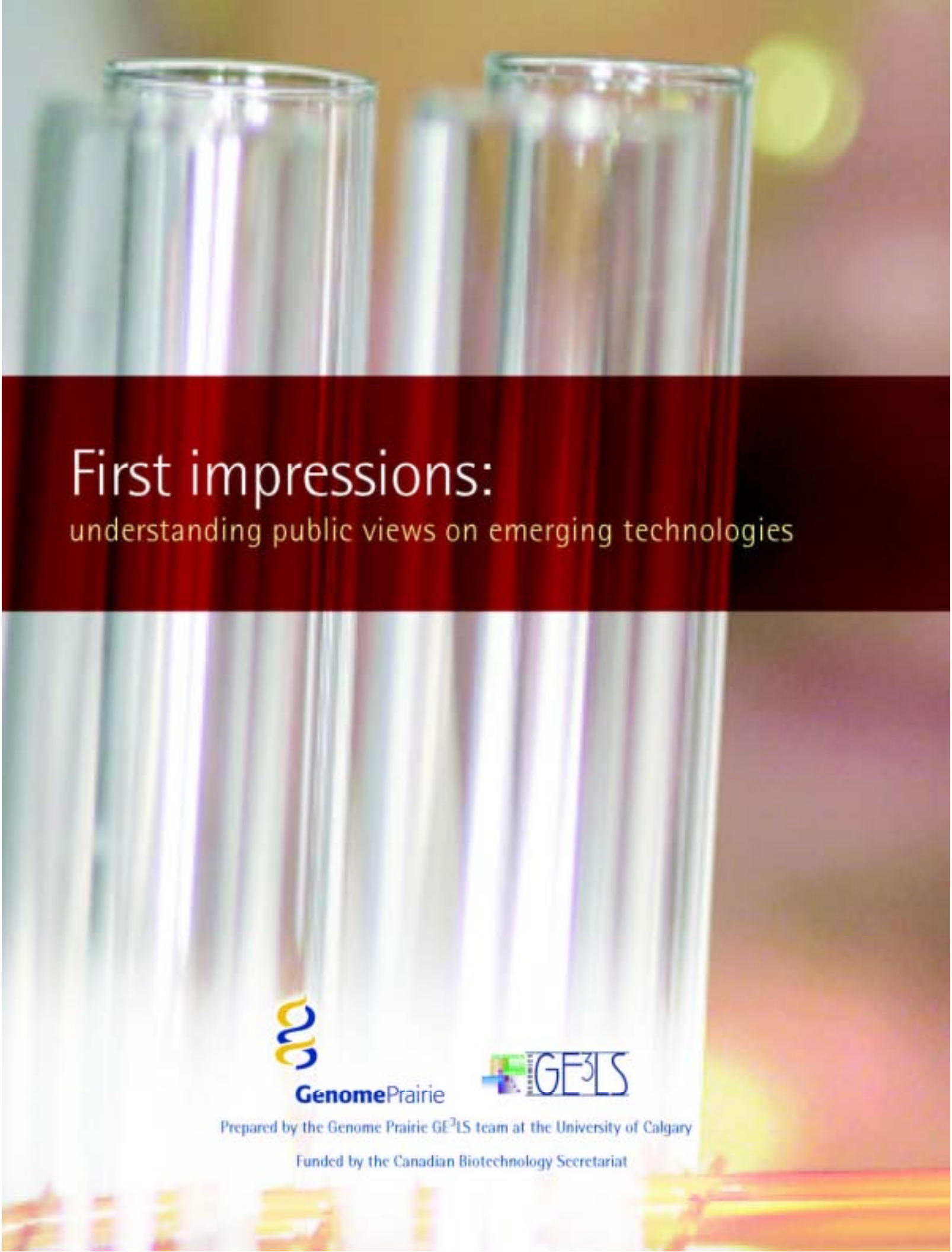

First impressions:

understanding public views on emerging technologies

GenomePrairie

GE³LS

Prepared by the Genome Prairie GE³LS team at the University of Calgary

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Table of Contents

Introduction:
Making Sense of Emerging Technologies.

