The Future of Public Perception of Gene Therapy in Europe, an Educated Guess

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Abstract

Public perception of the opportunities and risks of gene therapy is taking shape in Europe, and various applications of biotechnology are being perceived by the European public. Bio- and gene-technology applications in the medical area are generally seen more positively than applications in the food and agricultural sector (e.g. GM-food). These inclinations, however, cannot sufficiently be explained by different distributions of risks and uncertainties in these areas, instead, the main reason for supporting medical applications may rather be found in the expected future benefits on the individual level. In an attempt to find scenarios regarding the future perception of gene therapy, the following factors may play an important role: the continuous differentiation between applications of gene therapy (e.g., body or germ cells; physical, mental, or behavioural characteristics; and diseases or aesthetics) and their different evaluations; increasing complexity in the post-genomic era including shifting perceptions on (genetic) determinism and perceived control over this new technology; the availability of trustworthy stakeholders and useful information on the issue to make informed decisions; and the possibility that the discourse is being used by some societal interest groups pursuing their particular worldviews. Finally, some brief ideas on how these factors could be dealt with are presented as an input for future discussions on gene therapy.

Keywords: public perception, red and green biotechnology, perceived benefit, differentiation, genetic determinism, worldview, interest groups, trust.

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1. INTRODUCTION: RISK PERCEPTION

Risk is perceived not solely by technical parameters and probabilistic numbers, such as expressed in the formula $Risk = Probability \times Damage$, but also in our psychological, social and cultural context. Individual and social characteristics form our risk perception and influence the way we react towards risks. Our perception is attenuated or amplified in a typical pattern described, e.g., by the psychometric paradigm [1] or by the mental model [2]. These patterns must be taken into account in dealing and working with risk or risky human activities or natural events. It is important to understand the "soft facts" that, especially in case of lay people, outdo the "hard facts" such as technical or medical expertise [3]. Experts typically define risk strictly in terms of annual mortalities or additional costs. Lay people almost always include other factors in their definition of risk, such as catastrophic potential, equity (i.e., whether those receiving benefits from the technology bear their share of risks), effects on future generations, controllability and voluntariness. These differing conceptions often result in lay people assigning relatively little weight to risk assessments conducted by technical experts or government officials [4]. This does not mean that lay people are not aware of, or that they badly estimate, annual fatalities [5,6]. Lay people use other criteria in evaluating risks. Experts include statistical data such as annual fatalities more frequently in their assessment of risks, but they also seem to be prone to many of the same biases as those of the general public, particularly when they are forced to go beyond the limits of available data and rely on intuition and extrapolation [7,8]. See Table 1 for an overview of the most important psychological and social factors influencing risk perception.

Table 1. Psychological aspects attenuating or amplifying the perception of risk.

Attenuate risk perception	Amplify risk perception
Familiar	Exotic
Individual control	Controlled by others
Natural	Manmade
Statistical	Catastrophic
Clear benefits	Little or no benefit
Risks and benefits fairly distributed	Unfairly distributed
Voluntary	Imposed
Information by trusted sources	Information by untrusted sources
In the media	Not in the media

2. RISK PERCEPTION TOWARDS RED AND GREEN BIOTECHNOLOGY

Risk perceptions of a series of biotechnology applications were examined in a public (non-expert) sample and an expert sample [9]. Compared with the experts, the public perceived all biotechnology applications as more risky, a result that can be observed over a wide range of different technologies. An interesting aspect, however, was that both groups perceived food-related applications to be riskier than medical applications. Other studies have previously found similar attitudes towards medical and food/agricultural applications. In the Eurobarometer study [10] carried out in several European countries, respondents asked whether they thought the applications of biotechnology were:

- useful for society,
- risky for society,
- morally acceptable, and
- whether they should be encouraged.

A total of six applications of biotechnology were presented:

- *Genetic testing*: using genetic tests to detect inheritable diseases such as cystic fibrosis mucoviscidosis, thalassaemia.
- *Cloning human cells*: cloning human cells or tissues to replace a patient's diseased cells that are not functioning properly, for example, in Parkinson's disease or forms of diabetes or heart disease.
- *GM-Enzymes*: using genetically modified organisms to produce enzymes as additives to soaps and detergents that are less damaging to the environment.
- *Xenotransplantation*: introducing human genes into animals to produce organs for human transplants, such as into pigs for human heart transplants.
- *GM-Crops*: taking genes from other species and transferring them into crop plants to increase resistance to insect pests and
- *GM-food*: using modern biotechnology in the production of foods, for example to increase the amount of proteins, keep longer or change the taste.

The results showed clearly that applications that would assist fighting diseases and could directly improve our health were more readily accepted than those affecting food production. Although no application for gene therapy was used in the survey, another application namely genetic testing was judged positively in all 15 country surveys, resulting in the strongest support of any of the six applications (see Table 2).

