The public career of the 'gene': trends in public sentiments from 1946 to 2002

The Public Career of the 'Gene' – Trends in Public Sentiments from 1946 to 2002.

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Abstract

The paper shows, on the basis of longitudinal analysis of the British press, that public opinion of genetic research and biotechnology varies over two long-term waves: from 1946 to 1972 and from 1973 to the 2000s. Each wave shows a nested phase of enthusiasm and of scepticism. During the first wave biological news has little salience and evaluation parallels the attitudes to general science. During the second wave genetic engineering becomes a major news item, and its phase of evaluation separates from that of general science and technology. While general science improves its public profile, biotechnology becomes publicly controversial during the 1990s. Public perceptions, as far as data is available, follows the changing trends of the press with some lag. For both waves of public sentiment the paper highlights events and topics that fuelled public imagination and that led to the present mix of controversies over genetic technology in food production, biomedicine and law enforcement. The watershed events of 1996 (gm soya) and 1997 (Dolly the sheep) did not initiate the trend changes which started already in mid 1980s, but catalysed an already established trend towards more sceptical sentiments in the late 1990s.

Keywords: social representation, long-term trends in public opinion, media monitoring, DNA, genetics, biotechnology.

Opinion polls and studies of public sentiments towards genetic research in all its modes and applications abound, but only in recent year when public controversy has become apparent. Long-term continuous data streams on public opinion and public sentiment on anything is generally hard to come by. Outside voting intentions, the labour market, fear of crime, and the consumer climate, the social sciences have few established 'weather stations' that take readings of public sentiments comparable to the innumerous readings of temperature, humidity and wind speed that go into weather forecasts. The rule seems to be: no controversy, no opinion poll. For the long-term study of public sentiments towards genetic research we suffer exactly that shortage of readings, but we may be able to compensate the handicap by resorting to longitudinal analysis of newsprint. The present paper analyses the trajectory of genetics in the British press between 1946 and 2002. The paper makes several conceptual, substantive and methodological points.

Representation matters

Despite post-modern ruminations of a 'crisis of representation', the presumption of this paper is that representation of biotechnology matters. 'Representation' has however several meanings. First, it means to speak on behalf of somebody, either in court for a client or in parliament for a constituency. Secondly, it means to collect data from a population in a unbiased manner ensuring that each member has the same chance of being selected (this meaning is part of our methodology, see below). And finally it refers to re-presenting something that is absent with semiotic tools such as iconic images, indexical markers, or word symbols, expressions or stories. And absent means being presently at a different location or a matter of imagination, or having had a past existence, or having a future as a not-yet-being. Representations thus accommodate reality and are a potential space, past and future. I will use the term 'representation' mainly in the latter semiotic sense. Furthermore, representations are no private matter, but communicated among people. They are the resources we all use to make sense of the world and world events (see Wagner & Hayes, 2005; Jovchelovitch, 1996; Farr & Moscovici, 1984). Hence, representations of biotechnology, the focus of this paper, are not epiphenomena of a techno-political fait-accompli, but they are an integral part of the public sphere that, by focusing

attention, motivate and legitimate or question and resist this new technology (Bauer & Gaskell, 1999). A convenient data stream, albeit not the only one, for the reconstruction of representations is mass media reportage. A key problems is how representations come about, are sustained, and change over time in any public forum. Representations of any public issue are sponsored and contested by social actors, and in this contest we like to think of an emerging technology as a quasi-social movement that competes for public attention and thus enhances or shortens its future (see Bauer, 2002b; Bauer & Gaskell, 2000).

The analysis of media representations is complicated by the double nature of mass mediation: expression of public opinion on one hand, and lever of social influence on the other. Mass media are both means and mediator. Our daily news in Britain is in a classical sense public opinion. It is the expression of a constitutionally protected freedom of speech about matters of common interest in a competitive market of opinions.[i] But news and reportage is also influential in setting the agenda and framing the public opinion process: thus they are means to tell the people what to think about, and how to think about matters public. The mass media are the targets of strategic controls and thus prone to explicit and implicit bias.

Content analysis of news makes two contributions. First, it shows what many actors were perceiving, or at least were able to, as public opinion at the time. Politicians, business people, civil servants and scientists attend to newsprint and thus encounter public opinion. For many the news is a marker of public opinion. This opinion is selected and elaborated by the daily practices of journalists and news production in a competitive market for audience attention (Hansen, 1993). It is like an exhibit in the London Tate Modern gallery: it reflects a mixture of ethos and the commercial and cultural sense for a good story. After all, newsprint responds to a readers' market of attention; what is of no interest, does not sell; hence over time we expect, the stories that sell reflect the reader mentality by way of accommodation. Media analysis offers an index of 'opinion in public', while an individual reader may privately very well have ignored, agreed or disagreed with its contents. Secondly, the mass media circulate images and arguments and insinuate to the readers what to opine about. For many social actors, strategically intent upon setting the agenda on an issue such as biotechnology, media coverage is instrumental: to frame public discussions, to

cultivate certain views, and to persuade the public to support a certain course of action. In the long run, news coverage and reportage will, by way of simple redundancy, cultivate particular public views, thus create, stimulate or caution expectations of things to come. Mass media analysis offers therefore early indicators of public opinion in the making, albeit with a exaggerated amplitude. For example, 'sexing up' is part and parcel of preparing the ground for new technology. There is method in hype and the modernist bias for innovation: 'revolutionary' innovations need the attention of funding agencies, venture capital and the young. Some occasions demand more moderate claims making and reassurance that nothing is in the making that might require new regulation and laws.[ii] Contradictory rhetoric comes with new technology, as different audiences need to be pleased.