Edna F. Einsiedel
University of Calgary

Emerging technologies can be described in a number of ways. These are technologies in the developmental stage of production, perhaps not yet fully exploited by firms. For many of these, basic research may still be taking place and the projections of potential applications remain just that – projected aspirations and hopes.

When we look back to the histories of various technologies now embedded in society – from vaccines to computers, electricity to enhanced foods, we see historical trajectories that have led to numerous life and societal changes – from reduced mortality to revolutionized working conditions. These histories also remind us that once upon a time, these technologies may not always have been greeted with excitement and anticipation.

What is interesting about the introduction of new – and particularly revolutionary – technologies today is that societies, publics, and policy makers are in on the conversations much earlier in the developmental trajectories of new or emerging technologies. This is because of the ubiquity of information sources, the desire of governments to make a given technology "happen" (thus creating the conditions for such a happening to occur), the savvy of social groups in society or the attentive citizen.

Such attentiveness may also develop from experiences with older technologies, when controversies surrounded their introduction, led to their demise, or brought about a redesign more in keeping with public demands or interests.

In this report, we have chosen to investigate technologies that are in pre-commercialization or early commercialization stages. These happen to be nanotechnologies and biotechnologies. The latter, of course, has a longer evolutionary history but it consists of a range of applications in various commercialization stages. In this respect, the choices for our focus are somewhat arbitrary. On the other hand, these are "revolutionary" technologies. We do not use this word lightly. A technology is "revolutionary" when it has the capacity to change a wide range of sectors. Biotechnology has had impacts on what we eat and how our food is produced, how we view and treat disease, how we clean up the environment, even how we carry out justice in our judicial systems with DNA evidence. This wide-ranging set of implications and the nature of impacts makes for a "revolutionary" technology. Nanotechnology, still in its technological infancy, is similarly expected to have impacts on the types of materials we use and how they are applied, how we diagnose and treat disease, how we produce energy, and how we communicate.

Perhaps because of the impacts of these technologies, "everyone" has taken notice of them much earlier in the innovation process. "Everyone" includes the scientists working away on various aspects of the technology, the institutions these scientists belong to, the potential and actual venture capitalists ready to jump on "the next big (or small) thing", the media who are alerted by early exciting prognostications, other stakeholders who see the potential benefits and the potential risks, and the publics who have become earlier voyeurs, watching the various aspects of the technology as these are being rolled out in fits and starts, or as claims and counterclaims are being made about them in public arenas.

In this collection of reports, we have focused on two specific "actors" in the landscape of emerging technologies: the first group are the publics who are going to be eventual users, who currently bankroll some of the research through their tax dollars, or who sometimes make decisions in the political sphere through the ballot box or through their choice of political decision-makers, or who may bear a greater burden of risks than others. The second set of actors are the media who highlight or ignore various technological developments, who "package" these developments in particular ways, who tell their stories through selection of certain voices.

The way publics have been viewed has changed over time. Perhaps the earliest way of envisioning 'the public' involved a unidimensional view of a monolithic public, subject to the vagaries of information disseminated from "the experts". This simplistic view has changed significantly, with 'publics' (plural emphasis) engaged or inattentive at various times, occupying different roles at different times – citizen, consumer, patient, environmentalist -- being naïve or displaying expertise, becoming active or non-commital depending on context and circumstance. One important contextual difference has been identified in terms of the confluence of geography and culture, evident in transnational differences on biotechnology applications (Gaskell et al., 2001; Hallman, 2004)

What we have also learned is that other actors' views of publics are also changing. While others have talked about publics as "a second hurdle" (Von Wartburg and Liew, 1999) after regulatory development, the increasing prominence given to publics today, if one is to go by public policy pronouncements, is less in terms of hurdle, more in terms of 'participant' in the technology development process.