In addition to these kinds of straightforward surveys with closed questions, more in-depth discussion on the issue have been carried out in several

Table 2. Level of support and opposition in European countries for six biotech applications in 2002. (++) Strong support; (+) Weak support; (−) Weak opposition; (−−) Strong opposition

Country	Genetic tests	Clone human cells	Enzymes	Xeno	Crops	Food
Spain	++	++	++	+	++	+
Portugal	++	++	+	+	+	+
Ireland	++	+	+	+	+	+
Belgium	++	+	+	+	+	−
Sweden	++	++	+	+	−	−
Denmark	++	+	+	+	−	−
UK	++	+	+	+	+	−
Finland	++	+	+	−	+	+
Luxembourg	++	++	+	+	−	−−
Germany	+	+	+	+	+	−
Italy	++	++	+	+	−	−
Netherlands	+	+	+	+	+	−
France	++	++	−	+	−	−−
Greece	++	+	+	−	−	−−
Austria	+	+	+	−	−	−

(*Source*: from Ref. [10]).

so-called consensus conferences (CC). These conferences typically involve a small number of lay people that discuss a specific issue with the support of relevant experts (for clarifying questions). Such conferences pretend to gather the "public opinion", which maybe to stimulate political decisions or support management with societal conflicts. In the field of biotechnology most of the CCs carried out so far focused on GM-food or GM-crops, however, at least one CC could be found dealing explicitly with gene therapy (see Table 3).

Representative statements drawn from seven CCs on risks and uncertainties of genetically modified organisms (GMOs) and GM-food can be seen in Table 4. The reaction towards so-called green biotech applications is relatively uniform, taken the different regional and cultural backgrounds of the CCs. Generally, the attitudes are rather sceptical and mostly a "wait and see" approach is preferred, a notion that was reflected in the precautionary principle towards deployment of GM-crops in Europe (1998–2004). Most authors explain this (lay-) reaction towards a new technology by the fact that uncertainties are high and people in industrialised countries have become relatively risk averse, as they expect more to be lost than to be won. In other words, new technologies are rejected on the basis of their uncertainties and risks. An explanation for this phenomenon might be the theory of reflexive modernisation. Reflexive modernisation starts with the notion of a (western)

Table 3. Overview of consensus conferences on some biotechnology applications

Country	Issue	Year	Source[1]
Denmark	Gene therapy	1995	Loka 2003
Norwegian	Food biotechnology	1996	Loka 2003
France	GM crops	1998	Loka 2003
South Korea	GM food	1998	Loka 2003
Australia	GM food	1999	ABC Net 2003
Canada	Food Biotech	1999	University of Calgary 2003
Switzerland	Genetic technology and nutrition food	1999	TA Swiss 2003b
Denmark	GM food	1999	Loka 2003
New Zealand	GM food	1999	Loka 2003

[1]See: ABC Net 2003. http://www.abc.net.au/science/slab/conscont/report.htm#final; Loka 2003. http://www.loka.org/pages/worldpanels.html; TA Swiss 2003. http://www.ta-swiss.ch/www-remain/reports_archive/publications/1999/ta_p_1_99 e.pdf (*Source*: from Ref. [10]).

contemporary change, where "first" (or industrial) modernity makes room for developments leading to "second" (or reflexive) modernity. Under the rule of first modernity, society was based on the belief that everything can, in principle, be mastered by calculation and is thus controllable. The term "reflexive" modernity refers to the erosions of such beliefs and the accompanying intellectual concepts, life styles and policy patterns due to a loss of traditions. This entails uncertainties and different views of nature. Accordingly, the notion that nature as well as society can be steered at will is increasingly vanishing in the western world, leading also to more cautious approach towards new technologies (see e.g., [11–13]).

Given the uncertainties that are comparable in green and red biotech applications, one would expect similar reactions towards these two applications. If the theory of reflexive modernisations may explain the changes going on in western societies, it should predict a rather sceptical and cautious approach also towards red biotech applications. Proof of this theory could be the Danish consensus conference held in 1995 on gene therapy. In this CC the risks and uncertainties were discussed and the attitudes towards gene therapy became visible. Surprisingly the risks and uncertainties – although comparable to green biotech applications – were judged differently.

As an example, when the lay-panel was asked whether it is "*justifiable to implement gene therapy before DNA has been mapped?*", they responded: "*Previously, in combating diseases researchers have researched and applied medicine and methods whose effects and side effects had not been determined in detail before use, and still satisfying results have been achieved. The history*

Table 4. Typical statements from different consensus conferences on green biotech applications

Country, Issue, Year	Representative statements
Norwegian, Food biotechnology, 1996	Too many uncertainty factors are associated with genetic engineering. (The panel) wants more research on effects of eating genetically modified food.
France, GM crops, 1998	We need to be sure there are no higher risks than natural risks before intensifying this type of farming
South Korea, GM food, 1998	We, the Citizen Panel, believe those researchers to be far too optimistic. We believe this because overconfidence in science may have led scientists to be much too optimistic in their abilities to prevent such hazards.
Australia, GM food, 1999	There is currently a lack of understanding in the general community of the risks and benefits involved in introducing GMOs into the food chain, both short- and long-term.
Switzerland, Genetic Technology and Nutrition Food, 1999	According to the opinion of the panel, an estimation of the long-term effects of genetically modified foodstuffs on human health is not possible at the present time. In order to remedy the lack of knowledge about risks, the Citizen Panel recommends that research looking into the area of ecosystem influence be encouraged.
Denmark, GM food, 1999	But experts strongly disagree on the degree of the effect – and whether or not it is hazardous. The disagreement is not only rooted in science, it also stems from ideologic differences.
New Zealand, GM food, 1999	...many of the consequences of this technology are not completely understood. Although scientists seem confident that their procedures are reliable, and the final product safe, they cannot give any guarantee.

of medicine shows that treatment has always been associated with uncertainties. Researchers believe that gene therapy makes it possible to cure a disease whose defective gene is known. It is not necessary to know the entire genome. So far, tests have not disproved this hypothesis."