Thus, by looking over the shoulders of past newspaper readers, we can gauge how genetics was mirrored in society at different periods in time, and this, because independent of the polling industry, not only in times of controversy. This mirror, because of its double nature, however, is neither plain nor plane.

The public sphere, topic salience and framing

News is a dramatic narrative centred on events, actions, persons and a moral point (Schudson, 2003; Burke, 1945). Equally, science news offers the reader a personalised drama in and around science and technology. This idea of 'drama' has several implications. Firstly, it avoids the expectation that news reportage is isomorphic to scientific activities and is therefore to be judged by its 'accuracy'. To the contrary science news as dramatic representation of science is to be judged by its rules of operation: the selection and elaboration of events according to news values, and by its contribution to the formation of public opinion (Neidhardt, 1993). Representations of science in newsprint are contributions in and for the public sphere, neither primarily true nor false, nor irrelevant, nor educational, nor entertaining. News foremost dramatises events to synchronise and modulate public attention, provides frames of interpretation and stimulates everyday conversations (Bauer & Gaskell, 1999).

We distinguish public opinion from the public sphere on the one hand, and from opinion measurements on the other; three distinct but related concepts. The public sphere is an historical structure of forums where reasonable opinion emerge on matters of general concern, subject to the constraints of a ideal of free speech (Habermas, 1989). The public sphere requires constant vigilance against tendencies of decline. Within a public sphere, public opinion is a process that can be studied by its outcomes, classically a vote or an opinion poll. However, it is important to avoid the fallacy of operationalism and define public opinion by what public opinion polls measure. I research 'public opinion' as covariance of mass media contents and public perceptions over time. Like other measures, once visualised, they offer 'movable immobiles' of otherwise intangible phenomena. Secondly, the notion of drama focuses attention to the stage setting and the plot. The setting opens space, and the plot links acts and actors into complications and offers a moral. Here I consider two elements of such drama: the space given to and the evaluation of the act of 'genetics'.

Methodology

The long-term trends of the press coverage are reconstructed from two research databases of British media coverage. We[iii] consider the number of articles in a single newspaper as indicator of public salience and the mean evaluation of genetics and biotechnology across the articles as an index of public attitudes. Our method is content analysis (e.g. Bauer, 2000; Krippendorff, 1980). With two simple indicators we characterise the unfolding public drama of genetics over the past 50 years. The value of this procedure is the simplicity and ease with which longitudinal data streams can be constructed. If public opinion is a process, then its faithful representation must at least be a dynamic picture.

Data for the period 1946-73

The database 'Science and Technology in the British Press, 1946-92' comprises newspaper articles dating from 1946 to 1992 (see Bauer et al., 1995). The corpus is a probability sample of press articles, stratified by year and newspaper including the

Daily Telegraphy, *Daily Mirror*, *Daily Times*, *Daily Express*, and the *Guardian.* The study coded scientific and technology themes (Q36 and Q37), for our purposes we selected the materials on biology or genetics. 'Biotechnology' was not a term in public discussions before the 1980s. Intensity scores are estimated based on the sample and weighted to a single source basis; the bi-annual scores are interpolated for the missing years. The 'evaluation' of the scientific event is rated for each article (code Q18) between 1 (= discourse of great promise) and 5 (= discourse of great concern). These ratings are recoded so that the neutral position is 0 (-2 to +2). Note that on average the pre-1973 evaluation of genetics is slightly on the negative side (mean = -0.15; std dev = 0.24; n=165). Annual mean scores are a reliable index of the changing evaluation of 'genetics' between 1946 and 1972. Inter-coder reliability of this process is 0.87.

Data for the period 1973-99

The international project 'Biotechnology and the Public' conducted press monitoring of biotechnology news in the elite press for the period between 1973 and 2002 (see Durant, Bauer & Gaskell, 1998; Bauer & Howard, 2004). Salience figures are based on a single source outlet (UK: *Times* until 1987; *Independent* after 1987); until the mid 1980s figures are based on Times Index entries. In later years we have access to on-line resources and used the search keywords 'genes', 'biotechnology', 'cloning' or 'DNA'. We enumerate all references. Comparisons of different news outlets show a high annual correlation of topic salience, because of strong competition in the newspaper market. This suggests that a single source is a good enough long-term indicator. The content coding is based on an annually stratified random sample of articles. The 'evaluation of biotechnology' is based on two scales, a negative (Q23a: 0 = not applicable; 1= slightly negative; 5 = discourse of great concern) and positive rating (Q23b: 0 not applicable; 1= slightly positive; 5 = discourse of great promise). The evaluation index is defined as the difference of positive and negative ratings. Note that on average the post-1973 ratings are positive (mean = 1.09; std dev = 1.90; n= 802).

We consider these ratings functionally equivalent before and after 1973. For purposes of analysing long-term trends we calibrate the two series. The overlap of the two data

series from 1974 to 1992 helps to validate both intensity and valuation figures in the two series. We standardize the evaluation scores in both data series to their long-term average. The graphics below show the annual deviations from the long-term average (mean = 0, std dev = 1). The standard score of 1972 is slightly lower than that 1974; to link the two time-series we raise the pre-1973 series by adding a correction of (+)0.2 to standard score. This avoids the wrong impression of a 'sudden jump' in 1972-74, which is likely an artefact of using different measures.