Views of the media have also become more nuanced. The media are not just purveyors of what might be "news" or what they consider to be "newsworthy"; like publics, the media are disparate sets of voices performing a variety of roles (Einsiedel, 2005), channels of information, channels for hope and hype, extenders of scientific claims (Bubela and Caulfield, 2004), amplifiers of risk and controversy, and new venture marketers.

With this particular focus on publics and the media, we are also suggesting that a technology becomes emergent when it assumes its form in the public sphere – when others not necessarily involved in the technology's direct development become privy to its gestation, most often and most directly through the media. This happens partly because scientific institutions (such as the leading journals or academic institutions) are linked even more directly to these popular channels, because scientists have become more strategic in their use of these popular channels, because the media are constantly on the look-out for stories that whet the public imagination, and because "life-enhancing" stories are continuing fodder for the public imaginations.

Given this context, the emergence of new technologies in the public arena is occurring much earlier in the innovation trajectory; many becoming a fixture in the public landscape even as early as the stage of "technology design". In some ways, this may be occurring from the benefit of hindsight. That is, when we look back to the experience of "older" technologies – nuclear power, GM food are particular examples – we see that discussions of these technologies occurred at the commercialization stage when it was 'too late'. Those engaged in nanotechnology design see this as a key lesson to be learned (see, for example, Royal Society and Royal Academy of Engineering, 2004).

The currency of these public conversations is hope – but hope is only meaningful in the context of fears; risks are meaningful only in the face of uncertainties. In this context, the set of reports presented here are early explorations of what these emerging technologies look like from the vantage point of representations among publics and the media. These are early impressions in some instances, longer-term and more developed views in others. We expect these pictures – snapshots at this point in time -- to similarly evolve with the technologies' evolution. How these different interactions develop over time remains to be seen.

The contributors to this volume have had the benefit of long-standing collaborations. Our individual perspectives have been enriched by these cross-national comparisons and sharing of data. The current work has been made possible through the generosity and support of the Canadian Biotechnology Secretariat and Genome Canada support to the Genome Prairie GE3LS (Genomics, ethics, environmental, economic, legal and social studies) Project.

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Report on a Study of Emerging Technologies in Canada and the U.S.:
Prevailing Views, Awareness and Familiarity.

Jeff Walker
Independent Researcher

Prevailing Views, Awareness and Familiarity

It is clear that Canadians see their lives becoming increasingly influenced by emerging technologies. Most Canadians believe emerging technologies like stem cell research and nanotechnology can be beneficial to society, particularly in the areas of health and medicine. At the same time, it is also clear that some of these emerging technologies pose significant risks, and that some raise ethical concerns.

Before asking about specific areas of emerging technology, some questions were posed regarding technology in general, and awareness and familiarity with some key aspects of emerging technology. These core questions are questions that have been tracked over time, which enables us to draw conclusions not only about what the data indicates for this year, but how that data tracks over time.

As has been the case over the last few years, both Canadians, and to an even greater extent Americans hold positive orientation toward technology in general. In the survey, when asked about two thirds of Canadians and seven in ten of Americans have a positive reaction to the word "technology." Only one in twenty have a negative view about technology.

Focus groups reveal that while new technologies can have downsides and side effects, that ultimately they almost always prove to provide great benefits for humankind. They also reveal that this generally positive orientation has an influence on the way in which people will generally come at new technologies.

The picture is somewhat different for biotechnology, although orientations toward this word have remained quite consistent over the last few years. Neutrality is the dominant theme, and among those that offer an opinion, by a ratio of 2:1, respondents in the two countries offered a positive view of biotechnology (a little over a third of Canadians (35%) and Americans (38%) hold a positive impression). The percentage of people who hold a negative reaction toward biotechnology is at 18% in Canada and at 16% in the U.S. Of note, Quebecers are most likely to have a positive reaction (51%), while British Columbians are most likely to have a negative reaction (24%).