Here the panel made it clear that it is not necessary to know all possible effects, and that it is fine to use a hypothesis as long as it is not disproved. In sharp contrast, the GM-food issue is judged the opposite as uncertainties are not accepted and industry has to prove that there is no risk involved.

Another statement in the CC was: "*As the treatment would primarily be used on seriously ill people, it is probably an acceptable risk.*"

Also, the CC panel was asked: "*Can gene vectors spread from laboratories to organisms in the surroundings and impact on them ("Turtle Effect")?*", and the response was "*As weak viruses are used, the risk that gene vectors will spread from laboratories and impact on the surroundings is virtually non-existent. They would simply not be able to survive in the natural competition.*" (See more questions in Annex A.)

If we consider – as mentioned before – that comparable risks and uncertainties occur both in red and green biotech applications, the question is: Why is the perception and attitude towards these applications so different?

The reasons for difference is probably not found in the degree of uncertainty and the extent of risks but the benefits involved. The theory of reflexive modernisation departs from the perspective that people in western societies do not want to gain additional benefits or take opportunities but rather want to avoid losses and reject risks. This is probably true in the case of the food sector as can be seen in the "No" – labels used to define quality food products (e.g., no preservatives, no colorants, and no genetical modification; even the organic label rather tells the consumer that it was not produced the conventional way).

In the health sector the notion is different, as long as people suffer from diseases. One quote (from an unknown source) describes this endless challenge: "*Nobody is healthy, he/she just was not checked well enough!*".

Therefore, improvements in health care and medicine are always seen as benefits and opportunities and not as avoided losses. Also the perceived interaction between benefit and risk is of major importance. Although risks and benefits are positively correlated in the real world, they are negatively correlated in people's perceptions. Affect mediates this negative correlation such that if a person feels bad about a technology, they will perceive greater risks and lower benefits. Alternately, if a person feels good about a technology, they will perceive greater benefits and lower risks (see Fig. 1).

Taking this model as a reference, red biotech applications fall under the categories A and B, while green biotech applications fall under the categories C and D (see Fig. 2).

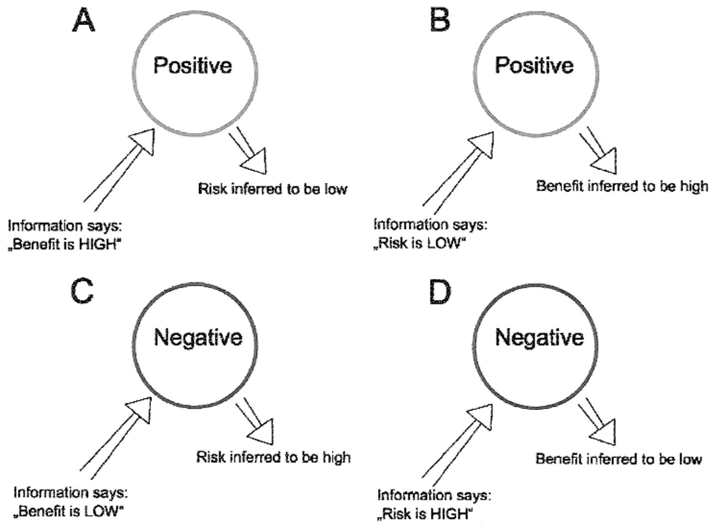

Fig. 1. Model showing how information about benefit (A) or risk (B) could increase the overall affective evaluation in the case of red biotechnology and lead to inferences about risk and benefit that coincide actively with the information given. Similarly information could decrease the overall affective evaluation as in case of green biotechnology (C) and (D) (from Ref. [21]).

3. POSSIBLE FACTORS THAT WILL SHAPE FUTURE (RISK) PERCEPTION

After this brief introduction on contemporary risk perception towards red and green biotech applications, the question remains how risk perception will develop in the future towards medical applications of bio- and gene-technology and especially towards gene therapy. Of course the following chapter can never be more than an educated guess, or to quote the Danish physicist Niels Bohr (1885–1962): "*Prediction is very difficult, especially about the future.*"

Still some ideas on the future shall be discussed in the wake of the "Prospective Technology Assessment" on gene therapy. Some of the factors that come to mind that could be of importance to the future perception of gene therapy are the continuous differentiation between various applications of gene therapy and their particular risk–benefit distribution, the role that genetic determinism and complexity will play in the future, the availability of trustworthy stakeholders and useful information; and the influence of societal stakeholders and movements trying to put forward their particular worldviews.