Public perceptions: being optimistic about biotechnology

The optimism index is based on the UK data of Eurobarometer, an instrument of the European Commission to monitor opinions across European member states. Each data point corresponds to a representative survey of the UK population with a sample of n=1300 face-to-face interviews (Britain and Northern Ireland). This instrument measured public attitudes to science and technology in general (EB 10a of 1978) or to biotechnology in particular (EB 35.1 of 1991; 39.1 of 1993, 46.1 of 1996, 52.1 of 1999, 58 of 2002). One item serves here as a comparable index of 'general optimism' about biotechnology and genetic engineering. In 1978, The British and other Europeans were asked: *'do you think that the transmission of hereditary characteristics which could make it possible to improve the qualities of living species is worthwhile'* (or of no particular interest, or an unacceptable risk). On later occasions the equivalent question reads '*do you think biotechnology will improve our way of life in the next 20 years'* (or has no effect, or will make things worse, or don't know). We report the percentage of 'optimistic attitudes' reflected in answering 'worthwhile' (in 1978) and 'will improve' (from 1991 to 2002). All reported percentages have a maximal margin of error of (-/+) 3% at 95% confidence level.

The Path of Genetics in British Public Opinion

Figure 1 shows the salience and the evaluation of genetics/biotechnology in Britain over a 55-year period. The graphic shows the take-off of biology news, mainly biotechnology and genetic engineering news from the mid-1980s onwards. By 1999 we find over 1600 references to 'genes', or 4 to 5 per day, in a single British national

quality newspaper.[iv] In the 1950s or 1960s, gene news was a monthly event at best. Clearly the British public gives sizable attention to this topic the second half of the 1990s.

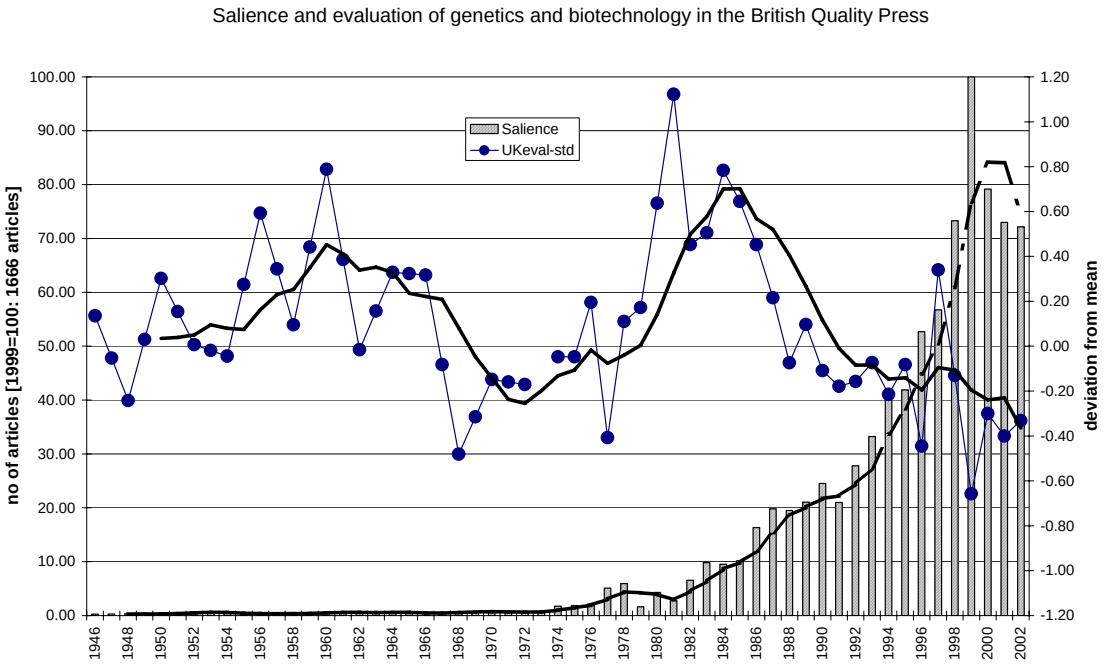

Figure 1 *shows the salience and evaluation of genetics and biotechnology news between 1946 and 2002 in the British quality press. The index of salience is 100 = 1999 representing a count of 1666 different references to biotechnology in a single source. The evaluation index shows the deviations from the long-term average. The evaluation is based on annual average ratings of articles as 'discourse of promise' (high values) or 'discourse of concern' (low values). Ratings are standardised and calibrated to the long-term trends before and after 1973. The smooth lines show 6-year moving averages.*

The picture shows two waves of growing and declining enthusiasm for genetics. Until 1960 the evaluation of genetics is ever more positive to turn more negative in the early 1970s. Then again until 1981 the news is ever more positive, only to reverse after the mid 1980s and into the 1990s. As biotechnology news expands, the discourse becomes more varied and more sceptical (note: the graphs denote deviations from the long-term mean and not the level of evaluation). However, despite these trend

changes and contrary to polemical perceptions of media coverage, the attitude of the British press stays positive (see Bauer et al., 1998). Both indicators, salience and evaluation, suggest two phases of news on genetics and biotechnology: a first period from 1946 to the early 1970s, and a second period from the early 1970s to the end of the century and probably beyond, each period with a phase of enthusiasm. The mid 1970s are indeed the beginnings of what became known as 'new biotechnology' based on recombinant DNA techniques and direct interventions at the level of the gene. This is contrasted to 'old biotechnology' that intervenes, and has indeed done so for centuries, at the level of the cell with techniques such as fermentation or animal husbandry. Whether this was a 'revolutionary' watershed or not is still the sticky point of regulatory debates, and the key to the 'transatlantic gap' in the 1990s. Whether the production of transgenic farm animals can and should be regulated under the same rubric as age-old cheese making hinges on how this development is construed: process or product (Jasanoff, 2005).

