Sensitive Technologies and European Public Ethics – STEPE

Final Publishable Summary Report

1. Executive Summary

Sensitive technologies and European Public Ethics (STEPE) investigated societal perceptions of technological innovations in the life sciences and biotechnology that have, or have the potential to come into conflict with social values and/or raise ethical concerns amongst the public.

The project comprised three interrelated foci:

i. a qualitative investigation of how experts (policy advisors, CSOs, industry, funding agencies, scientists and the media) think about the past, present and possible future situation in the country regarding technology conflicts, governance and the public. These interviews had two objectives – to give an overview over new developments potentially relevant to the EB survey for the update of the questionnaire and to provide contextual information to contribute to the interpretation of the survey findings.

ii. the design, analyse and reporting of the 2010 Eurobarometer survey on the life sciences and biotechnology with a particular focus on sensitive technologies (stem cell research, synthetic biology, nanotechnology, transgenics and cisgenics, biobanks and animal cloning) social values and the public's views regarding the governance of technological innovation.

iii. the application of advanced multivariate statistical procedures to facilitate the analysis of the Eurobarometer's multi-national data in particular in the context of segmenting the public and making cross-national comparisons.

The expert interviews provided helpful guidance in the selection and framing of issues to be included in the Eurobarometer survey. However, such was the heterogeneity across Europe's national experts that a relatively small number of interviews was insufficient to provide a basis for generalisations. In part the heterogeneity reflects different stages in the development of science and technology and in democratic processes.

The Eurobarometer survey showed that the crisis of confidence between science and the public evidenced around 2000, is now no longer the dominant issue. Rather, there appears to be a turn towards 'critical concern with contents': are technologies safe, are they useful in the context of resource depletion, and are there 'technolite' alternatives with more acceptable ethical-moral implications? The survey shows a nuanced view of technology governance: there is no rejection of the innovation and commercialization agenda but Europeans are in favour of appropriate regulation to balance the market, and wish to be involved when it comes to decisions related to the most sensitive technologies - a 'mixed model' of technology governance.

The application of advanced multivariate techniques yielded important insights into the evidence that can be extracted from Eurobarometer data. Latent trait modelling revealed notable cross-country variation in measurement properties of items on knowledge about science. Latent class analysis was used to segment individuals to generate a typology of public confidence in biotechnology actors. Cluster analysis provided a way of segmenting countries, clustering them sequentially based on attitudes towards biobanks and regulation. Finally, multilevel modelling was used to explain individuals' support for embryonic stem cell research, in terms of individuals' characteristics (e.g.religious denomination) and country level factors (e.g. prevalence of religiosity).

The STEPE research ends with a review of 40 years of biotechnology. This traces the emergence of ethical questions, the evolution of public perceptions and of various methods designed to engage the public; the latest of which is mobilisation and mutual learning towards the goal of responsible research and innovation.

2. Summary description of the project context and the main objectives

Past developments in the domain of modern biotechnology, such as for example the fate of GM food in Europe, have shown that the consideration of public concerns is crucial for sustainable technology development. Such concerns are likely not only to be based on sound science understandings of risks and utilities but, and increasingly so, to involve ethical issues and general ideas about "*how we want to live*". This is especially likely with sensitive technologies in the life sciences such as embryonic stem cell research, synthetic biology or human-animal chimeras, to name but a few. The purpose of the STEPE project was to investigate these broader public concerns – which we conceptualise as "public ethics". The project is innovative in contributing to the *early identification of potentially controversial technological developments and related public ethics*, by systematically considering both the view of key stakeholders in technological, political and societal life and the perceptions of European citizens in 25 European member states, thereby contextualising the findings by a systematic analysis of policy developments both on national and European levels. The interdisciplinary and multi-method approach aimed at establishing an integrated *European Map of Public Ethic*s. It was our aim to stimulate new, empirically grounded, thinking on public ethics as a contribution to wider debates and policy making on responsible technological innovation.

