wrong.' But, in 1997, Rich-Edwards and her colleagues reported 'strong evidence' of a connection between low birth weight and a heightened risk of coronary heart disease and stroke. In 2000, Rich-Edwards and her Harvard colleague Matthew Gillman published a paper titled 'The Fetal Origins of Adult Disease: From Sceptic to Convert.' (*The New Yorker* 19/11/2007)

As this and other media accounts suggested, scepticism of foetal programming's opponents could be overcome if only they engaged more with this research. Commenting on her own 'conversion' or change of scientific position, Rich-Edwards argued in *Time* magazine that 'there's nothing like your own data to change your mind' (*Time* 04/10/2010). It also seems that framing opponents of foetal programming as 'sceptics' allowed, at least to some extent, to protect the reputation of this field against criticism, as sceptics could always be expected to change their mind, or transform from foetal programming's 'detractors' to its 'adherents'.

Overall, the religious imagery surrounding foetal programming in the media did not seem to result in negative portrayals of this science. Rather, it created an impression that this rather small and 'heretical' field is expanding, and that it is moving scientific debates forward by winning over its opponents. By contrast, the metaphorical expressions denoting quasi-religious beliefs were occasionally used to discredit foetal programming's opponents, for example the proponents of the frameworks of lifestyle or genetic factors. As Barker himself argued in the press:

> 'The study of cardiovascular disease in the past 30 years has been characterised by extremely rigid thinking, dogma, and a lot of evangelism

> that should have been replaced long ago by science,' he [David Barker] argues. (*The Herald* 24/12/1993)

Strikingly, the metaphors of 'dogma' and 'evangelism' have here rather negative connotations, and they are used to undermine the credibility of lifestyle explanations of cardiovascular disease, while foetal programming is framed by Barker as 'science', *tout court*.

It seems that in the case of foetal programming the religious metaphors and imagery were used in the press in a flexible fashion. The meanings they carried and the effect they had depended heavily on the context, and in my corpus they were used to support foetal programming, or, alternatively, to undermine its opponents. This finding does not lend itself to an easy interpretation. On the one hand, this framing strategy may indicate that foetal programming has managed to solicit considerable support in the media circles, as journalists tended to use religious metaphors in a way which enhanced rather than undermined foetal programming's reputation. On the other hand, it might also suggest that the 'science is religion' metaphor is used more effectively in attempts to discredit a dominant scientific framework rather than an emerging field, or a scientific underdog such as foetal programming. Media stories about scientific underdogs and 'David and Goliath struggles with a seemingly bright go-it-alone scientist bucking an intransigent, conservative scientific establishment' have a powerful popular appeal, and the audiences – and journalists alike – 'are predisposed to root for the underdog' (Dearing 1995: 344). It thus may be that in the context of the press coverage of foetal programming the media drew on an entrenched use of religious metaphors, which in the past were mobilised by vocal minorities such as creationists or climate sceptics (who, interestingly, sometimes described themselves as heretics) against the hegemonic theory of evolution or climate science (see Nerlich 2010) – but more research would be needed to investigate how religious metaphors are deployed in the context of other scientific disciplines.

As shown above, various discursive tools such as metaphors, clichés and paradoxes were strategically used to carry out boundary-work in the media coverage. This boundary-work operated on several levels as it helped to frame foetal programming first as a science (by positioning it as new research, new theory, and subsequently as a new field), second as an approach competing with the lifestyle and genetic frameworks, and third, as a revolution, paradigm shift or indeed a scientific approach akin to religious awakening, a scientific revolution or a paradigm shift in the understanding of early origins of disease risk.

4.3 Certainty-building

Alongside claims of revolutions and paradigm shifts, certainty-building is another feature of scientific communication which, as Bucchi (1998) claims, aims to increase the credibility and reputation of science. This study has uncovered yet another discursive tool which increased certainty of the new science of foetal programming in the press, namely hedging. Findings show that when discovery narratives of foetal programming were not yet in circulation, hedging was used in the press to reduce uncertainty surrounding this science and to present it as a legitimate field of enquiry. This section first analyses hedges and then discusses discovery narratives of foetal programming in the media.

4.3.1 Hedges as discursive strategies

Hedging is a discourse strategy which aims to reduce the force or truth of a statement – and as such hedging constitutes a strategy of reducing risk in communication (Kaltenböck et al. 2010: 1). The term of 'hedge' or 'hedges' was coined and popularised by the cognitive linguist Lakoff, and it denotes 'words whose meaning implicitly involves fuzziness – words whose job is to make things fuzzier or less fuzzy' (Lakoff 1973: 471). This fuzziness, also understood as vagueness, has been identified as playing a crucial role in both spoken and written discourse (Kaltenböck

et al. 2010: 1), as well as a distinctive feature of academic writing. As Hyland has noted:

> Hedges express tentativeness and possibility in communication, and their appropriate use in scientific discourse is vital. Hedging enables writers to express a perspective on their statements, *to present unproven claims with caution*, and to enter into a dialogue with their audiences. It is therefore *an important means by which professional scientists confirm their membership in research communities.* (Hyland 1996: 251-252; emphasis added)

Hedging of claims can be achieved with a help of a wide range of words and expressions such as 'suggest', 'seem', 'appear', 'may', 'might', 'could', 'probably', as well as 'more research is needed', 'this has to be confirmed', and so on[8]. Such words and phrases soften the strength of statements, or they round the sharp edges of new and bold claims making them easier to swallow, so to speak. The strategy of hedging claims, for example, while advancing a new hypothesis, is so widespread in academic writing, that as Myers has put it, 'a sentence that looks like a claim but has no hedging is probably not a statement of new knowledge' (Myers 1989:13). There has been much debate about the purposes that hedges serve in written scientific communications. For example, it has been theorised as a politeness strategy which is deployed by an author of a written text who seeks to criticise competing theories or to advance his own claims (see for example Brown and Levinson 1987). In this sense, hedging is a face-saving device for the author or a reader of a scientific text (Myers 1989).

Hedges may play another important role and be used as a strategy to strengthen the scientific argument, by, paradoxically, weakening its claims. According to Meyer:

[8] For a discussion of criteria of identifying hedges in academic writing see Crompton (1997); for a general discussion of hedging in English see Hübler (1983).

> Academic discourse (…), at least as judged by its own proclaimed epistemological standards, should aim at producing statements that are falsifiable. Claims should be made as strong as possible. The stronger they are, the easier they are to falsify. Hedging typically weakens the strength of speech acts, making them less 'negatable' (Hübler 1983:23). (…) the more certain [knowledge] is, the less hedging is needed to state it. It is only when research activities fail to provide a basis for unhedged statements that *language comes in to compensate for the lack of certainty*. (Meyer 1997: 21 and 39, emphasis added)

Thus hedging helps scientists not only to formulate and advance a new hypothesis in a fashion that is acceptable within a research community, but also to defend as yet unproven scientific claims. Therefore, hedging can be used as a strategy to reduce uncertainty or to increase certainty in scientific texts such as research articles (Meyer 1997).

4.3.2 Hedging in popular media

While hedging is common in scientific texts (Myers 1989), it is less frequent in the coverage of science in popular media (Jensen 2008). Indeed, journalists are often blamed for making 'science more certain than it is' (Stocking 1999: 24), while in the journalistic reports on science 'the research is stripped of caveats, limitations, and other indicators of scientific uncertainty' (Jensen 2008: 347). When hedges do appear in the media, journalists may still be criticised for using them in an inappropriate way (Shuckburgh et al. 2012).

Hedging constituted an important feature of the journalistic coverage of research into foetal programming. It appeared already in the first media text in my sample which in 1988 mentioned Barker's research. According to a short article *'Mother's diet link to heart disease; Study by Professor David Barker*' published in *The Times*:

> People *may be* dying of heart disease because their mothers had unhealthy diets in childhood, a leading research scientist said yesterday. Studies showed *an apparent link* between what a baby received from its mother in the womb, and from breast feeding, and the development of heart disease in middle age. (*The Times* 23/05/1988, italics added)

This early communication contained Barker's core argument (presented here as 'a leading research scientist') that coronary heart disease stems from nutritional environment in the womb and in infancy. Interestingly, this new and arguably bold claim was hedged by more cautious statements, as according to the article Barker's studies showed 'an apparent link' between early nutrition and heart disease in middle age. A media report which appeared in Australian press a few days later covered Barker's research in more depth, but it also signalled its tentative nature by referring to 'a close link' between heart disease and the nutrition in early life discovered by Barker (*The Sun Herald* 29/05/1988).

Studies which report on findings based on statistical correlations often use such words as 'links' or 'associations' to highlight a relationship between two events that might but are not necessarily proved to be causal. In the media coverage of foetal programming, such words as 'links' but also 'clues' played a similar role, namely they signalled a hypothetical nature of claims being made in the press, while simultaneously supporting the validity of these findings, for example 'cradle clue to heart attacks' (*The Guardian* 08/09/1989), 'baby clues for the future adult' (*The Times* 17/05/1990), or 'baby diet link in heart disease' (*The Sun Herald Australia* 29/05/1988). This created a peculiar dynamic in media reports which seemed to sound an alarm about negative consequences of poor growth in early life for future health, while at the same time suggesting a speculative character of these claims.

This discursive strategy was used in titles and headlines which often warned about serious health risks related to early life. An extreme example of that kind involved an article from an Australian newspaper which warned about an 'Infant weight gain linked with suicide' (*Herald Sun* 04/11/1995). In a similar vein, when

ten years later the field of foetal programming was turning its attention from being born small to being born big, a Canadian newspaper alerted their readers to 'High birth weight linked to cancer' (*Ottawa Citizen* 07/02/2005).

To see how the notion of a 'link' played out in journalistic texts it is useful to have a closer look at the following example from *The Times:*

> Research suggests that some diseases in adulthood might be directly linked to the unborn child (…). Insights into adult health are beginning to emerge from studies of the infant and the unborn child. Startling evidence has been found that the origins of heart disease, stroke and other serious illnesses can be traced back to the womb. (*The Times* 22/11/1990)

Here the negative consequences of early life, such as 'heart disease, stroke and other serious illnesses' in adulthood are framed simultaneously as uncertain and certain. On the one hand, the article advances a hedged - or an attenuated claim that these diseases 'might be directly linked to the unborn child'. On the other hand, only a few lines later it asserts that 'startling evidence has been found' to support these claims. Also, while this text emphasises the novelty and potential noteworthiness of research into foetal programming, it also moderates and hedges this statement by saying cautiously that 'insights into adult health are beginning to emerge'.

The media articles on foetal programming also contained various other types of hedging, but what stood out in my sample was the expression of the 'growing evidence', 'accumulating evidence or 'increasing evidence'. These expressions were used in the coverage, across time and the spectrum of media outlets, for example:

> The latest research adds to growing evidence that what happens in the womb determines an individual's risk of heart disease. The study found a strong link between the size of a baby's abdomen at birth and levels of blood fat or cholesterol in adulthood. (*Daily Mail* 10/12/1993);

> (…) the roots of obesity lie in the first year of life. (…) Evidence is growing that feeding babies properly in their first 12 months sends out the right hormonal signals and programmes the body's metabolism correctly. (*The Observer* 08/06/2003);

> Increasing evidence suggests that all three [heart disease, diabetes and kidney disease] begin as the baby is developing in the uterus. (*Newcastle Herald* Australia 14/06/2013)

These hedges were woven into the texts to suggest that evidence was still needed to fully support claims that for example 'what happens in the womb determines an individual's risk of heart disease', or 'the roots of obesity lie in the first year of life'. Overall, the strategy of qualifying claims of risks of early life with hedges did not produce an image of a science that was being undermined[9]. To the contrary, hedging created an impression of a confident emerging science which, according to *The Times* was able to claim that:

> The result will need confirmation, but there is certainly a growing body of evidence that the nine months in the womb may make or mar a child's life. (*The Times* 04/02/1994)

In this quote hedging was used to strengthen the argument of science by weakening its claims (Meyer 1997). The startling claim that 'nine months in the womb may make or mar a child's life' in terms of her health prospects in adult life is moderated by hedges of 'the result will need confirmation' and 'there is certainly a growing body of evidence', which suggest an early stage of scientific research. In

[9] This analysis did not test how hedging of foetal programming's claims in the media affected specific audiences – to find this out more research is needed in the future. However, it seems that hedging of scientific claims in the media may in some cases favourably influence the lay perception of science. A study conducted by Jensen (2008) suggests that if the media coverage of science contained hedges expressed by scientists involved in the research in question, the public perceived both the scientists and the journalists as more trustworthy. On the other hand, a study on the media coverage of climate change (Shuckburgh et al. 2012) suggests that hedging may increase a perception of science as uncertain. Since hedging in science communication is under-researched, in future more studies could examine how hedges influence public understanding of science.

this example, it seems that hedging does reduce uncertainty surrounding science: although evidence reported in the article is not definitive, it is still used to make definitive statements about risks of life in the womb, statements which might also be interpreted as inflated claims or claims verging on hype.

Given that the mass media do not normally draw on hedging (Jensen 2008), it was surprising to find that in the case of news coverage of foetal programming hedging, and in particular the hedges of 'links' and 'growing evidence' have been used over time and by a range of news outlets. In her exploration of the media coverage of science Nelkin (1995b) claimed that scientists tend to impose their culture, values and concerns on journalists, and these insights help to interpret the case of foetal programming in the news. In this light, the hedges of 'links' and 'growing evidence' in popular press can be read as reflecting concerns and practices of the community of foetal programming researchers.

This analysis suggests that scientific norms concerning appropriate ways of constructing and proposing novel claims have had a considerable influence over the ways in which popular media covered research into foetal programming. While in their reports the journalists did not necessarily shun the colourful language usually associated with their trade (as illustrated by the quote 'the nine months in the womb may make or mar a child's life'), in many instances they adopted scientific ways of hedging to attenuate claims made in the media (like in the example: 'The result will need confirmation, but there is certainly a growing body of evidence that…').

It also seems that in the journalistic texts hedges had an important role in building credibility and certainty of research into foetal programming. In some instances, hedging helped mask gaps in knowledge, or as Meyer has put it 'to compensate for the lack of certainty' of science (Meyer 1997: 39). In these instances, hedges diverted attention from uncertainty by stressing a near-certain character of science: links uncovered between facts tended to be 'strong', and evidence, though not yet conclusive, was 'growing', 'mounting' or 'accumulating'. This type of uncertainty-reducing hedging may have been particularly useful in the early days of

foetal programming in the late 1980s and in the 1990s, when the field was fighting for recognition both in the public and scientific arena, and when it had to discursively compensate for the lack of consensus surrounding its claims. But some examples from this study also suggest that hedging may have helped to introduce and make credible in the public realm some inflated claims about the scope and reach of the effects of foetal programming on adult health prospects, for example by suggesting that events in the womb could spell a disaster – or 'mar' a baby's future health.

4.3.3 Discovery narratives

While hedging, as demonstrated by this study, is an effective though under-researched way of enhancing certainty surrounding science in the media, discovery stories are tried-and-tested (as well as well-researched) narrative devices which present science as unequivocally certain and solid. Discovery stories directed at wider publics usually differ from those told to more specialist audiences, as they draw on different kinds of plots, or on what Brannigan called 'repertoires' of scientific narratives (Brannigan 1981). At the popular level, discovery narratives tend to employ a repertoire of a 'scientific genius', while discovery narratives targeting specialist publics draw instead on the repertoire of 'cultural maturation'. The first type of narrative presents discovery as a product of an exceptional individual, while the second presents it as an outcome of 'inevitable collective knowledge growth' (Bucchi 1998: 172). Alternatively, some other types of stories try to present a scientific discovery as a serendipitous event (*ibid*.). Though these accounts differ in terms of kinds of stories they tell, they share a common feature, namely they discursively legitimate scientific discovery and make it harder to question its core findings. In that sense they constitute celebratory discourses of science (Mulkay 1985) which emphasise science's achievements and recognition, while eschewing uncertainty, controversies, or disagreements.

While the media coverage of foetal programming drew on certainty-enhancing hedging from the inception of this field, discovery narratives about this

science began to appear in the press only from the mid-1990s, when the Barker hypothesis had started to gain recognition, and some of his studies had been replicated by independent scholars. These accounts drew almost exclusively on the repertoire of a 'scientific genius', which put Barker at the centre of discoveries which led to the emergence of the foetal programming framework.

The discovery narratives usually involved two types of artefacts - maps and books, records or ledgers - which helped explain how and why Barker came up with his hypothesis. The maps were used as a reference to the geographical studies conducted by Barker and his colleagues in the 1980s, and the books, records and ledgers were used as a reference to the subsequent Hertfordshire Cohort studies which relied on the data about the birthweight of patients included in this research (cf. Syddall et al. 2005, see also Chapter 1). In journalistic accounts these artefacts helped anchor abstract concepts of foetal programming in more familiar and concrete objects of maps and books, which in Western culture have been associated with science, journeys and discoveries. In addition, in the media accounts the physical 'discovery' of these maps and records was conflated with the scientific 'discovery' of foetal programming, creating an impression that the mere reading of the information they contained was sufficient to formulate a scientific hypothesis. For example, *Newsweek* reported on Barker's discovery in the following fashion – and this quote is reproduced at length to illustrate the unfolding narrative:

> The discovery of fetal programming might never have happened if Dr David Barker (…) had not noticed, in 1984, some maps that did not seem to make sense. They displayed measures of health throughout England and Wales. Barker saw that neonatal mortality in the early 1900s was high in the same regions where deaths from heart disease were high. That was odd. In general, infant mortality rises in pockets of poverty; heart disease is supposedly a disease of affluence (butter, meat and all that). They shouldn't go together. Barker wondered whether the search for the cause of heart disease should begin in the womb. To embark on his quest, he needed birth records, and lots of them, going back decades, to link

> conditions at the beginning of life with the health of the adults he would study. Lending a hand, Britain's Medical Research Council hired an Oxford University historian to scour the country for such records. During a two-year hunt, the historian found records in archives, lofts, sheds, garages, boiler rooms and even flooded basements - but the best records were in Hertfordshire. There, the lady inspector of midwives had recorded the weight of every baby born in the shire (…) from 1911 to 1945. Barker had his data. (*Newsweek* 27/09/1999)

This media account emphasised Barker's qualities of a scientific genius, or a person uniquely placed to conduct scientific research, as without him 'the discovery of fetal programming might never have happened'. The discovery of foetal programming was related here to an accidental discovery of maps that Barker simply 'had noticed' and to an active search and discovery of birth records, a search likened here to a hunt for treasure in unexpected places including 'flooded basements'.

The media also suggested that the actual discovery or the revelation of truth or facts happened the moment when 'Barker had his data', thus obscuring the socially constructed and negotiated character of what is deemed to be fact, evidence and science by a professional community (Brannigan 1981, Collins 1992). This and other media accounts presented the formulation of the Barker hypothesis in an isolation from the social context, eschewing controversies and negotiations of the meaning of Barker's research. Instead, the discovery narratives presented the emergence of foetal programming as akin to a romantic adventure, (Franklin 1995), a quest or treasure hunt. This last framing was particularly salient in the articles which likened the 'discovery' of medical records to a 'trove of excellent records' *(Yukon News* 6/12/2002), a 'treasure trove of data' (*Aberdeen Press and Journal* 21/02/2015), and 'the doubloons' (*The Independent* 19/01/1997), or golden coins found in pirate treasure troves.

Certainly, the media accounts framing a scientific discovery as an adventure or a treasure hunt seek to tell a good story. But, as Mulkay argued (1985), discovery

narratives should not necessarily be perceived as analytically vacuous as they are never told in the same way and can lend themselves to different interpretations. Framing Barker's discovery in the media as an adventure or a treasure hunt, and his findings as golden 'doubloons' contributed to the construction of his hypothesis as an unquestionable achievement. 'Gold', as rhetorician of science Leah Ceccarelli writes, is 'a metaphor for idealised states of knowledge and understanding' (Ceccarelli 2013: 66), while the metaphors and narratives of adventures entrench further the stereotypical image of scientific progress and a steady 'marching forward into the unknown' (Franklin 1997: 12).

4.4 Objectification of science

Objectification of science is the process during which unfamiliar and abstract concepts and ideas are turned into something concrete, be it an object or a person (Bucchi 1998, Moscovici 1961). In the case of communicating science in public, the objectification of science usually involves personalisation, or 'identification of theories and results with the faces and names of visible scientists' (Bucchi 1998: 126). For example, in the public realm Albert Einstein stands for the theory of relativity and more recently Craig Venter has been identified with synthetic biology (Balmer and Herreman 2009).

Although over the years many prominent foetal programming scholars appeared in the press, on the radio or television, Barker seems to have secured a privileged status in the media coverage: he was the main protagonist of the *BBC Horizon* TV film (2011) on foetal programming, one of the main protagonists of the *BBC Radio 4* broadcast (2011), as well as the most often quoted foetal programming scientist in the press (based on my Nexis sample). Just like in the public realm Stephen Hawking stands for the Big Bang theory (Bucchi 1998: 125), Barker is the human face of foetal programming, not least because the hypothesis that led to emergence of this field bears his name. In the words of Mark Porter, a medical doctor and author of the *BBC Radio 4* series on foetal programming, Barker is 'Professor of Clinical Epidemiology at the University of Southampton and the man behind the

Barker theory' (*BBC Radio 4*). In many ways Barker has become what Rae Goodell (1977) has called a 'visible scientist', or a scholar able to attract media attention because of their 'extraordinary personality, high level of communication and self-presentation, and the attractiveness of the topic of his/her work with reference to problems and fears of society' (Weingart 1998: 870). In addition, associating science with one scientist makes it easier for the media to 'humanise science' and 'to provide the dramatic core for good stories that reading, listening or watching audiences would want to follow' (Fahy and Lewenstein 2014: 84). Representations or images of scientists in the media can be read as representations of science itself, as they usually conflate the identity of the individual scientist with the field they stand for. Such images do not only help represent and communicate science to wider audience, they also help sell science, promote its claims and further its interests and influence (Nelkin 1990). This section discusses the imagery of Barker as a scientific adventurer and a wizard which helped promote the relevance and significance of foetal programming in public.

4.4.1 Professor Barker and adventures in science

As Nelkin (1990) and Haynes (2003, 2016) have noted, popular media draw on well-entrenched clusters of metaphorical or mythical representations of scientists, which range from alchemists, adventurers, warriors, mad scientists to saviours of society. Such representations rely on 'the myth of scientific differentness that stresses the extraordinary intelligence, persistence, foresight and modesty' of scientists (LaFollette 1990, quoted in Lewenstein 1995a: 354-355). While such representations constitute the 'folklore of our time', they also reflect public values and fears related to science (Haynes 2016: 253). On the other hand, as Nelkin (1990) reminds us, such imagery is often actively promoted by scientists themselves, as they entrench the image of science's exceptionalism (Nisbet 2005), or its unique role and status in the public sphere.

Media coverage of foetal programming also drew on such stereotypical representations, and they were most vividly on display in *BBC* radio and television programmes. For example, the *BBC* 2 *Horizon* production heavily relied on the image of Barker as an adventurer. The prototypical scientist-adventurer breaks new ground and solves problems in science by travelling to faraway places to unveil secrets or mysteries, which usually serves as a good starting point for some great storytelling (Van Gorp et al. 2014: 653). In the *BBC* 2 *Horizon* programme Barker did exactly that: his job took him to exotic places in search of proof to support his hypothesis and to defeat his scientific opponents. According to *BBC* 2 *Horizon*:

> To silence his critics, David embarked on a worldwide search. He has travelled to the four corners of the globe to find crucial evidence to back up his provocative theory. Because to prove his theory, he needed to show that his idea held true on every continent and for each and every one of us. (*BBC Horizon* 2011)

In this account, Barker's heroic search for evidence amounted to a search for universal laws or truth which applied to every human being, a statement that clearly sought to establish foetal programming not just as *a* scientific field, but as *the* field able to answer fundamental questions about humankind. At the same time this scientific adventure was not without perils, as the danger was lurking in a form of critics who, as the film implied, would or should be silenced. The *Horizon* episode suggested that these questions related to risk in early life, as, according to this broadcast, Barker's idea 'was starting to reveal universal truths about how our future health was determined before we were even born' *(BBC Horizon* 2011).

On television, Barker's research took him to such places as the Netherlands, India and Saudi Arabia, where he hoped to find evidence supporting his theory. Such evidence usually took a visual form of books or ledgers containing birth records, including birthweight of thousands of babies. Upon his travel to Saudi Arabia, Barker explained in the film that: 'I'm here because there are potentially important medical records here in the desert of Saudi Arabia', and he was subsequently shown pouring

over handwritten pages of some old ledgers, in which the proof of his theory was supposedly found. These visual and discursive representations relied heavily not only on the imagery of a scientific adventure, but also on the imagery and the metaphor of books which held the secret of life.

The trope of secrets, mysteries and truth uncovered by the heroic scientist-adventurer was a recurring feature of the *Horizon* production which championed the Barker hypothesis as aiming to 'reveal universal truths', to discover 'the secret of a healthy, happy, long life… for all of us', and to understand 'what happened to us in the mysterious world of the womb' (*BBC Horizon* 2011). Similar metaphorical framing which draw on the unknown or the mysterious appeared also in the printed press which framed foetal programming as uncovering various nature's secrets or as finding the key to knowledge, for example: 'Prenatal care is secret of life' (*Hamilton Spectator* 30/06/1999); 'secrets of the womb (…) how the unborn are programmed for life' (*The Weekend Australian* 01/07/2000); 'good maternal diet is the key to health in later life ' (*The Herald Glasgow*, 11/09/1992); or 'the key to wellbeing lies with the mother's healthy eating before conception' (*Daily Mail* 03/07/2001). These framings are not new: they draw on a long tradition in Western culture to represent science as revealing the secrets of nature and of human mortality, and in particular as revealing the secret of life, which has traditionally been seen as pertaining to women as they are able to bear children (Keller 1992). As this analysis has shown, the media took up the trope of secrets of life, as well as the metaphor of a scientist-adventurer to frame foetal programming as metaphorically holding the key to the mystery of human health and illness.

4.4.2 Professor Barker and the power of divination

The metaphor of a scientist as an alchemist, wizard, or magician is a recurring feature of popular accounts of science (Nelkin 1990: 45), and similar metaphors and imagery were used in the media coverage to depict unique qualities of Barker. *BBC* radio and television programmes drew extensively on the metaphor of a wizard or even a

crystal-ball gazer (Nerlich 2007). According to Van Gorp et al., 'the wizard is the personification of a perception that science is the best or even only way to solve problems, as the ultimate answer to all questions that society faces' (2014: 654). At the same time the metaphorical representation of a diviner or wizard is useful for science writers as it allows telling a good story about science without having to understand it or explain it (LaFollette 1990: 100). These features of the wizard metaphor helped construct foetal programming in the news as resolving pressing problems of humanity in a mysterious and not entirely comprehensible way.

In the radio and television programmes, the scientific competence of Barker was framed in terms of his ability to make predictions about incidence of chronic disease in future, the ability which amounted to a gift of divination. According to the *Horizon* television programme, the story of the foetal programming framework is 'the story of one man's struggle to unravel our destiny'. This man, David Barker, 'wanted to not just understand our destiny, but potentially re-write it', as 'he believed [that] from the moment they were born, scientific predictions could be made about (…) people's lives' (*BBC 2 Horizon 2011*). The film subsequently showed Barker gazing at a display of pre-war photograph of children from Hertfordshire, an area from which the famous birth records that supported the Barker hypothesis had come from. Commenting on the children in the photographs Barker stated that:

> 'I think their destiny is in large part already wrought. Much of their lifetime's well-being and ability – mental ability, physical ability and health is already determined'. [Narrator:] 'How long they would live. How healthy they would be. Whether they would have a happy and fulfilled old age'. (*BBC 2 Horizon* 2011)

As this quote suggests, the science of foetal programming endowed Barker with the power to confidently predict these children's future or 'destiny' in terms of their health and physical performance in adulthood. *Horizon*Barker was able to make such predictions 'using only the information contained in these books – the birth records of the county of Hertfordshire' (*BBC 2 Horizon 2011*) – which evokes books

of revelation. At the same time, the processes of early development were metaphorically framed as fate or destiny (the topic which will be discussed in Chapter 6), and the scientist's task was to unravel, understand and even 'rewrite' it. The metaphorical frame of rewriting or changing destiny of future generations suggested that this science was able to offer scientific means, such as cures or interventions, to alter the course of people's health in future. The programme also suggested that the Barker hypothesis was akin to a universal law as 'the real power of the Barker theory applies to us all' (*BBC 2 Horizon* 2011).

A *BBC Radio 4* programme on the Barker hypothesis provided more clues as to how such predictions could be made. Here, Barker explained the predictive power of his theory in the following fashion:

> 'If you show me a baby when it's born I can tell you something about that baby's likely destiny. If you show me the placenta as well I can tell you a lot more, and if you show me the mother's body and the placenta I'm not sure that I need to see the baby at all, because the baby is an expression of the mother's body and the placenta. That's what it is.' (*BBC Radio 4* 2011)

Barker suggests that an assessment of a newborn based on body weight, head and abdominal circumference, as well as measurements of the placenta could provide clues about development in the womb, which in turn could predicting the baby's likely future outcomes. But the whole process is couched in the language of divination or reading the future from signs or clues provided by development *in utero*.

Drawing on the image of divination, though controversial, is not new. A couple of decades earlier James Watson, the co-discoverer of the structure of DNA, famously stated in *Time* magazine that 'We used to think that our fate was in our stars. Now we know, in large part, that our fate is in our genes' (Jaroff et al. 1989: 67). As these quotes demonstrate, although when speaking in the media the proponents of foetal programming sought to undermine the hegemonic status of

genetic research, they used similar imagery and metaphors to communicate about their field. As Nelkin (2001) argued, 'genes are destiny' was a popular metaphor that circulated in the public realm after Watson's press intervention. Following Barker's appearance on the *BBC* broadcast, it was now possible to claim that our fate or destiny was written in the womb, and Barker himself was able to read early signs of future health.

The metaphor of a scientist-wizard promotes an image of science which is mysterious, beyond comprehension and which requires an almost blind trust (LaFollette 1990, Van Gorp et al. 2014). Thus framing Barker as a wizard or diviner, and his hypothesis as akin to divination contributed to constructing foetal programming as a somewhat superior science which does not have to be explained to be respected and whose authority should be taken for granted.

4.5 Backstage exposure

As this analysis has shown, the media coverage contributed to establishing foetal programming as a new and exciting science, or even as a paradigm shift in understanding risk of adult disease . But, as Bucchi (1998) warned, attempting to establish new fields in the public eye is not without risk. If scientific claim-making is like a performance, the show of establishing a new field can be disrupted by some unexpected events or unruly publics. This disruption or contestation of science, or a 'backstage exposure', can seriously damage the science's credibility and prospects. For the performance of science to run smoothly, the backstage exposure in the form of disagreements, controversies and conflicts should be controlled to protect the 'frontstage' - or the science's image and reputation. In a sense, controlling the 'frontstage' of science is a type of boundary-work identified by Gieryn (1983) which seeks to protect the autonomy of science from charges of being unscientific. Thus, the analysis presented in this chapter goes full circle from exploring boundary-work, or the ways in which science is discursively established to the ways in which it responds to its opponents in the public realm. The next section first examines the critical media coverage of foetal programming, and it goes on to explore how critical

opinions about this field were discursively dealt with in the press by means of contingent repertoires (Gilbert and Mulkay 1984).

4.5.1 Foetal programming and its critics

Although, as discussed earlier, from early on Barker's research was framed in the media as new and exciting, the status of a field in the making made it potentially more vulnerable to criticism and reputational damage. Surprisingly, foetal programming emerged unscathed from this challenge. In my sample which spanned three decades of media coverage critiques and contestations of the Barker hypothesis were rare, and they occurred mostly in early coverage, i.e. in late 1980s and early 1990s, when the field was still emerging, and then again in late 1990s and early 2000s, when they were driven by critical assessments of foetal programming's claims by two female scholars. In 2011 some critical opinions about the field emerged predominantly in the British press, and they were featured in reviews of the *BBC 2 Horizon* programme.

Overall, the criticisms of foetal programming in the media were isolated, which is rather surprising given the backlash it had to face in the professional realm (see Chapter 1 and Chapter 5). When critiques did appear in the press, they either countered the scientific character of this field or they focussed on its social implications, especially on mother-blaming (see also Chapter 6). For example, in 1990 Professor John Dobbing of Manchester University Medical School questioned the Barker hypothesis by arguing that:

> 'It is science fiction without the science to tell parents what the outcome of their child will be. The human species has an enormous compensatory ability to overcome disadvantages.' (*The Times* 17/05/1990)

Significantly, Dobbing's was the only critical and short opinion which appeared in an otherwise favourable press report from a conference on foetal programming, and his charge that the Barker hypothesis did not have sufficient scientific basis was not further investigated. About a decade later, Australian and

Canadian press published a few articles containing critical assessments of the foetal programming/DOHaD framework. On separate occasions, two female scientists argued that foetal programming's claims might be exaggerated as development in the womb can explain only a small proportion – if any – of the risk of adult chronic disease in later life. Dr Lesly Campbell, an Australian specialist in diabetes, contested foetal programming's findings in the following fashion:

> '(…) I don't think it's proven. They found if you were a small birth weight baby you are more likely to have diabetes or obesity. They went on to do lots more studies in other countries looking at the same thing and some of them reproduced the (original) results and some of them didn't,' Dr Campbell said. 'Their most recent evidence is that if you have small birth weight and then you become fat as a child or as an adult, then you are in trouble. In other words you're at higher risk of certain diseases. 'My criticism is people who get fat have a higher risk anyway. I'm not convinced.' (…) She said the findings may explain 2-3 per cent of the incidence of a disease, but the majority of major illnesses were due to genes and other environmental factors. (*The Sun Herald* 14/03/1999)

Similarly, the media quoted Dr Rachel Huxley of the Institute for International Health in Australia, who:

> examined dozens of studies linking low birth weight to high blood pressure in adulthood, and concluded that the case for fetal origins may be seriously overstated. The fetal origins field, she said in an e-mail interview, is 'getting ahead of the evidence.' (*Yukon News* 06/12/2002)

In a separate article, Dr Huxley went on to claim that:

> 'The size of the association [between birthweight and adult disease] was negligible. It was so small that it really wouldn't have any material effect in later life,' said Rachel Huxley.(…) 'If we're trying to reduce our risk of having a heart attack, what matters most is the things we do now -

> taking responsibility now for our diet and exercise and smoking patterns.' (*The Daily Telegraph* Sydney Australia 08/12/2004)

To sum up, in these scholars' view the size at birth, which is an indicator of the quality of development in the womb, seems to have only a small – if any – impact on the risk of chronic disease in adult life. In their opinion, genes as well as adult diet, smoking and exercise were far more important in determining the incidence of heart attack or diabetes. Although such publicly expressed opinions questioned the very bases of foetal programming's research they did not seem to damage its reputation, as the media did not investigate such views further. Alternatively, they used such criticisms to label foetal programming's claims as 'controversial' rather than 'unscientific'. For example, Huxley's negative comments that foetal programming is 'getting ahead of the evidence' were immediately followed in the press article by the following statement:

> Controversial or not, so many researchers are exploring fetal origins that the first World Congress on Fetal Origins of Adult Disease, held in India last year, drew some 500 delegates. (*Yukon News* 06/12/2002)

This statement effectively dismissed Huxley's criticism by emphasising the popularity of the foetal programming frameworks, and the quoted number of 500 delegates to this field's World Congress discursively outweighed the significance of Huxley's isolated intervention. This example illustrates that criticism of foetal programming expressed by other scientists tended to be side-lined in the press. It also seems that at times opposing voices were used to frame foetal programming in the press as 'controversial' rather than 'unscientific'. Indeed, over the years, the media kept referring to this field as 'this intriguing but controversial hypothesis' (*The Independent* 19/01/1997), 'the mysterious, and still disputed, realm of foetal programming' (*The Guardian* 12/09/2003), and in a more recent coverage as a hypothesis which is 'no longer controversial' (*The New Yorker* 19/11/2007). This kind of framing allowed the journalists to signal controversies surrounding this field

while still being able to tell a good story about science and not having to delve into details of such debates.