How does the path of biotechnology compare to that of science in general (see Bauer, 2000; Bauer et al. 2006a). Over the post-war period the biomedical sciences (biology, medicine) displace the physical sciences (physics, geology, chemistry, astronomy) in public attention. Science reporting moves from the 'rocket-scalpel' to the 'gene-meteorite' complex (Bauer, 1998). At the peak of science news in 1962, the physical sciences carry the big stories: nuclear power, 'big bang' and space explorations. The salience of genetics is insignificant and hardly affected by the Sputnik shock of October 1957 (our index shows a small increase in coverage between 1959 and 1961, which is however insignificant in the general surge of science news at the time). Its discourse of evaluation converges with that of general science: increased enthusiasm into the 1960s, declining into the 1970s. The 1970s sees much science-sceptical and anti-technological public sentiments. The rising salience of biotechnology since mid 1980s is the new wave of science news. By the 1990s, biotechnology has become major news. However, the trend in the evaluation of biotechnology diverges from that of other sciences. British enthusiasm for science and technology recovers through the 1980s and into the 1990s. While for genetic engineering enthusiasm decreases after its peak in 1981-1984. This public scepticism is specific to biotechnology and is not generalised to all science and technology as in the 1970s, when this was a matter of public alarm. The personal computer, astronomy and environmental research

command public fascination during this wave of science news. Streams of news of the Personal Computer (PC) in the 1980s and of the internet in the 1990s, had no limits, until in April/Mai 2000, the bubble burst and the stock market slumped into a major crisis. In hindsight much of this discourse was hyperbole but functional. In the 1990s Observers started to appreciate the significance and the persistence of exaggerated news as a driver of future expectations that enable new technologies.[v] Hype is not explained by the 'enthusiastic bias' of a handful of science writers.

In summary, the first decline in enthusiasm for 'genetics' in the 1960s parallels that for general science with sceptical public sentiments rising in the late 1960s and early 1970s. This sentiment is fuelled by self-criticisms emanating from scientific circles themselves. The second reversal of attitudes in the 1980s and 1990s is specific to genetic engineering and does not extend to other sciences; except maybe to nuclear power that continues to stay far from public grace. The evaluation of genetics separates from that of others sciences. A closer look at each period is revealing.

Before 1973: the discovery phase in scientific mode

Before 1972 is the phase of scientific discovery in genetics. In hind-sight, the key event was the presentation of the double helix model of DNA of Watson and Crick at Cambridge University in 1953 (Nobel Prize with Maurice Wilkins in 1962). Figure 2 shows increased coverage of biology in the British press in 1952 and 1953, but the 'double helix' had little echo at the time. It took weeks until the first isolated news reports of the helix model appeared (see Turney, 1998, p135), there is no Nobel effect in 1962. Its historic significance is a re-construction of the late 1960s, centred around Watson's controversial account of the discovery and the now famous photo of the three dimensional helix model (Chadarevian, 2003), and of the 50-year celebrations in 2003.

In those days, most science news is in celebratory summaries of papers published in *Nature* and *Science*. Such news coverage tends to increase the public awareness of research and the citation counts of the authors by up to 70% over the next 10 years (see Philips, 1991). With an average of one article per month genetics news is insignificant compared to that of the physical sciences and to what will become the

level of genetics news in the 1990s. Science news, and there is increasing amounts in the late 1950s and early 1960s, focuses on atom bombs and, after the Geneva 'Atoms for Peace' conference of 1955, increasingly on civil nuclear power and its potentials. Britain is a major player, linked the world's first civil nuclear power station to the electricity grid in 1956 (Calder Hall) and enjoys the 'special relationship' with the US based on their joint nuclear capability. Genetics remains marginal news, but at times its surfs the news issue with stories on nuclear fallout and the risks of genetic mutations at various levels of radiation exposure (see Weart, 1988, 200ff).