3.1. Continuous differentiation

The recent Eurobarometer study showed that a majority of Europeans believe that scientific and technological progress will help to cure diseases

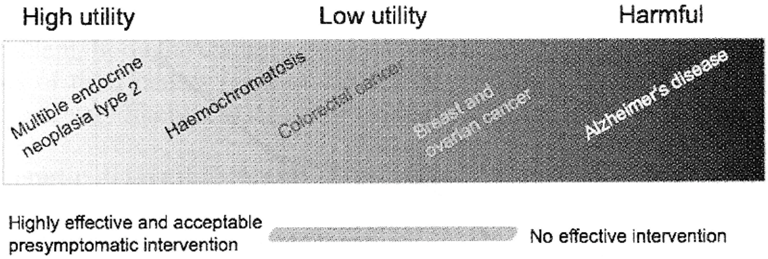

Fig. 2. Utility in predictive genetic testing on five exemplary diseases (from Ref. [14]).

such as HIV-Aids or cancer. Starting from this rather general positive attitude it is likely that attitudes will develop to a more differentiated point of view. Such a differentiation is currently taking place regarding gene testing [14], practically saying that gene testing is only useful in hereditary diseases if a proper treatment is available, otherwise the results are not only not useful but might impose additional psychological stress to the patient (see Fig. 2). Hence the benefits and limitations of a new technology and their socio-economic implications become more and more visible.

On the other hand, over the years more and more reports show an increasingly differentiated picture of the influence of the genome on the (human) phenotype. In a media analysis [15] using US newspaper from 1919 to 1995, it was found that the relative amount of articles describing that *different* genes may have *different* effects on *different* physical and mental state have increased, over articles saying that the cause–effect chains were rather simple (one gene causes one trait) (see Fig. 3). Another form of acknowledging differences – found in the same study – was the different assignment of genetic influence on different human traits (see Fig. 4) such as

- physical characteristics (e.g., size, weight, colour of hair and eyes, some diseases),
- mental characteristics (e.g., intelligence, psychological disorders), and
- behaviour (e.g., personality, criminal, amoral and polygamous behaviour).

Especially interesting is the decrease in beliefs on genetic influence regarding behaviour. (Unfortunately similar studies for Europe could not be found in the literature so far.)

The results shown in Fig. 4 also indicate that gene therapy that interferes with behaviour is unlikely to happen. As long as gene therapy has the aim to cure hereditary diseases the public is likely to accept it, however if mental or behavioural characteristics are at stake the outcome would be rather negative or unclear (imaging the public response to e.g., a genetically engineered piano talent or politician).

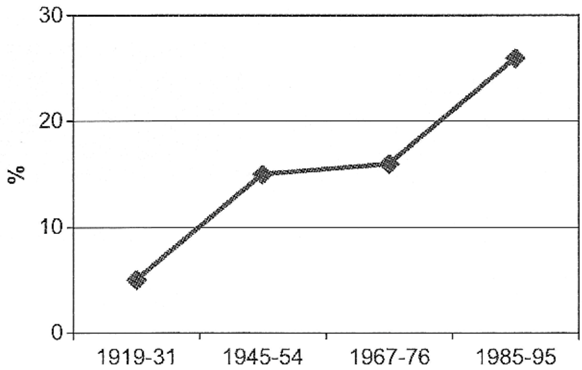

Fig. 3. Share of "differentiated" articles in US Media (from Ref. [15]).

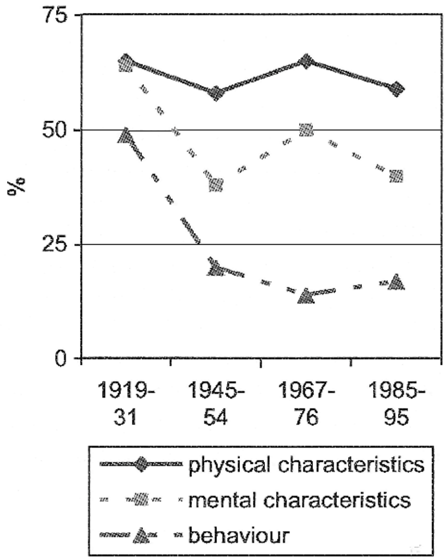

Fig. 4. Characteristics reported to be caused by genes alone in US-Media (from Ref. [15]).

In one case differentiation has already taken place, gene therapy should focus only on somatic cells (body cells) and not on germ cells, and the reproductive parts of the human body. Hereditary of man-made genetic changes in humans[1] will probably remain an ethical taboo.

Differentiation is also an issue regarding the particular risk–benefit distribution of the use of genetic information. As long as genetic information is used

[1] This phrase is a funny pleonasm! In this case "man made" means changes from gene therapy.

with the sole intention to cure diseases (e.g., doctors), people see not so much of a problem. If, on the contrary, personal genetic information is used to pursue interests of third parties (e.g., private industry such as insurance companies) people will very likely refuse such intentions if they have the power to do so.

3.2. Genetic determinism and complexity

As we have seen in the chapter on differentiation the general trend might go (slowly) from a more simple point of view to a more complex one. It is, however, very likely that a notable part of society will not change for the more complex point of view. For reasons that cannot be discussed here the more simple notions of (genetic) fatalism and (genetic) determinism are likely to persist in parts of society as they meet certain pre-existing world-views. As it is foreseeable that this will not affect a minority, this brief chapter is devoted to genetic determinism.

Since the time of ancient Greek philosophers, people asked themselves how our physical appearance and behaviour is shaped. Most of the explanations are oriented on a bipolar nature–nurture model, saying that either all human characteristics are inborn or defined by the genes (nature) or saying that all characteristics are shaped by the environment during lifetime (nurture). This nature–nurture discourse, however, is not restricted to philosophers or scientists but includes practically everybody in our society. It is hardly possible to find anybody who does not have an opinion on this issue.