Dunwoody (2014) has claimed that science journalists tend to 'hang their stories' on traditional news pegs, such as controversy and novelty. Hence, framing foetal programming as 'controversial' may have enhanced - and not diminished - this field's popularity as a potential topic for the media, and it increased this science's visibility in the public realm. At the same time the media did not seem to engage with the critics of foetal programming in a meaningful fashion[10], which led to the situation in which the voices questioning this research or some of its claims were not sufficiently heard. Meanwhile, the presence in the media provided some members of foetal programming's community with a platform from which they were able to challenge their opponents - and the following sections explore this issue in more detail.

4.5.2 Playing up contingencies

As Bucchi (1998) noted in the situation of 'backstage exposure' defending the boundaries of science may involve the use of what Gilbert and Mulkay (1984) called a 'contingent repertoire'. This is a type of discourse used by scientists which 'enables speakers to depict professional actions and beliefs as being significantly influenced by variable factors outside the realm of empirical biochemical phenomena' (Gilbert and Mulkay 1984: 57). The contingent repertoire is used in relations to claims or research with which the speakers disagree, and it tends to stress

[10] The ways in which the media engage with and report about scientific debates and controversies, and how they interpret the rules of balanced reporting, have been of particular interest for social sciences in general (Dunwoody 2005), and especially in the context of climate change (Boykoff and Boykoff 2004). However, the question of why the media did not seem to sufficiently address criticisms of the foetal programming framework is beyond the scope of this study – further research will be needed in this regard.

> idiosyncratic causes of the results, and social and psychological pressures on the people holding those belief: the contingent repertoire explains, rather than justifies, positions (Sismondo 2010: 153).

This kind of discourse, as Gilbert and Mulkay have argued, appears predominantly in informal settings, for example in conversations, as opposed to the 'empirical repertoire', used mainly in published scientific texts. While what the scientists/speakers consider to be valid science is described in empiricist terms, the purportedly erroneous or outdated science is explained in terms of various extra-scientific factors.

In the media reports on foetal programming, contingent repertoires were used to challenge the opponents and to question their credibility. For example, some article suggested that some scholars who did not support foetal programming's claim did so on the basis of non-scientific factors, for example their professional interests. As Professor Keith Thornburg, a prominent foetal programming scholar noted:

> 'So here in the United States we talk to the American Heart Association and they make a list of risk factors and I agree with all those risk factors, but what they don't say and what other people don't know is that virtually all those risk factors were already in the person by the time they were born.' (*BBC Radio 4* 2011)

The suggestion is that the medical establishment kept silent and did not inform the wider public about the risks associated with their development in the womb. According to another media piece, foetal programming was opposed by other researchers because it was perceived as threatening their respective disciplines, be it public health or genetics. As Barker explained:

> 'People are going to throw flack at this hypothesis because it seems to threaten (a) the idea that by behaving properly in adult life, God will give you added years, which is a theory very close to the hearts of Western control freaks, and (b) because it seems to threaten the genetic trend. In

> fact it doesn't. What we're saying is the genes that enable you to survive in foetal life unfortunately don't always do good things to you in later life.' (*The Independent* 19/01/1997)

A decade later a similar claim appeared in Barker's profile published in *The New Yorker*:

> (…) many doctors disliked the idea of fetal origins, in part because it undermined a decades-long public-health message that linked heart disease to adult behavioral factors. The late Sir Richard Doll, Britain's leading epidemiologist, told Barker that he was 'very disappointed,' and Barker heard that as an understated but unmistakable form of academic censure. (*The New Yorker* 19/11/2007)

In these accounts, foetal programming was positioned as threatening competing disciplines – such as genetics and public health, and as undermining professional interests of the medical profession. This made it possible to dismiss criticism and cast foetal programming's opponents as driven by personal beliefs, self-interest, or politics, and not by scientific facts.

4.6 Discussion and conclusions

This chapter has drawn on Bucchi's (1998) framework of science communication to explore the media coverage of foetal programming, and, in particular to analyse the field-making processes and strategies that were used to promote and establish this research as a new scientific field. These strategies involved boundary-work, certainty-building, objectification of science as well as strategies aiming to protect science from reputational damage (or backstage exposure). The analysis has shown that over the years boundary-work helped frame foetal programming first as an emerging approach and theory, and subsequently as a field on its own, a scientific revolution and even a paradigm shift in understanding early risk of adult chronic disease. At the same time the various discursive tools such as paradoxes, anchoring, clichés and metaphors which were used to achieve boundary-work in the media

helped to distinguish foetal programming from the competing frameworks of lifestyle and genetic factors, and also to challenge and discount these rival approaches.

The media also deployed certainty-building strategies which aimed to legitimate science by representing it as certain, solid and unambiguous. While according to Bucchi, the strategy of certainty-building relies primarily on discovery narratives, or highly schematic origin stories of scientific fields and inventions, this study identified another strategy of certainty-building not included in Bucchi's original framework – namely hedging. The findings suggest that hedging and hedges helped increase certainty surrounding foetal programming especially in the early stages of development of this field, when the debates about this research were still raging in the scientific realm, and when there was a lack of consensus about that validity of its claims. This meant that the usual stories of discoveries about this field had not yet emerged and could not be harnessed to strategies of legitimation in the media coverage in this field. This analysis has shown that in the absence of accepted discovery narratives in these early stages of science formation, other discursive devices, such as hedging, were used in the media to substitute for these stories and to increase credibility of this research, and even to promote bold, inflated claims about this fields' findings. However, once a consensus about foetal programming had started to emerge, foetal programming discovery stories also started to appear, and they were subsequently integrated into the legitimating narratives in the media coverage.

As this analysis has shown, the discovery narratives of foetal programming deployed the imagery of discovering books and maps which held the key to the secret of longevity and good health – the tropes which are well-entrenched in culture and well-known from the studies of public communication of genetic and genomic science (Nelkin and Lindee 1995; see also Chapter 3 and Chapter 6 for the discussion of genetic metaphors). These and other examples discussed in this chapter suggest that promoting new fields in public necessarily involves anchoring messages in the existing cultural understandings and modes of representations, such as narratives and metaphors, and that they are difficult to change, even in the context of promoting a

field that claims to bring a paradigmatic shift in science and to be radically different from the competing framework of the genetic factors.

The field-making strategies in the media also drew on 'objectification of science', or such representations of science that made it more real and concrete. Similarly to discovery narratives, these strategies also relied on the stock of cultural framings pertaining to science. As a result, in the media coverage David Barker became the human face of foetal programming, and the representations of this field tapped into a stock of culturally-embedded imagery and discursive tools. These included metaphors which framed the science of foetal programming as an adventure, or an idealised quest for universal truth. They also framed Barker as an adventurer, a wizard, and even a diviner capable of reading people's destiny. By drawing on the imagery of magic and mystery such metaphorical framings suggested that science as such does not have to be understood, and that its authority and legitimacy should be taken for granted. This kind of coverage, while used to promote foetal programming, also reinforced stereotypes about science in general.

Finally, this analysis has highlighted the strategies of protecting the foetal programming framework from reputational damage (or backstage exposure) in the media coverage. This study has shown that the media paid relatively little attention to debates and criticism of foetal programming which were taking place in the scientific realm. If the opinions of the opponents of this approach appeared in the media, they were not further investigated, they were deemed unworthy of attention – or they had to be 'silenced', as claimed in the *BBC Horizon* episode on foetal programming. The lack of a wider debate about the foetal programming and its claims in the media resulted in a rather one-sided coverage of the developments in this field. This was compounded by the effects of other afore-mentioned strategies of boundary-work, certainty-building and objectification of science which built and consolidated the legitimacy of this field in public. They also helped circulate in the public realm a rather simplified, if not overblown message of what programming in the womb does, how important it is in terms of the health of future individuals and generations, and how it can be predicted and mitigated at the level of individuals and populations. As

a result, the media has painted a highly favourable image of the foetal programming framework and represented it as an exciting new field of research.

Chapter 5. Making sense of a new scientific field: Narratives and metaphors of foetal programming in interviews with scientists

5.1 Introduction

This chapter draws on interviews with scientists who have been involved in research and debates related to foetal programming/DOHaD, and it seeks to answer the following questions:

- How do scientists conceptualise and talk about their field of research?
- How do they interpret the contribution of this field to a new understanding of the origins of health and disease risk?

In a sense, this chapter offers up a mirror to Chapter 4, where the issues related to field-making, such as positioning the new discipline among rival approaches by means of boundary-work, and legitimising the emergence of foetal programming through discovery narratives, have been explored through the lens of the media. As discussed above, not only journalists but also scientists speaking to journalists shaped the ways in which research into foetal programming was covered, and thus used the media to shape their field (Lundby 2014).

In this chapter these and other related issues are studied from a different vantage point which explores scientists' first-hand accounts of the emergence of their field. This chapter is thus interested in the ways in which scientists made sense of the emergence and rise of the foetal programming framework. As it will be shown, the interviews gave the scientists the opportunity to adopt the register of modesty and moderation (Pickersgill 2016) while they were reflecting on the field, as opposed to what many of them viewed as extravagant, ostentatious or hyped claims about this science which were circulated in the media coverage.

This chapter proceeds in the following fashion. First, it discusses the origins of the field through the lens of discovery narratives in interviews. Second, it examines issues surrounding objectification and personalisation of science. Third, it analyses boundary-work and claims related to lifestyle and genes, and then reactions

to criticism and hype. Finally, it explores claims of a paradigm shift, after which the chapter concludes

5.2 Scientists and discovery narratives: (re)constructing the origins of the field

As discussed in Chapter 4, in reporting on the emergence of the foetal programming framework, the media (supported by some of the key players in the field) drew on a range of conventional representations of this science for a lay audience, including discovery narratives. These narratives compressed the long process of corroborating data, formulating the hypothesis and building the scientific field into a short story featuring a single event pivotal for the constitution of this discipline: the 'discovery' of maps and records/books carried out (almost) single-handedly by Professor David Barker. Such discovery narratives, as discussed above, drew on culturally-embedded metaphors and narratives of science which presented Barker as a prototypical 'scientific genius', and his discovery as a treasure hunt for gold or idealised truth. This discovery narrative increased certainty surrounding foetal programming, obfuscated the negotiated and socially constructed character of science, and helped legitimise its claims in the public realm.

During the interviews, I was interested in how scientists themselves might talk about the birth of the foetal programming framework, and what kind of narratives they deployed to explain the emergence and developments in this field. The origins of foetal programming proved to be a popular topic during the interviews, especially for some senior researchers who had met Barker, had witnessed his early work or had been his colleagues or peers. These scientists offered their personal recollections of the time when Barker was in the midst of formulating or propagating his new hypothesis, and they drew on a variety of repertoires to make very different points about their field and about the process of doing science. While many of these stories were realistic accounts exposing 'warts and all' of doing science, some others drew on conventional narratives of a 'scientific genius' and 'discoveries' of books and maps. Though the repertoire of a 'scientific genius' is used at popular rather than at specialist level of science communication (Bucchi

1998), the appearance of this type of narratives in scholarly interviews is not that surprising. Interviews are also narratives and stories (Mishler 1986), and conventional forms of framing and story-telling are more likely to creep in in this type of setting. Though conventional, such narratives, as Mulkay (1985) argued, are not necessarily analytically vacuous, and they provide important contextual information about the field. While keeping Mulkay's (1985) comments in mind, in the following sections I will explore in more detail the discovery narratives of foetal programming as told by scientists.

5.2.1 Tales of a genius and serendipity

Questions about the origins of the foetal programming framework prompted a few scientists (for example participant 1, participant 4 and participant 8) to mobilise the discovery narrative of a 'scientific hero' (Brannigan 1981). These accounts focussed on Barker who back in the 1980s made a discovery of maps, books or records that led to the formulation of the Barker hypothesis. As participant 1 said:

> David Barker, who had sort of led this renaissance and established the field as a more mainstream academic, sort of clinical area of interest, (…) he just asked the question whether those areas of the UK where you see the highest incidence of chronic heart disease in adulthood at the end of the 20th century, how does that relate to say the rates of infant mortality at the beginning of the 20th century. And when you looked at those relationships you saw that those areas of the UK that used to have the highest rates of infant mortality now have the highest rates of adult cardiovascular disease. (…) And he was just able to go back and find the birth records and relate those to the adult health records and he found that in a number of different populations. (…) And epidemiologists have looked at that data and found there are some correlations between shape, size, early growth and long-term outcomes. (Participant 1)

According to this account, the field of foetal programming emerged thanks to Barker's exceptional qualities. Barker is credited with establishing foetal programming as a scientific discipline and with introducing it to a wider academic audience – or leading a 'renaissance'. At the same time, rather than being a messy process, the 'discovery' of foetal programming is represented as a step-by-step journey of science which proceeds in an organised and orderly manner. First, Barker 'just asked a question' about the incidence of heart disease in 20th century Britain. Then, the Barker hypothesis was born out of the comparison of epidemiological maps of infant mortality at the beginning of that century with maps of adult mortality from cardiovascular disease towards the end of the 20th century. Next, this hypothesis was supported by studies of birth records that Barker 'was just able to go back and find', and then to 'relate those to the adult health records'. Finally, his insights were confirmed by other 'epidemiologists [who] have looked at that data'. The 'discovery' of foetal programming is depicted as a neat and linear process, while contingencies and uncertainties surrounding the formulation of the Barker hypothesis are largely absent. This account is broadly consistent with the 'scientific genius' stories which are used especially in science popularisation.

Participant 8 also drew on the narratives of geographical maps of infant and adult mortality to depict the origins of the field. However, this account presented a slightly different perspective on this issue, as the discovery of foetal programming was attributed to chance:

> [Barker] came across it by chance, as most scientific discoveries happen, they happen serendipitously. He was interested in health of people in different areas of Britain and he happened to just show a graph that related to different areas of Britain with different areas of neonatal mortality 50 years earlier and found that it was a really good correlation. (Participant 8)

This account draws on the repertoire of serendipity, a discursive strategy usually used by scientists (Bucchi 1998). This repertoire seeks to combine two seemingly incompatible views, namely that first, discoveries emerge 'naturally' as a

result of the growth of knowledge, and second, that they are born out of exceptional qualities of their discoverers – who see what others might not be able to see. Thus, the discovery though unexpected, is not that surprising, given that only excellent minds are capable of grasping the novelty brought to their attention by a chance event[11]. In the case of foetal programming the discovery emerged due to chance as well as to Barker's intellectual disposition and his interest 'in health of people in different areas of Britain'. This type of framing echoes media accounts of this science, according to which 'the discovery of fetal programming might never have happened' without Barker (Chapter 4). Hence, discovery stories told in the media and by scientists were not as different as one might expect.

5.2.2 Flexibility of discovery narratives

By drawing on the repertoires of the scientific genius and serendipity, participant 1 and 8 seemed to paint a rather heroic picture of science and of Barker himself. However, in the interviews such narratives competed with other origins stories told even by the very same scholars – and here they differed from the popular media accounts. For example, while reflecting on the intellectual backdrop against which the Barker hypothesis was formulated, participant 1 admitted that:

> If you go back there are other people that have sort of coined this concept but no one had ever really taken it to have an effect on long term adult health. (Participant 1)

This researcher implied that ideas about the impact of early life events on health had circulated prior to the emergence of foetal programming. In this view Barker's role was to elaborate on these ideas by pushing the timeline of when the adverse effects of early life events start to be felt.

[11] Or, to quote Louis Pasteur 'Le hazard d'ailleurs favorise les esprits préparés' (Bucchi 1998: 172) – 'chance favours prepared minds'.

Participant 8 who, as we have seen, suggested the serendipitous character of Barker's discovery, also reflected on Barker's intellectual predecessors, such as the German endocrinologist Günter Dörner or the Austrian ethologist Konrad Lorenz (as discussed in Chapter 1):

> There's a guy in Germany [Dörner] that's shown it all. Barker popularised it and showed that it could actually account for disease, whereas before it was like Konrad Lorenz got his Nobel prize for showing that as soon as a duckling got out of its egg it followed the first thing that it saw moving because the chances are that that was his mum. And that in a sense is critical periods of development and how it was programmed to respond to something that might benefit in the long run. So that was all there… Barker simply said that actually for non-communicable disease a certain amount of the risk of getting it could be attributable to development environment and how things are set up to get that disease more readily. (…) but in a sense this sort of basis for it was there and I am sure you could find it if you looked through the writings of Aristotle and others that they probably knew that people who followed a certain pathway their offspring tended to follow that pathway as well. So I think it has always been there. People have known about it, but Barker was good popularising it and getting the evidence to suggest it, but it was always there. (Participant 8)

In this account the Barker hypothesis stems from the incremental growth of collective knowledge (from folk beliefs, through Aristotle to Lorenz and Dörner) rather than from a discovery made by an individual scientist. In this sense, participant 8, but also other researchers (for example participants 2, 3, 7, 12, 16 and 18) drew on the repertoire of 'cultural maturation' (Branningan 1981) to account for the emergence of the field. Such narratives situated the discovery in a larger context of previous traditions of research, thus adding credibility and prestige to the claims of scientific achievement.

According to Bucchi (1998), the ‘cultural maturation’ repertoire is used to demonstrate that a discovery was somehow inevitable as it built on foundations laid out by previous generations of scholars. It tends to de-emphasise individual agency by concentrating on the incremental nature of science-making and it occurs mainly at the specialist level (for example in written scientific communications). That the ‘cultural maturation’ repertoire appeared also in less formal contexts, such as in research interviews for this study, and that it was deployed simultaneously with other explanations of scientific discoveries (such as the stories of a genius and serendipity) indicates that these discourses are not firmly tied to specific specialist or popular types of communications. Rather, they can be used in different contexts and in a more flexible fashion, and instead of constraining the scholars to the use of one explanation they enabled them to foreground or background different aspects of doing science, highlighting the personal qualities of the scientist (‘the scientific genius’ stories), the purported role of chance (the ‘serendipity' stories) and the input of intellectual predecessors (‘cultural maturation’ stories). The interviews for this study suggest, that rather than being mutually exclusive, these repertoires complement each other and offer scientists a greater interpretative flexibility in accounting for the origins of the field.

5.2.3 The uses of discovery stories

However, the repertoires of a genius, serendipity and cultural maturation still seem quite banal and highly scripted, especially when compared with the more pragmatic discourses of doing science which will be explored later in this chapter. A question then arises as to why some researchers felt compelled to fall back on stereotypical discovery narratives when they were able to produce – and did produce - much more reflexive, realistic and nuanced accounts drawn from personal experience. Schaffer’s (1986, 1994) work on scientific discoveries might shed light on this issue.

Schaffer notes that instead of taking discoveries at face-value, it is more productive to see them as parables or myths which condense lengthy periods of research into one discernible event labelled a 'discovery'. In his view:

> When a candidate event is given the status of a discovery, it is 'fixed', just as Fleck suggested that scientific facts are fixed. This 'fixing' is linked with assent to the matter of fact and to the identity of the discovery. (Schaffer 1986: 397)

Gaining a status of a discovery means that some events arising from research activities become 'facts'. In this process, ambiguities and uncertainties surrounding research are set aside and the discovery becomes 'real'. Settling the controversy does not mean that the work of establishing a discovery is complete. Schaffer further argues that to have its status sustained, discovery has to be continuously reaffirmed and the facticity of the phenomena that it describes needs to be re-established (Schaffer 1986: 398). This happens when members of a scientific community refer to the facts underpinning the discovery (ibid.), or in other words, this happens when scientists tell and retell the story of discovery. In so doing, they recognise and confirm its reality and they pledge allegiance to the scientific programme in question.

Other scholars have made similar points. In the context of synthetic biology Molyneux-Hodgson and Meyer (2009) have argued that stories about the beginnings of the field act as a discursive glue that binds together members of an emerging scientific community and mobilise them around a new research agenda. Such stories, or origin myths, as Engel has noted, constitute 'narratives of authority', and their retelling can be 'many things at once: an act of insight, a reinterpretation of the past, a reaffirmation of core values and beliefs, and a 'reactualization' of the cosmic order' (Engel 1993: 792).

It thus seems useful to investigate not just what discovery narratives of foetal programming say but also what they do. In the context of my interviews the narratives of a genius, serendipity and cultural maturation seem to have been used not as 'just-so stories', but as Engel's narratives of authority and tools of persuasion

to sustain and confirm the status of foetal programming as a credible research programme. This also includes persuading oneself of the value and legitimacy of one's research. That such discovery narratives appeared during the interviews suggests that at least some scholars – in this case senior researchers - were keen to stress both their commitment to the foetal programming framework and the 'reality' of its findings. This is supported by other comments that were made during the interviews. The celebratory discovery narratives appeared there alongside more defensive statements that seemed to dispute the idea that foetal programming might be perceived as somehow not grounded in materiality. For example, one of the participants felt compelled to assert that

> The animal work has shown *unequivocally* that *these phenomena are real and not the result of confounding*… I mean one could do endless studies and *I am a believer*. I think *these are real phenomena*. (Participant 7, emphasis added)

Another participant stated that:

> I would consider myself… I think it [foetal programming] is an interesting biological phenomenon and *I believe it is there*. *I believe in it* and *I believe that it is transgenerational*. (Participant 8, emphasis added)

These and other statements indicate that some scientists, even senior researchers who had been in the field for many years, felt the need to emphasise the credibility of their research programme, as if it was somehow still questioned – using almost religious language, they affirmed their 'belief' in the theory. This suggests that discovery stories may have been deployed during the interviews not only as 'celebratory discourses' (Mulkay 1985) which emphasised the triumphs of science but also as tools of (self and other) persuasion which sought to pre-empt potential questioning or attempts to re-open controversies surrounding this field. It is useful to remember that for many years foetal programming had been subjected to severe criticisms (Susser and Levin 1999), and this may have shaped the ways in which scientists used discovery stories to communicate about this field.

5.3 Pragmatic tales of doing science

In popular accounts science is often portrayed as a lonely endeavour (LaFollette 1990), despite the fact that scientists increasingly work in teams. As shown in the previous chapter, the media represented foetal programming as 'discovered' or spear-headed almost single-handedly by one man –David Barker. They also emphasised Barker's exceptional qualities of a 'scientific genius', or alternatively his abilities of a scientific 'wizard' and 'adventurer'. In the press, but particularly in radio and television programmes, these qualities seemed to confer an aura of authority and exceptional capabilities on the science of foetal programming as well. This science was endowed with a power to make predictions about individuals' health and disease in adulthood. The media coverage also conflated Barker's identity with that of his hypothesis, to the point that he became a 'visible scientist' (Goodell 1977) and the 'human face' (Fahy and Lewenstein 2014) of foetal programming.

Such popular stories which were told in the media to personalise science , contrasted with the pragmatic accounts provided by foetal programming scholars, especially with their views on a number of issues, such as: Barker's role in establishing the field and his role as a 'human face' of foetal programming; the ways in which science is done; and finally the actual ability of foetal programming to predict adult disease. In engaging with these issues the scientists drew, though usually indirectly, on norms of scientific and professional conduct (Merton 1973), and often expressed ambivalences related to various claims made in their field and in public communication about this research.

Such ambivalent attitudes regarding the media visibility of science are, as Peters (2013) argues quite frequent in scientific communities, which see engagements with the media as rewarding and beneficial, or, alternatively as potentially damaging for the scientist and the science in question. On the other hand, there is an increasing expectation that scientists should engage with wider publics and communicate their research in the media (Gregory and Miller 2000). Given the pressure to communicate, Rödder (2013) argues that scientists have developed

strategies to manage ambivalences towards the role of a 'visible scientist'. Under certain conditions a scientific community can appreciate an individual scholar playing such a role, providing that the 'visible scientist' has a record of 'sound scientific work' and promotes the field rather than him/herself (Rödder 2012: 169). The following sections will explore how such ambivalences played out in the interviews with scientists.

5.3.1 Science and the imperative of communalism

In his classic essay 'The normative structure of science' Merton (1973) sought to codify the 'ethos of science' or four 'institutional imperatives' governing scientific conduct, namely universalism, communalism, disinterestedness and organised scepticism. Merton's description of scientific norms proved to be influential, though over the years numerous critics challenged various assumptions underlying the Mertonian 'ethos of science', questioning the extent to which these norms shape scientific practice and behaviour (Storer 1973: xviii). Despite these criticisms Mertonian norms of scientific conduct continue to be relevant for science studies scholars, although these norms tend not to be understood as a set of rigid principles. Rather, more recent scholarship argues that they constitute are 'flexible 'ideological-rhetorical' repertoires on which scientists can draw to justify their actions to colleagues, policy-makers and public opinion' (Bucchi 2015: 236). In what follows I will draw on this more discourse-oriented view of scientific norms to see if or how they were relevant for the ways in which foetal programming scholars talked about the emergence of their field.

As mentioned earlier, during the interviews scientists provided pragmatic accounts of doing science. They recalled the intellectual trajectory that lead to their involvement with this research, and subsequently to their contribution to this field. In this context some researchers, especially the senior ones, recalled the time when foetal programming was still a field in the making, and when what later came to be known as the Barker hypothesis was still being consulted and discussed by Barker

and his collaborators. In contrast to the media accounts which shrank the 'discovery' of foetal programming into a single event performed by a 'scientific genius', these accounts centred on long stretches of time during which science was being done in a more collaborative and collegial way rather than in a purely individual fashion. The stories told by these scientists reflected the Mertonian norms and values of scientific conduct (Merton 1973), especially the 'institutional imperative' of communalism, which posits that results of scientific activities or discoveries cannot be assigned to an individual researcher but rather to a scientific community.

This collaborative aspect of doing science was particularly emphasised by participants 2, 8, 14, 18, 19 and 21. Many scientists also dwelled on their personal contribution to the foetal programming framework, while at the same time acknowledging Barker's leadership. For example, participant 18 recalled one of their first conversations about Barker's interests in the following fashion:

> (…) he [Barker] said I have a little problem I am wrestling with which you might be able to help me with. So he described his first observations that if you looked at the mortality from heart disease in districts in England in the 60s and 70s and you compared them with the infant mortality rates in the same areas in the first parts of the 20th century then those areas that had high infant mortality rates had high rates of cardiovascular disease. He said he presumed that (…) [it had] something to do with my area of expertise and therefore he wondered if there was any way in which biologically these observations could be linked. So I went away and looked at literature and I came back and [discussed it with] him. (Participant 18)

This quote refers to a point in time when the Barker hypothesis was still a 'discovery in the making'. Although the maps of mortality distribution in England had already been 'discovered', it was still not clear if and how they could be meaningful and how exactly they could be explained. In other words, participant 18 reflected on a moment in time when the data or the ecological 'observations' made

by Barker still remained largely silent, and when Barker sought help to make these data 'speak for themselves' (Keller 1992: 27). This in turn involved a lengthy process of consultations, discussions and debates with numerous colleagues and collaborators which helped shape and consolidate the Barker hypothesis. The process of corroborating data and building the hypothesis, as described in this account, reflects well the norm of communalism according to which 'knowledge is the product of a collective and cumulative effort by the scientific community' (Bucchi 2015: 235).

The comment made by Participant 18 chimed with recollections of many interviewed scholars who readily acknowledged that the Barker hypothesis emerged gradually and as a result of many and often contingent processes and collaborations, including their own. Although Barker's leadership was always acknowledged, these personal and realistic accounts eschewed the notion that he executed the discovery in a heroic and single-handed fashion. Instead, these accounts celebrated the emergence and development of the field by focussing on team work, intellectual excitement and joy of doing science (Koppman et al. 2015). As one of the scientists recalled their involvement in this research:

> So it was at a fairly early stage at the development of the field. (…) no one believed it and we were very few and far between, researchers working in that area, and so from that aspect yeah it was good fun and interesting to see if there was anything in it. So that is where I got into it and so we were in Southampton with David Barker and the others, who sort of started it. (Participant 8)

In this scholar's account, the excitement of doing science stemmed from the feeling of breaking new ground at a time when the field was small ('we were very few and far between'), its claims were contested ('no one believed it'), and the goal was to find out if the Barker hypothesis was true ('to see if there was anything in it'). Although, according to this participant, the seeds of the field were sown by Barker, so to speak, other researchers were also seen as playing a crucial role in the emergence of this field, as they 'sort of started it'. In this account, foetal

programming emerged as a collaborative effort of many different people, even though in the interviews David Barker was always positioned as a person who gave an impetus to it.

The view that science is – or should – be conducted in a collaborative fashion constituted a pervasive feature of the interviews and seemed to reflect well the norm of communalism. One of the interviewees even resorted to sociological theorising and drew on Latour's (1987) concept of enrolment to capture Barker's role in the emergence of the field:

> So that's Latour, I mean he [Barker] absolutely created the scientific agenda and got people interested in the problem for whom it was good as well. (…) Science needs different kinds of people (…) especially now that more and more science isn't a one man show, it is very much a team science to move these things on. So I mean yes people like David Barker and other people who have had huge effects on scientific ideas they are fascinating because you need them to keep the movement and the momentum. And so there are different roles to play and then there is Clive Osmond's role to actually make the data really as clear as possible so that people could really look at the different interpretations and see whether it is suggesting six different interpretations or really is there one clear message coming out of this. (Participant 14)

Here Participant 14 appreciated the crucial part played by Barker in spearheading the new research programme ('he absolutely created the scientific agenda') and in enrolling collaborators and followers ('he got people interested in the problem for whom it was good as well'). Nevertheless, this participant also suggested that excessive focus on scientific stars obscures the fact that science is a collective effort and that many valuable contributors might have been overlooked – such as Professor Clive Osmond, the statistician who collaborated closely with Barker and who made 'the data really as clear as possible' so that there is 'one clear message coming out of this'. This and other personal accounts about the beginnings of the

field celebrated its emergence by focussing on science as a team effort and attempted to paint a more realistic picture of doing research by highlighting contributions made both by Barker and various other scholars.

In the context of discussions about science as a team effort, a few researchers expressed some ambivalence regarding media representations of foetal programming, especially on radio and television. Such responses were either prompted by interview questions or – in one case – occurred spontaneously during the conversation. For example, Participant 14 was critical of several high-profile TV documentaries which in this scholar's view relied excessively on the 'science as one man show format'. Commenting on a programme broadcast by the *BBC PanoramaPanorama* this scholar said:

> The one thing I thought was a bit sad was the last documentary that I saw. (…) It was on Barker. (…) Yes it was all about him and he just kept repeating himself and repeating his punchline and the (…) evidence in my eyes wasn't convincing. (…) I was really excited that he was doing this programme and I thought he missed a trick there in a way. If they had gone to the labs in Australia, in Oregon, all these people who were building [foetal programming], (…) but there was this lone guy on the *Panorama* programme and maybe that was the fault of *Panorama* and this is the whole completely nonsense about science. I mean he was absolutely the most important cog in the wheel in this story, but what you needed to show was how he had then really got everybody else going so I just remember thinking (…) that's a shame that it is not being seen as this really big collaborative team of people all over the world. (Participant 14)

As this quote illustrates, this scholar was highly critical of media representations of foetal programming which rather than focussing on stereotypical stories about a scientific lone genius should have – in this scholar's view – shown a more Latourian 'science in action' with a network of people working in labs and research institutions across the world. This quote also suggests that participant 14

was not *a priori* against increasing the visibility of foetal programming in the media – to the contrary, this scientist 'was really excited that he [Barker] was doing this programme' and saw it as a great opportunity to disseminate this science to the public – or to show 'this really big collaborative team of people all over the world'.

The media sociologist Peters (2013) has argued that 'norms of the scientific community (…) do not generally discourage media interactions, but they include explicit expectations about who should represent science and how' (Peters 2013: 14106). It seems then that by focussing on the image of 'this lone guy' the *Panorama* broadcast on foetal programming did not conform to participant 14's expectations about how their field should be represented in public, and possibly even to some broader expectations and norms of the scientific community, including the imperative of communalism. In this quote but also in other comments made during the interview this scholar expressed a worry that such representations were sending wrong messages to the public about science in general ('this is the whole completely nonsense about science'), and also about the field of foetal programming and its claims. At the same time this participant was ambivalent as to whether the media were the only ones to blame for such representations of science ('maybe that was the fault of *Panorama*') or whether Barker was also involved in dissemination of such stereotypical images of scientific research. As the previous chapter has shown, this was certainly the case. The next section will discuss this last issue in more detail, and it will investigate the media claims about foetal programming's power of prediction.

5.3.2 Divination and the PR of science

As discussed in Chapter 4, the media drew on the metaphors and imagery of a scientist-wizard or diviner to represent , and they depicted the science of foetal programming as akin to crystal-ball gazing or divination. The media – and Barker speaking in the media – thus suggested his research made it possible to predict an individual's future health. For example, using various measurements related to the newborn, such as the birthweight, the shape and size of the baby and of the placenta

as well as information about the mother, it was possible to predict, in Barker's words, 'that baby's likely destiny' (Chapter 4) in terms of risk of chronic disease in adulthood.

During the interviews, I was trying to gauge whether in the participants' view, foetal programming was well-equipped to make this kind of prediction about health risks for individuals and also how they assessed such claim-making in the media. This question was often met with surprise on the part of researchers, but nevertheless they tried to engage with it. For example, responding to my question about individual predictions participant 3 stated that:

> I mean you can predict at a group level. If you had a hundred or thousand babies with these particular configurations and a thousand with more favourable measures, then one group will do better than the other. At an individual level you can't predict. (Participant 3)

As this researcher pointed out, although it was possible to make predictions at a group level based on the data related to big cohorts of people, neither in foetal programming nor in other fields of health-related sciences was it possible to predict an individual's likely health outcomes in future. Answering my question participant 8 made a similar point by saying:

> Yeah I know what you mean and probably no. (…) It [disease] is so affected by how your genes interact with years and years of lifetime environmental exposure that all you can say is look, on average if it's born big, you have got a big old baby. Then on average we are going to say that they have got a greater likelihood of being overweight later on, so just be, that individual should maybe just pay slightly more attention than the next person on what they eat (…) and that's about it really. (Participant 8)

In this participant's view birthweight as well as other indicators at birth were, taken alone, not good predictors of future health outcomes, as the likelihood of

disease was shaped by interactions of this baby's genes with various lifestyle factors occurring throughout life. In addition, and confirming the point made by participant 3, this scholar dismissed the possibility of an authoritative science-based prediction of an individual's future risk of disease.