As a key data source, this project was based on the Eurobarometer survey on the Biotechnology and the Life Sciences. The Eurobarometer surveys have become a benchmark as the systematic and dispassionate assessment of public perceptions, or what we term 'public ethics', of the life sciences and other technologies interpreted in the context of issues of trust, governance and social values. In a sense the Eurobarometer surveys are a form of 'social observatory', complementing prospective technology forecasting initiatives; supporting the development of societally sustainable innovation; informing communication strategies on aspects of science and technology; and, with the time series dimension, providing an explanation of the evolution of public opinion. The survey findings are an important resource for science policy makers and communicators in the European Commission and in National governments, medical, physical and biological scientists, industry representatives, civil society groups and for social researchers.

This project took the 2010 Eurobarometer forward in three distinct ways. In terms of content, it covered upcoming socially sensitive technologies – for example synthetic biology, stem cell research and so-called chimeras. In terms of analysis, we employed

recent developments in social statistics to make comparative cross-country comparisons more valid. In terms of policy-relevance, we developed a methodology to systematically combine the survey data with national indicators relating to science and technology and society in science, allowing for an enriched and more valid interpretation of the survey data.

The project objectives were as follows:

i. To understand national policy contexts in relation to science and technology policy and society in science through a series of elite interviews with key stakeholders – policy makers, ethicists, NGOs, scientists and journalists
ii. To design the 2010 Eurobarometer Survey on Biotechnology and the Life Sciences, ensuring that key time series or trend data is retained
iii. To employ new multivariate statistical procedures to ensure that cross national comparisons are valid and to extract more added value from the data
iv. Analyse the data of the 2010 Eurobarometer Survey on the Life Sciences and Sensitive Technologies, identifying general patterns and trends in relation to sensitive technologies in all European member states
v. Integrate the analyses and systematically consider contextualising background information
vi. Communicate the goals and results of the project to the wide community of actors interested in STEPE activities

3. Description of the main S & T results/foregrounds

a. Main descriptive findings

Gaskell, G., Allansdottir, A., Allum, N., Castro, P., Esmer, Y., Fischler, C., Jackson, J., et al. (2011). The 2010 Eurobarometer on the life sciences. Nature Biotechnology, 29(2), 113–114.

The 2010 Eurobarometer survey on the Life Sciences and Biotechnology, based on representative samples from 32 European countries, hints at a new era in the relations between science and society. We see less criticism of technology based on distrust in government and industry; more enthusiasm for novel technologies and a more sophisticated appraisal of what technologies offer in terms of benefits, safety and sustainability. Europeans want regulation in the public interest and a voice in such regulation when social values are at stake; we highlight an emerging European landscape of social value differences that shape people's views of technologies.

That sustainability is framing perceptions of technology is illustrated in Europeans' overwhelming support for the 2nd generation bio-fuels, as well as their optimism about the contribution of different technologies to improving our way of life. Respondents were asked about a number of technologies. From their answers we create an index of technological optimism - the more positive the score the higher is the ratio of optimists to pessimists. Wind and solar energy, the sustainable options, are in the same league as the ubiquitous computers and IT. Green energies also show increasing support over the last 5 years. Nuclear power shows a similar increase albeit it now attracts equal numbers of pessimists as optimists. By contrast, all the non-energy related technologies show decline in optimism – it is possible that this is due to their lack of relevance to the sustainability agenda rather than a change in attitudes. Of note is that biotechnology has returned to the level in 1993 i.e. before the controversies over agri-food biotechnologies of the mid to late 90s.

The re-building of trust in regulators and industry from the nadir in the 1990s is in evidence. On an index capturing a trust surplus (the percentage trusting minus the percentage not trusting) we find National Governments at 46% up 13% since 2005, the EU at 56% up 14% and industry at 50% up 9%. On this index University Scientists maintain a trust surplus of around 80%

But along with increasing trust, Europeans expect to see appropriate regulation and are unwilling to accept a reliance on market forces. Science based regulation is widely accepted; however, when ethics and social values are at stake – in the cases of synthetic biology and animal cloning, for example- many want to see public involvement in decision taking.