The successes of molecular biology and genetic research since the discovery of the DNA in 1953 and the recent decoding of the human genome and the beginning of the post-genomic era have triggered the nature–nurture discussion again (see Fig. 5). Relatively new scientific sub-disciplines such as behavioural genetics claim major findings that explain human behaviour by genetics alone. Unsurprisingly, scientific progress aiding genetic determinism also lead to strong criticism, following fears that these

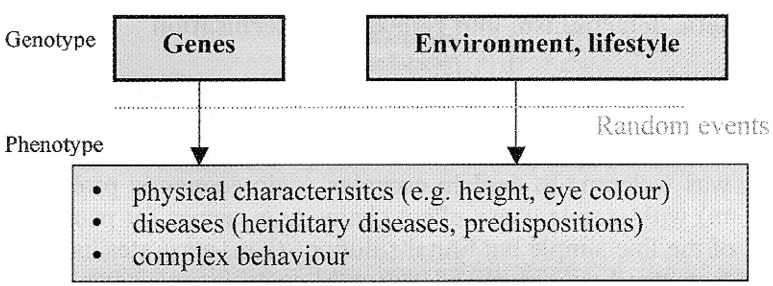

Fig. 5. Nature or nurture, the old question on which of these two “independent” factors shape the phenotype.

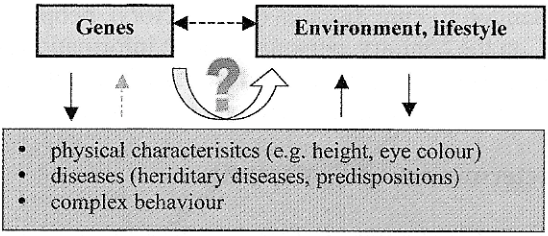

Fig. 6. Nature and nurture interplay in a complex pattern in defining the phenotype. Old notions of determinism are thus not very helpful to explain the formation of the phenotype.

new scientific insights could result in an erosion of human values, free will or moral and legal responsibility ("... my genes made me do it.") [16,22,23].

People defending the "nurture" concept – highlighting the importance of environmental influence – seem to criticise genetic determinism with the aim to uphold these human values. Although the impression is that criticism on genetic determinism is in reality criticism on determinism and fatalistic worldviews as such, as very few comments have been made on environmental determinism.

Beyond nature–nurture [17,25]: To overcome the nature–nurture conflict, one can contemplate what Hebb stated in 1980: "*Our behaviour is defined as 100% by our genes and a 100% by the environment*".

Therefore, the question is not if diseases and behaviour is caused by genes or environment, but rather how genes and environment interact? (see Fig. 6 for an improved concept). By realising the complex interactions among genes, environment and life styles borders are increasingly diluting. Increasing complexities also render it more difficult to define the actual causes of a disease and make precise predictions hardly possible. Especially societal forces promoting the concept of breaking down social borders, e.g., classes, seem to profit from a general non-deterministic worldview, as responsibility as it is understood today is only meaningful in such a context.

3.3. Genetic determinism and reflexive modernisation

Genetic determinism may also be discussed in the context of reflexive modernisation. For example, Allen [16] described the eugenic movement in the USA at the beginning of the 20th century. During this period genetic determinism was welcome to explain complex socio-economic problems (e.g., pauperism) with simple cause-effect chains (e.g., genes for pauperism). At the end of the line simple but brutal solutions (e.g., mass sterilisation) were realised to pretend an increase in perceived control over societal problems. Such an approach falls without doubt in the category of the first or industrial modernisation. For a recent and lucrative attempt to provide simple cause–effect chains in the field of genetic testing [18].

3.4. Public discourse

Although attempts were made to overcome the traditional nature–nurture conflict, the public discourse has only partially responded to increasing complexities. In a study conducted with focus groups in the USA, still 25% of the participants believed in the strongest form of genetic determinism [17]. The problem of genetic determinism is the rejection of active strategies to prevent the risk of diseases (or reduce the probability).

In the media analysis mentioned before [15] it was shown that genetic determinism was fostered by US print media. About 25% of the media reports referred solely to genetic determinism (see Fig. 7). On the other hand, over the years more and more reports showed an increasingly differentiated picture of cause–effect chains.

For clarification it has to be mentioned that only in some rare cases a genetic mutation is certain to cause a disease, whereas in most cases the interplay between genes and environment and lifestyle is of importance. Anyway, even in the post-genomic era, following the encoding of the human genome, it cannot be ruled out that some simple genotype–phenotype interactions will be discovered even for complex behavioural traits.[2]

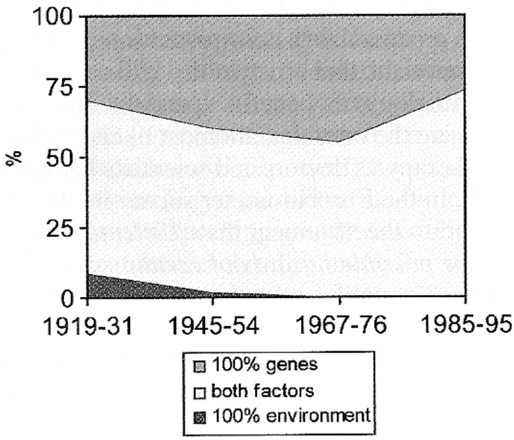

Fig. 7. US Media reports on gene/environment influence.