During the interviews it also became clear that some of the participants were familiar with the *BBC* broadcast, and the claims about foetal programming being able to predict individuals' future made them feel uncomfortable. Commenting on the *BBC* 2 *Horizon* programme one of the scholars said:

> Yeah, it makes good television but (…). I just thought it was awful. I really thought it was awful. I didn't like it at all. I can't remember why, well there were a lot of reasons why but yeah. (Participant 15)

Unlike other participants, this scholar did not seek to disprove the prediction claim by referring to scientific knowledge, and simply dismissed it as unscientific as 'it made good television'. In the same context another participant stated that:

> I think Barker's claim to be able to do that is a nice piece of PR (…). So I think it is yeah a silly claim. (Participant 2)

As these quotes illustrate, these participants were deeply ambivalent about the claims that were made about foetal programming in the media, especially over-certain and over-hyped ones. While some researchers dismissed them as inaccurate, the suggestion that Barker's claim constituted 'a nice piece of PR' indicates that they were also interpreted by the scientific community as misrepresentation of what the field of foetal programming is and what it can do, and even as hype. Hype, as Weingart (2017) recently argued, can be identified on the basis of 'the illegitimacy of the conclusions that it invites' (Weingart 2017: 112), and the claim about foetal programming's power to predict people's future health was clearly dismissed by the participants in this study. Similar points were also made by other interviewees, for example by participant 1 who said that:

> I think that's his sort of… I think the reality of that, that hasn't been confirmed. I think those sorts of statements that are maybe over-embellishing his ideas and concepts have constrained the take up of those ideas by other researchers. (Participant 1)

While in general hype, or as Weingart (1998) called it 'discursive overbidding', is usually assumed to confer some (unfair) advantage to science in terms of increasing the attention of the public and policy makers and increasing the possibility of getting funded, in this case hyped claims about foetal programming seem to have caused some reputational damage in the professional realm. In this sense, claims about foetal programming as a science of quasi-divination as well as other claims – as it will be shown later in this chapter – could be interpreted as instances of a damaging hype which, at least for a certain time, limited the uptake of the Barker hypothesis in a wider scientific community.

The ambivalence expressed by the interviewed scholars seems to have been heightened because Barker himself appeared to be involved in the dissemination of hyped claims about his field. As Rödder argued, the scientific community is more at ease with the visibility of their discipline in the media providing that the science communicator or the 'visible scientist' has a solid reputation in research (Rödder 2012: 169), the reputation which should also ensure the quality of information disseminated in public (Rödder 2012: 169). In this sense, the presence of the founding father of foetal programming in the media coverage which included hyped claims about this field seemed to be discomforting and difficult to accept for the participants, not least because, as Weingart argued, 'to communicate with hype is considered to be illegitimate in science' (Weingart 2017: 112-113).

In addition, this situation seemed to contradict a widespread perception that the media, and not scientists themselves, are responsible for inflating scientific claims for public consumption (*ibid*.). However, as noted by science studies and media scholars, scientists can also be a source of hype (Brown 2003: 14), while the

media can amplify and intensify the message and rhetoric that scientists want to convey (Nerlich and Halliday 2007: 62). As this analysis has shown, the media representations of the field of foetal programming, especially in terms of how this science is done, what it deals with and what it can do in terms of predicting future risk of disease contrasted sharply with the accounts of the interviewed scientists. Drawing on Weingart (1998) who coined the term 'discursive overbidding to describe inflated scientific claims, it can be said that during the interviews the scientists engaged in 'discursive underbidding', as they emphasised the limitations of science and carefully drew boundaries of what can be reliably said about science. This analysis also suggests that such popular representations were seen by scientists as unhelpful, as in their view they misrepresented their field, hyped this field's claims and even led to a potential diminishing of this field's standing in professional realm. These issues will be discussed further in the following sections.

5.4 Retracing the boundaries of science: foetal programming, its critics and hype

In the media coverage of foetal programming boundary-work, as discussed in Chapter 4, was an important means that helped put this field on the scientific map and establish it as a legitimate area of research. This discursive device was particularly useful when the media – and also the scientists speaking to the media - attempted to differentiate this field from the competing approaches of the genetic and lifestyle factors, to advance new claims about the benefits and contribution of the foetal programming research, to present their field as a scientific revolution, and also to defend their research against criticism.

This section seeks to engage with the same themes and issues surrounding the construction of this field which appeared in the media (as discussed in Chapter 4), albeit from a different and additional perspective, that is by drawing on interviews with scientists and their views and experience of conducting research and building this scientific field. As it will be shown, the inclusion of the scientists' perspective on the various processes of field-making helped provide additional interpretations on the

ways in which this field was discursively constructed, promoted and defended in the public and professional realm. It also helped shed some light on the issue of hype that, as discussed earlier in this chapter, seemed to be in some scientists' view a worrying feature of public communication about foetal programming. This section discusses scientists' perspectives on criticism levelled at the field of foetal programming and on the ways in which the field dealt with it, and then it discusses the issues of hype.

5.4.1 Science as critique

The dominant narrative convention of the scientific discourse is that, as Harré argued, 'science must present a smiling face both to itself and to the world' (Harré 1990: 87). These conventions suggest that uncertainties, conflicts and problems that beset individual researchers and scientific communities are often eschewed in official accounts of science, which tend to focus instead on heroic narratives of discovery, success and scientific progress. The media coverage of the emergence of foetal programming (as discussed in Chapter 4) seemed to belong to the same category of celebratory and unproblematic stories about science that circulate in the public realm. Such coverage contrasted with the interviews with scientists who offered more pragmatic and realistic accounts about conducting scientific research and about building the field of foetal programming. As the interviews progressed it was becoming clear that this field, as many others, was shaped not only by its successes and achievements, but also by its difficulties and problems. This involved struggles to get funding, counter-criticism, getting papers accepted for conferences and journals and gaining recognition in a wider scientific community.

In their general theory of scientific and intellectual movements Frickel and Gross have defined emerging fields as 'collective efforts to pursue research programs or projects for thought in the face of resistance from others in the scientific or intellectual community' (Frickel and Gross 2005: 206). In their view, these new intellectual movements are in essence motivated by grievances which 'are ubiquitous

in academe' (p. 2011), and which under specific circumstances may unite groups of scientists against a dominant intellectual practice. In contrast to Bourdieu (1988), who sees an academic career mainly as means to gain prestige and high social status, Frickel and Gross argue that the reasons for which academics engage in intellectual activities are much more diverse than an opportunistic pursuit of a highly regarded career. Scientists' grievances are usually expressed in what Mills (1940) has called a 'vocabulary of motive' (p. 211) which provide a range of explanations that justify and sustain the pursuit of a new research programme. One of such explanations, as Frickel and Gross notes, might draw on intellectual dissatisfaction with the ways in which science is being conducted, but the repertoire of explanations is usually rich and much more varied.

Although Frickel and Gross's framework is useful for this study, not least because of its emphasis on the resistance encountered by an emerging field, the notion of grievance might carry unnecessarily negative connotations. For example, the concept of grievance might imply that scientists are mainly power-mad careerists or moaners, while, as Lamont (2009) has shown, scientists are mostly driven by curiosity, and in addition to being good at competing, they are also good at building strong 'intellectual and friendship communities' (Lamont 2012: 235). Therefore, while using the term 'grievance' in the context of this study I will refer mainly to the 'intellectual dissatisfaction' which is inherent in Frickel and Gross's conceptualisation of grievance. In addition, the notion of 'intellectual dissatisfaction' corresponds well with the accounts provided by scientists in which they often expressed dissatisfaction or frustration felt while promoting their claims, establishing their field or countering criticism.

In the context of the interviews grievances, or rather critical reflections, constituted a frequent theme. They were voiced in relation to various situations which coincided not only with the emergence of the field, but which occurred over the years. For example, participant 21 drew on the discourses of intellectual dissatisfaction when recalling the years in which foetal programming was emerging. In this scientist's view back in in the 1980s and 1990s, the years which marked the

run-up to the Human Genome Project, scientific ideas about human development were too much influenced by genetics, and developmental biology in itself was enjoying a relatively low status. As this scholar recalled:

> With the push towards the Human Genome science had become reductionist. Development was thought to be simple. It was like building an organism from Lego. (…) You didn't have to be very clever to understand that. We had these bits that we knew and we found the genes for them and we built them up one by one and then of course the interesting thing happened after birth when it all suddenly started to work. So [compared to that] foetal programming was far more integrative and interdisciplinary. [But] it was deeply unfashionable because it was going against the gene-centric deeply reductionist science, it was unfashionable because it was challenging the established wisdom about lifestyle and adult disease, and of course it was unfashionable because it actually took things back to women and children. (…) So it was very hard to get funding for it. (…) You had to fight the major clinical vested interests like the American College of Cardiologists who said: 'Forget the development - it [the chronic disease] is all about adult lifestyle'. And then you had the gene-centric people who would say 'Yeah yeah, development. We are going to find the genes for these things, just give us some time'. (Participant 21)

This scientist's recollections offer a snapshot of the process of 'carving the niche' (see Chapter 4) for the emerging field of foetal programming in the scientific landscape, which in the 1980s and 1990s was dominated by the proponents of the genetic approach (the Human Genome Project) and life style factors (the American College of Cardiologists). In its efforts to advance its claims, foetal programming had to fight 'the vested interests' of its opponents as well as the dominant ideas of that time, including the view that human development was entirely controlled by genes and was akin to building an organism form Lego bricks using instructions contained in or dictated by genes.

On the other hand, the proponents of the lifestyle explanations of adult chronic diseases were at that time interested mostly in risk factors occurring in adulthood and concerning, for example, middle-aged men. In this context the focus on early development and on 'women and children' that foetal programming was advocating was dismissed by the community of cardiologists. This scholar also alluded to the fact that at that time pregnancy and childhood did not constitute high priority in research agendas or were 'deeply unfashionable'. This account paints a picture of an emerging science at risk of being thwarted or marginalised by two rival and dominant paradigms of that time. It also chimes with the findings from the analysis of the media coverage (see Chapter 4) which framed foetal programming as an underdog science challenging its hegemonic scientific competitors.

Some other scholars also remembered the times when the Barker hypothesis was met with disbelief and its proponents were a minority. According to Participant 18, in the early days of foetal programming research Barker

> organised a meeting where he invited senior colleagues from around the country who were experienced in cardiovascular disease and in paediatric nutrition, to come together and he presented his proposition [Barker hypothesis]. There were lengthy discussions and by and large the ideas were rejected and there was a small handful of people who were prepared to suspend their disbelief and allow them as being worthy of enquiry. (Participant 18)

The participant refers to a time when foetal programming could be described as an isolated science, rejected by elites and supported only by a small group of colleagues prepared to carry on with research in which they believed. This account is in stark contrast with the early media coverage of foetal programming which tended to allude to the controversial or disputed nature of the Barker hypothesis (see Chapter 4), but which nevertheless represented this field as new and exciting rather than at risk of marginalisation. In this sense, the early media coverage did indeed present to the world a smiling face of foetal programming, the field which

in its early stages was facing a strong resistance and even an outright rejection from major sections of the scientific community.

Another participant also recalled the scale and the force of the resistance with which this research was met at scientific conferences. As this participant said:

> We were the only ones there [at the conference] working in the area [of foetal programming]. [We were presenting] the research and [almost got] booed out of the hall, but virtually. There was a lot of resistance, definitely. You couldn't get the papers published. And that's how science goes, and they don't like when there is perhaps a paradigm shift as you say and there's not the evidence for it. It definitely met a lot of resistance earlier on, but then it picked up. (…) Subsequently it [criticism] has all been discounted, but there is still something in those… And sometimes when people just don't believe a new hypothesis because they haven't heard of it, they just don't believe it and the only way to believe it is if an independent laboratory repeats your experiments and shows the same thing and in time that's what gradually happened. (Participant 8)

It seems then that for a considerable period of time proponents of the foetal programming were operating in what may be described as a hostile external environment, where their claims were openly dismissed at professional meeting and papers were rejected for publication. This changed over time, when new evidence in support of foetal programming emerged and experimental studies were confirmed by independent scholars. Although criticism toward foetal programming was eventually overcome, this researcher seemed to suggest that some of the original resistance towards this still lingered on as 'there is still something in those [criticisms]'. Overall all this and other accounts painted a picture of foetal programming as a science under siege, which had to fight off resistance and strive for recognition in the professional realm, a picture at odds with the much more positive and upbeat media coverage of this field which was discussed in Chapter 4.

5.4.2 Grievance as reaction to critiques

Resistance of the scientific community to new ideas, as noted by Frickel and Gross (2005), is an important component of the emergence of new scientific and intellectual movements. In the context of foetal programming, the hostility of the scientific establishment towards the Barker hypothesis also seemed to have influenced the ways in which this field was constructed and shaped. When looking back at past developments in this discipline, participants also reflected on the ways in which foetal programming responded to its critics. Some scholars (in particular participant 1, 7, 8,14 and 21) expressed the view that attacks on the Barker hypothesis were motivated not only by valid scientific queries but also by what they perceived as vested interests of competing disciplines. At the same time these participants were ambivalent about the ways in which the field handled critiques, regardless whether such criticisms were in their view politically motivated or scientifically justified. In this context, scholars - in particular participants 2, 14, 15, 16 and 21 - emphasised the value of scientific debates which are necessary for producing good science. But some also suggested that foetal programming could or should have engaged in such debates about the validity of its claims in a more constructive fashion. As Participant 16 argued:

> Part of the difficulty in the developmental origins field was the backlash from the establishment against Barker's hypothesis. So people like Barker himself and his colleagues and others who thought he was right became very evangelistic about their area of science and that doesn't help. Evangelistic helps in as much as if it spreads the word, but it doesn't help if you have become fixed in your view. (Participant 16)

As this participant suggested, in reaction to criticism some proponents of the Barker hypothesis became 'fixed' in their views and 'evangelistic' . Interestingly, here the metaphor of 'evangelism' carries rather negative connotations, as it points to a war of words rather than to a dissemination of science, and it suggests an

intellectual rigidity, the two features that Barker deplored himself in his media description of his opponents (see Chapter 4).

Other scholars, especially participant 2 and 15, also suggested that the field was at times too much inward-looking and instead of engaging with criticism, it chose to ignore it, and even to discredit the critics themselves. Reflecting on the question on how the field dealt with criticisms, one participant said:

> To a certain extent I think it did [deal with criticism]. Perhaps not in the way you might have hoped. I think there was quite a bit of putting up the shutters and saying well, these people just don't believe us. We won't talk to them. And there were some colleagues around the world who were perceived in our field as just enemies. …. Ideally there would have been collaborations with someone who had different data, the response would be ok, let's work together let's have another [conversation]… But it would have required money, investment and money. It would have required the backing of major organisations I think. (Participant 21)

On a similar note, participant 14 reflected on the hostile environment in which foetal programming was emerging as well as on the adversarial fashion in which foetal programming was dealing with its opponents:

> Professor Barker always felt that he was fighting everybody and … he used to have quotes on his board. I can't remember what they said but kind of classical quotes saying 'You have to fight for your ideas'. All those sort of 'I am the underdog and I have got to fight and use a lot of energy in doing that'. (Participant 14)

As this scholar suggested, the somewhat belligerent attitude towards the critics also stemmed from the perception that compared to other disciplines the field of foetal programming was a scientific underdog and had to use all possible means or 'use a lot of energy' to succeed in the competitive market place of ideas. This

observation is to some extent consistent with the findings from the media analysis in Chapter 4, which showed that the framing of a foetal programming as a scientific underdog constituted a significant feature of the media coverage of this field. But while the media tended to stress the positive side of this underdog science, for example its drive to produce more research and to constantly 'accumulate the evidence' to support its claims, the interviews suggested a different aspect of being a scientific underdog, namely the inclination to fight its opponents rather than trying to address their arguments.

The fact that the field was at times reluctant to engage constructively both with its critics and with different opinions more generally, seemed highly problematic for some other scholars. particular Participant 2 and 15 felt that, even in more recent times, this science was too narrow-minded. As one of them noted:

> It's the kind of field where if you are not following the current dogma then you are on the margins of it and you wait for the dogma to shift again. (Participant 2)

As this scholar implied, a lack of scientific debate meant that the field, or at least some strands of research in this field, could at times be viewed as dogmatic, or driven by fixed views rather than science. Here again the use of the religious metaphor of 'dogma' suggests a rather critical appraisal of the scope of scientific debates within the field.

As these interviews revealed, the resistance of the scientific community against the emerging field of foetal programming shaped the ways in which this new science addressed criticisms and divergent opinions, both from without and within of this scientific field. According to some participants, the backlash of the scientific establishment contributed to what they perceived as unwillingness to engage with scientific opponents. These interviews also showed that the criticism directed at the field of foetal programming in the professional realm was far more significant and consequential for the development of this discipline than suggested by the media which tended only to allude to controversies surrounding this field. Despite the

initial backlash from the scientific establishment, foetal programming managed to develop and sustain a considerable reputation in the public realm which was reflected in a favourable coverage by major popular media both in the UK and abroad. As a result, the field managed its 'backstage exposure' (Bucchi 1998), or risk of reputational damage in the public realm in a very effective fashion, as it avoided being represented as diminished by controversies. This also resulted in one-dimensional and generally very favourable representations of this science in the media coverage, which helped legitimise this science and sustain its reputation even at times when it was questioned in the professional realm.

5.4.3 Making sense of hype

As shown in the previous sections, the experience of criticism and a backlash from the scientific establishment not only deeply influenced the emergence of the foetal programming framework. It also, in the participants' view, prompted the field to become more inward-looking and fixed in its views, and at the same time more 'evangelistic' in disseminating its findings and stepping up its claims. As discussed earlier in this chapter, some of these claims, especially the one that it was possible to predict an individual's future health and disease, were viewed by the participants in this study as 'over-embellished', if not verging on hype. In what follows I will draw on STS literature on hype and on the interviews with scientists to make sense of such claims.

The phenomenon of exaggerated statements about science and technology has constituted a long-standing interest in social studies of science, and it has been captured in research on promotional metaphors (Nelkin 1994), sociology of expectations and hype (Brown and Michael 2003, Borup et al. 2006) and discursive overbidding (Weingart 1998), to mention only a few influential approaches to this topic (see also Chapter 2). The common thread of this literature is the focus on the inflated claims, the dynamics of their production and the goals which hype is supposed to achieve, such as getting attention of the public and policy makers,

attracting funding, gaining recognition, and pursuing various other goals and interests.

While one of this literature's major findings is that not (only) the media but also scientists themselves are implicated in promoting hype (Weingart 2017), some of this research (for example Brown and Michael 2003) also argues that inflated claims and expectations about what science and technology will do in future are produced mainly by those sections of technoscientific communities which do not work at the heart of the discipline in question or do not belong to the 'core-set' (Collins 1999) of this field. This means that those individuals are more likely to have high level of confidence about what science can do, as they are not actively engaged in experimentation or theorisation of the field and do not experience uncertainty and doubts often related to primary research.

Alternatively, according to this literature, hype can be produced even by those scientists who in usual circumstances do not make exaggerated claims but who are somewhat compelled to resort to hype – or to wear 'their entrepreneurial hat' – in a bid to attract attention and investment (Brown and Michael 2003: 13) – something all scientists are now supposed to do in the modern impact-oriented academia (Nerlich 2013).

Drawing on the interviews as well as on the media analysis conducted for this project I offer a slight departure from the framework of Brown and Michael (2003) and want to argue that exaggerated promises may also emerge from the core-set of the field and can be sustained over long periods of times. In addition, inflated claims may be made not only with the view of attracting future gains, including funding or investment, as Brown and Michael (2003) and Nelkin (1994) suggest, or with the aim of establishing a new field (Weingart 1998), but also as a mechanism which seeks to defend its core claims and deflect criticism from the opponents. In what follows I will draw on the interviews to discuss what some of the participants considered to be hyped messages about foetal programming as well as their interpretations of the reasons behind such inflated claims.

5.4.4 Countering hype: on importance of genes and lifestyle

As discussed in Chapter 4, countering the lifestyle and genetic aetiology of adult chronic diseases was an important feature of boundary-work in the public realm, and the media often depicted foetal programming as the field which was able to offer both better explanations and predictions of future adult health risks. These claims were closely linked to attempts to legitimise this field and differentiate it from its competitors. In science the attempts to legitimise a new field often rely on binary thinking which helps frame it as novel and ground-breaking, or 'as opposed to' or 'in opposition to' the more established approaches in science (Somers and Gibson 1994), but it may also lead to some oversimplifications or exaggerations. Although scientists might be compelled to simplify the messages in the public realm, the interviews usually provide an opportunity for more nuanced reflections which reveal far more complex interpretations of science, as it has been shown for example in the context of epigenetics (Tolwinski 2013, Pickersgill 2016).

Similarly, in the context of the interviews for this project the participants presented various interpretations of the issues surrounding the contribution of genes and lifestyle factors to the incidence of adult chronic disease. As it was discussed in Chapter 4, in the media the boundary-work related to the legitimation of foetal programming involved claims that, for example, genes and lifestyle had little (if any) impact on the occurrence of chronic disease later in life. The interviews sought to gauge to what extent the boundary-work in the media overlapped with the boundaries of science traced by the participants, especially with their views on the contribution of early life, genes and lifestyle to health and disease in adulthood. It soon became clear from the interviews that virtually all respondents acknowledged the rather considerable importance of both early life development *and* genetic and lifestyle factors for the incidence of adult chronic disease. These issues will be discussed in depth in Chapter 7, but as an illustration of one of the ways in which the participants

conceptualised the relative contribution of all these factors it is useful here to quote participant 2 who said that:

> Well obviously we are talking here about non-communicable disease so my view would be that an individual's risk of say developing coronary heart disease is determined by the interaction of factors all the way through their lifespan. (…) So obviously it is a product of your immediate environment and lifestyle. So what diet do you follow, how physically active are you, do you smoke are the immediate determinants. The way in which they actually, those factors lead to disease depend on everything that has gone before, so essentially how you respond to your current environment depends on factors which have developed all the way through your life. So we have got genetic factors and clearly we know that that plays a big part in determining risk, overladen that we then have the impact of environment from conception all the way through to where you are in your life at the moment, so foetal programming as I see it is one important component of that risk. (Participant 2)

This participant, and other scholars as well for that matter, readily acknowledged the importance of both genes and lifestyle choices such as diet, smoking and exercise – the factors that as shown in Chapter 4 were often dismissed or downplayed in the media coverage of foetal programming. In this participant's view, foetal programming was one of the contributors to the emergence of chronic disease, though the scope and scale of this contribution was conceptualised in different ways by the participants in this study (as will be shown in Chapter 7). It thus seems that the boundaries of what foetal programming is and can do, and how it is positioned relative to its competitors were traced differently in the context of the media coverage and the interviews with scientists. The lack of overlap between these two sets of boundaries, or between these two sets of claims about foetal programming was sometimes used during the interviews as a starting point for discussing the ways in which science is or could be communicated. In other words, it gave rise to some reflection on the acceptable boundaries of claim making, and

whether such presentation of the contribution of lifestyle and genetic factors was a simplification or, possibly exaggeration.

This solicited varied responses. For example, participant 4 believed that simplification of claims is necessary, especially in the early days of science. In the context of the claims about the relative (un)importance of lifestyle and genetic factors, this scholar agreed with Barker's approach to simplify the claims of the field and to stress predominantly the importance of early development. According to this researcher:

> So there is no disagreement here at all, it's just a deeper level of thinking. It's not that Barker didn't think about these things [i.e. lifestyle and genes], it's just that initially when you are dealing with a new problem you don't get overcomplicated to begin with. You start by addressing the simple issues, (…) you take a reductionist approach. You start generally very superficially and then you sort of tunnel into it deeper and deeper and deeper and look into all the complexities. You don't dive into the complexities to begin with because you'd just get lost. I mean you would just lose your bearings. (…) I guess Barker was arguing, because people said, 'oh it's lifestyle, and it's genetics', (…) but Barker was saying, 'ah but there is another element to it and that's how you develop'. (Participant 4)

As this participant argued, simplification of scientific claims is important not only in science communication but also in scientific research, as it helps clarify the argument and maintain focus on what might be the core claim of a new hypothesis. In this sense reductionism and simplification constitute tools enabling scientific research rather than an interpretative lens through which the world is understood. This participant thought that Barker's stress on the importance of early life was conceptually necessary to differentiate this approach from competing framework, even if this meant excessive downplaying of the impact of lifestyle and genes.

Some other researchers seemed less comfortable with what they saw as oversimplification of some claims made about foetal programming which over the years appeared in the public and professional realm. According to one participant:

> [Barker] could really write, he knew how to write, but (…). You know he did over-interpret probably some of the things and over-egg things because you caricature things to make people notice. Already some people do that, you do that in a story, don't you, that is how you kind of do it and it certainly made people stand up and take notice. (Participant 14)

Here participant 14 reflected on the ways in which (some) claims are being made in science, and which involve 'caricaturing' research in order 'to make people notice'. This participant felt that Barker used his gift of story-telling or of writing in a compelling fashion to 'over-interpret' and 'over-egg' some of his claims with the view to promote his field and 'to make people stand up'. Interestingly, some participants suggested that claims may have been exaggerated in reaction to criticism from the medical establishment. As one participant stated:

> [Barker was] too much of an evangelist (…). Which may be in part because of some of the criticism he got from adult cardiac surgeons and they just wouldn't believe this at all and would just try and shoot him down when he presented his data. (…) Well I think to those people who were just working on adult cardiovascular disease they just considered it to be a disease of lifestyle (…). There was a degree of scepticism. I think that still persists today. And I think the thing about David Barker is that he was somewhat of an evangelist. He would go out there and he would always be very persuasive and everything in his eyes could be explained by your *in utero* experiences. And he was maybe suggesting that this could be more of an impact for adult and health wellbeing than say giving up smoking, which I think is somewhat of an exaggeration, obviously. And that sort of scepticism and that he was such an evangelist

> still meant that this potential impact is still debated by some people. (Participant 1)

in utero

This participant expressed ambivalence about the strategy of disseminating inflated claims as it entrenched the opponents in their 'scepticism' and meant that the real influence of early life for adult health 'is still debated by some people'. As this account suggests, the striking claims about the unimportance of adult lifestyle and even smoking were driven not only by a desire to differentiate the field from other approaches and to promote it in public, but also by the need to defend it against what was perceived as an aggressive and often unjustified criticism. But according to this participant, the fact that some scientists were still sceptical about the validity of the Barker hypothesis suggested that the strategy of hyping claims proved to be detrimental for the field's reputation.

These observations chimed with the comments of another scholar who reflected that:

> Barker's hypothesis came at a very bad time in terms of the development of the consensus in the research and biomedical community that you had to give people a very consistent message about smoking and diet and exercise. … And then Barker comes along and in order to advance his line whenever he'd speak he'd sort of say that smoking and adult exercise and diet are irrelevant or they are not important. I think that is a way to get noticed. It is not a way to make friends and my view is that this hypothesis remains majorly marginalised in the biomedical community. (Participant 7)

In this participant's view, the strategy of disseminating inflated claims to stand out from the scientific crowd antagonised some sections of the scientific community and may have hindered a more general acceptance of the Barker hypothesis in the scientific realm. *in utero*

Similarly, another researcher reflected on the causes and consequences of hyping the messages of foetal programming in both public and professional realm:

> [Barker] certainly didn't have any media training but he was a natural speaker and very good raconteur. But he pushed it too far in his attempts. The more antagonism he got from gene-centric people and from the adult physicians, the more he hyped up the message. We all tend to do that, it's very dangerous, and he started to say that smoking was completely irrelevant, that genes were completely irrelevant …He got good press coverage at times because press coverage can sometimes get you exposure, and sometimes to your scientific colleagues it actually cheapens the story. (…) Of course now our universities and REF system look at the impact and public engagement, but at the time when he was working in the 90s those were not major drivers. So it was probably being seen as being hyped and those who thought there was a bit of … sort of bullshit attached to it. (Participant 21)

As this scholar argued, while today's academia rewards efforts to disseminate science, back in the 1990s prominence in the media was frowned upon in scientific circles, especially when the press disseminated highly controversial claims, for example about the irrelevance of smoking. In this scientist's opinion Barker's presence in the media ensured a good coverage and reputation in the public realm, but the strategy of hyping claims contributed to a diminishing of this field's standing and slowed down its uptake in the scientific realm.

This last remark chimed with the observations from other scholars quoted earlier on in this chapter, especially from the participant 1, 7 and 8, who also thought that hyping the messages of this science affected its reputation in the professional world. Such statements contrasted with the media coverage which, as shown in Chapter 4, sought to represent foetal programming as a scientific revolution sweeping the world of science, or as a Kuhnian paradigm shift which, as claimed by

The Times, 'replaced wholesale' old theories about the emergence of adult chronic disease (Chapter 4). The media also emphasised the status of foetal programming as a promising and growing field whose ranks were swelling with new followers, and whose opponents or 'sceptics' turned into 'converts' to the cause, thus suggesting that the popularity of this approach was growing rapidly.

However, the pragmatic accounts of foetal programming provided by the participants for this study demonstrated much more moderation (Nerlich 2013) in discussing this field's scope, and they painted a different picture of the spread of Barker's ideas. Instead of talking about a scientific revolution, they suggested a more limited following of the Barker hypothesis, especially at the inception of the field, when it was largely rejected by the scientific establishment. Although with time the field gradually gained recognition, some researchers suggested that even today there remained doubts in some sections of the scientific community about this field's merits, doubts, which led one scholar to argue that the field was still 'majorly marginalised in the biomedical community'. It thus seems that media claims about the revolutionary character of this field can be interpreted as a 'preservative rhetoric' (Cherwitz and Hikins 1986, see Chapter 4) which sought to discursively mobilise the field while waiting for the professional recognition and uptake of these ideas to catch up with reality.

5.5 Discussion and conclusions

This chapter has focussed on scientists' views on the emergence of and developments within the field of foetal programming, as well as on its public communication. In so doing, this chapter has explored the ways in which scientists made sense of the various processes of field-making both in the scientific realm and in the media space. During the interviews researchers provided nuanced and reflexive accounts about the emergence and claims of foetal programming, and in so doing they positioned themselves as 'responsible' scientists communicating with modesty (Pickersgill 2016) and promoting a more moderate or humble science (Nerlich 2013).

Thus, this chapter has sought to avoid reproducing 'alien' (Collins 1999) accounts of the emergence of foetal programming by drawing on scientists' insider knowledge and professional understandings, which could have not been gleaned only from the media coverage of this field.

As this analysis has shown, the media coverage (as discussed in Chapter 4) presented to the world 'a smiling face' of foetal programming: it was depicted in largely favourable terms as an emerging field, as pioneering ground-breaking ideas and even as bringing about a paradigm shift in biomedical sciences. Criticism was rare, and when critical opinions appeared in the media they were not further investigated by journalists. Such enthusiastic and up-beat media representations of foetal programming in the press were at odds with scientists' views explored in this chapter. Researchers' accounts, alongside the celebratory narratives of this field's achievements, also told the story of a backlash from the scientific establishment and of the field's efforts to gain recognition and respect. This thesis suggests that the strategies of protecting reputation (or the strategies of managing 'backstage exposure') of the foetal programming framework were successful, as the public image of this field was highly favourable and did not fully reflect the criticism it faced in the professional realm.

As this analysis has shown, disseminating the science of foetal programming also involved what many participants felt was an oversimplification and even hyping of this field's core messages. Some participants suggested that inflated claims appeared, at least partly, in reaction to criticism and that hype may have led to a reputational damage of this science, thus harming or slowing down its uptake in the biomedical community.

While hype is usually associated with attempts to attract the attention of the public (Nelkin 1990), and with efforts to establish new fields (Weingart 1998), there may be a wider range of situations in which hype is deployed to create a certain vision of what science can or will be able to do. As Kitzinger noted, hype can do various kinds of rhetorical work, including not only promotion of some futures but

also a ‘particular rhetorical work in discrediting those promoting alternative views of the future’ (Kitzinger 2008: 432).

It seems that in the media coverage of foetal programming the use of hype sought to achieve various goals. It was used to increase this field’s credibility by suggesting that it could indeed control or at least predict the future, as shown in the media framing of this science as divination or crystal-ball gazing. Exaggerated statements also positioned this field as a scientific revolution even when the actual popularity of this field in the professional world was still limited. Hyped messages about the impact of early life programming on future health and the relative unimportance of genes and lifestyle in influencing disease in adulthood sought to increase this field’s credibility while simultaneously attempting to discredit the rival approaches. Hype seems to have not only been used as a tool to legitimise this science or to promote its claims, but also as a tool to delegitimise its opponents and diminish their standing. The interviews conducted for this study suggest that at least in some instances hype constituted a delegitimising device deployed against the scientific establishment who, at least initially, failed to provide support for the emerging field of foetal programming.

While hype is generally perceived to be potentially (though unfairly) beneficial for science, as it increases the chance of getting noticed and funded (Weingart 1998, Brown and Michael 2003), this study suggests that the consequences of hype may be mixed and are difficult to predict. It seems that in the case of foetal programming hyping the messages helped attract the attention of the media and contributed to establishing a favourable reputation of this field in the public realm[12], while in the professional arena it led to what some participants saw as a reputational damage and a slower uptake of this science in biomedical community. Thus, the case of foetal programming illustrates what might be called a harmful or damaging hype, the hype whose purportedly negative consequences for the field did not seem to have been expected nor intended. The interviews for this study also

[12] This study did not seek however to investigate whether the media exposure was beneficial for the field in terms of facilitating funding for research.

suggest that over the years that marked the rise of the foetal programming framework the norms concerning hype in science may have changed, and what seemed to have been inappropriate or damaging in 1980s or 1990s, could look more acceptable in the present higher education system which stresses the need of dissemination of knowledge, public engagement and impact. Further research would be needed to investigate if and how the scientific norms of what is acceptable in public communication of science have changed and if so what would be the potential consequences of that.

iseise

An additional finding of this study relates to the ambivalences that arise in scientific communities in relation to the role of 'visible scientists' as ambassadors of a particular discipline in the public realm. As Rödder (2012) argued, members of a scientific community are not necessarily opposed to science communication and to the role of a 'visible scientist', providing that the dissemination of research fulfils certain conditions and expectations about who and how science is communicated about. If certain criteria are met, for example if the 'visible scientist' enjoys a solid scientific reputation or is modest, that is does not seek publicity specifically for him/herself, the members of scientific communities can successfully manage their ambivalences related to the public prominence of their 'visible peer'.