Detailed questions about emerging technologies - nanotechnology and synthetic biology – illustrate the focus upon benefits and safety. Nanotechnology, described in the context of common consumer products, attracts support from 3 out of 5 with safety as the most important consideration followed by benefits. Although 83 per cent of Europeans have not heard about synthetic biology, their responses show what people expect from a novel technology. Asked which three of seven issues they would most like to learn about, 'possible risks', 'claimed benefits' and 'who will benefit and who will bear the risks' are the prevalent choices. Under what conditions would respondents support the development of synthetic biology? Europeans are evenly split between those opting for strict regulation and those who either reject synthetic biology altogether or who would only approve under very special circumstances. It is clearly a sensitive and potentially controversial issue – taking note of the evolving public perceptions may be prudent.

While the regulation of embryonic stem cell research is back in focus in the United States, 63 per cent of Europeans approve of embryonic stem cell research. There is a similar level of support for gene therapy. Xenotransplantation – an application long subject to moratoria in various countries – now finds approval with 58 per cent of respondents. And the solid support for medical biotechnologies is also seen in non-therapeutic applications. Moving from repair to improvement, we find that 56 per cent of the European public approves of research that aims to enhance human performance. But, support for regenerative medicine is not unconditional; approval is contingent upon perceptions of adequate oversight and control. The contrast between the public's reception of medical biotechnologies and the traditional agri-food biotechnologies is, however, greater than ever.

The survey was conducted one month before BASF's Amflora potato was approved by the EC, heralded in Nature as a potential new dawn for transgenic crops in Europe. But, the survey shows that some controversies never die; GM food is still the black sheep of biotechnology. The findings show declining support across many of the EU member states – on average opponents out-number supporters by 3 to 1, and in no country is there a majority of supporters. Why are there no winds of change for GM? The findings

show that public concerns about safety are paramount, followed by the absence of benefits and a worry that it is unnatural. Cloning animals for food products evokes similar concerns in almost all EU countries and attracts even less support than GM food. Food and biotechnology is an explosive cocktail – a point that nanotechnologists should not ignore as nano particles in food packaging and as food ingredients are nearing the plate.

Yet, there are indications that all is not lost for GM agriculture. Cisgenics, GM crops produced by adding only genes from the same species or from plants that are crossable by conventional breeding is a different story. In all EU countries, our example of the cisgenic production of apples receives higher support (55 per cent) than transgenic apples (33 per cent), with the former attracting majority support in 24 countries. Cisgenics might be seen as an example of the so-called 'second generation' of GM crops. Here, the benefits of GM apple breeding are achieved with a technolite process, a consumer benefit is offered (reduced pesticide use and pesticide residues) and as such it achieves better ratings in terms of benefits, safety, environment, naturalness, and double the support of GM food. The possibility of more acceptable solutions may indeed harden opposition to traditional GM.

To what extent are beliefs, socialisation and values associated with support for science and technology? Overall, the non-religious show more technological optimism and are more likely to support human embryonic stem cell research. Yet, when faced with a conflict between scientific and ethical views on regenerative medicine they are almost evenly split on which 'pillar of the truth' should prevail. This pattern is seen even among the adherents of Europe's major religions. Unsurprisingly, religious commitment is associated with greater concerns about ethical issues in stem cell research and with a belief that ethics should prevail over scientific evidence. But, here again there are many highly religious people who say that science should prevail in such a conflict of opinion.

What of education? The findings show that socialisation in a scientific family or having a university education in science is associated with greater technological optimism, more confidence in regulation based on scientific delegation, and more willingness to encourage the development of both nanotechnology and GM food. However, the findings also show that scientific socialisation either in the family or at university is not a magic bullet. For example, a majority of those coming from a scientific family background or with a degree in science are not willing to support the development of GM food.

Finally, looking at the way values relate to support for technologies across the European countries, we have suggestive evidence of five clusters of countries differentiated by two fundamental contrasts. The first contrast is between those countries in which, relatively speaking, the public prioritise science over ethics and those that prioritise ethics over science. The second contrast is between those countries that are concerned about distributional fairness and those that are not. Crucially, a country's collective viewpoint on these two contrasts is associated with technological optimism and support for regenerative medicines.

In countries where ethics takes priority over science, concerns about distributional fairness lead to a profile of lower support (Germany and Austria); but in the absence of sensitivities about distributional fairness, the profile of support is relatively higher (Denmark and the Netherlands). When science taking priority over ethics is combined with concerns about distributional fairness, we find only moderate support (Finland and Poland); but once more the absence of sensitivities about distributional fairness reveals a profile of high support (UK and France).