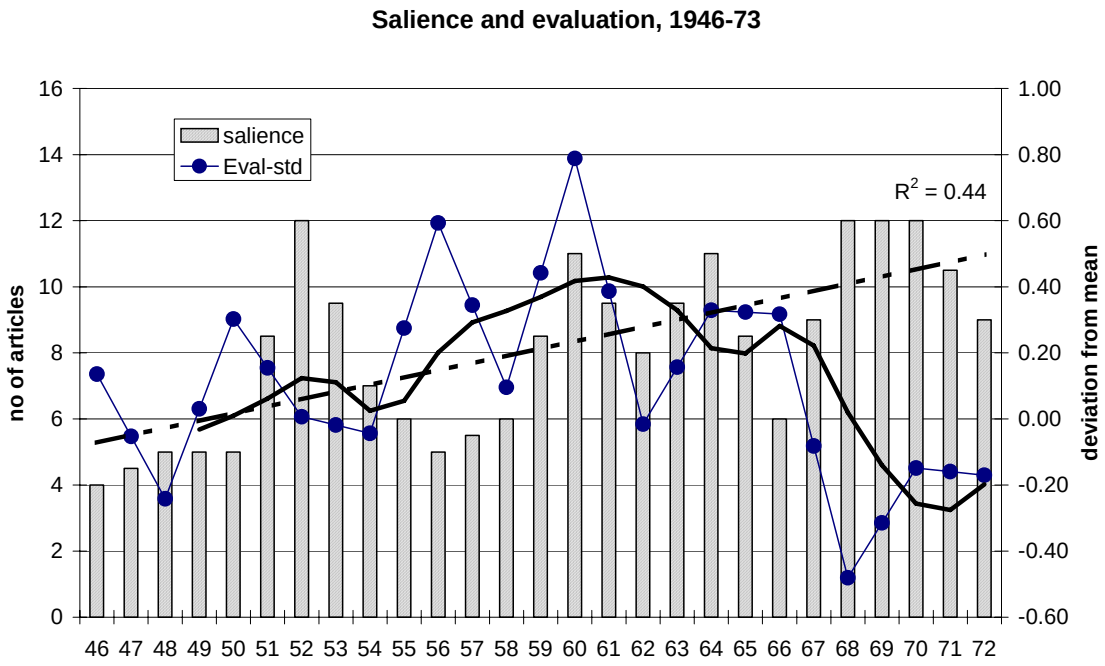

Figure 2 *shows the trends for salience and evaluation of biology in the news during the period 1946 to 1972. The dashed line indicates a linear trend for salience with a fit of* $R^2 = 0.44$*. The counts are numbers of articles per year in a single newspaper source, interpolated for every second year. The index of evaluation shows deviations from the long-term slightly negative average (mean evaluation = - 0.15). Low numbers mean lower than average evaluation, high numbers mean higher than average evaluation. The smooth line is a moving 4-year average of evaluation.*

Genetic and biology news increases in the early 1960s, reflecting the expansion of medical and clinical genetics and the controversial continuity of pre-war eugenics

(Kevles, 1995). The conference 'Man and His Future' of 1963 features Julian Huxley, founder of the WWF and former director of UNESCO, linking eugenic ideas and nuclear fallout. He argues that to halt human genetic deterioration from radioactive fallout mankind urgently needs to freeze stocks of sperms of healthy and intelligent males for later use (see Thom & Jennings, 1996, 227). The British Eugenics Society tries to stem decline and changes its name to the Galton Foundation in 1969. The burgeoning of genetic research leads to the identification of gene anomalies associated with syndromes such as Down's and Turner, and controversially links the latter to samples from convicted criminals in prison. In 1969, a London Hospital begins offering pre-natal diagnosis of Down's syndrome using amniocentesis, by 1972 35 clinics will have followed suit. These events are public news.

The revival of eugenic ideas does not come without challenge considering its notorious past in Europe and North America (Koch, 2004). The low-key post-war enthusiasm for a 'genetic revolution' led by British science and anticipating the idea of gene mapping reverses in the early 1960s towards a more sceptical note into the 1970s. Scientific issues are taken up by the student movements of 1968-69 culminating in the controversies over intelligence and 'Sociobiology' in mid 1970s. A strong controversy over nature-nurture in human development, spilling over from the US, bestows notoriety to British psychologists Burt and Eysenck by the end of the 1970s (see Gould, 1996). Note, that these are also the beginnings of the challenge to the neo-positivist and Mertonian canons in the philosophy and sociology of science.

After 1973: the business phase in industrial mode

The year 1973 is a watershed year for genetic engineering. Herbert W Boyer & Stanley Cohen of Stanford University, building on previous work by Paul Berg and by Annie Chang, secure a patent on their method of recombining DNA. This opens the new era of biotechnology with the prospect of a 'genetic gold rush': the commercial exploitation of design at the level of the gene. This watershed leaves a double legacy: it spawns a new business sector – Biotech or Life Sciences – and raises questions. In 1976, Boyer founds one of the first biotech firms in California, *GENENTECH.* This act of scientific entrepreneurship models a boom of joint ventures between

universities and private capital in the 1980s and 1990s (Haber, 1996). Many of these young companies go to the stock market in the 1990s, which leads to a flood of hyperbole business news promising a lucrative future to potential investors.