In the context of this study it seems that recognising hype prompted the participants to draw on different strategies to manage ambivalence (Rödder 2012) related to the appearance of such statements in the public realm. While some drew attention to the media which in their view seemed to encourage production of hype, others tended to contextualise hyped claims about foetal programming by emphasising the hostile environment in which this field was emerging as well as an aggressive behaviour of the opponents of this approach. Yet another group chose to counter hyped claims and drew on their scientific expertise to explain why in their views such claims were not backed by science.

Significantly, what emerged from the interviews was that hyping messages about science did not seem to affect the reputation of the scientist involved in this process. This contradicts the so-called 'Carl-Sagan-effect', a perception that prominence or popularity in the media can be damaging for scientific reputation, and that 'scientists tend to lose respect for scientists who communicate very much' (Rödder 2012: 164-5). This perception did not seem to apply to the context of this study. Although in the scientists' view Barker promoted not only the field but also inflated claims about this field, the participants seemed to have been able to conceptually separate the inflated claims made by the leader of the field, from his reputation of a scholar highly regarded within his scientific community (see also Chapter 1). This finding does not lend itself to an easy interpretation. That in the context of this study hyping science did not seem to have a bearing on the scientific reputation of the 'visible scientist' might stem from the fact that – as this study and other research (B. Martin 2011, Poliakoff and Webb 2007) have shown – scientists are under increasing pressure to communicate and to 'big up' their research findings, which in turn might lead to increased tolerance for hype, in fact to the normalisation of hype. Further research would be needed to investigate this issue in more depth.

Chapter 6. Making sense of a new health risk: Metaphors and narratives of foetal programming in English-language news

6.1 Introduction

Metaphors constitute principal conceptual and explanatory tools which help scientists do science and elucidate what has previously been unknown (Lewontin 1998). They are also crucial for science writers and journalists as they communicate about science in the media (Whaley 2010). For sociologists of science and STS scholars, the study of metaphors is instructive as metaphorical framings used in public communication of science express various hopes and fears related to risks of the emerging fields and technologies (Petersen 2006).

This chapter explores the key feature of the foetal programming framework, namely the concept of risk, and it does so through the study of metaphors in the media coverage. As it has been shown (see especially Chapter 4 and 5), the foetal programming/DOHaD framework has strived to differentiate itself from the competing approaches of lifestyle and genetic factors, and to offer a new understanding of the origins of disease risks. This also meant that by turning attention away from lifestyle and genes and by directing it to the womb and early life, this field has developed new concepts – and new metaphors – to describe these processes, to explain how the risk of disease arises and what it means. This chapter traces the emergence of such new metaphors and examines how they were deployed in the coverage of research into foetal programming in the English-language media over three decades. It asks the following questions:

- What metaphors are used to report on the findings related to risk of disease in the media coverage of foetal programming?

- How are these metaphors interpreted in the press, in what contexts and discourses are they used, and how may they contribute to framing public understanding of risk in early life?

To answer these questions this chapter draws on the framework developed by Maasen and Weingart (2013) (see Chapter 3) which claims that metaphors are nomadic by nature and that they connect and interact with various discourses in multiple ways over time. Eventually, both the metaphors and discourses which adopt them acquire new shades of meaning. This framework is used here to highlight continuity and change in the ways in which metaphorical framings of risk have been deployed in various contexts and various media outlets over time. By analysing which metaphors were deployed in the press and what paraphrases were used to explain them to the public, this chapter highlights the processes during which meanings of scientific metaphors were negotiated in the media coverage in specific contexts and discourses. It also explores the implications this might have for public understanding of the importance of early life. This research cannot, however, reveal how people actually perceive foetal programming in everyday life. Understanding public perception in this sense would need further research.

This analysis has identified three interlinked and important metaphorical framings used in the media coverage, namely the metaphor of 'programming', as well as the related metaphorical expressions of 'critical periods/windows' and the numerical metaphor 'the first 1,000 days of life'. In my corpus these expressions have often occurred together, which is not surprising, given that the term 'critical period' is part of the definition of the concept of foetal programming (see Chapter 1). In the media these interlinked framings have been paraphrased or accompanied by other clusters of metaphorical expressions which are also discussed in detail.

This chapter proceeds as follows. The next section examines the metaphor of 'programming', and it is followed by the analysis of the metaphor of 'critical periods', and subsequently of 'the first 1,000 days of life'. The chapter concludes with a discussion of the findings.

6.2 The metaphor of programming

Although 'programming' is a scientific term and it features in the name of the field of foetal programming, it also plays a metaphorical function as it shapes the way we think and talk about the various processes of early (human) development. The predominant conceptual source domain of programming is computers (the process of writing computer programmes), while the conceptual target domain is foetal life and adult health, or more precisely, the developmental origins of adult health and disease.

In my corpus, the metaphor of programming appeared predominantly in the Western press and it has been used from the inception of this field until recent years – although there are signs that its popularity might be challenged, as will be discussed later in this chapter.

While consistent, this metaphor has also proved quite flexible as it offered slightly different meanings depending on the context and grammatical form in which it was used (for example as a noun or as a verb)[13]. Sometimes journalists used it in a playful way, for example: '[scientists] coined the term "**foetal programming**" (…). Can they help "**de-programme**" the next generation?' (*The Guardian* 09/08/2010). Here playing with the words 'programming' and 'de-programme' gave an impression that programming could be reversible, as the next generation could be 'de-programmed'. In other contexts, however, such language games resulted in quite different effects, for example: 'babies born thin or short (…) are **pre-programmed** to develop (…) heart disease' (*The Independent* 19/04/1998). Here, in contrast to the previous example, the use of the prefix 'pre-' seems to reinforce the meaning of programming and it implies that its effects may be lasting.

This metaphor has also proved flexible in the sense that it could attribute the responsibility for programming to various actors – the question being: who is the 'programmer' and who has responsibility for the programming and resulting risks

[13] Following the conventions in the metaphor analysis, in this chapter I highlight in bold metaphorical expressions which appear in the quotes (see also Stelmach and Nerlich 2015).

and benefits? Sometimes the 'actor' was anonymous and, as a result, it made it possible to frame the processes of programming as passive - 'health and longevity **are programmed** during foetal development' (The Times 22/11/1990); 'unborn **babies were programmed** for the environment their mother lived in' (*The West Australian* 03/11/2007) – or, alternatively, as active, which shifts responsibility to ourselves as agents, or more commonly to our mothers - '**We're programming ourselves** early in life' (*St. John's Telegram Newfoundland* 30/12/2002); '**pregnant and breastfeeding** women who eat a diet high in fat and sugar **may be programming their children** to seek out the same food types later life' (*The Advertiser* 11/4/2014). As we can see, there is diversity in conceptualising both the agent and the object/subject of programming. While both people ('babies') and traits or properties ('health') can be programmed, the programmers can be identified as pregnant women, scientists or ourselves. This active/passive framing of programming suggests that the burden of responsibility for potentially negative consequences of programming might be placed on different actors or things, an issue to which I will turn later.

6.2.1 Programming as a root metaphor

In my corpus, the metaphor of 'programming' appeared for the first time in 1989 in an account of Barker's research. According to the *Advertiser*:

> Whilst cigarette smoking, diet and exercise are important, development in early childhood could be the major controlling factor in determining the risk of death from heart disease. 'We are talking about **the setting of clocks or programming of the body** which happens very early on' [Barker said]. (*The Advertiser* 29/06/1989)

Here the metaphor of programming uses as a source domain the experience of setting the clock or, possibly, using a (computer) programme, which could indicate an affiliation with genetic metaphors of computer programmes.

Interestingly, though Barker contributed to the huge popularity of the programming metaphor, he did not invent it. It is unclear whether it was explicitly borrowed from genetic research, namely from the work of François Jacob and Jacques Monod or of Ernst Mayr who are all credited as the first proponents of the metaphor of the 'genetic program' (Peluffo 2015), or whether it came to be used in foetal programming in some oblique ways. Barker himself drew on the work of Alan Lucas, a renowned childhood nutrition specialist who wrote an important paper on 'programming by early nutrition in man' (Lucas 1991). Some commentators have claimed however that a German endocrinologist Günter Dörner should be credited with the invention of the concept, as he was talking about programming of disease by metabolites and hormones as early as 1974 (Koletzko 2005a, Koletzko 2005b, Plagemann 2005). It is also possible that Barker may have used the concept of programming which had already been in circulation, and especially that had been proposed by a leading British epidemiologist Jerry Morris (Smith 2001).

Regardless of its pedigree, the programming metaphor brings to mind a rather mechanistic and deterministic vision of the human body and the processes of early development. Such a vision – and the metaphor itself - was actively promoted by Barker and other scientists, although in recent years it has been criticised within the field of DOHaD as too deterministic and too indebted to the conceptual tool-kit of genetics (Bateson and Gluckman 2011).

The view of the body conceptualised as a mechanism or a machine could be interpreted as what Pepper (1942) called a root metaphor. A root metaphor or a world hypothesis is a comprehensive theory which serves to interpret the world and construct the meaning of life. In other words, a root metaphor is a kind of lens that defines the ways of seeing and understanding the world. In this vein, the metaphor of the body as a machine proposed by René Descartes and underpinning a large part of his natural philosophy is also a root metaphor - and a successful one as well, as Descartes's ideas have shaped several centuries of Western thought about the mind and the body (Hatfield 2016).

In the context of foetal programming, the world hypothesis which posits that the world obeys mechanistic principles moulds the ways in which we think about how things operate and what is possible in life, thus making it easier to imagine that the human body can be programmed early in life. As we will see, the programming metaphor has turned out to be pivotal for the media coverage of the field of foetal programming and DOHaD, as it profoundly shaped the ways in which the processes of early development have been communicated in the public realm.

6.2.2 Making people like cars

The root metaphor of a body as a machine underpinned the media coverage of foetal programming in which discussions about the ways in which programming operated have generated rather deterministic and mechanistic framings. For example, *The BBC Horizon* film on foetal programming included a comment on some people's body composition and their propensity to diabetes: 'They were thin and fat. (…) From birth, it was as if these people's bodies had **the wrong settings**' (*BBC Horizon* 2011).

The metaphorical expression of 'the wrong settings' – or of an excess of fat and a deficit of muscles - conveys an image of the body that operates like a machine, and whose efficiency is determined early on – or 'from birth. A similar framing appeared in *The New Yorker* which claimed that: '(…) the fetus **sets its metabolic thermostat** during critical periods of gestation' (*The New Yorker* 19/11/2007).

The metabolic system of the foetus is here metaphorically framed as a thermostat, a device that automatically regulates or switches on the heating once the temperature has reached a certain point – or, as in this example – 'during critical periods of gestation'. This metaphor has its roots in cybernetics as dealing with control systems (with the thermostat as a typical example) in both machines and living beings. Interestingly, in this example the foetus is granted the agency to regulate its own metabolism, an agency which was rather absent in other instances of

mechanistic metaphors in the press which tended to focus on various processes affecting the rather passive bodies of babies, children and individuals. For example, an article from *The Weekend Australian* claimed that human bodies can be built like cars:

> 'If you imagine simplistically while some of us are **built like Rolls-Royces, others are like cheap Datsun**. That just might be because of the intra-uterine environment in addition to genes' [Dr Dodic says]. (*The Weekend Australian* 1/07/2000)

Framing the human body as luxury limousines or popular cars seems to put value on human health and also, probably inadvertently, links it to material markers of social and economic status. The issue of the quality of the human body built during early life was a recurring feature of the media coverage. *Times Colonist* reported, for example, that:

> 'Human beings **break down for the same reason cars break down; they're either driven on bad roads or made badly in the first place**,' said David Barker. (*Times Colonist* 3/12/2011)

Here, the extended metaphor of the human body conceptualised as a car implies that disease risk (or 'breaking down of a car') is either a result of a bad lifestyle or harsh conditions ('bad roads'), or alternatively of somewhat deficient processes of development (the body is 'made badly in the first place'). The striking feature of such framings is the vision of the human body as leaving an assembly line with some already in-built properties and risks, such as a strong or weak constitution.

6.2.3 Building bodies, designing foetuses

In the media the metaphor of programming was accompanied by other framings which linked the processes of early development to the images of factories, buildings

and architectural designs. For example: **'**the food that comes through from your mother not only provides **the bricks for the house**, but it also sets the systems of the body [Barker said].' (*Newsweek*, US edition 17/09/2007); or

> if conditions are not perfect at every stage then '**build quality**' is compromised. (…) Once a **build phase** is complete, and **quality** compromised, it cannot be improved after **the child leaves the 'factory.**' (*The Times* 16/08/2011)

Here development is likened to construction works, with the food supplied to the foetus from its mother framed as 'bricks for the house', or components from which its body will be built. In a similar vein the pregnant woman's body is seen here as a 'factory', a metaphor which historically has been used in medical discourse. Such framing not only reduces the pregnant woman to a machine producing babies, and the babies to products, but it also suggests a possibility of controlling women, their fertility and reproduction, just like industrial production is overseen by a factory supervisor (Martin 1987). Strikingly, this type of framing seems to emphasise anxieties about the end product, or the future child whose 'build quality' could be 'compromised' if only the 'conditions are not perfect'.

Other metaphorical expressions implied that it was not only feasible to build strong bodies of individual babies and children, but also of entire societies and nations. According to the media, '[Barker's idea] makes it possible to **build humans** who will live long and healthy lives' (*Daily Record* 22/08/2011), and *BBCRadio 4*'we have to **build a society of strong bodies**' [Professor Thornburg said]' (*BBC Radio 4* 2011), while yet another press article reported on '**Building a healthier Britain'** (*The Observer* 30/10/2005).

Preoccupation with the quality of its current and future citizens has been a longstanding feature of the neoliberal state which often links children's health to the destiny of the nation (Rose 1999). The media coverage of foetal programming clearly drew on these discursive traditions when it emphasized the need for building 'a society of stronger bodies' and 'a healthier Britain'. However, there is a conspicuous

absence of women who do not seem to have a clear role in the reproductive processes. It seems that more resilient societies and nations can be built instead by some abstract forces, such as an ill-defined collective – 'we have to build a society' – or thanks to science – or thanks to ' Barker's idea'.

Alongside the metaphors of buildings, houses and factories, the metaphor of 'design' also appeared in the press. Although it was not used as extensively as other mechanistic or construction metaphors, this one is interesting as it seems to have travelled to the media coverage straight from scientific texts. The idea of 'natural design' is popular among biologists (Bateson and Gluckman 2011), and it has been used in a wide range of scientific writings, including *The Blind Watchmaker* by Richard Dawkins (Dawkins 1986) which advocates a gene-centric vision of evolution. The metaphor also made its way into the realm of foetal programming, where the concept of 'good adult design' while in the womb was promoted – and later abandoned – by a prominent scholar Professor Sir Patrick Bateson (2001). The reason for ditching the 'design' metaphor in studies of early development seems to be that it 'has been contaminated by the growth of a new version of creationism – namely intelligent design' (Bateson and Gluckman 2011: 15-16).

In the press, the design metaphor bore no affiliation to the creationist agenda, although it had teleological undertones suggesting that the human body develops and grows in a certain way for a purpose. For example, an article in *The Times* argued that: 'The worst scenario is if nutrition in the womb was poor, so the foetus emerges **designed for life in a world of scarcit**y, only to find food in abundance.' (*The Times* 20/11/2004)

Here nutrition in the womb directs the ways in which the foetus develops – or is **'**designed for life' – thus making it well- or ill-suited for the future environment. Developmental processes are underpinned by the principles of adaptation: the amount of nutrition available to the foetus in the womb is the indicator of the availability of nutrition in the outside world, a clue to which the foetus adjusts its metabolism. Risk of future disease – or 'the worst scenario' – emerges when the

foetus ‘designed for life in a world of scarcity’ is born to the world where food is aplenty. This kind of framing implies that risk for the foetus is an outcome of broader and somewhat abstract evolutionary mechanisms at play, although the pregnant woman’s role is suggested by a reference to the poor nutrition in the womb. Also, the poor nutrition in the womb does not seem to constitute a risk in itself. Instead, risk seems to emerge from the interactions between the kind of the body that the foetus has developed as a result of a poor nutrition and the kind of environment in which it will later live.

A similar framing inspired by the concept of evolutionary adaptation appeared in a prominent article in *Discover* magazine. In this account the processes of development in the womb - or ‘**interior design’** (*Discover* 01/12/2002) – had the capacity to ultimately shape the core traits of an organism, and to make it well- or ill-equipped for later life. Other media also reported that:

> (…) there are key windows of development between conception and a child’s second birthday. If nutrition is not good enough at any of those stages, **imperfections will be built into** the growing person. (...) these **design flaws** will make someone more prone to illness later in life. (*The Observer* 6/11/ 2011)

Here the metaphor of ‘design flaws’ has rather negative connotations, and it works in tandem with the expression of ‘in-built imperfections’ to emphasise the potentially disadvantageous consequences of undernutrition during the key periods of development. These metaphorical expressions further suggest that the present flaws are the source of future problems as they increase propensity to illness in adulthood. Early life is thus framed as a time to which future illness could potentially be traced back. The design metaphor also implies control, but it is not clear who turns the control knob, so to speak.

As it has been shown, the media reports drew on the root metaphor of the body as a machine to represent and explain the processes of foetal programming. As a result, they have deployed a range of mechanistic metaphors which used as a

source domain the everyday experience of setting clocks or thermostats, driving or making cars, as well as constructing buildings and creating interior designs. These metaphors conveyed an impression that human bodies develop in a mechanistic fashion directed by some rather abstract or impersonal processes driven by the availability of nutrition and derived from the principles of evolution and adaptation. Such framings tended to focus on good or bad outcomes of early life development (or good or frail health) which were couched in an idiom of quality, strength, efficiency and its opposites, such as lack of quality (for example being 'cheap'), flaws or imperfections.

These accounts concentrated on the developmental processes and their outcomes, rather than on the foetus which was usually framed as passive and whose health or constitution was represented in a way reminiscent of a product. At the same time the pregnant woman's contribution tended to be only hinted at (or occasionally framed as a 'factory'), or erased altogether from such discourses, to the advantage of collectives, such as society, nation/state or science itself.

6.2.4 Something old: blueprints and maps

As the previous section has illustrated, the press framed the processes of early development and foetal programming in a range of mechanistic and construction metaphors which, though not entirely novel, are somewhat surprising when used in the context of a developing foetus or a future baby. Even more surprising was this study's finding that the media also resorted to the tried and tested metaphors associated with the genetic paradigm and decried by many natural and social scientists as deterministic. For example, the metaphor of 'blueprint' has managed to sneak into the media coverage:

> The nine months you spent in your mother's womb may well have stacked up a heap of health problems for you decades later. (…) David Barker (…) believes that a **blueprint for life (…) is programmed** into a person's body as they grow in the womb**.** (*Courier Mail* – Queensland, Australia – 25/11/1996)

Here the metaphor of the blueprint, once used to denote the power of genes to shape the lives to come, was deployed to convey the power of the processes of development, or 'the nine months you spent in your mother's womb' to shape the future health – or rather ill-health - of the individual. While in the context of genetic and genomic discourses, the blueprint was metaphorically located in the genes, here the' blueprint for life' is programmed in a more diffuse fashion in the foetus's body. Although the blueprint metaphor occurred only in one text of my sample, its presence is telling as it indicates that the old ways of talking about the human body that arose in the context of genetic and genomic discourses are difficult to shrug off even for foetal programming, the discipline which claims to offer an alternative to the genetic paradigm. The genetic metaphor of the 'blueprint' has proved particularly resilient as it also appeared in the media coverage and various discourses surrounding epigenetics. This emerging science, related to foetal programming also claims to offer a departure from the orthodox gene-centric view of human nature (Stelmach and Nerlich 2015).

Alongside the metaphor of the genetic blueprint, the metaphor of genetic 'maps' which could be read, written or drawn constituted a familiar feature of many genetic and genomic discourses (Nerlich et al. 2002, Zwart 2009) – and it also made its way into the media coverage of foetal programming, thus showing how metaphors travel between scientific and o media discourses. In the press, maps appeared regularly, although in a literal sense, as they were often invoked in descriptions of how foetal programming was 'discovered' by Barker by comparing historical maps of infant and adult mortality in England and Wales. But in other instances maps functioned metaphorically as they denoted imagined maps of future health of individuals that had been drawn in the womb. According to *The Guardian*, '**The diseases we are likely to get may be mapped out** before we have even been born' (*The Guardian* 10/03/1998), while Canadian press wrote that: '(…) what if the **outlines of a person's future health map are drawn** while still in the womb' (*The Globe and Mail* 05/08/2011). Here the metaphor of maps was deployed to speculate

that future health of a person may be influenced early in life, and its use is reminiscent of the ways in which genes were believed to contain an outline of a person's future constitution.

Some other reports focussed more on those who seem to yield the power to write such future health maps. According to *Daily Mail*:

> [experts from Southampton University] said the **health plan mapped out** for a baby in the womb by its mother has a greater effect than healthy living as an adult. The key to wellbeing lies with the mother's healthy eating before conception (*Daily Mail* 03/07/2001).

In a similar vein, a high-profile programme broadcast by *BBC Radio 4* stated that:

> (…) what young women today are doing is **writing the map of Britain** in 100 years' time in terms of illness [Barker said]. **That map may have already been written** for us, but while we can't change the past we can learn from our legacy and **write a better future** for our children and their children and their children's children [journalist Mark Porter said] (*BBC Radio 4* 2011).

In these examples women are responsible for having written the health maps of their babies, and more broadly of the nation state and many generations to come. The first quote implies that women's actions, such as 'the mother's healthy eating before conception', is more important for future health than the person's lifestyle in adulthood, a claim which makes women's role paramount for ensuring the wellbeing of individuals and nations. The second quote implies however that the women's actions can be somehow influenced and the process of drawing future health maps corrected by some unspecified collectives, as 'we can learn from our legacy and write a better future for our children'. It is also noteworthy that maps seem to refer not only to a certain space but also time (such as 'Britain in 100 years' time'), and

they seem to represent a continuity of risk of future adult diseases which stem from events located in the past.

As this discussion has shown, the old genetic metaphors of 'blueprints' and 'maps' have been creatively adapted to the media coverage of foetal programming research, where they have been related to wombs or even to concrete and real epidemiological maps that famously inspired the Barker hypothesis. But there remains the question of why communication about the field which claims to break away from the genetic paradigm clings to genetic metaphors.

This could be indicative of a linguistic and metaphorical conservatism of the ways in which scientists and journalists alike communicate about science. As Hellsten and Nerlich have argued, 'metaphors have cognitive and emotive staying power, and do not shift easily in parallel with scientific and technological development once they have proven their value in science communication' (Hellsten and Nerlich 2008: 100). Metaphors with a long history are particularly difficult to change, as it was the case of the genetic metaphor of 'the book of life' rooted back in antiquity and in the Judaeo-Christian tradition. As a result, scientific advances such as the transition from genetics to genomics did not bring about a flurry of new metaphors, but rather resulted in the extension of the old genetic metaphors, such as 'the book of life' to cover new situations. This has helped both scientists and the public to cope with various genetic and genomic revolutions which have occurred throughout the 20th century (Hellsten and Nerlich 2008, Nerlich and Hellsten 2004). In this sense, metaphors, especially those used to communicate scientific advances, rather than those used to bring them about (so-called constitutive metaphors, Boyd, 1993), may well fall behind scientific and technological developments. The occurrence of the 'blueprint' and 'map' metaphors in my sample can be interpreted in this vein. It might also indicate that in some ways the meanings these metaphors carry in the context of genetics/genomic and in the texts on foetal programming are not that different. Whether future health and various traits of an individual are written in the genes or, alternatively, set in the womb seem to have the same deterministic flair.

6.2.5 Something new: metaphors of religion and morality

Developmental origins and risks of health and disease were also communicated with the help of metaphors inspired by religion. For example, over the years the metaphors of roots and seeds appeared regularly in the press coverage: '(…) **the seeds of health** are planted even before you draw your first breath' (*Newsweek* 27/09/1999); and:

> (…) a fresh understanding of **the roots of our health** is beginning to emerge. (…) it now seems that the way our forebears lived - what they ate and how healthy they were - can reverberate down the generations. (*The Times* 20/11/2004);
>
> **The seeds of diabetes** may also be sown before birth. … Professor Barker said many of these early effects are **'set in stone'** and cannot be undone. He added that the key to health is ensuring women eat well throughout their lives. (*Daily Mail* 17/08/2011);

and:

> (…) adult illnesses like heart disease, stroke, cancer and diabetes can have **roots** in the mysterious months we spend in the womb. (*Times Colonist* 03/12/2011)

Framing adult health and illness as a plant or a tree with its roots or seeds reaching back to the womb might bring to mind visions of nature. However, it should not be forgotten that such metaphorical framing has its own 'roots' in the Bible, in particular in the Epistle to the Galatians which claims: 'Do not be deceived: God is not mocked, for whatever one sows, that will he also reap' (Galatians 6:7-8 ESV / 485). This biblical quote implies that everyone will bear the consequences of their own actions, and the moral concepts of responsibility and justice are here represented metaphorically as the act of sowing and reaping.

According to Lakoff (1995) and Johnson (1993, 2009) framing moral issues in metaphorical terms is ubiquitous, and much of Western moral traditions can be understood through the means of 'systematic conceptual metaphors' (Johnson 2009: 149). Lakoff (1995) suggests that the metaphor of 'moral accounting' is especially pervasive and it operates according to a small number of basic moral schemes, such as Reciprocation, Retribution, Restitution, Revenge and Altruism[14]. The scheme of Reciprocation is here of interest as it is realised in the following two principles:

> **The first principle**: Moral action is giving something of a positive value; immoral action is giving something of negative value. **The second principle**: There is a moral imperative to pay one's moral debts; the failure to pay one's moral debts is immoral. (Lakoff 1995: 2, bold in the original)

When the principles of the moral accounting metaphor are applied to the context of foetal programming in the media, it becomes clear that the moral implications conveyed by the metaphors of seeds and roots look quite problematic. Not only individuals – or foetuses in the womb - are supposed to pay someone else's moral debts, or to bear the consequences of someone else's actions and behaviours (for example of their mother and various ancestors or 'forbears'), thus breaching the second principle of Reciprocation. In addition, through the actions beyond their control ('before birth' or 'before you draw your first breath') they could become recipients of ill-health in the future, which contravenes the first principle of reciprocity rule stating that gifts are moral only if they have a positive value. Thus, the metaphors of the 'seeds of diabetes' and the 'roots of heart disease, stroke and cancer' clearly imply a moral failing on the part of the mother to confer good health to her future offspring.

Of course, the whole situation ceases to look morally reprehensible if we assume that the individual will enjoy good health in adulthood purportedly stemming

[14] The idea that the law given by God and morality in general can be seen from the perspective of exchange rationality and expressed through metaphors of economic calculation is further exemplified in Holm (2017)

from successful development in the womb – like in the examples of 'the seeds of health' and 'the roots of our health'. In that case, the rules of Altruism start to apply according to which a person builds up moral 'credit' by cancelling the other person's debt (Lakoff 1995: 3). In the context of foetal programming, mothers and ancestors who through their actions ('which reverberate down the generations') bring about health of future adults without asking for anything in return could be interpreted through such altruistic lens.

These were not the only religion-inspired metaphors in my sample. As we have seen in a previous example, the metaphor of 'the seeds of diabetes' was accompanied in the text by the metaphorical framing of early effects which were 'set in stone'. Here again, its origins could be traced to the biblical book of Exodus where God gave Moses stone tablets with Ten Commandments engraved on them. That the effects of foetal programming could be 'set in stone' thus implies a law-like rule that poor development will inevitably lead to adult disease. The effects of foetal programming or 'early effects' are then framed as certain, fixed, immutable and which 'cannot be undone' – a moral framing which places even greater responsibility on women advised here to 'eat well throughout their lives'.

6.2.6 Determinism, fate and medical salvation

Overall, religious framing as well as metaphors inspired by fate and the supernatural featured quite prominently in the media coverage. As one writer noted:

> [The thesis of programming] suggests a form of **medical predestinationism**. Some have their **cards marked at birth for an early grave** and others, like **Calvin's elect**, are **destined for longevity** (*The Herald* 24/12/1993).

The implications of foetal programming are here metaphorically framed as a medical form of 'predestinationism', a belief in a religious doctrine by St. Augustine and Calvin, according to which 'God has ordained all that will happen, especially

with regard to salvation of some and not others' (Oxford Dictionary Online). In this light, the consequences of foetal programming are akin to medical salvation, as some are programmed for health – or 'destined for longevity' – or, alternatively foetal programming is akin to medical damnation, as other people will fall fatally ill – or 'have their cards marked at birth for an early grave'. Interestingly, though according to predestinationism people's destiny is controlled by God, the quote above does not specify who is in charge of the processes of foetal programming - or who marks 'the cards for an early grave'.

Similar framings which drew on the ideas of salvation, damnation or reward for virtuous life also appeared in the press. Not only journalists drew on such metaphors. Barker was also quoted as saying:

> One of the most threatening things about fetal programming (…) is that it means that **God may reward you less than you think** for changing your lifestyle (*Discover* 01/12/2002).

Similar ideas about determinism and lack of control over the events that unfolded in the womb were conveyed by a range of metaphors which often drew on the concept of destiny or fate. Such framings constituted a recurring feature of the media coverage of foetal programming for over two decades. For example, back in 1992 *The Times* suggested that '**our fate is fixed** by what our mothers ate before we were born' (*The Times* 06/06/1992), thus pointing the finger of blame at pregnant women and their diets. In the media, programming or events occurring in early life had the power to decide about disease and even death of the future child. An extreme example of this kind involved a report in *Herald* Sun about '**children destined for suicide'** as a result of poor growth during the first year of their life and ensuing propensity to depression (*Herald Sun* 04/11/1995). Other media outlets argued, after Barker, that '**the fate of the foetus** was influenced by the stores of nutrients in the mother's body' and that 'rates of heart disease could be cut dramatically if pregnant women improved their diet and physical condition' (*Evening News* 02/07/2001). In general, the media tended to emphasise a universal fate-like nature of programming

which affected everyone and seemed impossible to control. As journalist and medic Dr Mark Porter argued*BBC*:

> Imagine this: the chances of you developing conditions like diabetes and cancer or succumbing to an early heart attack have been determined by events that have already happened. Events that occurred in the very earliest part of your life, events that you cannot undo. **The die has been cast**. (…) Man or woman, mother or father**, no one is off the hook**. (*BBC Radio 4* 2011).

In this example there does not seem to be any person directly responsible for the effects of programming, while in other instances quoted above the media have framed programming as fate brought about by pregnant women.

6.2.7 The sins of the mothers (and grandmothers)

While some of the metaphors of foetal programming deployed in the press only alluded to the role of pregnant women, others centred squarely on their ability to shape future wellbeing of their children – and on risks that this entailed. One of the most striking framings emphasised the kind and the quantity of food consumed by women at various points in time: in their own childhood, around conception, during pregnancy or throughout their lives. According to an article published back in 1992 '…the origins of adult disease could well lie in foetal and early life. **You are now what you ate then'** (*The Guardian Weekly* 29/03/1992). In this account, the ability of the pregnant woman to pass on nutrients to her baby is seen as a factor shaping not only propensity to adult disease but also this individual's identity.

A similar framing appeared over the years in various media worldwide, for example both Australian and British press reported that '**You are what you mother ate'** (*The Times* 04/11/1996; *The Sun Herald* 14/03/1999), while *The Observer* stated that '**We are what our mums ate**' (*The Observer* 06/11/2011). The assumptions underpinning these framings were explained in the press in the following fashion:

> To carry the ideally healthy baby… the woman needs to have been well nourished from childhood, and perhaps from the time when she was in the womb. In other words, pregnant women are responsible for the health of their own children, and, ultimately, for that of their grandchildren. (*The Times* 16/08/1990)

Here, nutrition and health of the pregnant woman is seen as determining health not only of her children but also her grandchildren – an idea that over the years gained prominence in the media, especially with the advent of epigenetics. This new and promissory field argues for transgenerational transmission of propensity to illness: not only mothers but now also fathers, grandparents, and other ancestors could have an impact on health of their children and grandchildren. This idea expressed in the Bible-inspired metaphor of the 'sins of the fathers', proved popular in the media reports of epigenetics (Stelmach and Nerlich 2015), but in the coverage of foetal programming it had a limited tracking. In the press, the role of men was rarely discussed with a few notable exceptions. For example, the Australian *Advertiser* published a report on a pioneering study which claimed, using word-play around the word 'weigh', that:

> Fat dads **weigh on kids' health**. Men who want to father healthy children should lose weight and exercise before trying to have children. … 'We know that male obesity has an adverse impact on sperm health and fertility, but this is the first time we have shown that the weight and metabolic state of the male impacts embryo and foetal health,' Dr Lane said. (*Advertiser* 11/04/2014)

In this account, obesity in men could be detrimental for their offspring's wellbeing – or it could 'weigh on kids' health' – as it affects the quality of sperm and subsequently development of the foetus. Significantly, in this article men's weight, fitness and lifestyle prior to conceiving a child was subjected to a similar scrutiny as those of women and considered as a source of potential health risk.

Instead of emphasising more the role of fathers and male ancestors the media continued to single out women, shifting the focus slightly from mothers to grandmothers. For example, a prominent article which outlined recent research on intergenerational effects and the role of parents and grandparents in transmitting propensity to illness had a title '**Just blame it on Granny**' (*The Times* 20/11/2004). Another article claimed that: '**You are what your grandmother ate'** (*Yukon News* 06/12/2003, while *The Times* suggested that 'there seems to be some kind of cellular **memory of what our grandmothers ate'**, which represented a 'tale of how **one generation's 'sins' can haunt the next**' (*The Times* 30/04/2007). Here, the memory of the food consumed by grandmothers is metaphorically represented as sins or ghosts that can haunt the next generation thus damaging the prospects for a healthy life. The metaphors of ghosts and haunting have been prominent in the coverage of the field of epigenetics which as we will see in the next section has also started to influence media reports on foetal programming/DOHaD.

6.2.8 Epigenetics and the contest of metaphors

As it has been shown, the programming metaphor proved be productive as over the years it appeared in a wide range of media and carried varied context-dependent meanings. However, in recent years it had to stand the challenge of new and competing metaphors which have emerged with the advent of epigenetics (Pickersgill et al. 2013). These are the metaphorical expressions of 'switches' which 'turn' the genes 'on' or 'off', as well as 'marks', 'tags' or 'labels' attached to the genome (Stelmach and Nerlich 2015). In the newspapers examined for this thesis, from late 2000s onwards metaphors referring to epigenetic processes have also started to be used to represent developmental processes and early life. This trend seems to reflect an increasing coupling of some strands of research into foetal programming and epigenetics (Bianco-Miotto et al. 2017), which might look surprising given that epigenetic research, while interested in some aspects of developmental processes, brings the focus back on genes. This could be seen as

unwelcome development by some foetal programming scholars who, at least discursively, sought to break away from the genetic paradigm (see Chapter 4). Commenting on such developments *The New Yorker* noted that:

> Given Barker's frequent caustic references to 'modern-day hereditarians,' perhaps the most ironic turn in the story of the Barker hypothesis is its convergence with a new field of biology known as epigenetics. (*The New Yorker* 19/11/2007)

In some instances, the press used the metaphors associated with programming as well as those associated with epigenetics (such as 'switches' or 'ghost messages') at the same time. For example:

> **the unborn child is programmed** in a process known as epigenetics, which involves **'ghost' messages** passed from one generation to the next (*The West Australian* 03/11/2007).