In both Canada and the US, there has been a year over year drop in the number of people who recall seeing or hearing about biotechnology in the media. Since last year, the number of Canadians who have heard any stories about biotechnology in the last three months, has fallen from 45% to 40%, while in the U.S., the number went from 46% to 47%, showing once again a gap. (This was also the case in 2003, but not in 2004). Focus groups suggest that biotechnology is not necessarily the "sexy new topic" that it has been in recent years, that other technologies like nanotechnology have taken some of the media spotlight, and that the controversies that surround the issue have not been as pronounced.

Consistent with the flattening and falling levels of media awareness with biotechnology, familiarity with biotechnology in both Canada and the U.S. has remained static on a year over year basis, after consistent growth over the past three years. The number of Canadians who say they are familiar with biotechnology has dropped by one point from last year from 57% to 56%. Of that group, 8% are very familiar and another 48% are somewhat familiar. Familiarity in the U.S. has dropped by two points this year from 68% to 66%. Of those, 10% are very familiar and 56% are somewhat familiar. In Canada, 13% say they are not at all familiar, compared to 9% in the U.S. Regionally, familiarity is highest in BC (65%) and Alberta (66%), while Quebecers are least familiar (39%). There are no significant regional differences in the U.S. In focus groups, it is clear that familiarity is greater than revealed in survey data, but respondents often feel as if the technology is moving so quickly that it is difficult to "keep up" with all of the new applications and advances in research, which leads them to feel that they aren't necessarily all that familiar with the field.

Overall Support and Opposition

The tracking data reveals a clear upward pattern in support for biotechnology overall over the past five years. Overall support for biotechnology has increased from last year in Canada but has decreased in the U.S., although the numbers still remain significantly high. For Canadians, support is drawn from over half of the population at 67%, up from 63%. In the U.S., 71% indicate support biotechnology, which has dropped by 3% from last year. In Canada, support is highest among younger people aged 18-34 (72%) and those in the Prairie provinces (73%). British Columbians are by far the most

opposed: only a small majority (54%) are supportive and a full four in ten are opposed, of whom 11% strongly. In both countries, men are more likely to be supportive than women; by 9% in Canada and by 6% in the U.S. The core segment of strongly opposed remains under 10% in both countries.

It is clear from the data that the two key demographic segments in Canada that expressed the strongest opposition to biotechnology are women and residents of British Columbia. Focus groups, combined with data, help to illustrate the key factors that drive opinion between these two groups.

- While women tend to have a generally positive orientation toward technology, they also tend to express greater levels of concern about both risks and ethical issues associated with biotechnology.

- Residents of British Columbia tend to have higher levels of concern about moral and ethical issues associated with biotechnology than those in other regions, and they also are shown to hold higher than average levels of opposition to GM food.

One other area where these two key segments of the population, as well as the broader Canadian population in general, appears to have a fairly high degree of concern regards safety and regulatory approval processes, for biotechnology products as well as products in virtually all of the other categories of emerging technology that were investigated in this research program.

Technologies Improving/Worsening Our Lives

Before moving into further modules about various emerging technologies, a set of general questions were asked about a number of new technologies in order to rank them by the perceived effect people believe they will have on their way of life in the future.

When it comes to the impact of new technologies that are being developed and how they impact their lifestyle, what was found was that most of these new technologies were going to be beneficial, but some were seen as being more beneficial than others:

- 88% of Canadians said hybrid cars would improve their life;
- 82% say computers and IT would;
- 74% believe stem cell research will;
- 69% believe biotechnology will;
- Nanotechnology was the least known of the new technologies tested, with 39% saying it will improve their life and only 5% saying it will make things worse, but with a full 43% having no opinion. However, when those who can offer an opinion are only counted, fully 75% believe that it will improve their life; and,
- What is most notable is that fewer than 25% believe that GM food will improve their life, in stark contrast with virtually all other aspects of emerging technology that were tested in the research.

And consistent with the evidence that Americans tend to be slightly more positively oriented toward technology than Canadians, this data revealed that on almost all of the technologies, Americans were more likely to believe that they would improve their future, by anywhere from 2-10%.