Looking across religious beliefs, socialisation and values we see a complex and hierarchical pattern of influences. So, what are the conditions for socially robust technological innovation in Europe? The 2010 Eurobarometer points to some of the general criteria – sustainability, benefits, appropriate regulation, safety and a fair distribution of benefits and risks. Harnessing the winds of change into the design of particular emerging technologies will necessitate listening and accommodating to the public's voice(s).

b. Main findings on the public's ethical considerations on stem cell research

Gaskell, G., Stares, S., & Pottage, A. (2012). How Europe's ethical divide looms over biotech law and patents. Nature Biotechnology, 30(5), 392–394.

The recent decision of the Court of Justice of the European Union on stem cell patents startled the scientific community. And the role of Greenpeace, notable for its opposition to agricultural biotechnologies, has raised eyebrows. More shocks of this kind can be expected in the future, as political factions capitalize on the ambiguities and tensions written into the EU's Biotechnology Directive of 1998[1] and into the ethics and public morality provisions of the European Patent Convention.

The CJEU's decision reminds us that patent prosecution in Europe involves more than the application of technical criteria. As the European Patent Office (EPO) observed in 1991, with the Oncomouse patent in mind, 'the granting of patents no longer depends on purely technical considerations; from now, applications will have to bear scrutiny in respect of their wider social implications'.[2] The CJEU's decision on stem cell patents tried to avoid these ethical and social considerations by adopting a particular interpretation of the relevant legislation.

First, it took note of the specificity of the prohibition against 'the use of human embryos for industrial or commercial purposes' in article 6(2)(c) of the EU Biotechnology Directive, thereby making a wide-ranging exploration of 'morality' or '*ordre public*' unnecessary.

Second, the CJEU reached its decision that the human embryo is formed at the moment of fertilization by reference to two basic policies of the Directive – harmonization of European law, and respect for human dignity. It then combined these to make its adoption of the strictest criterion seem entirely obvious. It reasoned that any uniform or 'harmonized' definition of the human embryo should be one that excluded 'any possibility of patentability where respect for human dignity could thereby be affected'.

In fact, the decision was not quite so straightforward. The Biotechnology Directive, on which the decision was based, embraces two ethical principles. Recital 16 affirms 'fundamental principles safeguarding the dignity and integrity of the person', while recital 17 declares that the patent system should encourage the production of medicines 'derived from elements isolated from the human body'. In affirming human dignity, the

[1] Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the legal protection of biotechnological inventions**,** *Official Journal* L 213, 30/07/1998, 13-21.
[2] EPO, Foreword, *Annual Report* 1991.

CJEU emphasized one of these principles at the expense of the other. And, in so doing, it chose to stand on one side of a tension that is deeply embedded in European culture.

This cultural tension is clearly revealed in the findings of the Eurobarometer 2010 survey on the Life Sciences and Biotechnology[3], which asked 15,000 respondents to answer the following questions after an introduction to regenerative medicine and stem cell research:

i. Research involving human embryos should be forbidden, even if this means that possible treatments are not made available to ill people
ii. It is ethically wrong to use human embryos in medical research even if it might offer promising new medical treatments
iii. We have a duty to allow research that might lead to important new treatments, even when it involves the creation or use of human embryos
iv. Should ethical and scientific viewpoints on regenerative medicine differ, the scientific viewpoint should prevail

These questions capture two contrasting ethical principles – the sanctity or dignity of life, and the duty of care and healing, both of which feature in the Directive. To investigate relative public support for these two ethical principles across Europe we used latent class analysis which assumes that respondents' answers to the set of questions reflect underlying latent classes – in this case ethical orientations.

Comparing the strong supporters, 13 countries have a majority for the principle of duty of care and 13 for the principle of the sanctity of life, with 6 having roughly equal percentages of the two. Combining the strong and moderate supporters 18 countries (including France, Italy and the UK) have a majority for the principle of duty of care while 10 (including Austria, Germany and Poland), have a majority for the principle of the sanctity of life and 4 are roughly split between the two. Overall, Europe leans towards the principle of duty of care, but clearly both ethical principles find support in all countries.