Here the programming metaphor is accompanied by the one of 'ghost messages' which refers to intergenerational transmission of propensity to illness, a concept which became salient in some strands of epigenetic research. However, in some recent articles on foetal programming/DOHaD, which also drew on epigenetic concepts and imagery, the programming metaphor was no longer guiding the understanding of early life events. In one article discussing the foetal origins hypothesis it was even replaced by the metaphorical expressions of epigenetic switches:

> The 'foetal origins' hypothesis suggests that the environment we experienced (…) determines health in later life. The way that this works is not fully understood but seems likely to involve **genes getting switched on and off *in utero*.** (*Aberdeen Press and Journal* 21/02/2015)

A potential waning of the programming metaphor was further exemplified in the high-profile *BBC Horizon* TV show 'The Nine Months that Made You' (2011) which did not mention the concept of programming even once, focussing instead on other framings, including epigenetic switches. In a press article which accompanied this broadcast Barker claimed that: 'If crucial **genes are not switched on** during foetal development… that can permanently change the structure and function of an unborn baby' (*BBC News* 22/08/2011). This statement constitutes a reformulation of the definition of programming proposed by Barker himself (see Chapter 1): while in the earlier days of the field it was programming that was thought to change the body's structure and functions, it is now epigenetic switches turned on and off in the womb which decide about the individual's constitution. Such a change of framing might indicate that the mechanistic metaphor of programming has started to lose appeal and is being replaced by an equally mechanistic framing of switches.

As these examples show, there is a contest between the epigenetic and foetal programming metaphors, which might be indicative of a struggle for autonomy or leadership in the field. Morabia (2011) has argued that, historically, laboratory sciences would take the place of epidemiology as leaders in a given field if they were able to contribute to causal knowledge of a phenomenon. The contest of metaphors may thus reflect the competition of concepts and ideas between the established research into foetal programming and the new lab-based science of epigenetics.

isation

One consequence of such contest is that it may diffuse the responsibility for negative effects of programming. As epigenetic research suggests transgenerational transmission of propensity to disease, it is now possible to blame not only the mother, but also the grandmother, the father and various ancestors for adult ill-health (Stelmach and Nerlich 2015). It seems however that the media have continued to single out women as the main 'vector' (Richardson 2015) of future disease risk. Another consequence of the contest of metaphors is that it makes it unclear what the

programming metaphor might mean when it is deployed alongside the epigenetic metaphors, not least that the field of epigenetics has developed its own, specific and more molecular-focused understandings of the term 'programming' and 'reprogramming' (Cantone and Fisher 2013). It remains to be seen whether epigenetic and foetal programming metaphors will continue to co-exist in the media coverage, and what new meanings might emerge from this co-existence.

6.2.9 The programming metaphor and discourses of blame

This analysis has shown how the media used, paraphrased and explained the metaphor of programming in the coverage of the foetal programming framework. Drawing on Maasen and Weingart (2013), this section examines how the programming metaphor interacted with texts, and it explores discourses of responsibility and blame which emerged from these interactions.

Overall, there was a tendency in the media to couch the issues surrounding programming in a deterministic and moralistic language which usually targeted women. There was a contradiction in the coverage which framed women r as rather passive environments for the developing foetus. Alternatively, the media referred to women's actions, diets or lifestyle, either chosen by women themselves or imposed on them by social and cultural norms, as a source of potential health risk for their children. Both journalists and scientists speaking to media contributed to such contradictory representations of women. Barker himself made striking appearances in the media talking about pregnant women's role in ensuring future health of their children. He was quoted as saying:

> 'I'm not being prescriptive about what women should eat. (…) I know people can say 'Oh it's easy to eat well when you're middle class and have lots of money. (…) But I'm very sympathetic to them. They don't have a chance because they don't know. No one has told them that a good diet is not expensive and not difficult. Now we either have to teach that in

> school or we have to get it back into our culture.' (*The Guardian* 20/05/2003)

Here the assumption is that people – and pregnant women – do not eat properly mainly because of their ignorance, and not because of lack of money. In recent years Barker was also quoted as saying that: 'A woman is merely the arena for miracles over which she has no control' (*The New Yorker* 19/11/2007), a statement which emphasises a passive role of women in the processes of reproduction - here referred to as 'miracles'..

There was some evidence in the media coverage that not all foetal programming scientists supported this sort of language and framing used in the public realm. For example, *The New Yorker* suggested that many of the sweeping statements made in public by Barker provoked hot debates in 'closed-door meetings' of the foetal programming community (*The New Yorker* 19/11/2007). On a few occasions, some scientists also intervened in the debate questioning the claims of foetal programming, its public communication, or both (scientists' views on these issues are explored further in Chapter 7). For example, Dr Lesley Campbell, an Australian specialist in obesity and diabetes, was quoted as saying:

> 'It gets my back up - it's the whole blame your mother thing, which I am sick of. We've been bashing them for centuries. Mothers are continually given flak for all sorts of things but I want to see better evidence.' The major causes of disease, like genes and other environmental factors, still play a major part. 'You either live or you don't because of your genes and people who are fat survive better. It's not necessarily that the mother has damaged the foetus in some way.' (*The Sun Herald* 14/03/1999)

Similarly, Dr Rachel Huxley who had published critical reviews of foetal programming research cautioned that:

> ‘We shouldn't really blame our mothers for what they eat during pregnancy. It doesn't have any material impact on our later risk of developing disease ... and size [at birth] doesn't matter’ she said. (*The Daily Telegraph* Sydney Australia 08/12/2004)

In both quotes these female scientists argued that the focus on pregnant women’s diet and responsibility for future disease of their children was exaggerated and that the impact of genes and various environmental factors was more important for future health than development in the womb. Still such interventions on the part of scientists constituted exceptions in press reports, and journalists themselves tended not to scrutinise or challenge the claims of this field either. Only occasionally did discussions around the responsibility of women for programming ill-health of their children provoke some angry reactions, typically from female writers. Most recently, bitter comments in the press have been sparked by the *BBC*2 *Horizon* TV episode *The Nine Months That Made You* (2011) which focussed on Barker and his hypothesis. As one TV reviewer remarked:

> Mothers have always agonised about the implications that their actions, health and diet have on their unborn children. But, now, a crowd of scientists have decided that it's not just the mammies that are to blame if a child has less than perfect health, but it's the grannies as well -- and probably all woman kind back to Eve. (…) Not a mention of the contribution of a father's lifetime nutrition to the heath of his child. Once again it seems it's the woman's fault if things go wrong. Ah, but sure we knew that anyway. (*Sunday Independent*- Ireland- 28/08/2011)

It should be noted that articles challenging the language of blaming women constituted an exception in the media coverage of foetal programming. On the other hand, over the years the burden of responsibility placed on mothers, grandmothers and wombs seems to have become heavier, as the list of ailments caused by programming has become longer. While back in 1988 programming was believed to lead to heart disease in adult life (*The Sun Herald* 29/05/1988), in 2010 it was

believed to be ‘affecting everything from our appetite and metabolism to our susceptibility to disease to our intelligence and temperament’ (*The Washington Post* 14/11/2010). Similarly, as an article in *Vogue* has claimed that:

> (…) what a pregnant woman eats can influence how prone her child will be to obesity, diabetes, heart disease, allergies, and asthma. Her moods may affect how likely her child will be to suffer from depression and anxiety. The air she breathes and the chemicals she encounters can shape facets of anatomy as intimate as the position of the urethral opening on her son's penis. (*Vogue* 06/2012)

As the above quotes from two prestigious media outlets – *The Washington Post* and *Vogue* – illustrate, the press closely followed developments in the field of foetal programming/DOHaD, which over the years identified new risks for a greater number of illnesses (as discussed in Chapter 1).

Also, over the years the risk associated with development in the womb seems to have become more widespread. Back in 1989 the media claimed that ‘Lighter babies face 'greater heart risks later' (*The Advertiser* 29/06//1989), and they tended to see signs of good health in larger infants. For example, in 1993 *Daily Mail* claimed that ‘Big, bouncing babies could have in-built protection against heart disease in middle age’ (*Daily Mail* 10/12/1993). However, from around the turn of the 21st century, which saw an increase in the number of big babies being born in Britain, the coverage has been marked by a rising anxiety surrounding health prospects of ‘this new generation of heavyweights’ (*The Independent* 10/11/1998). This change in reporting reflects changes in research carried out in the field of DOHaD, which at that time became interested in investigating nutritional imbalances and the impact of high birthweight on future health (see Chapter 1). For example, in 2011 *The Observer* claimed that ‘Big babies aren't immune either. Those over 9.5lb are more at risk of diabetes and obesity later in life’ (*The Observer* 06/11/2011). Rather confusingly for those who remembered headlines from early 1990s about the risk of being born small and light, big babies are now seen as more at risk of developing

diabetes or cancers later in life, as well as of becoming fat – which in the media was framed as a sign of bad health and a new equivalent of parents' moral failings. As one commentator wondered:

> Parents, do you worry about your children turning out bad? Falling into the 'underclass'? Becoming a misfit in society? Once upon a time, middle-class parents dreaded their offspring getting into drugs, having babies on benefit, doing time in jail or even dropping out of society altogether, but they now have a new worry. A survey has discovered the new underclass - the fat. [Barker] claims girth may be shaped by the mother's diet in early pregnancy (…). So it will turn out to be your fault after all. (*The Independent* 20/06/1997)

At the same time ideas of targeting girls and women with advice or interventions to prevent their future babies from growing too small or too big have become the staple of media texts on foetal programming, the point to which I will be returning later in this chapter.

6.3 The metaphor of 'critical periods/windows'

Another key metaphor identified in the media corpus was the one of 'critical periods' or 'critical windows'. This metaphor was deployed in various media outlets across the world, but in the Western context it often appeared alongside the 'programming' metaphor. In a sense, the term 'critical period/window', which is part of foetal programming's definition (see Introuction) is a companion metaphor of sorts, as it was often used in the media to explain what foetal programming is or what it does:

> Professor Barker's theory [of foetal programming] is that there are certain **critical periods** during gestation and the first year of life when the organs and the vascular system are formed. (*The Times* 28/05/1992)

This use of the 'critical periods' in the media follows quite closely its use in scientific texts, where Barker himself stated that: 'the essence of programming – a **critical period** when the system is plastic and sensitive to environment' (Barker 1998: 115).

Historically, the term 'critical/sensitive period has been widely used in natural and social sciences (cf. Bateson 1979, Prentice and Moore 2005). Back in 1921 Stockard who claimed that:

> the prenatal period is probably the most important in determining all later constitutional conditions since at this time the actual gross body form and structure is being laid down and any environmental peculiarity may exert a marked influence on the course of development. (Stockard 1921, quoted in Kuh and Smith 2004: 5)

These ideas have been elaborated by Bateson (1979) who coined the metaphor of the 'critical window'. He likened the process of development to a train travelling one way in an unknown direction, with some of its windows open or shut at different points of the journey. This proved to be a popular scientific metaphor, and in my sample the press has tended to use the metaphor of 'critical periods', 'critical windows', 'critical moments' or 'critical stages' to denote specific points in time when programming of health and disease may be operating. For example: 'There are, said Professor Barker, **critical windows of time** during which maturation must be achieved: failure of maturation is to some extent irrevocable' (*The Guardian Weekly* 29/03/1992); Or:

> [Professor Barker and colleagues] believe there are a series of **critical stages** in a child's development. If conditions are not perfect at each step, problems can occur later. (*Daily Mail* 17/08/2011)

As these examples demonstrate, the 'critical period/window' metaphor denotes a point in time in which some fundamental developmental processes have to

occur. If that does not happen, the consequences could be serious: according to the press ‘failure of maturation is to some extent irrevocable’ or ‘problems can occur later’. This kind of framing points to causes and consequences of perturbations in development, but it does not seem to indicate, at least directly, any remedy or action to address potential problems. It seems however that over the years the metaphor of ‘critical periods/windows’ started to change and acquire new shades of meanings (Maasen and Weingart 2013). Consider the following examples:

> [Barker] suggests that there are **critical moments** in the development of the foetus and the infant when the organs are being formed, **windows of opportunity** which, once missed, cannot be recaptured. (*The Times* 06/06/1992);
>
> The next **critical phase** runs up to the age of 2, meaning there is still **plenty of opportunity** to shape a child’s future. (*BBC Radio 4* 2011);
>
> **The critical window of opportunity** for the child is the first 1000 days of his or her life. (*Ghana News Agency* 20/12/2013);
>
> Australian mums are missing a **golden opportunity** to provide youngsters with the nutritional foundations for a healthy adult life (…) despite growing evidence that the first 1000 days of a child's life provide **a critical window of opportunity** to influence long-term health outcomes. (*The Morning Bulletin* Queensland 08/07/2014)

As these examples demonstrate, over a couple of decades of media coverage the metaphor of ‘critical periods/windows’ has gradually changed its structure and acquired new meanings by interacting and finally merging with another framing, namely the metaphor of ‘the window of opportunity’. The concept of ‘the window of opportunity’ was developed by Kingdon (1984) in policy studies. As Baumgartner explains, a window of opportunity in itself ‘does not necessarily create a change; it

may be a necessary condition for a major push in a new direction' (Baumgartner 2013: 253), or for a policy or an intervention to occur.

The new metaphor of 'the critical window of opportunity' which emerged in the media coverage seems to have brought with it such policy-oriented undertones which shift the attention from processes of development themselves to the ways in which these processes could potentially be acted upon, managed or influenced. In this vein, and according to the media quotes above, the 'critical phase' provides 'plenty of opportunity to shape a child's future', and 'a critical window of opportunity' allows 'to influence long-term health outcomes'. In addition, the opportunity arising during developmental processes is framed as 'golden', which indicates substantial benefits related to management of these processes, benefits that should not be 'missed'. Overall, in the media coverage the metaphor of 'the critical windows of opportunity' pointed to the need of some sorts of interventions targeting reproductive and developmental processes, and the appearance of this metaphor in the media may have reflected the growing interest within the DOHaD community in in policy implications of their research.

6.3.1 'Critical windows', opportunity and discourses of intervention

In media reports the metaphor of 'critical windows' interacted with discourses which focussed on possibilities of improving health of future individuals and populations. In Barker's words, 'What we are seeing is a **window of opportunity** where we can make better people [Barker said]' (*Daily Mail* 17/08/2011). According to the media, as well as to scientists and various commentators speaking in the media, such interventions could target pregnant women, as well as women and girls of reproductive age in general. As Barker stated:

> Prevention of chronic disease, allowing more of us to be healthier for longer, depends largely on the improvement in the nutrition of girls and young women. Many babies in the womb in Britain and around the world

> today are receiving unbalanced and inadequate diets. (…) **Chronic diseases are not the inevitable lot** of humankind. (…) We could readily prevent them, had we the will to do so. (*BBC News* 22/08/2011)

In contrast to other media quotes which framed development in the womb and programming as a sort of fate, this one argues that it is possible to escape destiny or the 'inevitable lot of humankind' by improving nutrition of babies in the wombs. Such interventions are framed as beneficial for society at large as they would allow 'more of us to be healthier for longer', but this quote does not specify any benefits for the women who could become subject of theses interventions. Women's role and citizenship is conceptualised not in terms of their political rights but rather on the basis of their reproductive capacities, i.e. giving birth and raising healthy children. This kind of reproductive citizenship (Lupton 2012) tends to elide women's needs and to focus instead on 'contributing to the welfare of society through private actions' (Petersen and Lupton 1996: 73).

Pregnancy and women's reproductive capacities were often represented as a 'critical window' or means to achieve collective goals through health interventions. Such interventions were usually tied to an economic argument, for example:

> 'Pregnancy therefore offers a **singular opportunity** to improve lives for decades to come, via interventions that cost little compared with the enormous price tags for obesity, diabetes, low birth weight and premature delivery. So why isn't **this critical window** one of our top health-care priorities? (*The Washington Post* 14/11/ 2010)

Turney (2009) noted that metaphors have important ethical implications and suggested that attention should be paid to metaphors pertaining to biology and related disciplines, like immunology or genetics, as they might have immediate consequences in the social world. In my corpus, the metaphors of 'the critical period/window' and 'the critical windows of opportunity' carried important ethical implications as they activated discourses of interventions and responsibility directed particularly at pregnant women. Future mothers and their reproductive capabilities

were represented as a resource which could not only be put to the service of the collective but also be monetised and contribute to savings in health-care. The emergence of this type of economic argument in discourses of intervention might also reflect the increasing interest in the DOHaD's framework on the part of health economists (Almond and Currie 2011) as well as the growing interest in potential policy implications of this research (see also Chapter 1).

6.4 'The first 1,000 days of life'

The last metaphor which is the focus of this chapter is the emerging numerical metaphor of 'the first 1,000 days of life'. This framing is a recent one: in my media sample it started to be used from 2011 and it appeared in various media outlets in the Global South as well as in the West. Its meaning was explained in the press in the following fashion:

> …the first 1,000 days of life, from conception to the first 24 months of a child's life … is when most of the damage to cognitive ability and growth occurs and much of that damage is irreversible (*Daily Balochistan Express* 05/02/2012)

The number 1000 is an outcome of the following calculation:

270 days of pregnancy + 365 days of Year 1 + 365 days of Year 2 = first 1000 days

I suggest that 'the first 1,000 days of life' is a numerical metaphor. Numbers are cultural artefacts and isationrather than providing an objective view of reality numbers seek to represent it in a metaphorical fashion (Morgan 1988). Like metaphors, numbers are partial representations, as they highlight some aspects of reality but ignore some others. According to Morgan:

> Just as we might attempt to rate the quality of last night's dinner on a scale of 1-10, and in giving it 'a 9' capture that it was indeed a very good meal, the accountant's numerical form of representation provides a very 'thin' and limited characterisation. It leaves much of the quality and over-

> all experience of the meal out of account. The metaphor 'it was a 9' remains silent on so many things. (Morgan 1988: 480)

As we will see, in the media the numerical metaphor of 'the first 1,000 days of life' was also used in the ways that foregrounded or backgrounded various issues related to health risk and opportunities. And like other metaphors, 'the first 1,000 days of life' not only had a communicative function, but it also played a performative and political role (Bono 2001) and was used as a call for action (Nerlich et al. 2009) for health interventions.

Another way of interpreting 'the first 1,000 days of life' is to see it as a metonymy of the metaphor of 'the critical window'. In the media texts, both framings often appeared simultaneously and in relation to each other, for example '**the critical window of opportunity** for the child is **the first 1000 days** of his or her life.' (*Ghana News Agency* 20/12/2013).

The metaphor of 'the first 1,000 days of life' was inspired by research by Barker who in 2007 co-edited a volume 'The Window of Opportunity: Pre-Pregnancy to 24 Months of Age' (Barker et al. 2007). It is unclear whether it was coined in scientific or policy circles, but it emerged after the UN Standing Committee on Nutrition published a new definition of the window of opportunity in early life, from conception to the second birthday (Barker 2007b). Other commentators (Pentecost 2016) have dated 'the birth' of the metaphor in 2008, when *Lancet* published an influential series of papers which recommended to focus health policies on the period of the first 1,000 days to alleviate the burden of disease in future.

Since then the metaphor of 'the first 1,000 days of life' has been used by various organisations, such as the UN Scaling Up Nutrition programme, the U.S. Agency for International Development, World Bank, Unicef, the UK-based National Childbirth Trust, or 1,000 Days, an American NGO dedicated to improving nutrition of women and children. In the policy realm, the term '1000 days' is largely associated with a global campaign, or 'a transnational project orchestrated by a

diverse set of actors within the 'global health' framework' (Pentecost 2016). It has also been taken up by food producers such as Danone or Sma (the manufacturer of formula milk).

In my corpus, this metaphor was used in the media from the Global South, such as Yemen, Ghana or Bangladesh, as well as in the press from New Zealand and Australia. It featured prominently in the *BBC Radio 4* programme *The First Thousand Days: A Legacy for Life* (2011), which subsequently prompted a short spike in the press coverage, predominantly in the UK (see also Figure 6). It is noteworthy that while 'the thousand days' metaphor seemed to prevail in the Global South, the 'programming' metaphor occurred very rarely in the press of the developing countries. This geographic specialism suggests that communication about the foetal programming framework has been tailored in the press for specific publics and contexts.

The first 1,000 days of life metaphor was frequently deployed alongside the one of 'critical periods/windows (of opportunity)', but it carried different connotations. While 'the critical period/window' denoted specific points in time in early development when future health and disease was being decided, the metaphor of the 'first 1,000 days of life' seemed to expand the concept of such a 'window', which now encompasses *the whole period of early development*, from conception to the second birthday. Bearing in mind Bateson's metaphor of 'critical windows' inspired by trains, we can also think about 'the first 1,000 days' metaphor as a kind of panoramic window of opportunity that one can also find on modern trains[15].

In the media, 'the first 1,000 days of life' metaphor was deployed to highlight both health opportunities and disease risks, for example:

> Stunting happens early in life. **The first 1000 days of life are the window of opportunity** to reduce cases of stunting. (*Health Daily Digest India* 06/11/2012)

[15] Many thanks to Brigitte Nerlich for this suggestion.

Here the period of the first 1,000 days is framed as chance to improve health in future – the metaphor has real performative force and action implications. Alternatively, 'the first 1,000 days' metaphor was used in the press to highlight potential risks related to early development. According to a media article 'the first 1,000 days of life' is a period 'when most of the damage to cognitive ability and growth occurs' (*Daily Balochistan Express* 05/02/2012). This type of framing seems to exacerbate the perception of risk, as the critical period during which damage can occur has been extended. On the other, it also seems to make the task of reducing risk easier to manage as the uninterrupted period of thousand days from conception to second birthday offers a continuous and stable stretch of time during which interventions may be implemented.

6.4.1 The first 1,000 days and discourses in the West

In Western media 'the first 1,000 days' metaphor was usually used to emphasise the impact of early life on future health and disease. For example, Professor Kent Thornburg, a leading foetal programming scholar explained that:

> **The first 1,000 days** are the most critical and during **those thousand days** the health of an individual is set for life. (*BBC Radio 4* 2011)

Similarly, *Daily Mail* claimed that:

> (…) **the first 1,000 days of a child's life** (the nine months in the womb and the first two years out of it) are vital to their long-term health. That period can permanently affect everything from a child's chances of developing diabetes or having a heart attack in old age, to their future weight and life expectancy. (*Daily Mail* 17/11/2011)

As we can see, this metaphor frames the life-long consequences of early development in a deterministic fashion and similar to the programming metaphor. However, it seems that in the Western press 'the first 1,000 days' metaphor also

prompted more positive discourses which highlighted not only health-related but also various other opportunities. ‘The first 1,000 days’ was a key period ‘to secure the offspring’s future’, ‘a long and happy life’ (*The Times* 16/08/2011), and even to ensure ‘your child's chance at success’ (*Irish Independent* 21/09/2011).

Discussions about the importance of ‘the first 1,000 days’ often centred on what individual mothers or parents should or should not do to ensure better health for their children. One example involved Lanai Scarr, an Australian journalist who vowed not to give her daughter sugary or salty food ‘for the first 1000 days’ and learned how to cook. As Scarr explained:

> Scientists now know that the food choices parents make for their kids for **the first 1000 days** can have a significant impact on their future development. Those precious **days from conception through to three-years, and particularly before a child’s fourth birthday** are **critical** when it comes to establishing healthy eating habits through to adulthood. (…) Both my husband and I wanted to make sure we were doing all we could to set up Molly in the best way possible for her future. (…) you'd actually be surprised with just how tasty things are without added sugar and loads of salt. (*The Advertiser* 14/03/2015)

In this account, food provided by parents amounts to a moral choice as it is seen as yielding the power ‘to set up Molly in the best possible way for her future’. Strikingly, the period of the first 1,000 days extends here beyond the second birthday up to the fourth year of the child’s life. This might imply that risks or moral dangers (Douglas 1992) related to such an extended period of early life have been interpreted by Scarr as even longer-lasting. This example illustrates that metaphors which travel from scientific or policy circles into the public realm are subjected to interpretations which defy arithmetic and shape their meanings beyond recognition. In addition, this and other media discourses, which highlighted opportunities related to the first 1,000 days of life, tended to reflect middle-class values and lifestyle, such as importance and choice of high quality nutrition or taking cooking classes.

By contrast, in a few articles published by the Western press 'the first 1,000 days' metaphor elicited discourses that foregrounded risks related to poor early life environment – and poverty in general. For example, a New Zealand newspaper reported that:

> A child advocate says New Zealand is sitting on a Polynesian timebomb if it does nothing about Maori and Pacific poverty levels. Lobby group Every Child Counts has commissioned a report which says the country is 'developing a brown social underclass'. It says of the 200,000 New Zealand children living below the poverty line, more than half are Maori or Pacific. '(…) doing nothing for the young increases the possibility that we will explode.' The lobby group wants increased investment in children in **their first 1000 days of life** and supports (…) a call for mandatory state monitoring of children until the age of 5. (*The New Zealand Herald* 02/09/2011)

This extract offers only a snapshot of the debates on child poverty and inequality in New Zealand and is quoted to illustrate the fact that the 'first 1,000 days of life' metaphor in the Western context also elicited discourses of heightened risk, especially when these discourses related to people from disadvantaged or ethnic minority backgrounds. Such heightened risk is framed here as a 'timebomb' resulting from a lack of investment in the first 1,000 days of life of poor Maori and Pacific children, a 'timebomb' which threatens the cohesion of the country as 'we will explode'.

Similar discourses of heightened risk related to disadvantaged social groups also appeared in some other articles, and they sometimes featured ideas about the ways to manage such risk. For example, a piece published in *Economist* (in which the terms 'fetal origins hypothesis' and 'the first 1,000 days' were used interchangeably) argued for the importance of intervening during the 'first 1,000 days' in the following fashion:

> But in the fetal-origins hypothesis there also lies one policy advantage. Many of the stresses known to damage fetuses can be ameliorated by better health education, nutrition supplements and targeted subsidies. Food vouchers have been shown to reduce the incidence of low birth weight among poorer women. (…) A monthly nurse-visiting scheme in America for poor unmarried first-time expectant mothers (…) led to fewer delinquent adolescents. (…) Alaska is installing free pregnancy-test dispensers in bars in an attempt to cut the rate of fetal-alcohol syndrome. (…) Well-designed and targeted interventions can be very cost-effective. (…) Fetal-origins effects are often large – and pregnancy, after all, lasts just nine months. (*Economist* 04/04/2015)

Here the 'first 1,000 days' metaphor prompted discourses of interventions which aimed to target pregnant women to prevent foetal damage and other related problems such as foetal-alcohol syndrome, adolescent delinquency and adult chronic disease. In this sense the 'first 1,000 days' really looks like a window of opportunity which allows to fix various societal ills at their source – or in the wombs. As we can see, in the discourses concerning disadvantaged social groups the call for action elicited by 'the first 1,000 days' metaphor is significantly different from the call for action in the discourses concerning middle-class parents and children – we are dealing with different kinds of performativity (Bono 2001). While 'the first 1,000 days' metaphor could be understood as prompting 'empowering' discourses for the better-off sections of society, in the context of low-income and ethnic minorities families this metaphor can carry complex and contradictory meanings. It can also prompt interventions which could be interpreted as an unwelcome state-surveillance or as a long-overdue help and support for those in need.

More research would be needed to examine the use and implications of 'the first 1,000 days' metaphor in policy-related documents as well as in social worlds. In the media coverage, the vast differences between the meanings of the 'first 1,000 days' metaphor in different contexts can be understood through the lens of Nelkin's

(1994) work on scientific metaphors in the public realm. Nelkin argued that popular appeal of some scientific concepts lies less in the public's interest in the science itself but rather it stems from the relationship of this concept to current social and political concerns. At the same time these scientific concepts, such as 'the first 1,000 days of life' are 'interpreted in a cultural terrain and appropriated to support prevailing beliefs (Nelkin 1994: 27). In my media sample 'the first 1,000 days' metaphor has been used in the way suggested by Nelkin, highlighting prevailing beliefs about motherhood, class and ethnicity, as well as beliefs about the causes and consequences of various social ills.

6.4.2 The first 1,000 days and discourses in the Global South

In the Global South, the press which reported on 'the first 1,000 days' concept tended to foreground quite different issues than the Western media. Rather than discussing food choices or risk of diabetes, the media focussed on current and pressing questions of how to tackle malnutrition and the resulting problems, such as stunting, delayed cognitive development or high infant mortality. These problems were also seen as stemming from collective issues rather than from individual parents' choices, for example:

> Speaking at a seminar 'Maternal and Infant Nutrition: Taking Advantage of the Window of Opportunity in the **First 1000 Days of Life,**' (…) Professor Ezeaka disclosed that 700 new born babies die daily while 240,000 babies die yearly in Nigeria. With this figure, she said, Nigeria has the highest infant deaths in Africa which is related to maternal malnutrition that could cause miscarriages, diarrhea, anaemia, weight loss and jaundice in babies. (*Daily Independent* Lagos 05/06/2014);

and:

> (…) for a new born child in Yemen, the greatest danger lies in lack of nutrition, for their future hinges on whether they can receive it. **The first 1000 days of life are the critical window for children**. If they do not receive the right foods, they can suffer lasting physical and mental damage. If this irreversible damage occurs, it will mean stunted growth, increased health problems, and an inability to learn. (*Yemen Times* 08/08/2011)

In these texts 'the first 1,000 days' metaphor was associated with rather different health risks than in the Western context. In developing countries, the media also tended to use this metaphor in the context of health or policy-related initiatives, conferences or media briefings. In general, this metaphor seemed to be closely related to discourses of international development and various state-led policies and programmes, and it rarely occurred in the context of primarily personal responsibility of parents for the health of their children. Instead, problems with access to food and health-care were identified in the media as the roots of ill-health, and tackling such issues was seen as a collective task requiring collective actions of the state, aid agencies and other public actors. As one article has argued:

> We have UNICEF, the World Food Programme, Save the Children, and others on the ground ready to work with Yemen and solve this crisis. They just need the support of the international community. All it takes is for a few in power to decide to take action to save the children and save Yemen. (*Yemen Times* 08/08/2011).

Similarly, the onus of responsibility for the health of the future generation was on public authorities rather than on individual women, and the case for public investment and intervention during the first days of days was often supported by an economic argument, for example:

> Stunting can have permanent effect on physical and mental growth and can reduce GDP by 2 -3 %. It is mandatory for government to invest in

> nutrition especially in first 1000 days of life of a child to reduce stunting and improve education and increase earning potential of our population. (*Daily Regional Times* Pakistan 08/10/2015)

In seeking to address the problem, the media in the Global South tended to mention structural issues such as the need to tackle malnutrition or famine, improve education or health care rather than to modify behaviour of women. In addition, investment in 'the first 1,000 days' was seen as means to nation-building, and more generally as a way to ensure a better society. This was particularly evident in a couple of articles about 'the first 1,000 days' initiatives in the Global South written by Western authors. For example, a high-profile feature story published by *The Atlantic* claimed that the first 1,000 days in 'the period that decides the health and wealth of the world'. Investment in the early human development is framed here as a kind of lever to address political, economic and societal problems. According to this piece:

> That in the **first 1000 days** parents' ambitions for their children begin to be fulfilled or dashed has become one of the biggest new ideas in international development. (…) Proper nutrition in the earliest years of life can influence an individual's ability to grow, learn and work – and determine the long-term health and prosperity of families, nations, and the world as a whole (*The Atlantic* 01/05/2016)

This extract shows particularly well the relevance of 'the first 1,000 days' metaphor for discourses of international development – and more research would be needed to analyse the ways in which 'the first 1,000 days' concept potentially shapes initiatives aimed at developing countries. This analysis shows that the travel of 'the first 1,000 days' metaphor from one context to another involves not only a change of its meaning, but also different performative and political dimensions which are activated in the media in wealthy Western countries and the developing world. It also echoes Turney's (2009) suggestion that instead of speaking about good or bad

metaphors it is worthwhile to examine how and why they are deployed in their context, and what consequences this might carry.

6.5 Discussion and conclusions

This chapter has explored the meanings of the key concept of the foetal programming framework, namely the meaning of early life risk of adult disease. It has done so through the study of metaphors and metaphorical framings used in the media coverage of this field in the English-language news over three decades. It has drawn on Maasen and Weingart's(2013) to investigate how these metaphors travelled from one context to another, how they changed their meanings and how they realised their performative, political and ethical function in different contexts and discourses.

This chapter has identified three important and interlinked metaphors, i.e. 'programming', 'critical periods/windows', and 'the first 1,000 days', as well as a number of other metaphorical expressions and paraphrases clustered around them. These are related to machines and mechanisms, such as cars or thermostats, to architectural buildings or designs, as well as to religion, fate and sins of ancestors, especially mothers and grandmothers. Occasionally, metaphors from other scientific fields have also been found in the journalistic texts on foetal programming, and they have included the genetic metaphors of blueprints or maps on the one hand, and the metaphors of epigenetic 'switches', 'tags' or 'labels' on the other.

This analysis has shown that the meaning and structure of the three important foetal programming metaphors identified in this study have been changing depending on time and context, and that these metaphors interacted with each other as well as with the metaphors 'borrowed' from other fields. For example, the 'programming' metaphor has in recent years been deployed alongside the metaphor of 'switches', and it is unclear whether it will eventually merge with epigenetic metaphors or maintain its own recognizable structure and meaning. Similarly, the 'critical periods/windows' metaphor has over time transformed into the 'critical windows of opportunity', a metaphor clearly inspired by metaphorical language from the policy

realm. These two examples suggest that changes in structure or meaning of metaphorical expressions might reflect various processes occurring around scientific activities, such attempts to forge alliances and collaborations with other fields or attempts to influence policy makers and translate research into interventions.

Some metaphors have also been shown to travel between contexts better than others. The 'programming' metaphor seems to feature predominantly in the press coverage in the West, while 'the first 1,000 days of life' metaphor has appeared both in the Western media and in Global South press. In these two different contexts 'the thousand days' metaphor carried different meanings and revealed a different performative and ethical dimension. In Western press, the metaphor of 'the first 1,000 days' was likely to emphasise opportunities of ensuring better health of babies and children in those media pieces which reflected middle-class values. By contrast, articles about disadvantaged social groups such as the poor and ethnic minorities were more likely to use the metaphor of 'the first 1,000 days' to highlight various health and social risks and to suggest policy solutions, such as interventions targeting pregnant women. In the Global South context, the metaphor of 'the first 1,000 days' was closely related to discourse of international development and health policies, and it activated discourses about interventions and the need of collective action to ensure health of the population.