[2] Example for possible genetic influence on complex behavioural traits "discovery" or "extrovert" gene. The recent "discovery" of an "extrovert" gene is an example of the interplay between quantitative and molecular behaviour genetics. These studies showed that the mean extroversion and novelty seeking scores were higher, while the conscientiousness scores were lower, for individuals with the "long" D4DR (dopamine receptor) allele than for those with the "short" allele. A credible hypothesis of the mechanism of gene action on the phenotypic characteristics is presented, based on the action of the D4D4 gene [24].

3.5. Trustworthy stakeholders and useful information

One of the most important aspects for people living in democracies is the ability to make informed decisions. This basically requires two things: (1) have enough useful information and (2) be able to use this information to make the right decision. In this chapter we do not focus on the decision-making process but discuss the way information is provided and judged.

In risk communication – and management – one of the most important factors is trust. In a complex and highly specialised world people have by no means the chance to be informed on all the issues affecting them. Instead, they rely on the expertise of scientists, regulatory institutions, doctors, non-governmental institutions and other sources of knowledge mostly brought to them by some kind of mass media (TV, radio, print media), the internet and sometimes specific information events. As long as people trust the experts, and those who finally make decisions, and those who watch over the deployment the situation is in most cases calm. Useful and honest information, open and transparent decisions for the benefit of the people are generally well accepted. In case of obvious disinformation, opaque decisions, increasing third party interests and hidden agendas, distrust and opposition is likely to appear. In addition trust has a large asymmetry it takes a long time to be gained, but it can be lost easily [19]. But what role does trust play in informing people? Normally, people tend to accept and use information if it affects them and if the information source is respected and trusted. Information from a trusted source is more likely to influence the decision process than a non-trusted source. For the future of gene therapy it will be important that trustworthy experts tell the public or the patient about this technology, its benefits and risks. In case of gene therapy, doctors and scientists are the ones that are most likely to play this role. This is good news for gene therapy as doctors and scientists belong to the groups that are most trusted [10]. In the Eurobarometer survey in 2002, however, 89% of the respondents agreed to the statement that: "*Scientists ought to keep us better informed about the possible hazards of certain scientific or technological advances*" being a clear signal for scientists to take this role serious.

Another statement found 85.9% agreement of the respondents: "*Scientists ought to communicate their scientific knowledge better*". With *better* they probably mean two things:

- any communication, and
- communication that an interested lay person can follow and understand.

This is basically addressed to scientists and journalists alike, as communicating complex issues in an understandable way is a demanding task. Taken the current situation on the availability of useful information, that gives a good introduction and comprehensive overview, there is still a great demand for structured, comprehensive and useful information. For the economic sector especially in highly dynamic branches "knowledge management" is something they have to deal with. There is no doubt that a lot of information is available (mainly in books, scientific articles and generally spoken on the internet), however, there is very little comprehensive introduction available that is likely to reach the people.

4. WORLDVIEWS, FRACTAL DISCOURSE AND TERRA INCOGNITA

This last chapter is probably the most difficult one. It starts with a simple question: What happens if at the end of the day – even in case most of the other points mentioned so far are solved – we recognised that the whole discussion on gene therapy is not about gene therapy. What, if even in presence of, e.g., a discourse on the risks and benefits of gene therapy, a public discussion on genetic privacy, the appearance of some religious or philosophical moral discourse heavy weight champion telling us what is right and what is wrong, what if all this classical aspects of a neat and nice discussion on gene therapy finally leads us to the conclusion that the discussion is not about gene therapy?

And if I am allowed to explicitly state my own point of view here, I would guess that it is also very likely, that the discussion on gene therapy will hardly be on gene therapy!

But if it is not on gene therapy, what is it then?

After Gill [20] the conflict in the green biotechnologies is not so much on knowledge – as natural scientists would guess – or on risks and interests – as social scientists would guess – but is motivated mainly by different worldviews. The expression "worldview" represents here a set of attitudes towards a number of different issues (e.g., role of humans in nature, political views, personal goals). For German-speaking countries Gill identified mainly three different worldviews[3] that face each other in the discussion:

(1) the conservative, identity oriented,
(2) the utilitarian, progress oriented, and
(3) the romantic, alternative oriented one.

These worldviews come into play if new situations have to be classified and put in context, also if these new situations involve uncertainties that allow several different ways of interpretation. Basically such worldviews[4]

[3] Of course people hardly fit entirely into one of these categories, and yes there are also other category attempts (e.g., cultural theory).

[4] A critical mind could argue that putting people into categories or "boxes" does not acknowledge a person's individual character, however the worldview is probably an expression of the individual character.

Table 5. Brief overview of the three worldviews and their perception of nature, diseases, science and technology

Worldview	View of nature
Conservative identity oriented	Nature as the rules of creation, each creature has its place and its identity. Disease as punishment for breaking this rules
Utilitarian progress oriented	Disease as consequence of a hostile nature. Science and technology as means to control nature and find a therapy.
Romantic alternative oriented	Disease because of science and technology, therapy by means of liberation from science and technology.

(*Source*: from Ref. [20]).

give humans a mental tool to structure their complex environment and to help them to – allegedly – understand the world around them, something that creates a feeling of security, rather than remaining in a world with unclear cause–effect chains and no ability to forecast events, thus causing insecurity and fear.

To give an example, Gill cites the different points of view of nature and their relation to science and technology (see Table 5).