[3] European Commission Publications

Do the different ethical orientations merely reflect religious denomination? The answer is no. Strong support for 'sanctity of life' predominates among Muslims, while strong support for the 'duty of care' is more frequent among the non-religious. By a small majority both Catholics and Protestants support 'duty of care'. In a further analysis we find that the religiously committed, assessed by the frequency of attendance of services, are they more likely to be strong supporters of the sanctity of life ethic.

This diversity of views, and more especially the basic tension between dignity and care, is likely to trouble the European patent system for some time to come. The provisions of the European Patent Convention allow members of the public to contest newly-granted patents on the basis of morality or public order, and the passage of the Biotechnology Directive gives opponents another forum (the CJEU) in which to contest the validity of biotechnology patents. Although the Directive has finally been implemented throughout Europe, it is not a straightforward piece of legislation. Member States have adopted different interpretations of the Directive with respect to, for example, the protection of the gene sequences, which are not given the same scope in all Member States, and the definition of genetic material,[4] and these inconsistencies only add to confusion over the status of biotechnological inventions in Europe.

The EPO has tried to insulate itself from the pressures of political or ethical opposition by defining morality as whatever is 'in conformity with the conventionally-accepted standards of conduct pertaining to European culture', thereby implying that morality is offended only where the broadest constituency of Europeans is affronted. So, regarding the patentability of human gene sequences, evidence of a deep tension between dignity and care is taken to mean only that the opinion of society is 'complex and not yet definitively formed', so that there is no common sense of morality. Similarly, the tension between animal welfare and medical progress was evidenced in the Oncomouse case was interpreted only as a sign of public 'unease', and unease could not be 'elevated to the status of moral disapproval in European culture'.[5] Hence, a conflict between opposing ethical positions proves only that there is no 'conventionally-accepted standard of conduct'.

It is not clear that this strategy offers a long-term fix. First, even in the EPO, what works for tribunals does not work for patent examiners, who are left in a dilemma about how to apply morality and *ordre public* provisions. Second, the entry of the

[4] *Monsanto* v *Cefetra* (2010) ECR 7.
[5] Board of Appeal of the European Patent Office, Decision of 6 July 2004, T 315/03.

CJEU into the patent field in the wake of the Biotechnology Directive complicates matters by adding another jurisdiction and another judicial perspective on questions of ethics. Indeed, by emphasizing the EU's policy of harmonization in the field of patent law, the CJEU is likely to intensify political and ethical opposition. In the process of turning Europe into a competitive market for biotechnological research it may flatten the moral debate entirely, and so offend both sides of the tension between 'dignity' and 'care'. So the decision by the CJEU is likely to be followed by others in which tribunals respond, not necessarily with a single voice, to challenges from both sides of Europe's ethical divide.

c. Main findings on the public's support for and preferences for participation in biobanks

Gaskell, G., Gottweis, H., Starkbaum, J., Gerber, M. M., Broerse, J., Gottweis, U., Hobbs, A., et al. (2012). Publics and biobanks: Pan-European diversity and the challenge of responsible innovation. European Journal of Human Genetics.

This article examines public perceptions of biobanks in Europe using a multi-method approach combining quantitative and qualitative data. It is shown that public support for biobanks in Europe is variable and dependent on a range of interconnected factors: people's engagement with biobanks; concerns about privacy and data security, and trust in the socio-political system, key actors and institutions involved in biobanks. We argue that the biobank community needs to acknowledge the impact of these factors if they are to successfully develop and integrate biobanks at a pan-European level.

d. Main findings on the public's views on science

Mejlgaard, N., & Stares, S. (2012). Performed and preferred participation in science and technology across Europe: Exploring an alternative idea of "democratic deficit." Public Understanding of Science.