This analysis has shown that while the foetal programming/DOHaD framework has successfully established its reputation as a field independent of and in opposition to the genetic paradigm by championing a new understanding of early life risk of adult disease it has not managed to break away from the genetic deterministic ways of talking about such risk. While in the past we could blame the faulty genes for our ill-health, now the onus of responsibility for health is on mothers and grandmothers, especially those from disadvantaged backgrounds. Although metaphors used in the foetal programming media coverage might offer scope for a nuanced conceptualisation of agency and responsibility for the effects of programming and the increased risk of disease, this potential does not seem to be fully realised.

As a result, many scientists and journalists alike kept blaming mothers (see also Richardson et al. 2014), especially poor mothers, casting them in the roles of 'reproductive citizens' (Petersen and Lupton 1996) on whose actions and behaviours depends the (economic) future of the nation. This pattern of mother-blaming, which stems from the old pattern of blaming women in medicine, epidemiology and recently also public health is broken in the event of serious structural issues such as malnutrition or famine in the developing countries. In these cases, the metaphor of the 'first 1,000 days' can activate discourses of interventions in which responsibility for future health conceptualised as a collective rather than individual task. The analysis has shown that the meanings of early life risk of adult disease conveyed in the media were context-dependent, and they were framed and interpreted on the basis of the prevailing social issues and cultural beliefs (Nelkin 1994). It also demonstrates that the break in the messages about women, risk and responsibility carried by deterministic and moralistic metaphorical framings was difficult to achieve (Hellsten and Nerlich, 2004).

The travels and adaptations of metaphors explored in this study can also shed some light on the metaphorical toolkit of the foetal programming framework. The flexibility of this toolkit, in particular a possible weakening of the 'programming' metaphor, the transformation of 'the critical window' metaphor and recent emergence of 'the first 1,000 days of life' suggests a considerable ability of this field to 'reinvent' itself, at least metaphorically, in order to address new publics, to influence policy makers, and to achieve new goals.

Chapter 7: Making sense of a new health risk: Metaphors and narratives of foetal programming in interviews with scientists

7.1 Introduction

This chapter returns its focus to scientists, and it draws on the interviews with scholars who have contributed to research and debates related to foetal programming and DOHaD to answer the following questions:

- How do scientists conceptualise and talk about risk of disease related to early life and what metaphors and narratives do they use to explain this risk?
- How do scientists interpret risk of disease related to early life and its implications for the new understandings of the origins of health and disease?

In parallel to Chapters 4 and 5 which analysed the issues related to field-making from two vantage points of the media analysis and interviews with scientists, the present chapter seeks to mirror the questions discussed in Chapter 6 which focussed on the metaphors and narratives of risk used in the media coverage of foetal programming. As it has been shown in Chapter 6, the media drew on a few key metaphors, such as 'programming', 'critical window' and 'the first 1,000 days of life' to convey a range of meanings related to early life origins of adult disease risk.

This chapter presents scientists' own conceptualisations of foetal programming and of risk of chronic disease stemming from early development. It shows that their understandings and interpretations of these issues were much more diverse and nuanced than suggested by the media accounts, despite the fact that those media accounts had also been shaped by scientists working in this field. By engaging with participants' interpretations of the meaning of risk, and by comparing their interpretations with the metaphorical framings of risk used in the media, this chapter seeks to avoid producing a one-dimensional, or 'alien' (Collins 1999) representation of the risk claims in foetal programming. Once again it draws on Pickersgill's (2016) notion of epistemic modesty, or the scientific norm of conduct implying moderation in making claims and communicating about science, which enabled researchers to

distance themselves from some metaphorical framings of risk in the media, and to offer alternative and more complex understandings of the emergence of risk of disease. It also draws on the sociology of low expectations (Gardner et al. 2015) to account for scientists' more realistic statements about the possibility to design new health interventions in a near future.

This chapter is structured as follows. First, it examines scientists' understandings of risk by focussing on the metaphor of programming, and second, it explores scientists' alternative interpretations and metaphorical framings of early life risk of adult disease. The subsequent section examines scientists' views on the possibility of translating their research into practice and it moves on to the issues of the responsibility of women for health of future children. Finally, it discusses challenges related to public communication of research into foetal programming, after which this chapter concludes.

7.2 Reflecting on science, appraising its metaphors

As demonstrated in Chapter 6, the metaphor of programming proved popular in public communication of foetal programming, and it was widely used in the media. . 'Programming' of adult health and disease also emerged as a topic and metaphor in the interviews with scientists, and participants took time to reflect on what programming meant to them and how this term was used and interpreted in their scientific community.

I It soon became clear that not only scientists interpreted the meaning of 'programming' in different ways, but also that their appraisal of this word as a scientific term varied. Some participants even raised objections to this term being used, as in their view it was laden with connotations that did not adequately reflect the biological process it aimed to describe. For example, participant 21 disliked the term 'programming' for being too closely related to the vocabulary of the genetic paradigm, according to which development in the womb could be seen as enacting and unfolding of the script or code contained in the genes (see also Chapter 6). As this scholar declared:

> I don't like the word programming because it harks back to the use by Jacob and Monod of the genetic programme for development. (Participant 21)

According to this researcher 'programming' conjured up too many associations with the idea of genes acting as main controllers of development. In addition, in this and other participants' views (for example participant 2 and 15) this term also erroneously suggested a deterministic or 'fixed' nature of programming effects which could not be altered. According to participant 16:

> I used the word programming and I said it wasn't a good word. That is exactly what I meant because it implies that it is fixed and we know that it probably isn't (…) a fixed process. (Participant 16)

By contrast, another scholar thought that the effects of programming – in terms of altered structure and function of tissues and organs - were indeed to a large extent fixed, but the term 'programming' itself still did not reflect the whole range of other aspects of developmental processes. As this participant explained:

> The word programming was brought in by some; it wasn't brought in by me. It conjures up a kind of understanding of some sorts that something is influencing and it stays changed. (…) So this idea (…) has helped in the word programming becoming a buzzword. It is a quick shorthand word. (…) The field understands it. (…) But [there is another] word 'dialogue' [that] can still be used as well. The dialogue of maternal hormones and how they affect aspects of foetal growth. (…) You always will have the dialogue. I think we just find words that we are comfortable with that help us understand and help us explain it to people, so personally I wouldn't put too much influence on what words people use. (…) There is a lot, so much we don't know. We are still describing DOHaD. It is a phenomenology. So the terminology reflects that as well. Probably imprecise. (Participant 19)

As this scholar argued, the term ‘programming’ reflected only one aspect of developmental processes as it drew attention to the permanent character of changes in structure and function of organs and tissues that were induced by events in early life.. However, developmental processes could be seen from yet another perspective: instead of interpreting them only as ‘things’ that happen to the developing organism, they could be understood as changes brought about by a ‘dialogue’ between the mother and the growing foetus. This participant also implied that though researchers may have preferences for particular terms, they were also aware of the limitations of their conceptual toolkit, including the limitations of the meaning of the term ‘programming’ (as ‘the field understands it’ and ‘we just find words… that help us understand’). As the actual processes underpinning programming still remained somewhat elusive (‘DOHaD is a phenomenology’), the term programming itself was in this scholar’s view ‘probably imprecise’, offering just one of the ways of looking at early human development. This participant also felt that other perspectives were equally important and potentially illuminating, not least because of uncertainties surrounding this science (‘there is so much we don’t know’). In a sense this scholar was referring to the metaphorical features of ‘programming’ which, like all metaphors, can both reveal and obscure different aspects of reality and of human development as well. This scholar also illustrated an aspect of science that is often overlooked in the media, namely scientists’ humility, modesty and honesty about uncertainties.

While in the media coverage the ‘programming’ metaphor played a key role in structuring understanding of and communication about risk, for scientists directly involved in the foetal programming research this term was not unproblematic. Researchers expressed various reservations related to this term, and they highlighted the features which could burden or skew its interpretation, in particular its imprecision and partiality, as well as its affiliation to the gene-centric vision of human development. Some also suggested that the term ‘programming’ was not entirely value-free. The following section will discuss this issue in more detail.

7.3 The metaphor and the values behind it

As Chapter 6 has shown, the media often emphasised the negative consequences of prenatal programming and they drew attention to various adult diseases which had 'roots' in the womb. By contrast, some participants arguedt that programming should not necessarily be viewed as a process resulting in negative consequences for health, but rather as a part of normal development:

> I think that still lots of people don't really understand that this is part of normal development. (…) Many doctors, but even many basic scientists who should know better still think that it is pathology while actually it is variation in normal physiology and development. And they don't understand that the disease doesn't start *in utero* and then gets worse and worse. What the environmental development does is to set the responses of the individual to later environmental challenges. So again the normal physiology of say the growing child (…) has been tweaked if you like by this development which then will alter their responses which then explains partially why later some children become fat. But these messages still don't get through. (Participant 21)

According to this researcher, early life programming should be understood as part of 'normal physiology', instead of being represented as 'a pathology', or the source of disease which starts in the womb 'and then gets worse and worse'. This account was at odds with metaphorical framings used in the press, according to which disease has 'roots' or 'seeds' in early life. As this participant argued, programming did not cause disease but rather it shaped the propensity to it – or it 'tweaked' the physiology of the developing organism. In addition, this 'tweaking' 'explained partially' why an individual developed a health problem later on, a statement which contrasts the claims made in the media according to which programming was the major force determining future's health, as it could 'make or mar a child's life' (see Chapter 6). This participant also deplored the various misunderstandings which surrounded the foetal programming framework, a

statement that may have indicated disagreements about this issue in the professional realm.

Participant 19 also objected to the view that programming was akin to a physiological disorder:

> It's not necessarily a perturbation. This has been the problem with the field. It is regarded almost like a toxicity. You have a poor environment that causes the embryo or the foetus to be malfunctioning, like a toxicity thing and it's not. I think that the thing about Barker is that he showed that it was birth weight across the normal range (…) [and] the signature of that very early environment, the legacy, is in the normal range. So I think that that is important. (Participant 19)

This participant, too, stressed that programming was part of normal physiology, and framed the consequences of programming as a 'signature' and 'legacy'. These framings did not necessarily entail negative connotations and pointed to individual characteristics – or a 'signature' of an organism rather than to a potential damage. This contrasted with the media representations of the consequences of programming which were explained for example as 'design flaws' or 'in-build imperfections' (Chapter 6).

Some scientists confirmed that in the professional realm the term programming tended to concentrate on the negative rather than on the positive consequences of early development As participant 2 noted:

> Well it [the term programming] is designated as a negative thing. [But] There is no reason why it shouldn't be positive as well. (…) Whenever we try to get funding for our research we always think in terms of disease and I think some of the funders would actually quite like us to be thinking in terms of how this could be a component of healthy aging. (Participant 2)

According to this scholar, while the term 'programming' shifted attention towards adult chronic disease as resulting from some perturbations related to development in the womb, another perspective was also possible, the one which saw early life as a starting point for a long and healthy life. It seems that by drawing attention to a variety of outcomes brought about by the processes of programming, this researcher, and also other participants in this project, were keen to avoid representing early life programming as some kind of biological stigma (cf. Müller et al. 2017).. Instead, they emphasised the universal character of programming processes and their widespread occurrence in normal populations. At the same time, the scientists were also clear about the fact that early life programming may indeed predispose individuals to some types of chronic disease.

This kind of positioning of programming thus presented contradictions, as on the one hand, it was framed as potentially beneficial and/or detrimental, and on the other hand as widespread and normal. Although such positioning and interpreting of foetal programming on the part of the scientists stemmed from their understanding of the processes in question, it also did yet another thing, namely it discursively drew boundaries around the ways in which programming itself as well as its consequences could potentially be judged or evaluated. Framing programming processes as widespread and non-pathological signalled a willingness, at least on the part of some participants, to keep these processes relatively free from what might be perceived as extra-scientific values. This was clear in the comments made by one scholar during discussions about various types of physiological constraints acting upon the baby *in utero*. Such constraints could not always be predicted nor controlled, and they could potentially limit the growth of a baby in the womb, resulting in a specific metabolic profile as well as in a shorter stature in adult life.

> We know that you can be constrained in that [growth, but] that doesn't mean to say you have a hopeless life. You just have a different life. Would I be better off if I were another 5 inches taller? I don't know. You live the life you live and you then get into the realm of putting the values on differences rather than simply acknowledging differences and there

> are differences. There is variability. Depending upon your own individual characteristics you cope with different environments, either better or worse to different degrees. Part of what we are able to do is to create our own microenvironment, which is a better thing for us hopefully. So it [foetal programming] is an observation on the complexity of biology and how it plays out and how it helps to explain variability and risk rather than necessarily having the sort of judgmental approach that doctors tend to [have towards] problems where they have to do things to problems. (Participant 18).

According to this participant , foetal programming presented an opportunity to understand human variability, including people's risk of adult chronic disease, rather than to 'put the values on differences' in the ways in which people and their bodies 'cope with different environments'. This participant was ambivalent about how propensity to illness could be judged or acted upon by medical professionals, and objected to seeing some physiological traits as an omen of future problems. Health, as this participant felt, was not only a matter of being born big or small, but it also of how individuals were living their lives in different environments. As this scholar went on to explain, the best way to help people stay healthy was to provide 'the opportunity for the balance that enhances, enables or provides the opportunity for health'. In other words, adult health was not only the matter of individual physiological characteristics stemming from intrauterine development; it was also strongly related to the kind of environment in which individuals lived their lives.

Some other participants also expressed a reluctance to interpret early life development through the prism of values that are often attached to various bodily characteristics, including a propensity to disease. Reflecting on the difficulties facing an organism developing in the womb one scholar argued:

> We are not a designed individual. In my opinion, there is no higher being that designed this perfection and then all we are doing is messing it up at every step [of *in utero*development *in utero*]. So we could argue that everyone who is alive and present must be some way optimal because

> they've made it through some awful tricky times. Pregnancy is not easy for the foetus and conception is not a simple process, so everyone is a success story. It is hard to know what optimum is, but, and I think that these are…. We will all die at some point and [even] if we could eradicate all disease we would still die of old age. (Participant 9)

As this quote illustrates, this participant refused to attribute values to the outcomes of pregnancy as 'everyone who is alive and present' is 'a success story'. This scientist's insistence that human beings could not 'designed' for perfection contradicted the messages from the media coverage (and some interviews with Barker), which drew on the metaphors of 'design' or 'build quality' to suggest that optimal physiology could somehow be achieved during *in utero* development.

This and other comments signalled the participants' efforts to free discussions about foetal programming from judgements surrounding pregnancy. Participant 9 also sought to avoid a moralising discourse surrounding health in general (cf. Greco 1993) by commenting that 'we would still die of old age' even if it was possible to eradicate chronic disease through optimal design *in utero*. As this discussion shows, the participants' accounts were markedly different from the media stories which often drew on moralising discourses and metaphors to the imperative of ensuring health of future generations.

7.4 Risk and early life: from determinism to chaos

As the media analysis in Chapter 6 has shown, the metaphor of programming helped both journalists and scientists speaking to journalists make sense of the processes occurring in early life. . A recurring feature of this reporting – and of the metaphor - was the emphasis on the permanent or fixed character of physiological changes brought about by programming, and the implications of such changes for future health. However, the interviews revealed that, in the eyes of some respondents, the permanent or 'fixed' character of programming's effects constituted a somewhat contentious issue. During the interviews I sought to understand how scientists

themselves made sense of programming, its 'fixed' nature, and the risk that it entailed for future health.

The fact that manipulations of the embryo or the foetus can change its structure and function in a permanent fashion is well documented in foetal programming literature (Gluckman and Hanson 2006). For example, undernutrition in the womb might lead to a reduction of a number of cells in an organ, say in a kidney, as well as to a reduction of functional capacity of these cells. Having a kidney with a reduced number of cells and/or with reduced function of such cells means that the kidney may work less effectively which in the future may give rise to a number of health risks. But the question of what exactly such permanent changes in structure and function meant for future health, and what was the scope and importance of the consequences of programming solicited varied responses from the participants who offered their own interpretations – and alternative metaphorical framings – of the early life risk of adult disease. These metaphors, in turn, highlighted different aspects of the foetal programming processes, the aspects which in the eyes of the participants were most crucial for understanding what foetal programming was and what it meant.

For example, participants 4, 6 and 19 were keen to emphasise the permanent character of the physiological changes brought about by programming and participant 4 in particular readily agreed with Barker's metaphor that such early effects are 'set in stone' (see Chapter 6). However, this participant argued that such permanent physiological changes could be better understood through the lens of the evolutionary theory and be seen as adaptations:

> Now some of these effects [of programming] might be harmful, but there's a school of thought out there that suggests that some of these effects may also be beneficial and that even at this very, very early stage of development the early embryo is sensing its environment and altering its growth and developmental trajectory to accommodate to what it might

> expect after birth. (…) [So] it is set in stone, but nature, evolution said well look shit happens right, but we can try and help you out here but there is a price to pay … It is going to catch up with you in later life and that's the payback. (…) but what we can do is prevent the problems from happening in the first place, so you prevent malnutrition, you don't expose yourself to environmental chemicals. (Participant 4)

As this scholar argued, programming was part of evolutionary adaptation mechanisms that allowed the individual to survive early life challenges and live healthily through the reproductive age. However, 'the price to pay' or 'the payback' for such adaptations was an increased risk of chronic disease in older age.

The moral language of economic transactions (Lakoff 1995), or the metaphor of 'the payback' used by this participant, does not implicate the responsibility of mothers for ensuring health of future children, as propensity to illness in adulthood results from larger evolutionary forces at play rather than from individual behaviours of pregnant women. It also seems that in this account the metaphorical framing of the programming effects as 'set in stone' carries slightly less deterministic connotations than in the media coverage, where it was used to denote the permanent and unchangeable nature of health and disease decided in the womb. Although participant 4 emphasised the permanent character of programming's effects, it also seems that its consequences – or the occurrence of ill-health could be somehow attenuated or prevented as suggested by the comments 'you prevent malnutrition, you don't expose yourself to chemical environment'.

Participants 6 and 19 also emphasised the permanent nature and consequences of the programming processes, and they used more dramatic imagery and metaphors to describe the effects of even mild and small triggers occurring in early life. In the words of participant 6:

> So I always look at it [programming], certainly in this kind of context you know we are standing at the top of the mountain and we are just

> flicking the first few snowflakes off the top and it causes an avalanche and you get to the end and you have got this offspring of ill health. What the initial cue may have been and what the final outcomes are, there are hundreds, thousands of stages in between. And all have their own effect and all send it on its course of ill health. (Participant 6)

In this account, a subtle change in early life framed here as a 'snowflake' falling on the top of a mountain can gradually lead to serious and unexpected consequences such as an avalanche, or ill-health of an individual. Participant 19 reflected on the subtle nature of early programming and its unexpected consequences in the following fashion:

> It's like the butterfly effect. Have you heard of this, a butterfly landing on something on one side of the world, change of wind, El Niño and then you have got a hurricane in the other. It is a bit like that in one sense. (Participant 19)

Both metaphors of a snowflake causing an avalanche and of a butterfly causing a hurricane draw on the chaos theory, and especially on the idea of a 'sensitive dependence on initial conditions' (Lorenz 2000), according to which a small change in one state can lead to vast differences in another state or system later on. In chaos theory the consequences of such small changes are unpredictable (Werndl 2009), and difficult to control. Thus, the metaphors of the butterfly and the snowflake used by the participants suggested that early life programming's effects, though permanent, cannot alone lead to the 'avalanche' or a 'hurricane' of ill-health. Instead programming is seen as a first but crucial link in the chain of events leading to vast and potentially serious consequences.

This framing differed from the claims made in the press that development in the womb was the major cause of adult chronic disease. The chaos metaphors also implied a different vision of the developing organism seen here as a complex and unpredictable system, rather than a body-machine with in-built control knobs and switches which dominated the media coverage of foetal programming. It is also

noteworthy that participants 6 and 19 referred to the striking images of natural disasters conveyed by the snowflake and butterfly metaphors in the context of the effects of programming they observed in cells and tissues of their lab animals. When speaking about the effects of programming in people, both participants used a more measured language and did not rely on catastrophic metaphors or discourses (cf. Weingart 1998) which would imply disastrous or large-scale health consequences of foetal programming in humans. However, the chaos metaphors that these participants used stressed the inevitable and potentially very serious consequences of programming.

7.4.1 What is risk? Nudging, layering and hits

As the chaos metaphors suggested, scientists' interpretations of programming implied complex and multi-level processes, both subtle and difficult to control. Other respondents (for example participant 2, 4, 8, 10, 12, and 21) also drew attention to the subtle nature of the processes they were observing. For example, in a laboratory setting, even mild interventions during pregnancy – such as slight modifications of animals' diet – could lead to observable effects, such as changes to structure and function of organs, effects which themselves were often subtle too. As mentioned earlier on in this chapter, in discussing such subtle effects of programming Participant 21 used the metaphor of tweaking to describe small modification or adjustment of the physiology in a developing organism. Participant 2 also highlighted subtle effects of programming by noting that:

> I think sometimes what we measure even in the animal studies is actually quite subtle. So if we are measuring blood pressure in animals who have had an adverse maternal environment we are not talking about anything we would define as clinically disastrous. We are talking actually about quite subtle shifts and so again thinking about this in terms of lifelong accumulation of factors it is almost a case of programming [which] has nudged blood pressure up a bit and then if your lifestyle is such that is

> going to push it further, that's what puts you into the disease bracket. It can be subtle. And you know we can't begin to understand all of it as well. (Participant 2)

As this scholar explained, difficult conditions in the womb did not result in a dramatic increase of blood pressure in offspring – or they did not lead to 'anything clinically disastrous'. Rather, they produced small increases, or 'quite subtle shifts' in blood pressure. The effects of such small shifts could be felt in adulthood after years of unhealthy lifestyle which could itself lead to increased blood pressure. In such case a propensity to higher blood pressure acquired in the womb could 'nudge' the blood pressure slightly up, but enough for it to become clinically significant. In this sense, the subtle effects of *in utero* programming combined with lifetime of unhealthy habits could at some point push the individual into the category of a patient with a high blood pressure. As the metaphor of 'nudging' implied, the effects of programming, though important, were not in themselves sufficient to lead to disease, as illnesses, such as high blood pressure, diabetes and other chronic ailments, stemmed from a 'lifetime accumulation of factors'. Such accumulation included the effects of development in the womb, genetic factors as well as lifestyle factors such as diet, exercise, smoking, stress and so on[16].

As the fieldwork progressed it became clear that virtually all participants in this study agreed that in addition to the conditions in the womb, genetic factors as well as adult lifestyle also mattered for the emergence of disease (see also Chapter 5), although scholars differed in the emphasis they put on the importance of some of these factors and used different metaphors to talk about risk of adult chronic disease. As noted earlier on, chaos metaphors emphasised the potential damage caused by programming by focussing on the relationship between the causes (understood as small and subtle) and the consequences (understood as large, unpredictable and serious). However, other participants drew on different metaphors which highlighted

[16] The notion of accumulation of risk over the lifespan draws on life course epidemiology (Kuh et al. 2003), the influential framework inspired partly by Barker's work and seeking to integrate studies of both biological and social processes implicated in risk of disease. In a broad sense, the life course approach could be seen as an extension of Barker's approach. See also Chapter 1.

other aspects of the emergence of disease. These metaphors tended to focus on the processes leading to disease, and they highlighted the pathways or stages through which disease gradually emerged. Reflecting on the interplay of lifestyle, genes and early environment participant 15 noted that:

> So my understanding of the evidence is that there is a genetic predisposition but it only explains a certain percentage of the variability of disease risk, so there is a genetic predisposition and there are early life factors and then you know it's all a layering of risk. I don't think you could say there is no genetic predisposition because I think we have got good evidence for that (…). It is very hard to tease everything apart, but I just think you could get everybody to eat really healthily in pregnancy but if people are still going to go on and be obese and smoke and inactive [in adulthood] then they are still going to get these diseases associated with that. (Participant 15)

In this account adult chronic disease results from what is metaphorically framed as 'layering of risk', or from accumulation of damage accrued throughout lifespan. In this quote early life factors are represented as one of such layers or one type of risk factors which, though important, do not seem by themselves to be able to determine future health and disease. Indeed, as this participant argued, ensuring that everyone has optimal conditions in the womb will not protect them from obesity or heart disease if in adult life people smoked, overate and did not to exercise. Thus, contrary to the media claims, optimal conditions in the womb do not seem to hold the key to healthy life and the importance of genes and social environment in adulthood should not be overlooked.

Several other respondents (for example participant 1, 9 and 16) drew on the metaphor of 'two hits' or 'multiple hits' to describe the relationship between foetal programming and risk of disease. Interestingly, this metaphor was borrowed from cancer research and was coined by Knudson (2001) to describe his theory of cancerogenesis. Knudson thought that cancer arose gradually and stemmed not from one event or one type of risk – or one 'hit' – but rather from accumulation of

mutations of DNA – thus from 'two or multiple hits'. Some participants used the 'two or multiple hits' theory to make sense of how adult chronic disease such as high blood pressure or diabetes was likely to arise. According to participant 1:

> I think in general there is a thought that you need to have two hits, so you need to be of some compromise during foetal development or childhood, but then you need to be exposed, say if you are in a low activity environment. (Participant 1)

Here, potentially negative effects of programming stemming from early life development – or from 'some compromise during foetal development or childhood' constituted the first step – or the first 'hit' to adult disease. The second or subsequent hits were in this participant' view directly related both to the lifestyle of individuals as well to what this scholar called 'an obesogenic environment' (Pincock 2011), or such social and economic arrangements and structures that promote poor diets, lack of physical activity, and so on. It was argued that this second or subsequent hits were ultimately implicated in bringing about chronic adult disease.

The metaphor of 'multiple hits' in cancerogenesis was also useful for participant 16 to account for different ways of understanding risk of chronic disease in the field of foetal programming and DOHaD:

> So in the cancer example (…) you have got an oncogene, a gene that predisposes you to cancer and you have that gene [and it's the first hit] and later on in your life you are exposed to a second hit, or third hit or a fourth hit or 24th hit that actually results in a series of events that ends up in the cancer. So it depends on one's view of developmental origins. Is it just that you, or an individual is exposed to something, an environmental challenge [in the womb] and that may be acute or it may be chronic and then that leads to an immediate permanent change that is the risk, that is (…) an altered physiology so that the environment after birth will result in ill health eventually. Or is this, for example, the first part of that [i.e. that there is the first hit] and maybe physiology adapts to that but if the

> external environment or the later environment doesn't match [then there is risk of chronic disease]. (Participant 16)

The potentially negative effects of programming in early life were framed here as an 'oncogene' or a gene that has a potential to cause cancer and therefore represents risk. The question as to whether the presence of such oncogenes was sufficient for the occurrence of cancer or alternatively, whether there had to be other factors necessary for the disease to emerge could in this participant's view readily be transposed to the debates within the DOHaD community about the importance of foetal programming. Was one hit in early life enough to cause say diabetes and high blood pressure in adulthood? In other words, was programming in the womb enough to bring about chronic adult disease irrespective of later environmental influences? Or were unhealthy environment and lifestyle choices in adulthood also indispensable factors that together lead to the build-up of such ailments? Reflecting on these questions participant 16 explained that:

> I think from all of the human and animal studies that there have been done (…) it is pretty clear there isn't one single event, so that there isn't one single critical window, it is not just early pregnancy, it is not just late pregnancy. (…) I think there is pretty clear evidence there is no single window of opportunity, critical window that this isn't exclusively a foetal matter, and it is not exclusively an early postnatal matter either but that those early influences through into childhood may all have a long-term effect. (Participant 16)

This participant drew on the metaphor of multiple hits to discount the concept – and the metaphor – of the unique window of opportunity occurring in early life which could help ensure health in adulthood. In this researcher's view disease was an outcome of various events, or hits, unfolding throughout lifetime.

This analysis demonstrates that scientists' interpretations of risk of disease related to foetal programming were much more nuanced than the media representations, according to which early life development was the most important (if

not single) factor contributing to the emergence of adult chronic disease. While chaos metaphors stressed the potentially uncontrollable damage and ill-health caused by foetal programming, the metaphors of 'layers', 'hits', 'nudging' and 'tweaking' highlighted the cumulative nature of risk which could be accrued over lifetime.

7.4.2 Programming and the question of scale

As discussed, scientists differed in their interpretations of the meaning of foetal programming and of the risk of disease that it entailed. As the interviews progressed it was also becoming clear that the question about the potential scale of the consequences of foetal programming for later health and disease in humans presented some difficulties. It was clear to many of the scientists interviewed that small or mild changes or 'insults' occurring in early life, such as slight dietary imbalances had observable consequences in the form of structural and functional changes of organs and tissues, which in turn had an impact on the metabolism of the developing organism. But what was the actual contribution of such effects of programming, to the emergence of disease in future? Could the scale or magnitude of such effects be somehow estimated? Given the debates in the field there did not seem to be a consensus on this issue (see Huxley et al.2002). Likewise, many interviewed researchers felt that providing reliable estimates was an impossible task, especially given the complexities not only of human biology but also of social and environmental factors operating throughout lifespan. Hence the replies to the question of scale varied considerably, with some scientists hesitating to put a number on the contribution of *in utero* programming to the emergence of an adult disease. As participant 2 further explained:

> The pathway to disease as we now think of it is too complicated to be able to quantify that because nobody has yet done the study that looks at all those factors [i.e. genetic, intrauterine and lifestyle factors] and how they interact with each other. (…) Nobody does those sorts of studies so I

> would really hesitate to be able to put that kind of figure. It could be huge, it could be minor. (Participant 2)

In this scholar's view, the contribution of early life programming to disease was hard to assess for a number of reasons: it was difficult to disentangle it from other factors, and the scale of its effects seemed to be highly contextual, depending on the kind of chronic disease under investigation and the kind of interactions between the effects of early life programming and for example particular genes implicated in causing chronic disease. Reflecting on such difficulties, another participant noted that:

> It depends on what you measure as an outcome. (…) I would say that for aspects of vascular function the effect is probably about the same as that of smoking. But it's very hard to know because we're dealing with a subtle shift in physiology and so how you take that across the life course and then work out what the contribution has been. (Participant 21)

Similarly, participant 10 also felt the effects of programming, although difficult to quantify, were probably significant. By contrast, some respondents (in particular 7 and 8) thought that the impact of programming for the emergence of adult chronic diseases was statistically small – so small that it did not play a major role. According to one scholar:

> [Programming] can set people up, absolutely, but the actual scale, the scale of risk, the proportion of risk that can be directly attributable to programming is so small to be not important. And so why did I change [my mind] about programming? It was because (i) it is very, very small effects and (ii) what can we do about it? Not much. (Participant 8)

Interestingly, in this scholar's view though programming's effects were observable ('programming can set people up, absolutely'), its limited impact on the increase of risk of future disease meant that it was difficult to control. According to

this scientist this also implied that translating programming into specific health guidelines or health interventions targeting pregnant women would probably result in limited benefits in terms of improved health in a population, as there was 'not much' that could be done about it – and I will return to this issue later on in this chapter.

This view was not shared by all participants in the study, especially those who were also involved in clinical practice. For those researchers, even if the effects of programming were statistically small, on an individual level they could still matter for some of their patients and affect their health in future. Therefore, the participants who were responsible for the care or treatment of pregnant women or new born babies and their families still felt that an awareness about the potential effects (both beneficial and detrimental) of programming should inform the way they worked. For example, participant 20 reflected on the ways in which the Barker hypothesis changed this scholar's thinking about pregnancy and early life development:

> [When] I trained [as a doctor] (…) the idea was that the uterus protects the baby from the environment, including the mother. You know it is big buffering. [The idea that] the placenta is a fantastic organ that filters everything and there is no doubt that that happens but the realisation that there was more to it than that and the fact that the maternal environment has an important effect on the baby really only emerged after Barker's papers I'd say. There will be other people that might say that the concept had been previously put forward, but I think it was Barker who really raised the general awareness that this was something that we should focus on and questioned that paradigm. (…) So at a very a very practical level if I was called to see a [pregnant] mother who had fallen down the stairs I would spend most of my time reassuring her that the uterus is going to protect her baby from anything that happened. Post Barker I might say well yes it protected it physically, but it probably generated a stress response which was transmitted to the baby and who knows what impact that had long term. (Participant 20)

This participant used a hypothetical case of an accident to a pregnant woman to show how the Barker hypothesis influenced this participant's thinking about health and well-being of patients. While in the past a doctor would be preoccupied with immediate consequences of the accident to the developing foetus, now – or 'post Barker' the medical practitioner would also reflect on the hidden, yet possible long-term effects of the stress experienced by the pregnant woman on the baby in her womb. Using a more day-to-day example, this participant also noted that the risk of having higher blood pressure in adulthood as a result of adverse programming in the womb was statistically small. Even so, they felt that it was their duty to consider even such small risks while caring for their patients. This scholar also felt that more studies should be carried out to find ways of mitigating such risks in the clinical care of pregnant women and their babies.

As this and other quotes illustrate, scientists differed in their interpretations of the scale of effects of foetal programming. In addition, the significance they attributed to the importance of foetal programming for the incidence of adult chronic disease did not rely solely on the statistical estimates of such risk. Even if small, risk could still be perceived as substantial and its interpretation was highly contextual. Such nuanced and varied accounts of risk attributed to foetal programming contrasted with the media reports which presented quite simplified claims that for example early life was 'the major controlling factor' in determining risk of adult disease.

While the media framed programming in the womb in a highly deterministic and even fatalistic fashion – as 'fate', 'destiny' or 'seeds' of a disease - the metaphors used by scientists conveyed a more complex images of the effects of programming and were framed as 'layers', 'multiple hits' or 'nudging' and 'tweaking'. These metaphors suggested that in addition to early programming, other factors ('layers' or 'hits') such as genetic or lifestyle factors were necessary to bring about a disease in adulthood. Foetal programming did not then constitute 'the key' to health and wellbeing as the media implied, but rather one of the many, and as some scientists argued – only a *potential* cause of future health problems. On the

other hand, chaos metaphors used by some participants in this study painted a much more dramatic picture of the effects of foetal programming that were hard to predict and control. Thus, the interviews highlighted a considerable variety of views that scientists held on the nature, importance and scale of effects of foetal programming, a variety that was not reflected in the media coverage of this field.

7.5 Science, and what to do about it

In the media coverage the often-repeated promise of foetal programming was that optimal conditions in the womb would ensure better health of future generations. This claim came to the fore particularly in those journalistic pieces which relied on the metaphors of 'critical windows', 'windows of opportunity, and 'the first 1000 days of life'. In such accounts the period spanning the time from around conception, through pregnancy to the second birthday of a child constituted a unique 'window of opportunity' during which bodies, physiologies and metabolisms could be shaped, optimised or 'programmed' for future health. This in turn led to claims that this research could guide new health interventions or state and international aid investments. Therefore the issue of how the science of foetal programming/DOHaD could be put into practice became an important part of the interviews for this thesis.

This question produced rich data and it also proved to be the one which generated widely different responses from the participants. While several respondents had interests in or substantial experience of work at the intersection of science and policy, for some other participants the issues of science translation and policy design were beyond the scope of their professional interests, and they sometimes claimed they lacked specific expertise to come up with such solutions. Even so, some engaged in creative imagining of future applications of this science, and they explored the possibilities of harnessing the emerging research into epigenetics to design new ways of diagnosing and even treating early effects of foetal programming. In this context the promise of personalised medicine (Collins F. 2010) was also rehearsed and examined.