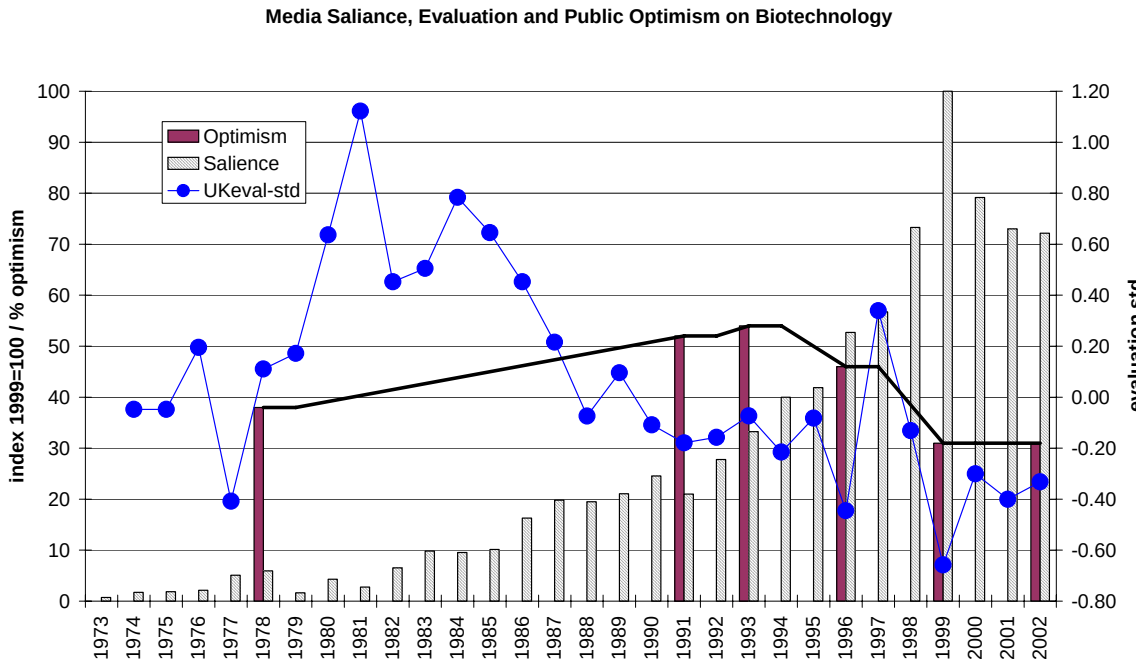

Figure 3 *shows the rise and later fall in salience, the cycle of evaluation in the press, and the changing public optimism about biotechnology in opinion surveys. Salience is indexed to 100 in 1999, when 1666 articles on biotechnology were published in a single quality newspaper source (left scale). The index of evaluation shows the deviation from the long-term slightly positive average: low figures indicate evaluations more negative, positive figures indicate evaluations more positive than average (right scale: mean = 0; std dev = 1). The dark bars give the percentage of UK respondents who declare optimistic expectations about biotechnology when asked in 1978, 1991, 1993, 1996, 1999 and 2002 (left scale).*

On the other hand, the group of scientists involved in recombinant DNA research publish an open letter (Berg et al., 1974) simultaneously in *Nature* and *Science* pointing to potential hazards of their research. They call for a moratorium until the

risks of rDNA research are defined and contained. The 1975 Asilomar conference in California discusses these points in a semi-public forum. Similar discussions take placed in Britain and elsewhere. This is a historical first: hitherto scientists have been concerned with breaking the social constraints on their enquiries, now the avantguard blows the whistle on themselves (Yoxen 1983). Initially the concerns are laboratory and public health hazards, later environmental and developmental risks, and the ethics of such designs which put at disposition the very nature of 'human nature' (Rose, 2001).

Both streams of events prove historically significant, however, have little immediate public visibility as shown in figure 3. We find increased coverage by 1977-78, a dip in press evaluation, and a moderate level of optimism over these new developments in public perceptions; 38% of British think rDNA research is worthwhile. Soon the scepticism of Berg et al. and Asilomar will be displaced by the celebration of scientific progress and economic prospects of biotechnology (Yoxen, 1983), and the big story of 1977-78 is the birth of Louise Brown, the first test-tube baby (Turney, 1998). In the 1970s, reproduction is part of the discourse of 'biology turned into a technology'. But Britain at the time worried about many other things: energy crisis, the winter of discontent, the punks, high inflation and several elections.

By 1980 the new British government of Margaret Thatcher officially recognises, as did the OECD and others, that new biotechnology is the future. This is reflected in the rising enthusiasm in the press. Coverage grows exponentially and continued to do so to its peak in 1999, rising from a monthly news item to five or six stories a day in a single newspaper. The year 1984, the test year for Orwell's dark predictions, sees the arrival of 'DNA fingerprinting', a British invention. Henceforth crime news carries genetic references. The identification of the remains of the former Russian royal family became 'gene talk' in the early 1990s (Durant, Hansen & Bauer, 1996). In 1990 the European Community regulates the release of genetically modified organisms into the environment with leading British input, and the debate cools off: reduced salience but stable evaluations. At the time, many observers felt that the controversy over biotechnology, as far as there ever was one, was now settled and closed. In hind-sight, we now know it occurred differently.

For the 1990s we can compare public perceptions and mass media discourse. After 1984 the media enthusiasm cools off, while optimism in public perceptions continues to rise until 1993. Optimistic attitudes increase from about one third in 1978 to over 50% of the population by 1993. Thereafter optimism shrinks to 30% by 1999 and remains at that level by 2002. This trend reversal in public perceptions appears to follow that of the mass media discourse, but with a considerable time lag. However, our data is not conclusive here. I am not aware of any public perception data of biotechnology in the mid 1980s, when media enthusiasm was at its peak. A hypothetical poll in 1985 might show equally enthusiastic attitudes as displayed in the media discourse, and thus show a closely parallel decline in optimism in media and perceptions from the mid 1980s onwards. On the other hand 1985 is the year when the Royal Society laments the deficient public appreciation of science in its famous report (Royal Society, 1985), which, if the tone of that report can be considered evidential, would suggest that public attitudes did not mirror the media discourse at the time.