Republican ideals of active scientific citizenship and extensive use of deliberative, democratic decision making have come to dominate the public participation agenda, and academic analyses have focused on the deficit of public involvement vis-à-vis these normative ideals. In this paper we use latent class models to explore what Eurobarometer survey data can tell us about the ways in which people participate in tacit or in policy-active ways with developments in science and technology, but instead of focusing on the distance between observed participation and the dominant, normative ideal of participation, we examine the distance between what people do, and what they themselves think is appropriate in terms of involvement. The typology of citizens emerging from the analyses entails an entirely different diagnosis of democratic deficit, one that stresses imbalance between performed and preferred participation.

e. Main findings on tools for cross-national report

Over the years Eurobarometer reports have generated considerable attention and influenced policy. Standard procedures that document top-line percentages for each Member State are valuable. However, analyses that go beyond raw percentages are important but rarely done. This project aimed to produce a step change in the exploitation of European public opinion data by demonstrating that modern statistical analysis can produce better quality information from survey data and by showing social researchers how this can be achieved in practice. A user guide on statistical methodologies for cross-national comparisons was developed. In this guide, statistical methods for scale construction, segmentation and multi-level modelling were used in order to: (a) examine whether the survey questions operate comparably across different countries; (b) assess ways of segmenting Europeans and (c) European Member States; and (d) analyse how values and attitudes are affected by multi-level systems in which they occur.

i. A cross-national assessment of measurement tools: latent trait analysis of knowledge items

Responses to individual survey items are determined not only by the content of the question, but also by question wording, the available response options, the cultural understandings that respondents bring to the item content, and particular response tendencies they may have, as well as a degree of random error. In order to construct valid and reliable measurements of psychological attributes – e.g. scientific literacy, to take an example – it is highly desirable to combine information from many items rather than to take single items as trusted indicators of these phenomena. Using analyses such as latent trait models, from the family of Item Response Theory (IRT), we examined how the items functioned in the survey, whether they tapped into the same construct, which items were the 'anchors' for that construct, which were most powerful for discriminating between respondents, and where there were response effects (e.g. acquiescence bias) that might have distorted the information in the data.

A major concern of those using cross-national data is guaranteeing comparability of measurement scales across country samples. In this section, latent trait models were used to provide powerful diagnostic information about the utility of individual

questionnaire items. We used data from the Eurobarometer 63.1 survey on Europeans, Science and Technology (European Commission, 2005) to derive a single measure of knowledge about science for each respondent. We explored the measurement equivalence of these knowledge items. In order to do so, we allowed item response intercepts, or intercepts and slopes together, to vary by country.

ii. Segmenting individuals by attitudes: latent class analysis of public confidence in actors in biotechnology

The type of analysis of cross-national survey data that was considered in this section was translating individuals' responses to several survey measures of a concept into a single measure or 'score' of that concept. As an illustrative example, we considered the concept of public confidence in different people or groups in their roles in the area of biotechnology. We used data from the Eurobarometer 73.1 survey on Life Sciences and Biotechnology (European Commission, 2010) where confidence was assessed using 11 survey questions. Each question referred to one actor in the area of biotechnology, and the respondents indicated whether they felt that the actor was or was not "doing a good job for society" in that area.

Our aim was to use the responses to these 11 questions to derive a single measure of confidence for each respondent. We were led to the idea of *segmentation* of individuals, where the aim is to use the responses to the 11 questions to assign individuals into a limited number of different segments or classes, each of which represents a distinct level or pattern of confidence in different actors in biotechnology. A model with 6 latent classes was selected, as providing a reasonable balance of model fit and interpretability.

iii. Segmenting countries by attitudes towards science and technology: cluster class analysis of attitudes towards biobanks and regulation

Studies often present data at the European level, providing a valuable general picture of public opinion, and at the national level, giving detailed comparisons of 27 Member States. Both approaches have their shortcomings: the pan-European approach gives a snapshot; the country-by-country analysis gives a detailed picture. But falling

between these levels of aggregation is the possibility of clustering a number of countries according to similar profiles. Such clustering gives a statistically derived assessment of the Member States that fall into particular groups according to similarities in, for example, levels of support for new technologies, confidence in governance, and scientific engagement and knowledge. This provides valid ways of disseminating a complicated set of data in an accessible yet valid manner.

In this section we demonstrated the use of cluster analysis for exploring the similarities and differences of Member States on selected aspects of public opinion related to biobanks. We used data from the Eurobarometer 73.1 survey on Life Sciences and Biotechnology (European Commission, 2010). We considered eleven country-level indicators of preferences regarding biobanks and more general regulation – as used in an article for *Nature* magazine, in which Gaskell and Gottweis (2011) analyse the same indicators, using the same technique, but focusing on seven countries in detail.