In the case of GM-crops the discourse and argumentation frequently followed these worldview conflicts. Interestingly, similar kinds of arguments appeared throughout different levels of the discussion, forming a "fractal-like" pattern of the discourse. As a consequence the observer may draw the conclusion that the discourse on e.g., GM-crops is rather a surrogate conflict of competing worldviews than a conflict of the issue at stake.

A novel issue like gene therapy fulfils at least some of the criteria to become a surrogate conflict between pre-existing worldviews. The novel technology could even be used by some worldview representatives to put forward their demands, claiming the way how to deal with it. To use a metaphor drawn from the world of explorers, the new technology is like a newly discovered island, or continent and each piece of land is going to be conquered, colonised, claimed and defended by the discoverers. The question now is, what kind of post-genomic terra incognita is about to be colonised? Is it mere a *go west* – free for all region, an internationally governed Antarctica type of territory, an arctic icecap, or another worldview surrogate battlefield like in GMO-istan?

A first taste of this *terra incognita* is the recent discussion on gene testing where patient groups and other stakeholders call for a more participative discourse between patients and doctors, instead of the conventional relationship between these two groups. In fact this is not particularly a consequence of the technologies of gene testing, but a wish for reforms in the doctor–patient relationship. A new technology offers the opportunity to install these reforms more easily than to break up old habits and long running "business as usual" (the Collingridge-dilemma). That is why new technologies may be seen also as a barometer for societal consent or dissent, and the way dissent is managed. This is also why a new technology in a sensitive area may be hijacked by interest groups and some stakeholders to pursue their own worldviews and interests.

5. BRIEF IDEAS ON MANAGEMENT

After discussing some of the factors that might play a role in future of public perception (and public discourse) one might ask how to prepare for these. To make it clear, it is not the aim of this article to give management advices. Some very basic ideas, however, may be developed here.

As in most risk communication challenges, also in the case of gene therapy it pays off to follow an open, transparent and proactive strategy in communicating the results and insights of this technology. A slightly improved form of communication, however, is necessary (compared e.g., with GM-crops), one that is able to translate the complex issue of gene therapy into a comprehensive but still "true" content, one that is able to reach to the people, using the communication channels most frequently used by the public, one that is communicated by well respected and trusted individuals, and one that gives the public the opportunity to participate somehow in the way decisions are made. If this is done, a good basis for most of the issues discussed here – regarding knowledge, risks and interests – will be available. In case the issue expands beyond the borders of knowledge and interests, namely to the realm of worldviews, the issue will be much more difficult to resolve. Still, other forms of mediation and conflict managing tools will have to be used.

ANNEX A. PARTS OF THE DANISH CONSENSUS CONFERENCE ON GENE THERAPY (1995), STATEMENTS ON RISK, UNCERTAINTY AND ATTITUDES TOWARDS GENE THERAPY

Question a: Is it justifiable to implement gene therapy before DNA has been mapped?
Answer a: Previously, in combating diseases researchers have researched and applied medicine and methods whose effects and side effects had not been determined in detail before use, and still satisfying results have been achieved. The history of medicine shows that treatment has always been associated with uncertainties. Researchers believe that gene therapy makes it possible to cure a disease whose defective gene is known. It is not necessary to know the entire genome. So far, tests have not disproved this hypothesis.
Question b: Can we be certain that gene therapy will not activate inactive DNA (DNA junk)?
Answer b: To date no problems have been registered in relation to activation of that part of the DNA molecule called DNA junk by a gene implanted through gene therapy. Whether DNA junk can be influenced is not known. Consequently, the risk exists, but experts rate it as small.
Question c: Is there a risk that more than one gene may be injected into the same cell – and which consequences would this have?
Answer c: There is a theoretic risk that more than one gene may be inserted into the same cell, as the gene vector cannot be controlled completely. At worst this could create a mutation which may generate cancer. In the US tests on humans, work is being done on technologies which can trace the implanted gene. A control gene is implanted which allows doctors to intervene and kill the cell.
Question d: Is there a risk that germ cells may be influenced when body cells are treated – and how resistant is our hereditary material to such influence?
Answer d: In general, the treatment of body cells will not affect the germ cells. The risk is limited, but cannot be completely ruled out. If the treatment is effected outside the body, there will be no risk of influencing the germ cells. A similar risk is found in chemotherapy and irradiation. Human genes are very resistant to changes. In a middle-aged person, gene changes may be found in every cell without the person being ill.
Question e: Are there risks of side effects of gene therapy – e.g., that the patient may start to grow again or that viruses (gene vectors) become active?
Answer e: There might be a risk of side-effects in gene therapy, but so far they have not been observed in tests on humans. One side effect of transplantation of several vectors in a cell could be that it metamorphoses into a cancer cell. As the treatment would primarily be used on seriously ill people, it is probably an acceptable risk. However, hypotheses of side effects which, for instance, would cause patients to start growing again, are highly

unlikely. As a weak virus is used as gene vector, the risk that it may become active is minor.

Question f: Can gene vectors spread from laboratories to organisms in the surroundings and impact on them ("Turtle Effect")?

Answer f: As weak viruses are used, the risk that gene vectors will spread from laboratories and impact on the surroundings is virtually non-existent. They would simply not be able to survive in the natural competition.

Question g: Can gene vectors spread from the patient to other persons?

Answer g: Neither of the gene vectors spread from one person to another.