Alongside technoscientific imaginaries (Marcus 1995) related to possible application of this science in a future where the hopes of identifying epigenetic markers will have materialised, there emerged numerous questions about the aims, scope or feasibility of new guidelines or policies to be implemented in more immediate timeframes. In contrast to the enthusiastic claims in the press about the potential to put the science of foetal programming into immediate use by focussing on nutrition of pregnant women and more broadly on nutrition of girls and women of reproductive age, scientists were much more cautious and measured in their assessments of such possibilities. In their accounts scientists displayed what Will (2010, also Pickersgill 2016) referred to as 'epistemic modesty' or a moderation in advancing claims about what can be known by and done with the help of science. Much of these concerns stemmed from differences in understanding risk as well as from uncertainties surrounding science. During the interviews scientists took time to spell out the reasons why specific health interventions should or should not be introduced in a near future, and what kind of research would be needed to support such interventions. Scientists engaged in what might be interpreted as the management of enthusiasm (Will 2010) surrounding potential applications of foetal programming by pointing to the available evidence (or a lack of thereof) that could warrant such developments. Such discursive strategies of balancing enthusiasm against evidence are, as Will (2010) has argued, one of the ways of defining a scientific field. They can also be understood as strategies to assert the reputation of science (Gardner et al. 2015) which could potentially be harmed by overly optimistic and unfounded claims. Hence, reassessing the optimistic claims propagated in the media and situating them in the context of their own scientific expertise allowed the participants to present a different and more modest kind of future that foetal programming might offer.

The construction of such more modest visions of future has recently become the focus of the nascent body of work called 'the sociology of low expectations' (Gardner et al. 2015, Broer and Pickersgill 2015 and Pickersgill 2016, see also Chapter 2). In contrast to hype which harnesses grand statements and promises to

marshal the prospect of glorious future possibilities, the construction of more modest visions of future involves 'recalibration' of claims (Gardner et al. 2015), a process of deflating some of the extravagant promises made about science in the public realm. Recalibration stems from 'the need to dispel the rhetoric of a 'quick fix' and to replace it with a more realistic vision of the future, a future with some incremental gains, and possibly some setbacks' (Gardner et al. 2015: 1008). Painting more realistic visions of future requires the engagement of the authority of scientists who often draw on the skills and expertise from different backgrounds to support their more modest claims about the future (ibid.: 1017).

During the interviews scientists did indeed engage in recalibration of expectations surrounding the foetal programming framework and its potential applications, and they reflexively interrogated the robustness of science and possibilities of its implementations. But what also emerged during the interviews was that a large part of scientists' concerns about future interventions was related to the political, social and cultural terrain (Nelkin 1994) in which this science was operating. As the interviews revealed, scientists felt that this terrain could have an impact on how their research would be interpreted and deployed in social and cultural life, how it could be operationalised in the realm of health interventions and various policies, and how it could ultimately influence the outcomes of such new interventions.

Scientists were acutely aware that their research did not exist in a social void and that an assessment of the usefulness or effectiveness of science-based advice, treatments or policies could not be separated from the world around them, and especially from the various expectations (created both in science and in the social realm) regarding what this research could actually do for mothers, babies, and even societies and economies at large. Thus, it seems that scientists' attempts to recalibrate the expectations pertained not only to the limits and possibilities of the science of foetal programming *per se,* but also to a vast array of assumptions about what science *tout court* is for and about, how it might be used, how health and disease emerge, and so on. It should be noted that since scientists' opinion on this matter

differed, the scope of recalibration of claims also varied along various degrees of optimism and/or pragmatism stemming from scientists' specific expertise and interests.

Reflecting on such entanglements of science and society, respondents pointed to various types of limitations to what science could do, with a couple of participants expressing doubts whether specific health interventions underpinned by the science of foetal programming were worth being applied. As discussed in Chapter 6, the metaphors of 'critical windows' and of the 'first 1,000 days' were used in the Western media to suggest that focussing on the health and nutrition of pregnant women could improve various health outcomes of their children, and in the case of disadvantaged groups it could also act as a policy lever and help alleviate various societal ills. These optimistic media claims were at odds with much more careful assessments of the possibility of such interventions expressed during interviews. Participant 7 in particular was sceptical as to whether such interventions could actually benefit pregnant women, especially in Western countries where populations are generally well fed and the cases of severely undernourished mothers and babies – the traditional focus of the foetal programming – are relatively rare. In this participant's view, developing large-scale interventions targeting pregnant women in high-income countries was problematic, especially as the potential impact of such interventions, for example vitamin supplementation, could not be anticipated, not least because the mechanisms underpinning programming in the womb were still unknown. According to this scholar:

> I don't know what the underlying biology is and I don't know what really the punchline is with respect to prevention and treatment. (…) I think our current state of knowledge [is that] in a high-income society (…) it's rather worrying to intervene with supplements in pregnancy. I have never been a great enthusiast. (…) I am not driven by the notion of what to do to intervene. (Participant 7)

This participant scaled down the hopes that interventions underpinned by foetal programming could benefit women in the Western world quite considerably, as

there were significant uncertainties and unknowns surrounding such potential interventions. By contrast, this participant thought that there was enough scientific evidence to develop new models of feeding and treating malnourished babies in the developing world to help them grow into healthy adults. This participant was 'cautiously hopeful' about some claims as well as 'constructively sceptical' about others (Gardner et al. 2015: 1002), and the degree of recalibration of scientific claims differed according to the amount or strength of evidence that this scholar felt was available.

Alongside reassessments of science-based claims, this scientist also engaged in reassessing claims related to a wider context in which the science of foetal programming and science in general were operating. In particular, this respondent was highly critical of the ways in which contemporary science was used to support various social, political and economic agendas, instead of focussing rather on the scientific questions and medical and clinical problems.

> What do we do about it [the science] other than in situations where you have very malnourished mums? But on the other hand, it's like there is this tendency in health research to kind of sometimes to… I think the arguments for nourishing women properly in pregnancy are moral arguments and (…) they don't require the elaboration of the foetal origins of adult disease. (…) Because they are moral arguments because a malnourished mother, it's wrong. A malnourished human being it's wrong. I mean it is self-evidently wrong. I mean you do not, it's like you don't need a study to show that. (Participant 7)

As this respondent argued, science, including the science of foetal programming, could and should not be expected to resolve what this participant saw as moral arguments rather than what in the policy realm could be perceived as socio-economic problems requiring techno-scientific fixes (Sarewitz and Nelson 2008). This participant objected to the view that science could be treated as a tool – or as an excuse – for implementing various policies, and felt that ideas for solving fundamental ethical issues – such as hunger and malnutrition - should be sought

beyond the realm of the science of foetal programming (cf. Jasanoff 2007). In this case, recalibration involved deflating claims and expectations related not only to the core claims of the science of foetal programming, but also to what this participant felt were misguided expectations and assumptions about the role of science in contemporary societies.

Participant 16 was also ambivalent about the expectations related to how the science of foetal programming could be translated into practice, though in contrast to participant 7, this scholar was in favour of developing various types of interventions, especially based on information and education for women and prospective parents. However, participant 16 seemed acutely aware of the pitfalls surrounding expectations that future health interventions underpinned by novel technologies, such as potential epigenetic biomarkers, could safeguard health of future generations. This responded noted:

> What's the intervention? What's the magic epigenetic intervention? Am I going to give [pregnant] mothers a magic pill that is going to wipe all their epigenetic marks and then provide them with another magic pill that, call it folic acid, that provides them with the building blocks to make the epigenetic marks? (…) If the theory of multiple hits [that lead to disease] is correct then it is probably not just your biology or physiology [shaped in the womb], but the other [lifetime] influences that come along. So what are those influences? Are they a sedentary lifestyle with dietary imbalance? So I think what is unlikely is that medicine can solve it in as much as medicine can define the risk and medicine can find some interventions, etc., but if society decides that we all need three cars then the society decides that is how it wants to be. But if the world from the sort of social programming sense, if the world decides, or if the country decides, if society decides that this is the way that we live, medicine probably can't solve that. That medicine can point it out. It can find the mechanism and point out the mechanism, but can't solve it on its own. (Participant 16)

According to this respondent, the expectation that the epigenetic science will help design early life interventions which will safeguard future health amounted to a belief in 'magic'– the word this participant used repeatedly during the interview. As discussed in Chapter 4, the media coverage used the imagery of 'magic' to describe the power of foetal programming to predict and change people's destiny. While in the media coverage such framing conveyed a sort of blind trust in science, in this participant's view such blind trust and unrealistic expectations were obliterating other crucial aspects of social life which influenced health in at least equal measure. These aspects – which participant 16 creatively framed as 'social programming' as opposed to biological processes of foetal programming – included various social, cultural and economic arrangements such as availability of healthy food, the perceived need to own multiple cars which led to physical inactivity, using lifts instead of walking up the stairs, and so on. Such arrangements, this participant felt, were beyond the scope of what science or medicine could potentially change, although science could critically appraise the consequences of the 'social programming' or the various social and economic structures which could promote ill-health. Thus, while this participant recalibrated hopes related to clinical applications of epigenetic markers in a near future, they also critically reassessed more general expectations related to the effectiveness of early life interventions, in particular the assumption that such interventions could act like 'magic' and guarantee health in future.

Likewise, participant 15 felt that the knowledge of biological processes underpinning foetal programming would not itself be sufficient to improve health in future children.

> Yeah, well I think it is fine being a biologist and focussing on the biology but then as soon as you want to argue OK, what do we do about this, how do we change that biology in the human population to intervene, then you have to start looking in the human population and think oh what would we need to change and that comes back to dietary patterns. And dietary

> patterns we know are determined by not just by personal preference and choice but lots of environmental factors about food accessibility and education and all of that is strongly linked to…. You immediately step into social science and health promotion and public health really. (Participant 15)

This participant, while being firmly in favour of early life interventions that could help future parents raise healthier babies and children, also felt that science alone could not provide a technological fix to social, cultural or economic issues, and that other disciplines and kinds of expertise should be involved to help all people – and not just pregnant women - live healthier lives.

Other respondents also drew attention to the fact that numerous factors other than nutrition in early life contributed to shaping health in the womb and beyond, although they attached various weight to the importance of such factors. Stress was often mentioned, and while scientists talked about the impact of stress experienced by pregnant women on birthweight and health outcomes of their future children, they also highlighted the complexities and uncertainties surrounding studies on the impact of stress, such as the questions as to what stress really meant, what levels or kind of stress could be harmful, and so on. Such deliberations were inevitably tied to the social and economic contexts of daily lives of pregnant women. As participant 5 noted, while having a healthy weight and good diet during pregnancy was crucial, stress also had an important role to play, though it was more difficult to control:

> I think it is very difficult if you are in a relationship which is stressful or in a job which is stressful, you can't just say oh well I'll leave my job. (…) I mean a post doc or something like that it is very difficult if you are pregnant. (…) I think being stress free is not possible, but having a lifestyle which is not stressful, for example it is optimal to have a house which is comfortable to live in, things like that, not to be homeless, maybe to be financially stable, all the things that could impact upon

> maternal stress levels and can alter hormone levels [that influence the baby in the womb]. (Participant 5)

Similarly, participant 17 noted that:

> Stress can be all sorts of things. I mean stress can be depression, it can be mental health problems or it could be just the environment you are in is stressful. If you are suffering from abuse from your partner for example or you an ethnic minority, that can be stressful in certain situations. You may be on a very low socioeconomic status which is very, very stressful. You may have lots of children and be a single parent, that's very, very stressful, but that doesn't necessarily mean that you have depression or anxiety or any other mental health problem. So I think stress is used as an umbrella term as well because we can look at a range of different things. (Participant 17)

As these comments illustrate, although scientists acknowledged the importance of food and diets in pregnancy and early life, they highlighted the fact that other factors – such as stress as well as larger socio-economic structures and personal circumstances weighed heavily on the wellbeing and health of mothers and their children. While focussing on nutrition in early life was crucial, overlooking the importance of these other factors could influence the effectiveness of early life interventions and in turn have an impact on the reputation of the field of foetal programming.

By drawing on various sets of scientific skills and expertise (related to the studies into nutrition in foetal programming but also to the studies of stress, public health, social sciences etc.) participants reflexively recalibrated not only what is possible to do with the science of foetal programming, but also what is possible to do with this science in a current social and economic context. Such recalibration allowed the scholars to maintain the authority and reputation of the science they represented (Gardner et al. 2015), by simultaneously positioning themselves as more

pragmatic and responsible or able 'to adopt the appropriate register of modesty or ostentation' (Pickersgill 2016: 199).

The complexities, uncertainties and challenges related to the social and cultural environments in which potential interventions may be delivered constituted a frequent theme of such reflections. However, unlike the press which reported on the implications of the science of foetal programming both in the West and the Global South, especially in the context of 'the first 1,000 days of life movement', the participants in this study focussed predominantly on the context of the UK where they all lived and worked. Only a few participants raised the issue of whether the science of foetal programming may benefit populations across the world. One scholar in particular argued strongly in favour of integrating the tenets of this framework into health policies in countries at various stages of economic growth. This would, however, entail vastly different interventions which would have to be adjusted to the complexities of daily lives of women, children and societies at large. As Participant 21 noted:

> I think they're [tenets of foetal programming] applicable everywhere. Absolutely everybody in the world is at risk of non-communicable chronic diseases. (…) So whereas in the West we worry about maternal obesity and gestational diabetes, in parts of Sub-Saharan Africa there are still many children [who are] underweight and there is stunting. (…) In the countries that go through socio-economic development – we know that [when people get] small amounts in the increase of cash in relatively poor countries that unfortunately people don't spend it on going to the gym or on buying healthier food. They would spend it on junk food and sedentary activities, buying TV etc. So it's [foetal programming] true everywhere, we just see different aspects of the same problem. (Participant 21)

In contrast to participants 7 and 8 who, as discussed earlier, thought that the impact of programming for future health was small and doubted in the benefits of translating this science into health interventions, participant 21 felt that foetal

programming was ‘applicable everywhere’ and could benefit people across the world.

As this discussion illustrates, the media claims that interventions based on the science of foetal programming would ensure the health of future generations contrasted with more varied accounts of the interviewed researchers. Participants differed considerably in their opinions as to whether interventions into the early development were possible or necessary, and if so what kinds of interventions were feasible and whether they could be deployed in a near future. Irrespective of their views about the possibility, scope or kind of imagined interventions, researchers were much more modest (Nerlich 2013) in their claims about what science could do, when compared to the claims in the media. Participants tended to avoid grand statements about the ways in which their science can change the world and did not see potential applications of this science as technological fixes (Sarewitz and Nelson 2008) or a solution to intractable problems (Nelkin 1990, see Chapter 4) - although some respondents had much higher hopes about positive effects of such interventions than others. The scientists also emphasised various social and economic structures contributing to health and disease that were largely absent in the media accounts of foetal programming. From this perspective, even if the potentially negative effects of foetal programming could be mitigated by interventions focussing on early life, it seems that the larger forces operating through what one participant called ‘social programming’ could t be neither overlooked nor underestimated.

7.6 Science and women

The question of women’s responsibility for the health of future generations constituted an important feature of the media coverage of foetal programming (see Chapter 6), and it also emerged during the interviews for this thesis. Scientists tackled this question in different ways. A few participants viewed such issues as ‘ethical questions’ beyond the remit of their expertise. Some others felt that such questions would be better addressed by specialists in public health. Yet another

group was willing to engage in conversations about the implications of foetal programming for girls and women.

Given the expertise of the interviewed researchers, the issue of diet and nutrition attracted the most attention. Many scientists felt that public messages surrounding diet for future mothers were confusing. In particular, participant 2 felt that new dietary guidelines for pregnant women should be introduced to help them eat better:

> I think it would be nice if we could say to pregnant women: this is what we think you should be eating, here are some menu suggestions, try and follow this throughout your pregnancy. I think that would be useful, because at the moment we say: eat a healthy, balanced diet. Don't eat unpasteurised cheeses. It is incredibly vague. (Participant 2)

This scholar felt that because of a gap in studies and evidence about what healthy diet meant, pregnant women as well as mothers intending to wean their children did not have the best scientific information about what to eat and how to feed their babies and toddlers. This participant was also careful not to blame women for their dietary choices, as 'being a mother is hard enough', and felt that science should help them live healthier lives. Participant 16 also thought that 'a lot of the healthy eating things and a lot of the public health messages are unproven in themselves' but felt that in addition to new scientific evidence to prevent for example obesity in children and future adults, a change in social attitudes was needed as well as involvement and cooperation of future mothers. While this participant was convinced that breastfeeding was crucial for future health, they also advocated for more support for women:

> So what are we going to do in British society about that [obesity in children]? What we need is information [for] …and an informed consent [from mothers]. Not to breastfeed your infant should require informed consent. It shouldn't be a default, it's just my choice, which I do believe in, but actually there should be an informed process which discusses the

> risk and the benefit for both the infant and for the mother and acknowledges some of the difficulties, so it isn't just about we should do it and it is good for you and it is good for him. It should be about yes but actually some women do find that difficult and this is how we are going to support you. And so breastfeeding is one example, but how you wean your infant, how you deal with a screaming two-year old on one leg whilst trying to wean the baby in the highchair, how you manage the social situation, how you cope with it if you are working, how you cope with preparing the foods if you are not working but you feel unconfident about cooking and selecting foods for the family. How you do that. So it isn't I think just about medicine and about deciding what the [critical] windows are. I think it is about what society does to support young families and that is very different and if we think about what has happened over you know in social change over the last 100 years how that is for mothers today is very, very different. And as a nation we have probably got to wake up and think those things through. (Participant 16)

In this account, women had a considerable role to play in helping their children grow healthy and with healthy weight. However, this participant also suggested that perhaps not all women were able to do that because of lack of information, lack of support, the need to juggle work and raising children and so on. While, in this participant's view women should get better health information, the onus of responsibility for ensuring favourable conditions for 'young families' was on 'British society' and the 'nation', rather than on individual mothers. This contrasted with claims made in the media where behaviours and diets of mothers influenced the health of societies, economies and whole nations.

Some other participants also sought to align the scientific interests of their field with the interests of women and children, and they positioned the foetal programming/DOHaD framework as an advocate for change that would result in a more favourable and health-promoting social environment. While participant 16 highlighted the problems with 'British society', some other scholars (in particular

participant 1, 12, 13, 14, 15, 16 and 21) drew attention to politics, the lobbying of food industry, and poverty which in their view underpinned problems surrounding healthy nutrition for babies and young children. According to one scholar:

> Parents get blamed for lots of things about their children. Your child is that way because you didn't reprimand them in the right way when they were doing this wrong and that is why they are stealing cars now, all those sorts of things and the same could be true of a person's diet and what you give them and how much exercise you give them. Are you able to take them swimming? Have you got the money to take them swimming, all those sorts of things. So you could blame parents. (…) There needs to be concessions that allow people with very little money to access those and they need to be able to get nice, fresh food and not have to eat it in fast food restaurants all the time. It is how you address that and it does mean taking from people who have got more and giving it to people who have got less. That is the hard thing. Because politicians it is all about winning votes, isn't it, so can they get that balance right for them and the people with lots of money often have influence over people who make policy and you know lobbying in UK Government and European Government is very strong. McDonalds might have a lot of money and say well you are going to lose 50,000 jobs if you do this to us and that's a big sway because you know if you are making 5,000 jobs by you know moving some of the money around but you are losing 50,000, it is getting the balance right. (Participant 12)

Likewise, participant 1 claimed that:

> [Politicians] like to be conservative, and in terms of health economic benefits if the improvements [in health] aren't [immediate] then that's not necessarily… Politicians are more interested about more short-term goals. And also they tend to be men, don't they, so maybe if there were more women politicians they may be more amenable to taking these

> things up [i.e. the health of women and children] and also there is the pressure from the food industry. (Participant 1)

This scholar pointed to such issues as party and political interests, short-termism in policy making, as well as the predominance of men in politics and governmental institutions that prevented taking the health of women and children seriously. Pressure from the food industry resurfaced in this and other interviews, as participants were clearly concerned with the quality and price of food available for families with children.

As this discussion illustrates, during the interviews participants positioned themselves as responsible scientists (Pickersgill 2016), and they were careful not to blame women for the health outcomes of their children. Such accounts were in stark contrast with the media reports which often framed women and their wombs as the main source of chronic ailments plaguing societies and nations. It is noteworthy that such aggressive press coverage of foetal programming blaming pregnant women even prompted a group of social and biomedical scientists to publish a comment in *Nature*. In this piece social and natural scientists, including researchers into foetal programming, urged fellow scientists to moderate their claims in public and to consider how their work 'is likely to be interpreted in popular discussions' (Richardson et al. 2014).

In this context several participants admitted problems with communicating about foetal programming in public. Conveying complex information in a language accessible for a wider audience clearly presented difficulties, as such communication was often perceived as drawing on culturally embedded stereotypes about mothers and blame. As participant 3 noted:

> So it [the concept of programming] could be seen that it is a sort of non-psychological form of the refrigerated mother or whatever, the womb is to blame and that is one criticism of the DOHaD field. (Participant 3)

Another participant noted the difficulties about finding the balance between informing and telling the women what to do, especially if communication about research and advice came from 'middle aged blokes':

> I hate the idea of saying to, not hate, but I don't like the moralism of saying to women you really mustn't drink and feel bad about that, I don't like it, but on the other hand if there is evidence there then it has got to be out there and I think it is all about how you communicate risk and women are entitled to know that information but if you have people standing up pontificating, middle aged blokes standing up pontificating about what women should and shouldn't do… (Participant 7)

Participant 7, but also participant 10 felt that the fact that research related to women's reproduction could be communicated to women by (often) male scientists in a moralising fashion was problematic and contributing to the impression that science is oppressing women, thus leading to what one of the participants called 'feminist interpretations' of foetal programming. Even experienced communicators admitted that talking about reproduction-related research to non-specialists presented significant challenges, as such information was inevitably processed by lay audiences through the lens of existing social and cultural understandings of early life. For example, participant 13 recalled their experience of giving a talk about the importance of early life to policy-makers and was surprised that their presentation proved far too complex for an educated audience. As this scholar observed:

> I was asked to give a ten-minute talk for a group of policy makers, which I did, and I think that was completely… It was much too complicated and the person who was chairing obviously didn't understood a word I said, so it is really important to be very, very simple, which is what I have done before, just say pregnancy. I should probably have just spent ten minutes just saying pregnancy. But it is a different skill to learn how to talk to policy makers and persuade people.

This participant drew attention to the pitfalls of science communication, namely that too complex information could be misunderstood and misinterpreted, while too simple messages may sound vacuous and unconvincing to the policy makers and other publics. The interviews thus revealed significant tensions between what scientists intended to do and the effects it produced. The scientists' declared intentions related to their wish to communicate in a responsible fashion without soliciting blame or guilt, and with demonstrating the relevance of their research for society. On the other hand, the actual interpretations or effects of the messages which the field was sending in the public realm, and which led to blaming women, were in scientists' accounts unintended and often unexpected. . Still, the effects of such scientific communication were lingering with a potential to affect the image of the field as patriarchal or 'anti-women'. In the views of the respondents then, the potentially negative effects of communicating about this research could be interpreted through the lens of unintended consequences of social actions whose effects can sometimes last longer than those of the intended ones. As Giddens noted, 'the consequences of activities chronically escape their initiators' and social actions can 'lead to consequences that rebound upon those who initiate' them (1986: 375). From this perspective, the negative messages about women's role in increasing risk of adult disease for their children that were communicated through the media and in other social arenas could be read as a 'side effect' of an intensive communication campaign that aimed to provide publicity and recognition for the emerging field of foetal programming.

7.7 Discussion and conclusions

This chapter has drawn on interviews with scientists to explore the meaning of early life risk of chronic disease, the key concept in the foetal programming/DOHaD framework. The focus of this analysis was on scientists' own interpretations and understandings of risk, and in particular on metaphorical framings and narratives that they used to talk about early life origins of health and disease.

During the interviews, the discussions about the meaning of foetal programming and of risk gave the participants the opportunity to position themselves as responsible and modest scientists (Pickersgill 2016). They also allowed them to do boundary-work which demarcated what they considered legitimate knowledge from what they deemed to be inaccurate understandings or inflated claims about risk. In so doing, the scientists deployed various discursive strategies which aimed to recalibrate or deflate risk claims (Gardner et al. 2015), especially those claims that circulated in the media accounts of this science. At the same time these strategies aimed to confirm the reputation of their science by excluding illegitimate, erroneous or 'alien' (Collins 1999) interpretations of risk.

The interviews have revealed much more varied and nuanced understandings of risk than those presented in the media coverage. While in the press the meaning of early life risk of disease was structured and conveyed in large part by the key metaphor of programming, as well as by a range of metaphorical framings clustered around it, not all scientists believed that the concept and the metaphor of programming captured well the nature of the processes occurring in early life. While some participants viewed this metaphor as too negative, deterministic, and indebted to the genetic conceptual tool-kit, others highlighted its partiality, that is its inability to capture a wider range of phenomena occurring in early life. Yet another group questioned the connotations carried by this metaphor, namely that the effects of programming are fixed and constitute the main risk factor for adult chronic disease. Despite these reservations on the part of scientists, it should be noted that the programming metaphor was still used during the interviews, primarily as a shorthand to describe the phenomena in question. This suggests that despite some criticism of the concept of programming, this metaphor may not have yet outlived its communicational usefulness, at least in the professional realm.

At the same time participants also drew on alternative metaphors of 'tweaking', 'nudging', 'multiple hits', 'layering of risk' as well as on the metaphors related to chaos theory to describe the interplay of early life events and adult disease risk. These metaphorical framings offered more varied and nuanced understandings

of risk than those conveyed by the programming metaphor. In contrast to the media accounts according to which programming was the major risk factor of adult chronic disease, these alternative framings emphasised the relevance of other factors such as lifestyle and genetic factors for the incidence of chronic diseases in adulthood. They also suggested that the scale of the effects of programming and its impact on health and disease in future, though difficult to quantify, was more limited than it was implied in the media coverage.

Recalibration of risk claims also meant that during the interviews the meaning of critical periods and critical windows in development was also reconsidered. While in the media risk was represented as 'set in stone' in early life and inevitably prompting disease in adulthood, many scientists emphasised – though to varying degrees – the role of events occurring during lifetime in shaping risk of adult disease. Such conceptualisation of risk as cumulative over the lifespan rather than latent and stemming from the early life period also meant that for many participants in this study the media claims that intervening in early development may eliminate adult chronic disease and various societal ills seemed unrealistic. Scientists were acutely aware that biological phenomena which constituted the focus of the foetal programming framework did not operate in isolation from the material and social conditions, and that the effects of 'social programming', as one participant put it, were as important as the effects of the biological one. By recalibrating claims of risk and by pointing to the limitations of what the foetal programming framework could accomplish in the social realm, some scientists also painted a more modest and humble (Pickersgill 2016) picture of the role of science in contemporary society.

Different interpretations and understandings of the effects of programming, its nature and scale also brought into focus competing ideas about how the science of foetal programming could be translated into practice. While for some participants the idea of designing health interventions remained elusive, some others were keen to see its applications. In contrast to the media which emphasised the benefits of such potential interventions for society, economy or the state, scientists did not tend to draw on such discourses of techno-scientific fixes (Sarewitz and Nelson 2008).

Instead, they sought to align the interests of their field and the benefits of potential interventions or new health guidelines with the interests of women, children and families, especially those from disadvantaged backgrounds.

In contrast to the media which often drew on moralising metaphorical framing of risk, scientists did boundary-work to demarcate what they considered as neutral knowledge produced by the science of foetal programming from social values and judgements that could have a bearing on the interpretation of this research in public. They also avoided the language of blame that permeated the media coverage of this field and they sought to position the field as the advocate of women.

Finally, this chapter has highlighted scientists' ambivalences about public communication of their research and has suggested that the negative messages about the role of mothers in adversely programming their children's health could stem from unintended consequences of scientists' efforts to promote the field in public. ise

Chapter 8. Conclusion

8.1 Introduction

This thesis has set out to examine the emergence of the field of foetal programming/DOHaD as well as public communication about this science and its claims that it constitutes a paradigm shift in understanding the origins of risk of adult chronic diseases. According to proponents of the foetal programming framework, the amount and quality of nutrition in the early stages of development, from around conception, through gestation to the second birthday of a child's life shape the structure and function of organs and tissues and determine the kind of metabolism an individual will have, thus influencing risk of such chronic diseases of adulthood as cardiovascular disease, diabetes and obesity. This thesis has explored this field and its claims by drawing attention to the discursive strategies and tools which were deployed to position it as a new science uncovering new health risks. This analysis has been carried out in two settings: *i)* by studying themedia coverage of research into foetal programming and *ii)* by conducting interviews with researchers in this field. In particular, this thesis has focussed on the field-making strategies, such as narratives and metaphors which helped the media and scientists to make sense of the emerging foetal programming framework, and also to make sense of the new concept of early life risk of adult disease which this field was advancing. This thesis has sought to explore two sets of questions. First, how did the media coverage frame foetal programming research and its risk claims? What narratives and metaphors were used to position this field as a new science of risk, and what implications did these media representations have for the public understanding of risk in early life? Second, how did scientists conceptualise and talk about the emergence and significance of the foetal programming framework and about its risk claims, and what narratives and metaphors did they use to explain the early life sources of adult disease risk?

In pursuing these questions, this thesis has sought to put the foetal programming framework on the map of STS investigations of emerging fields and

biotechnologies. Although the Barker hypothesis was first proposed some three decades ago and it is claimed that it constitutes a paradigm shift, with great attention to new health risks in the public realm, including popular media, this field has received little attention from STS scholars. Scrutinising the claims of this framework and the conditions in which this field has been emerging is especially timely now, when foetal programming/DOHaD has yet again attracted the attention of the popular press. This renewed media attention was brought about by recent advances in epigenetics, a new postgenomic field which, it is hoped, can provide molecular explanations of the processes underlying early life programming of adult disease risk. Claims about early life sources of adult disease risk have not only been circulated in the press, radio and television, they have also inspired international health and aid policies, as illustrated by the global movement of 'the first 1,000 days of life' which aims to improve the health of future generations by focussing on the nutrition of women and children. By exploring conceptualisations of this field and its risk claims in the media coverage and in interviews with scientists, this thesis has sought to address an important gap in scholarship and has offered one of the first monograph-length analyses of these issues.

The aim of this final chapter is to summarise the main findings of the thesis and to discuss its contribution to the field of Science and Technology Studies and also its broader relevance. This chapter is structured as follows. The first section presents the key findings of the thesis. The second section discusses the contribution of this research to STS and public communication and understandings of early life, and it also discusses the contributions of the empirical chapters. The third section offers reflections on methodological challenges encountered during the research for this thesis. The chapter then concludes with some ideas for future research.

8.2 Summary of findings

This thesis has explored discursive strategies and tools that were used in the media coverage of foetal programming and in interviews with scientists to make sense of the emergence and significance of this field and to make sense of its risk claims. This study has found that there were significant differences in the ways in which the

media and scientists conceptualised and communicated about i) the meaning of risk and ii) about the field of foetal programming. These differences were reflected in narratives, metaphors, and other discursive devices which were deployed in these two sets of discourses. This thesis also sought to make sense of the differences in these accounts, and the third key finding of this research relates to the issue of communicating this science in public, and to the issue of hype.

The analysis has shown that, on the whole, the media offered highly favourable, upbeat and optimistic accounts of what the foetal programming framework is, what is says about new health risks and how this science can be applied to improve health of future generations. Thus, the media representations of foetal programming can be viewed as an instance of what Pickersgill has called an 'epistemic ostentatiousness' (2016: 198-199), or such a display of scientific knowledge that presents 'the best side' (*ibid.*), or 'a smiling face' (Harré 1990) of foetal programming, while eschewing uncertainties, criticisms and conflicting interpretations of core research claims. By contrast, the interviews with scientists offered much more nuanced and measured accounts of the field and its claims, and the participants often scaled down the expectations about what their research can achieve and whether and how it can be put to practice. Thus, the 'epistemic modesty' (Pickersgill 2016) displayed by scientists during the interviews indicated a much more realistic and humble vision of the science of foetal programming, its risk claims and its significance for improving the health of populations.

8.2.1 Early life risk and what it means

The first main finding of this thesis is that conceptualisations and metaphorical framings of risk in the media coverage of foetal programming differed significantly from the understandings and metaphorical framings used by scientists during interviews. This thesis has identified three key metaphors of 'programming', 'critical windows' and 'the first 1,000 days of life' which structured the meaning of risk in

press reports and radio and television broadcasts. Taken together, these metaphors as well as clusters of metaphorical expressions that accompanied them in texts conveyed three core features of early life risk of adult chronic disease. First, risk emerging in early life was latent and inevitably manifested itself in later life. The effects of early life programming in the womb were irreversible, as they were 'set in stone', and they could shape not only the propensity to a particular illness but also a variety of health traits – or they could 'make or mar a child's life'. Second, the early life sources of adult disease risk could be controlled by ensuring adequate nutrition, especially during 'critical periods' of development when key aspects of metabolic functions of the growing organism are being decided, and when the body of the foetus or a child is 'built' like a 'house' from nutritional 'bricks'. Ensuring optimal nutrition during these 'critical windows of opportunity' could prevent or reduce the risk of chronic disease later in life. Third, in the media accounts risk was a moral issue, and the press tended to put the onus of responsibility for the health of future generations on future parents, especially mothers. Alternatively, in the context of the Global South the media tended to emphasise the role of various institutions, such as governments or aid agencies which were deemed responsible for reducing such risks.

By contrast, scientists' conceptualisations of risk were more nuanced and complex, and they differed considerably from those in the media coverage. First, although the metaphor of 'programming' was used during the interviews, it did not seem to structure scientists' understanding of risk in the same way as in the media. Participants were reflexive about different ways and contexts in which the metaphor of 'programming' was deployed, and they offered critiques and various interpretations of the meaning of programming and the risk it entailed. In addition, scientists drew on their professional understandings and on linguistic creativity to convey their own conceptualisations of early life risk through a range of metaphors such as 'tweaking', 'nudging', 'layering', 'multiple hits', 'social programming' and chaos metaphors. These metaphors as well as narratives that scientists drew on during the interviews suggested a much wider range of understandings of risk than in the media. These metaphors also went beyond the descriptions of early life risk as

latent and determining future health outcomes of an individual. They also tended to explain the risk of disease as arising during the lifetime rather than only during the time spent in the womb. According to the participants of this study the propensity to chronic disease could indeed be shaped in early life, but the actual risk of developing such diseases was also shaped by other events over the life span, including dietary choices, smoking and levels of physical activity. Thus, rather than being purely latent and static, risk of adult chronic disease was described as cumulative, more dynamic, and changing during the lifetime. In addition, rather than being the most important determinant of adult health, the effects of early life programming were framed by scientists as subtle and also more difficult to quantify than what was claimed in the press.