We focused on the five-cluster solution produced using Ward's method. Looking at the mean cluster scores for each items we were able to summarise the positions as follows:

Cluster 1. Cautious in regard to biobanks.

Cluster 2. Detached from concerns about biobanks and their regulation.

Cluster 3. Enthusiasm for roles of responsibility both for those who work closely with biobank data and for those who work at the broadest policy level.

Cluster 4. Positive sentiments both towards biobanks themselves and towards public institutions and science actors.

Cluster 5. Mixture of low concern about informed consent alongside relatively high confidence in national, and low confidence in EU-wide, law-making on biotechnology.

iv. Citizens in their national contexts: A multi-level analysis

To illustrate multilevel modelling, we referred to an example in regenerative medicine. Specifically, we were interested in predicting people's level of support for the use of embryos for research when we have respondents from a number of different countries. Using multilevel modelling, we were able to deal with the possible within-country dependencies among the observations, while also testing effects at different

levels. Most interestingly, we were able to evaluate whether individual and country-level variables interact in predicting the support for embryonic stem cell research.

Using multilevel modelling we tested for the effect of views on science and religious beliefs on attitudes towards embryonic stem cell research while taking into account the hierarchical structure of the data. The results showed that positive attitudes towards science and religious denomination predicted support for research using embryos. Furthermore, a cross-level interaction effect between the country's religiosity and the individual's trust in science was found to be significant. In highly religious countries, trusting science did not have a strong effect on supporting embryonic stem cell research. This is the difference in support for those who do not trust science compared to those who do trust science was not as relevant. But in non-religious countries trusting science did make an important difference. Overall, those who did not trust science in non-religious countries were the most critical ones, while those who did trust science in non-religious countries were the most supportive ones.

4. Description of the potential impact and the main dissemination activities and the exploitation of results

Through publications in academic journals, conference presentations and participation in workshops the STEPE project has:

i. Raised the profile of the concept of public ethics in scientific and technological innovation; explained the bases of public ethics and the ways in which these inform public perceptions, and pointed to the nature of innovations that are more likely to achieve public acceptance. We have shown that the public are not irrational or suffering deficits, but rather that their perceptions of science emerge, in part, from a background of ethical issues related to equity, responsibility and social values. Thus a technology is assessed through a number of perspective that include benefits and risks, distributional issues, values and the ways in which public policies for science deal with these issues. In so doing the STEPE project provides support for decision makers at all policy levels, scientists and innovators to adopt a more dynamic and inclusive approach to the governance of the science and society relationship as envisage in the concept of Responsible Research and Innovation.

ii. Set a higher bar for standards and ambitions in the conduct and analysis of comparative quantitative research in the social sciences. Our accessible technical reports explain how to achieve best practice by integrating an interdisciplinary and multi-method approach that simultaneously follows the highest standards in applying social research methods and in ensuring validity of the interpretation. Academic publications arising from the STEPE project have shown the benefits of using state of the art developments in statistical comparative analysis for the fuller exploitation of Eurobarometer survey data, yielding greater value for money from the considerable resources directed towards the assessment of public opinion. In this regard the methodological and analytic lessons of the STEPE project are of central relevance to commissioning of all new Eurobarometer surveys

iii. The series of Eurobarometer surveys on the Life Sciences and Biotechnology have had a considerable impact over the last decade. The reports have been widely consulted in European and National contexts by policy makers, people in industry and science, civil society organisations and academics. Articles

presenting the key findings from earlier surveys have been published in Science, Nature, Nature Biotechnology, Nature Materials, Public Understanding of Science and other academic journals. The 2010 Eurobarometer survey has built upon and sustained this high visibility with academic papers directed towards the social scientific community, scientists and public officials. In particular papers in Nature, Nature Biotechnology, Nature Review Genetics and the European Journal of Human Genetics focusing on cisgenics, stem cell research and biobanks, have featured in discussions and debates in a number of EU member states.

Project Website

www.stepe.eu

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