Question h: Will gene therapy on body cells give an increased incidence of hereditary diseases where generation after generation will see more and more persons becoming dependent on gene therapy?

Answer h: In hereditary diseases, where the disease only erupts when the person has had children, gene therapy will not increase the incidence of these hereditary diseases. In hereditary diseases erupting before a person has had children, gene therapy will increase the incidence of these hereditary diseases. This is of course true of all disease treatment.

Question i: Is there a risk of abuse of gene therapy for e.g., genetic warfare and terror actions?

Answer i: As weakened vectors are used, there is no risk of gene therapy abuse for e.g., genetic warfare or terror. In conclusion, it cannot be ruled out that gene therapy may present risks in the long run, as there are very few test results to prove otherwise. Consequently, it will be necessary continuously to evaluate risks to be able to discover any negative side-effects.

REFERENCES

[1] P. Slovic, Perception of Risk, *Science*, 1987 **236**, 280–285.

[2] C. J. Atman , A. Bostrom, B. Fischhoff and M. G. Morgan, Designing risk communications: Completing and correcting mental models of hazardous processes, Part I. *Risk Anal.*, 1994, **14**(5), 779–788.

[3] WBGU, World in Transition. Strategies for global environmental risks. Annual report of the German Advisory council on global change (WBGU), 1998.

[4] V. T. Covello, D. Winterfeldt and P. Slovic, Communicating scientific information about health and environmental risks: Problems and opportunities from a social and behavioral perspective, in *Uncertainty in Risk Assessment, Risk Management, and Decision Making* (eds. V.T. Covello, B. Lester, A. Moghissi and V.R.R. Uppuluri) Plenum Press, New York, 1987.

[5] S. Lichtenstein, P. Slovic, B. Fischhoff, M. Layman and B. Combs, Jugded frequency of lethal events, *J. Exp. Psychol.: Hum. Learn. Mem.*, 1978, **4**, 551–578.

[6] P. Slovic , B. Fischhoff and S. Lichtenstein, in *Rating the risks: The structure of expert and lay perceptions* (eds. V. T. Covello, J. L. Mumpower, P. J. M. Stallen and V. R. R. Uppuluri), Environmental Impact Assessment, Technology Assessment, and Risk Analysis. Band 4, Berlin, Springer, 1985, pp. 131–156.

[7] D. Kahneman, P. Slovic and A. Tversky, *Judgement under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge, 1982.

[8] M. Henrion and B. Fischhoff, Assessing uncertainty in physical constants, *Am. J. of Phy.*, 1986, **54**(9), 791–798.
[9] L. Savadori, S. Savio, E. Nicotra, R. Rumiati, M. Finucane and P. Slovic. Expert and public perception of risk from biotechnology, *Risk Anal.*, 2004, **24**(5), 1289.
[10] Gaskel *et al.,* Eurobarometer 58.0: Europeans and Biotechnology in 2002, 2003, www.cordis.at
[11] A. Giddens. *The Consequences of Modernity*, Stanford University Press, Stanford 1990.
[12] Z. Baumann, *Modernity and Ambivalence*, Blackwell, London, 1992.
[13] U. Beck, *World Risk Society*, Blackwell, London, 1999.
[14] J. P. Evans, C. Skrzynia and W. Burke, The complexities of predictive genetic testing, *Brit. Med. J.*, 2001, **322**, 1052–1056.
[15] C. M. Condit, M. Ofulue and K. M. Sheedy, . Determinism and mass-media portrayals of genetics, *Am. J. Hum. Genet.*, 1998, **62**, 979–998.
[16] G. C. Allen, The social and economic origins of genetic determinism: a case history of the American Eugenics Movement, 1900–1940 and its lessons for today, *Genetica*, 1997, **99**, 77–88.
[17] B. R. Bates, A. Templeton, P. J. Achter, T. M. Harris and C. M. Condit, What Does "A Gene for Heart Disease" mean? *Am. J. Med. Genet*, 2003, **119A**, 156–161.
[18] CPR, Marketing genetics. Consumers' Association in England, 2003, http://www.which.co.uk/
[19] M. Siegrist, Die Bedeutung von Vertrauen bei der Wahrnehmung und Bewertung von Risiken. Akademie für Technikfolgenabschätzung in Baden-Württemberg, Stuttgart, 2001.
[20] B. Gill . Streitfall Natur: Weltbilder in Technik- und Umweltkonflikten, Westdeutscher Verlag, ISBN: 3531138383, 2002.
[21] M. L. Finucane, A. Alhakami, P. Slovic and S. M. Johnson, The affect heuristic in judgments of risks and benefits, *Journal of Behav. Decis. Making*, 2000, **13**, 1–17.
[22] J. S. Alper, Genes, free will and criminal responsibility, *Soc. Sci. Med.*, 1998, **46** (**12**), 1599–1611.
[23] J. S. Alper and J. Beckwith, Genetic fatalism and social policy: the implications of behavior genetics research, *Yale J. Bio. Med.*, 1993, **66**, 511–524.
[24] R. C. Bailey, Hereditarian scientific fallacies, *Genetica*, 1997, **99**, 125–133.
[25] R. Steven, Moving on from old dichotomies: Beyond nature-nurture towards a lifeline perspective. *Br. J. Psychiatry*, 2001, **178** (suppl. 40), pp. 3–7.