1994 sees the arrival of genetically modified (gm) food products on supermarket shelves, the *CALGENE* Flavr Savr tomato in the US and the *ZENECA* tomato paste in Britain. Both products have a short life cycle, less because of consumer rejection - consumer were given little opportunity to make decisions - more because of corporate reasons (Martineau, 2001). The first consensus conference on plant biotechnology takes place in 1994. Experimenting with public participation, a model of public deliberation imported from Denmark (see Joss & Durant, 1995; Einsiedel, 2001), coincides with the launch of these first gm food products. The term ‘Frankenfood’ was coined either by the *Daily Mail* or the *Telegraph* alluding to the myth of Dr Frankenstein’s monstrous design which, once carelessly abandoned, strikes back. This image resonates with a public opinion that is already sensitised to food issues. Britain is going through a series of food scares and, since 1985, the BSE epidemic in cattle. ‘MAD COW CAN KILL’ prints the *Daily Mirror* on the day following the government’s official admission of a link between BSE and vCJD (variant Creutzfeld-Jacob Disease) on 19 March 1996. The lingering issue of ‘dangerous British beef’ spreads through the mass media of Europe (Bauer et al, 2006b) and changes the scene for things to come.

Engulfed by a global mission and ignoring early warnings of limited consumer enthusiasm for gm food, available from Eurobarometer surveys (Gaskell et al., 1997), the new Live Science sector and crop producers steam roll ahead. Imports of Monsanto's Round-up Ready gm soya into Europe from autumn 1996 onwards fall into a climate of opinion that creates an opportunity for issue entrepreneurs (Lassen et al, 2002). An EU regulatory loophole on food labelling allows the mobilisation of consumer and environmental concerns. What follows puts into doubt not only the agrochemical multinational *MONSANTO*, but the entire project of a 'Second Green Revolution' to feed the world in the 21st century. Sabotaged field trials, blockaded ships and other stunts create world wide attention. British food retailers such as TESCO and SAINSBURY pledge to avoid and to label products with gm ingredients. Gm feed and foods, now globally controversial, stall an emerging consensus in international regulations based on the US model of 1985. Europe sees a de-facto moratorium on gm crops and foods between 1998 and 2004 sustained by Brazilian exports of non-gm soya (Bauer, 2006).

As if gm crops do not make enough 'gene drama', in February 1997, the Scottish Roslin Institute announces, in a letter to *Nature,* the first successful cloning of an adult sheep some 18 month ago (Wilmut et al, 1997). Photographs of Dolly the sheep gazing into the cameras travel fast and create concurrent world news. The story develops immediately into a moral outcry over the possibility of human cloning. Ironically, the translation of 'adult nucleic transfer' into 'cloning', which offers a much richer anchor for social representations, does not come from the scientists but from Nature's own press release (Einsiedel et al, 2002). The more recent controversy over stem cell cloning takes its impetus from the Dolly alarm and merges with the lingering awareness of human genome mapping which started in 1990 with very little public attention (Durant, Hansen & Bauer, 1996).

Gm soya and the cloning of Dolly are watershed events in the public career of genetics during 1990s. Henceforth, public discourses split into 'green' agricultural biotechnology, sceptically observed, and 'red' biomedical biotechnology with moral questions but generally supported because it gives or save lives. The press measurably cultivated this separation (Bauer, 2002a and 2005). The public deliberations of 'GM Nation' in 2002 are an expression of the split frame: debating GREEN conveniently

focuses protest energies and shields RED from undue attention.[vi] This course of events has some similarity with the 1950s, when strategic efforts were made to split the public atom into a military and a civil nuclear power under the banner of 'Atoms for Peace' (Langer, 1995). Weather this was, considering the techno-scientific infrastructure, a substantive or a rhetorical split preoccupies analysts ever since facing the issue of proliferation (Weiss, 2003). The aftermaths of the 11th of September 2001 brought to public attention that biotechnology might have a proliferation problem, too. However, significant by its absence, in our press corpus less than 0.5 percent of articles refer to a potential military uses of biotechnology, and all references predate the events of 2001. [vii]

Conclusions: towards longitudinal comparative research

In this paper I distinguished two 25(+) year long phases, 1946-1972 and 1973-2002, in British public sentiments over genetics and biotechnology. Each phase comprises a wave of rising and declining enthusiasm.[viii] Several topics were identified that engaged public opinion through these phases of enthusiasm and concern. Scientists themselves raised the alarm on potential hazards of genetic engineering in mid 1970s, but with limited impact at the time. These concerns were crowded out by hype and enthusiasm for this strategic technology of the 21st century. Twenty years later lingering concerns resurfaced and merged with others, such as food safety, globalisation and bioethics. This time round the public resonance was far greater. Today, the actor-networks of rDNA and genomics engages debates over the safety of gm foods, the environmental soundness of gm crops, the corporate dominance over gm seeds and biodiversity, the patenting of life forms, the psychological and social consequences of genetic identity, the ethics of genetic testing, enhancement and embryonic stem cell cloning, the risks of xenotransplants, the prospects of individualised medicines and the reliability of DNA finger printing in a genetic information society.