Second, while the media suggested a considerable degree of control in preventing early life sources of adult disease risk, scientists were more ambivalent about the extent to which the adverse effects of early life programming could indeed be controlled. This was reflected for example in the use of chaos metaphors which depicted early life development as complex and difficult to predict, as well as in the metaphorical statement that optimal health could not be 'designed' in the womb.

Third, in contrast to the media accounts which often couched early life risk in moralistic metaphorical framings and apportioned blame for disease risk to future mothers, scientists sought to avoid moralising language when explaining risk during interviews. They also tended to align their field's interests with the needs and interests of women, children, and disadvantaged families. Rather than focussing on the responsibility of individual mothers, they emphasised the role of such structural conditions determining health outcomes as poverty, access to healthy food, food policies, and so on. In sum, the media representations of risk differed from scientists' conceptualisations in three important areas related to *i)* the nature of risk, *ii)* the ability to control or reduce risk and *iii)* the issues of responsibility and blame surrounding early life risk of adult disease.

8.2.2 The field of foetal programming and what it can do

The second key finding of this thesis relates to the foetal programming as a scientific field and its representations in the media and in the interviews with scientists. Here again, both sets of accounts differed considerably in three aspects. First, the media coverage was a site of field-making discursive strategies which sought to define foetal programming as an independent field, and also to position it as a frontier science, and even as a paradigm shift in the biomedical sciences. Narratives and metaphorical framings deployed in media reports depicted this field as akin to magic and capable of changing people's destinies, or, alternatively as a sweeping scientific revolution which gained followers and recognition. These grand narratives about the uniqueness of the foetal programming framework were underpinned by quite conventional imagery of heroic science and scientific geniuses, which further confirmed stereotypes about science in general. Second, the media coverage emphasised the practical implications of the Barker hypothesis, namely the possibility of designing health interventions and polices which would reduce or eliminate the risk of adult chronic diseases and which would target women of reproductive age, both in the West and the Global South. Third, and relatedly, the media also tended to imagine additional benefits of such interventions which linked the health and nutrition of women and children to such issues as the elimination of poverty, reduction of violence, and ensuring economic growth and prosperity of nations and states. Thus, the applications of the foetal programming research were framed in the press not only as health issues but also as economic arguments.

In contrast to the media coverage which provided celebratory and upbeat accounts of foetal programming, scientists interviewed for this project were more modest in their claims about their field and its status among other disciplines. First, they tended to avoid the language of grand narratives (Lyotard 1979) of science. While during the interviews scientists did use celebratory discourses to emphasise the achievements of the foetal programming framework, they also reflected on the challenges related to establishing and sustaining a new scientific field, especially at the time when this field experienced a backlash from the scientific establishment. Thus, the interviews

suggested that the optimistic media stories about foetal programming did not fully reflect the challenges it faced in the professional realm, and that they tended to overstate what this field could elucidate and achieve. Second, in contrast to the media coverage, scientists expressed a wider range of views about potential health interventions based on foetal programming research. While some participants felt that discussions about health interventions went beyond the scope of their expertise, others expressed ambivalence about the rationale, effectiveness and feasibility of such health interventions. Yet another group thought that foetal programming research could indeed underpin new health initiatives, such as issuing new dietary guidelines for pregnant women and introducing new health policies and programmes both in the West, and in the Global South. The interviews thus highlighted more pragmatic assessments of the current potential of the foetal programming research to be translated into practice. They also revealed a lack of consensus among the participants about how exactly foetal programming research could be applied to improve health. Third, and relatedly, participants did not tend to draw on the narrative of science as a driving force of progress and economic growth. A few participants even objected to framing foetal programming research, and science in general, as a technoscientific fix for pressing societal problems, although they acknowledged current pressures on scientists to position their research in exactly this fashion. All in all, during the interviews scientists recalibrated the claims about their field and tended to play down exaggerated expectations related to future applications of this science. The interviews also highlighted a lack of consensus on the ways in which this research could be integrated with healthcare and health policies.

8.2.3 Hype and its effects

The third main finding of this thesis relates to the issues surrounding public communication about foetal programming research. The interviews revealed scientists' ambivalences about the ways in which this science was framed in the public realm. Although scientists tended to acknowledge difficulties that arise from

the need to communicate both accurately and effectively about research, they also felt that public messages about their field were, at least in some situations, hyped. Examples of such hype related to the core claims about this field and its conceptualisation of risk, and included the messages that, for instance, the negative effects of undernutrition in the womb were more serious than the effects of smoking in adulthood, or that birthweight and other features of a newborn could predict this child's future health. During the interviews scientists offered their interpretations of the reasons behind such public messages about the field. On the one hand, hype was understood as a means of promoting science by telling interesting, though embellished, stories about research. This performative hype contrasted with the public messages which, as participants felt, were 'bigged up' in the media in reaction to the criticism levelled at this field by its opponents. Such defensive hype sustained the reputation and public image of foetal programming among non-specialist audiences even at times of crises in the professional realm. For some participants, however, this hype seemed to be a double-edged sword as in their views it affected the credibility of the field and slowed down the uptake of its ideas in the wider biomedical community. Aggressive public communication about this field, as well as simplified and exaggerated messages about early life risk may have also contributed to the perception that the foetal programming framework was 'anti-women', the view that some participants acknowledged but also opposed. In this case, the brand of women-blaming science may have been an unintended consequence of hype and intensive public communication which attempted to build and promote this field in public. Hyping messages in public did not however seem to affect the reputation of individual scientists, and the participants of this study also suggested that at least some degree of hype or of 'bigging up' the message was a frequent feature of academic life.

8.3 Contribution of the thesis

The findings of this thesis have some important implications for STS and STS-inclined studies of science, as well as for the public understanding of early life.

As mentioned before, this thesis has sought to put the foetal programming framework on the map of STS investigations of postgenomic sciences. It seems that the emergence of this field and the evolution of its claims have been largely overlook by STS scholarship, and this thesis strives to fill this important gap by paying close attention to the discourses surrounding the formation of this research and its core concepts. In a way, this project has attempted to 'recover the visibility' (Shapin 2016) of foetal programming for social scientists, and, in particular, it has attempted to shed light on the complex, and often contradictory understandings of this field and its claims that have been uncovered in the media and interview analyses. In a sense, this study recalibrates the claims of foetal programming for social scientists, as it presents a wider range of meanings and conceptualisations surrounding the foetal programming framework than acknowledged in some of the emerging social science literature on this field. In doing so, this thesis demonstrates that the foetal programming framework does not easily lend itself to categorisations and labelling, which seek to align research in this field with neoliberal values or, alternatively, with some feminist and fat acceptance agendas, as argued by some social scientists (see Chapter 2). Instead, this study suggests that any future attempts to theorise this field should be grounded in wide-ranging and in-depth empirical investigations. This could not only further the understanding of this field by social scientists, but also prevent the production of 'alien' (Collins 1999) or even hyped accounts (cf. Pickersgill 2016) of this science by social science investigators.

This thesis has also sought to contribute to the literature on hype. Although much has been written about hype in science, this topic still seems to be under-researched (Master and Resnik 2013, Nerlich 2013). The concept of hype itself also seems to be under-specified and used as 'blunt tool' (Kitzinger 2008) to characterise a wide range of complex processes. Weingart (2017) has called for more empirical investigations of hype which could offer a more nuanced analysis of this phenomenon. Weingart has also identified several areas where more research is needed, such as the attitudes of scientists towards hyping public messages, the actual effects of hype, including its effects on the credibility of science and so on.

This thesis has attempted to address these concerns and has provided an empirical study of hype in public communications of foetal programming research. Its findings provide novel insights into the conditions under which new fields are actively constructed in the public realm through discursive strategies, including hype. While someresearch on hype posits that hyping is performative as it helps create new fields and expectations about it (Borup et al. 2006, Weingart 1998), this study offers a more nuanced analysis of hype. The case of public communication of foetal programming research shows that exaggerated claims can indeed be produced to build and promote the field in public, and they can be interpreted as instances of preservative rhetoric which grabs the headlines and spreads good news about science while waiting for the actual scientific achievements to materialise. The findings show however, that in some cases widely exaggerated claims can be produced in reaction to criticism of science. Such instances of hype can be interpreted as acts of defiance and attempts to sustain the reputation of science in the public arena, even more so if it is threatened in the professional realm. The findings of this thesis also seem to contradict the Carl Sagan effect (Martinez-Conde 2016, Rödder 2009) whereby prominence in the public realm seems to be detrimental for careers in academia. This thesis suggests that, at least in the case of Professor David Barker, visibility in the media and even 'missionary zeal' (Pincock 2013) and hyping messages about science did not affect his reputation as a leader in the field. More research would be needed to see if and to what extent hyping science is damaging for scientists' reputation in other scientific fields and contexts.

The findings of this thesis also have implications for public communication and the public understanding of risk in early life, and especially for the understanding of the responsibility of future mothers for the health of their children. This thesis has revealed significant differences in communicating about early life risk and its implications for lifelong health in the media and in the interviews with scientists. These differences are potentially consequential for the understanding of early life by various publics who, as a result of the media coverage, are exposed to over-simplified and often misleading interpretations of this science, and who may indeed

be led to believe that mothers – and not genes, lifestyle choices and various other factors - are the main cause of their children ill-health in future. This study has also highlighted ambivalence and criticism by some participants of the ways in which their field was framed in the public realm, and the resulting reputational damage in the scientific realm. These findings suggest, alongside the recent analysis of the public communication of foetal programming research (Richardson et al. 2014, Winett et al. 2016a and 2016b), the need for the media and scientists alike to manage the enthusiasm about science (Will 2010) and communicate in a more responsible fashion.

More specifically, the empirical chapters of the thesis have provided analyses and insights about various aspects of the foetal programming framework. Chapter 4 has offered a detailed empirical analysis of how the field of foetal programming was discursively established in the media and the public realm more generally as a legitimate area of inquiry and as a paradigm shift. This chapter has examined this field's emergence by analysing three decades of media coverage of the research in this field. This extended timeframe for analysis has enabled this study to identify patterns in the communication about this science which contributed to the successful promotion of this field in public. First, over the years the messages related to this field were remarkably consistent, as they represented the emerging field of foetal programming as a scientific underdog fighting for recognition alongside the competing frameworks of genetic and lifestyle factors of risk. Various discursive devices such as paradoxes, metaphors, narratives and anchoring were used in boundary-work which sought to differentiate foetal programming from its rivals by presenting it as more innovative and reliable. While much of such media coverage drew on inflated claims about the superiority of the foetal programming approach in comparison to genetic and lifestyle factors, it also drew on what might be called as 'anti-hype' (Kitzinger and Williams 2005), or such a presentation of rival approaches which seeks to diminish their standing and de-legitimise at least some of their claims. Thus, as Chapter 4 demonstrated, the promotion of a new scientific field might entail

a long-term strategy that involves both hyping its own scientific contribution and anti-hyping the contribution of the competitors.

Chapter 4 identified hedging as an important strategy of reducing uncertainty surrounding an emerging field, and even contributing to hyping of its claims. Using long-standing insights from linguistics that are so far largely overlooked in STS/media analyses (but see Kitzinger 2008), this chapter has demonstrated that hedged or qualified statements used in the media coverage of foetal programming helped increase the certainty and robustness of its findings, while at the same time hedges enhanced the credibility of some inflated or dubious statements about the severity of early life origins of risk, such as 'the nine months in the womb may make or mar a child's life'. As the literature about the use of hedges in the press reports of science is not large, this study contributes to such scholarship by shedding light at this understudied discursive strategy. In future, more research could be conducted to investigate the use of hedges in promoting emerging areas of research.

Chapters 5 and 7 engaged with scientists' views on their field and on the meanings of risk, and they sought to provide additional perspectives on the ways in which the foetal programming framework was built and promoted in the public and professional realm. In particular, they investigated the issues of hype surrounding public communication of foetal programming and scrutinised scientists' accounts of the context in which inflated claims about science were produced and disseminated.

Metaphors are crucial both to doing science and communicating about it to various audiences, and Chapter 6 as well as Chapter 7 provided a detailed analysis of the metaphorical framings of foetal programming used both in the media coverage of this research and by scientists. This thesis has identified a web of metaphors, including key metaphors of 'programming', 'critical windows of opportunity', as well as 'the first 1,000 days of life' used in the media coverage, as well as a plethora of metaphorical framings that accompanied them in journalistic coverage. The analysis has shown how these metaphors emerged and how their meanings changed over time and in different contexts. It also highlighted some ethical implications of

these metaphors in relation to understanding early origins of disease risk. In particular, Chapter 6 illustrated that the way in which metaphors are understood and interpreted depends to a large extent on the cultural terrain (Nelkin 1994) in which they are adopted and used and also that they are deployed to support and confirm prevailing beliefs. What this suggests is that metaphors related to the early life origins of risk might be used with a view to empowering some groups of women – for example, those who are wealthier and better educated, or to blame and scapegoat women from disadvantaged backgrounds.

8.4 Methodological challenges

This section provides some reflections on methodological challenges associated with this research, and it discusses the following issues: research design, anonymisation of the data, and limitations of this study.

8.4.1 Research design

Choosing a particular research design is one of the most important decisions during the research process, as it shapes the kind of data that is analysed, and ultimately it influences the outcomes of the whole project. Various factors influence such decisions, from the fundamental ones, such as the suitability of a given design to the research questions of the project, to more pragmatic considerations, such as the feasibility of alternative designs. This thesis draws on the analysis of two sources of data: the media coverage of foetal programming research and interviews with scientists to achieve a complementarity of data and gain insights into additional layers of meanings. But studies of scientific claims in the public realm can also be designed in different ways. One such way would be to integrate more sources into research design. In addition to media articles and interviews, this might include examination of press releases and scientific articles. While such a research design offers the possibility to study a wider range of contexts in which scientific claims are being made and negotiated, it also presents challenges, not least given the time and resource constraints associated with a PhD project. In addition, the range of sources and the amount of data generated by such research design would mean that the

project would have to focus on shorter timeframes of public communication about this science. The research design chosen for this thesis, which combines media coverage and interviews, has allowed me to analyse longer timeframes of public communication of this field, from its inception to the present day.

8.4.2 Anonymisation of data

The anonymisation of data poses a range of challenges for research projects that rely on the data gathered under the condition of anonymity and confidentiality. Researchers have to balance the objective of avoiding accidental disclosure of the identity of participants with the need to gather rich, detailed and interesting data. Such challenges are particularly salient when researching small scientific fields, and especially when interviewing scientists working in small fields where networks are dense and scientists tend to know the minutiae of each other's approaches and conditions of work. During fieldwork for this thesis I took great care to anonymise details which could accidentally point to the identity of participants. I also decided to conceal the identity of all participants, even though some were happy to speak on the record. This was because of the nature of networks in this field meant that revealing the identity of one participant could lead to revealing the identity of those who wished to remain anonymous. I also sought to incorporate the maximum amount of detail relevant to the questions asked by this project.

8.4.3 Limitations of research

This study has analysed discursive strategies and tools that were used to make sense of foetal programming and its claims in two settings: media coverage and interviews with scientists. It has limitations which stem both from its research design and the data it has analysed. For example, although this thesis analyses a range of meanings conveyed by the media coverage of foetal programming, and it reflects on the potential implications of such coverage for public understanding, it does not explain

how such media reports are actually interpreted by different publics. Future audience research could shed light on this issue.

Given the various limitations of the Nexis R database (Deacon 2007) discussed in Chapter 3, as well as the research design which prioritises the study of broad patterns of coverage as well as oppositional and deviant cases, the findings of the media analysis provide qualitative insights into media reports, but not statistical information about numerical frequencies.

Although the issue of gender in science is interesting and worth exploring, this study has not been able to detect any connections between the gender of research participants and their conceptualisations of risk and responsibility for health in the context of foetal programming research. This may have been related to the size of the sample as well as to the difficulty of recruiting a larger number of female researchers for this study. Future research could engage with this issue in more depth.

8.5 Ideas for future projects

Given that the field of foetal programming remains under-studied from the perspective of STS, there are a number of broad areas where further research would be useful. First, more detailed investigations of the meaning of risk in different settings and on the basis of different kinds of sources could yield interesting insights into the ways in which risk is conceptualised and communicated in different settings as well as by and for different publics. In this context, integrating different kinds of sources, such as the afore-mentioned press releases and comparing them with scientific articles and other data could be a fruitful avenue for future research.

Second, the findings of this study indicate that research into foetal programming is starting to inform or at least inspire various both local and global health initiatives, as illustrated by the emergence of the metaphor of 'the first 1,000 days of life' in different geographical and institutional settings. Future research could shed light on the ways in which this metaphor makes risk meaningful for different

populations and institutions, and how potentially the concept of ‘the first 1,000 days’ is being operationalised in the context of health policies and healthcare.

Finally, exploring the ways in which the ideas of early life programming of disease are understood by various lay publics, including current and future mothers, and if/how they inform beliefs and behaviours could constitute an exciting research agenda for scholars interested in the study of risk and human reproduction.

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Appendix 1. Figures and tables

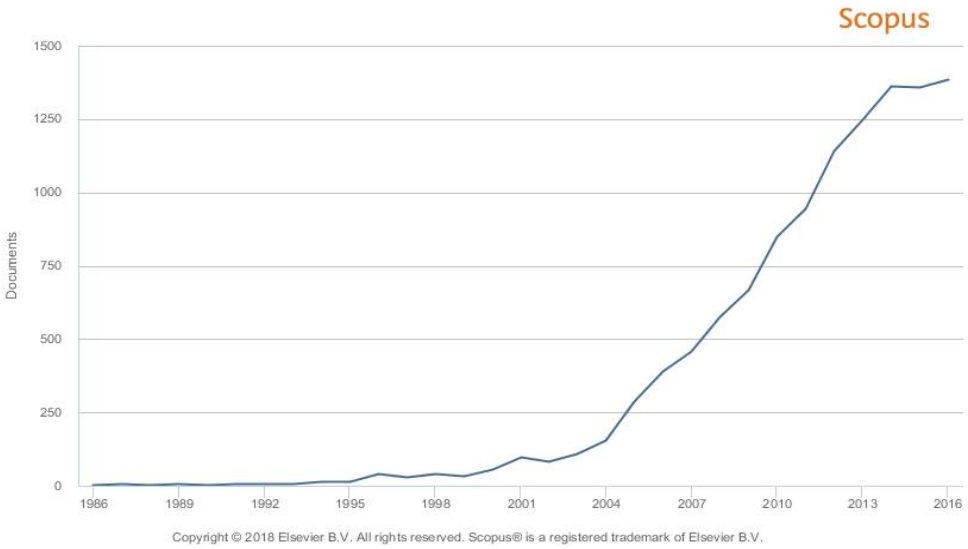


Figure 1. The growth of the field as measured by the number of scientific publications on Scopus (search for 1986-2016, keywords 'foetal OR fetal programming' and 'developmental origins of health and disease').

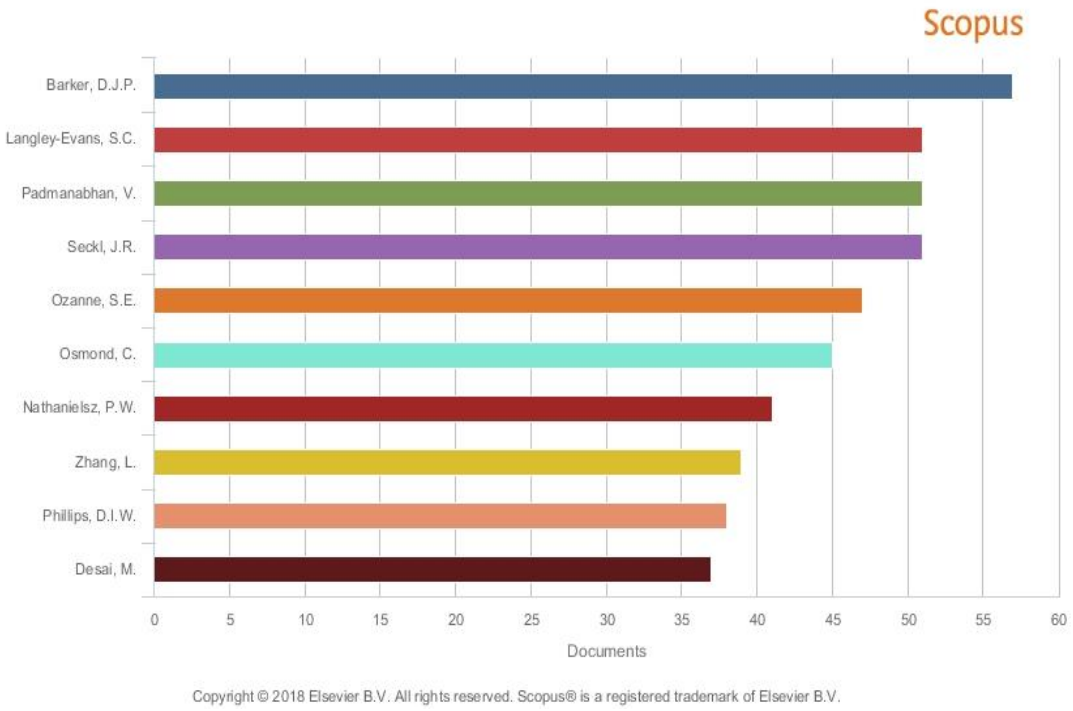


Figure 2. According to Scopus, David Barker is one of the most prolific authors in the field of foetal programming (search for the period 1986-2016, keyword 'fetal programming OR 'foetal programming').

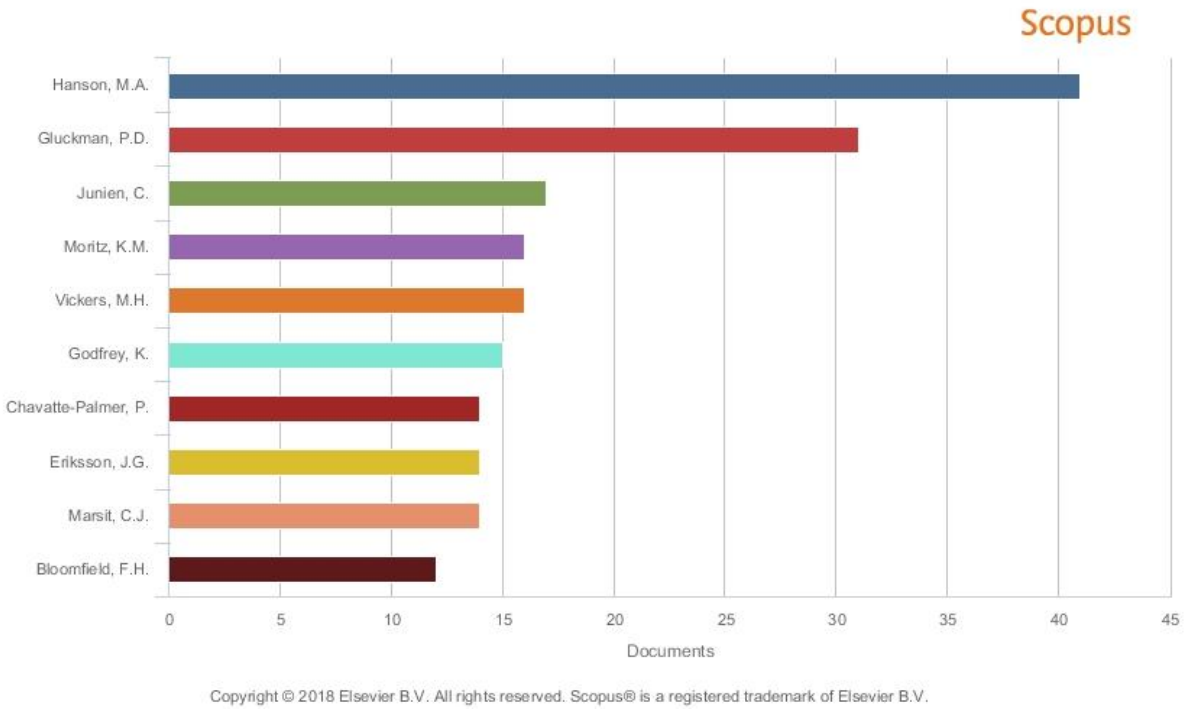


Figure 3. According to Scopus Mark Hanson and Peter Gluckman are some of the most prominent authors in Developmental Origins of Health and (search for the period 2003-2016, keyword 'developmental origins of health and disease').

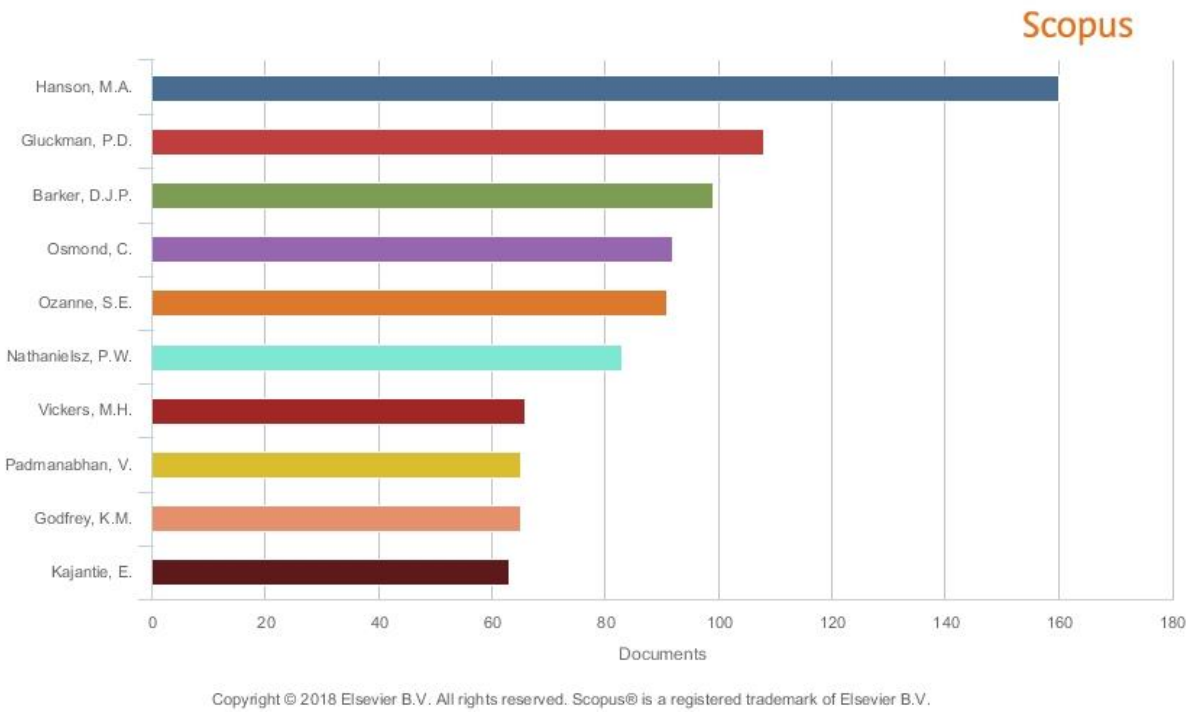


Figure 4. Mark Hanson, Peter Gluckman and David Barker have authored the highest number of publications in the field of DOHaD and foetal programming (search for the period 1986-2016, keywords 'foetal OR fetal programming' and 'developmental origins of health and disease').

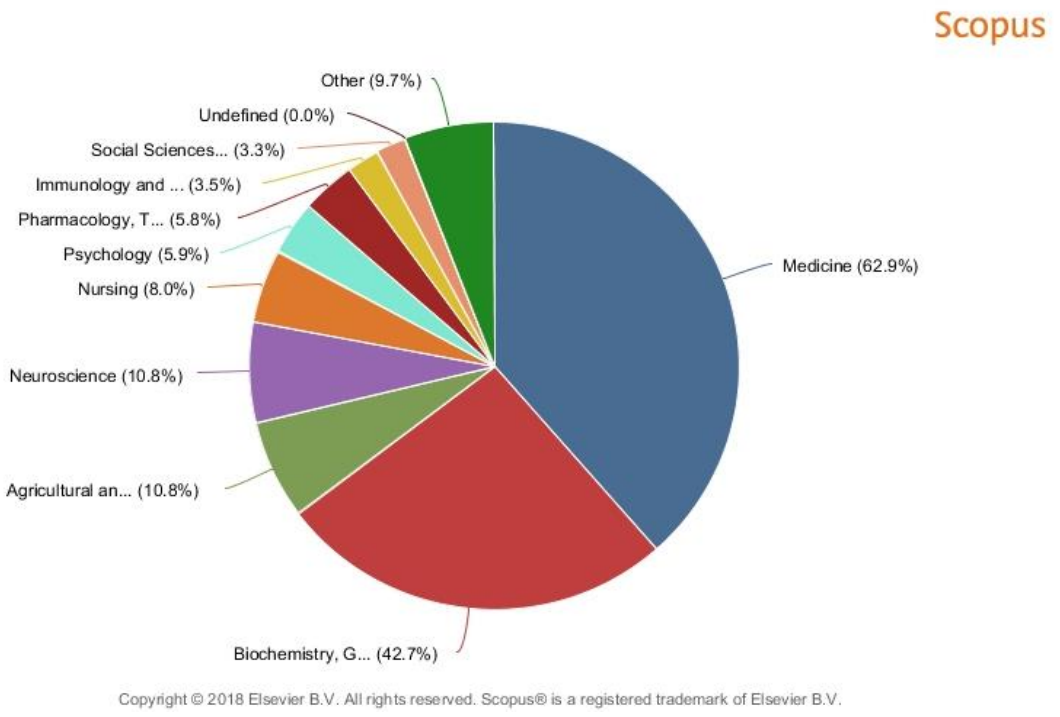


Figure 5. Scientific research drawing on concepts from foetal programming/DOHaD has been conducted mainly in medicine and biochemistry, but also in numerous subject areas, often with only loose conceptual or disciplinary connections to core DOHaD research (search in Scopus for the period 1986-2016, key words 'foetal programming' and 'developmental origins of health and disease').

	Key scientific publications in the field	Number of citations until 2016
1.	Hales, C.N. and D.J.P. Barker (1992). 'Type 2 (non-insulin-dependent) diabetes mellitus: the thrifty phenotype hypothesis', *Diabetologia*, 35 (7), pp. 595-601	2000
2.	Barker, D.J.P. (1995). 'Fetal origins of coronary heart disease', *BMJ*, 311 (6998), p. 171	1955
3.	Barker, D.J.P., Osmond, C., Winter, P.D., Margetts, B. and S.J. Simmonds (1989). 'Weight in infancy and death from ischaemic heart disease', *The Lancet*, 334 (8663), pp. 577-580	1895
4.	Hales, C.N., Barker, D.J.P., Clark, P.M.S., Cox, L.J., Fall, C., Osmond, C. and P.D. Winter (1991). 'Fetal and infant growth and impaired glucose tolerance at age 64', *British Medical Journal*, 303 (6809), pp. 1019-1022	1840
5.	Barker, D.J.P, Hales, C.N., Fall, C.H.D., Osmond, C., Phipps, K. and P.M.S. Clark (1993). 'Type 2 (non-insulin-dependent) diabetes mellitus, hypertension and hyperlipidaemia (syndrome X): relation to reduced fetal growth', *Diabetologia*, 36 (1), pp. 62-67	1804
6.	Barker, D.J.P., Godfrey, K.M., Gluckman, P.D., Harding, J.E., Owens, J.A. and Robinson, J.S. (1993). 'Fetal nutrition and cardiovascular disease in adult life', *The Lancet*, 341 (8850), pp. 938-941	1675
7.	Gluckman, P.D., Hanson, M.A., Cooper, C. and K.L. Thornburg (2008). 'Effect of in utero and early-life conditions on adult health and disease', *New England Journal of Medicine*, 359 (1), pp. 61-76	1639
8.	Barker, D.J.P., Osmond, C., Golding, J., Kuh, D. and M.E.J. Wadsworth (1989). 'Growth in utero, blood pressure in childhood and adult life, and mortality from cardiovascular disease', *British Medical Journal*, 298 (6673), pp. 564-567	1441
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Table 1. Key publications in the field of foetal programming/DOHaD based on the number of citations in Scopus (based on the search for the period 1986-2016 with the keywords 'fetal programming', 'foetal programming', 'Barker hypothesis', 'the Barker hypothesis', 'fetal origins of adult disease', 'developmental origins of health and disease', 'Barker D.J.P.', 'Hanson M.A.' and 'Gluckman P.G.').

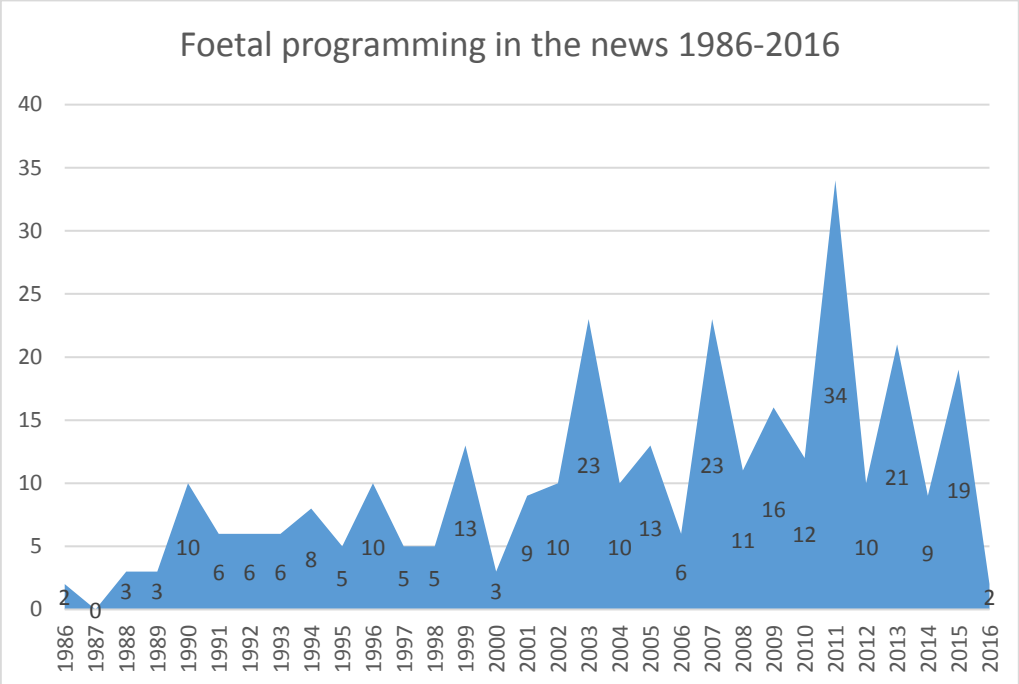


Figure 6. Foetal programming in the news 1986-2016 (based on search in NexisR on a high similarity setting with keywords ‘Professor David Barker’ OR ‘foetal programming’ OR ‘fetal origins hypothesis’ OR ‘developmental origins of health and disease’ OR ‘the first 1000 days of life’).

Appendix 2: Media sources in chronological order

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