Our data shows that the trend has changed towards a more sceptical public attitude to biotechnology, so much deplored in the 1990s, started in the press already in the mid 1980s, and was observable in public perceptions by mid 1990s. The public events of

1996/97 did not initiate this trend change, but catalysed it. They internationalised the debate and split it worldwide into a matter of either GREEN or RED biotechnology. While corporate actors ignored early warnings, issue entrepreneurs successfully capitalised on the changing public sentiment and cornered the debate on GREEN biotechnology in Britain, probably to the relief of anybody working on RED biomedical biotechnology.

Under a long-term perspective, it is tempting to compare biotechnology to other technologies and their paths through public opinion. The source of historical analogy of genetic engineering will continue to preoccupy actors interested in technological futures. Is it the civil nuclear power, the hurdle of public opinion was raised some twenty years after a promising start in 1956; or is it the information technologies with its bubbling waves of new enthusiasms? I dare no prediction.

To tell the history of the public imagination of genetics is an historian's task. Jon Turney (1998) admirably traced the footsteps of Frankenstein's monster through various episodes of the popular imagination of biology. This paper might contribute two ideas to such ambitions: a criterion for periodization and longitudinal indicators. On the example of Britain, I demonstrated two long-term and nested phases in public sentiments towards DNA, genetics and biotechnology based on news coverage and the evaluation of events offered by this coverage. These phases reflect research events, but also trends in the 'Zeitgeist', the spatio-temporal mentality. Historians may find it helpful to consider such indicators in the construction of a narrative of popular genetics. Also, I hope to have demonstrated the need for and the advantages of longitudinal indicators, even seemingly crude ones based on content analysis. The fluctuating nature of public sentiment, as demonstrated on biotechnology, alerts readers to the risks of basing a trend analysis on the comparison of few time windows with little information in between. The graphics presented in this paper show that, would one pick different windows over the 50 years, very different conclusions on trends would result. I summarise the caveat like this: better simple and longitudinal (large t) than few and far apart cross-sections (small t). In any problem area, curves show best whether one is on the way into or on the way out of trouble. Some methodologists generally call for more continuous data streams in psychology and the

social sciences to overcome much conceptual and methodological nonsense and to enhance causal understanding of processes (Fassnacht, 2000). I concord.

A final comment on how unique this British story might be. Our past research has shown considerable divergence in timing and substance of the biotechnology debates, within Europe, across the Atlantic, and across the Americas (see Gaskell & Bauer, 2001). The global convergence on such matters is either wishful thinking or political agenda (see Jasanoff, 2005). The international comparison of the representations of science and technology in the press must expect convergence and divergence. It is likely that the public take-off of modern biotechnology is a common feature. However, the timing and the steadiness in increase of coverage during the 1980s, or the watershed years of 1996/97 leaves ample space for comparative puzzles. Synchronicity is a criterion for an emergent trans-national public sphere, across Europe or globally. However, time is fractal and the particular time window of 'synchronicity' determines the conclusion (see for example Seifert, 2003). These are eminently empirical questions that depend on the availability of comparable data streams. For the period after 1973, our mass media database covers eighteen different countries across Europe, North America, and Japan, and researchers are invited to consult, contribute and analyse this growing database. Let a thousand comparisons flourish ! A global public opinion of science and technology is in the making and the challenge is to track it as it happens.

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[i] The state of this freedom of speech is subject to global international monitoring, because it can be restricted by formal state censorship, dangerous working conditions, self-imposed censorship or powerful monopolies of opinions. Occasionally this right to freedom is challenged and tested in courts. Britain regularly figures in the upper 15% of the worlds' countries. In 2002 it ranked 21, in 2004 it ranked 24 of 170 ranked countries, top are Scandinavian countries (see reporters without borders on www.rsf.org).

[ii] There is a rhetorical game played by social scientists: first one proclaims a revolution, the axial transition into a new society; and later, to reassure the regulators or when the 'revolution' takes longer than expected, one calls it off again. Both observations will be news that hit the headlines.

[iii] I use 'we' in this section, because the methodology is the collective effort of the project 'Biotechnology and the Public' including colleagues from 18 countries.

[iv] This peak of 1666 references to genes or biotechnology needs to be kept in perspective. Back in 1998 the Guardian regularly compared weekly press coverage: in the eight months May-December 1998, the events in Northern Ireland or 'Clinton Gate' got two to three times more coverage than all the science related stories during that period together. Human stem cell cloning got about 300 column inches in December 1998, while the Omagh bomb got 12 times more column inches back in August 1998 alone. Hence, compared to political news events of the day biotechnology is at best a mid-size news item even at its peak.

[v] A new area of sociological research is claimed focussing on this kind of hyperbole: the sociology of expectations (see Brown N & M Michael, 2003)

[vi] One looks across the Atlantic to sees a mirror image: in the US the recent debate is focussed on the RED biotechnology, on genetic testing and in particular on embryonic stem cells cloning, while GREEN biotechnology seems to be a non-issue as far as policy is concerned; this is often referred as to as 'transatlantic gap'. In the US this reflects the power of lobbying to set the policy agenda on Capitol Hill (see TenEyck, 2001 and Sheingate, in print)

[vii] Our 18-country press corpus contains 106 references to military uses out in a total of over 20000 articles or 60000 gene references (an article is coded for up to three references), of which 23, mainly US references, are from 2001 or 2002.

[viii] One might be tempted to speak of long cycles, but 'cycles' connote too much regularity. To avoid a false impression of regularity I used the terms 'phases' and 'waves' to identify the ups and downs in coverage and evaluation.