Key Factors Influencing Overall Attitudes

In Canada, almost half of the population (43%) believes the regulatory system is probably either somewhat or very lax, which is a fairly significant level of concern. In the United States, people tend to have slightly higher levels of confidence in regulatory authorities, but at that, more than one third (35%) believe that these systems are probably lax.

- Canada is almost evenly divided between rules and systems being strict and being lax: 44% believe they are strict (of whom 7% say they are very strict) and 43% say they are lax (of whom 9% very lax).
- In the U.S. there is a quite a sizeable difference between both views: 54% believe they are strict (12% think very strict) and only 35% believe they are lax (7% very).

On questions involving moral and ethical oversight regarding these technologies, results were quite similar. While 44% of Canadians believe the rules and systems in place are strict (6% very), a clear majority (55%; 15% very strict) of Americans believe the same about their ethical oversight. Canada once again is evenly divided with another 44% believing the rules to be lax (9% very), only 37% (9% very) of Americans agree.

Focus groups reveal that there are several key reasons why these views are evident. Compared to past research, concerns like these appear to be growing, rather than abating.

- Concerns that people who work in regulatory systems are not able to "keep up" with new technologies;
- Concerns that corporate influence can have undue influence on decisions make by regulatory bodies;
- Concerns that not enough resources are dedicated to this function within government;
- Cases like the pullback of Vioxx and Celebrex, undermining the overall level of confidence in the abilities of regulatory agencies; and,
- Concerns that privately funded research takes place largely absent moral and ethical oversight.

All of this makes it more difficult for people to be comfortable with where some of these technologies are heading, and causing many people who are broadly supportive of the technology to ask for more controls, more stringent regulations on new innovations. In focus groups, many people indicated that even though they are positively disposed toward these technologies and want them to go forward, these

concerns lead them to ask for more stringent oversight mechanisms on both risk as well as ethical issues.

At the back-end of the survey, a number of attitudinal questions about orientation toward emerging technologies like nanotechnology and biotechnology were asked. The results indicate:

- Generally speaking, people believe (by a margin of 2:1) that decisions about biotechnology should be based mainly on the views of experts, and not on the views of the average Canadian or American. That is not to say that people wish to defer to experts entirely – indeed, focus group discussions on these issues reveal that lay people need to have a voice in decision making processes – but rather that expert views need to be well represented in decisions about technology.

- A majority of Americans (55%) and Canadians (60%) believe their government probably doesn't do enough to study and manage the risks associated with biotechnology. This lack of confidence is an issue that appears to be growing. In focus groups, it is revealed that this lack of confidence manifests itself in the widespread number of people who are only willing to approve of various emerging technologies with the proviso that there will be tighter regulatory controls.

- There are mixed levels of trust in those in the scientific and ethics community to ensure that research that is occurring is taking place in consideration of their values and interests. Focus groups reveal that the most serious concern is not about most scientists, but rather about "rogue elements" of the scientific community that may pursue avenues of research that ordinary people do not find acceptable, and they deeply fear that those rogue elements cannot easily be monitored or managed. These concerns are not necessarily more pronounced than they have been in the past, but remain very clearly in evidence.

    - While Canadians are split on whether biotechnology research has been carried out in consideration of their interests – 49% believe that has been done and 43% believe it has not been done-, Americans are more likely to believe their considerations have been taken into account (57%).
    - About the same number of people in both countries (57% and 58%) trust those in authority to ensure that biotechnology research taking place in their country will follow strict ethical guidelines.

- Americans generally tend to be less eager to have their government involved in issues, something that is evident in biotechnology as well: While 85% of Canadians agree (39% strongly) that the government should lower the use of biotech until more is known of the risk, only 61% of Americans share that view (of whom 28% agree strongly).

- Most people (90% in Canada, 92% in the U.S.) also agree that authorities should inform people about biotechnology and let them decide for themselves whether they want to use products developed using these techniques.

- At the same time, most (83%) also agree that if the best available scientific evidence says that a particular use of biotechnology is safe, it should be allowed.

- There is also a high level of agreement (81% in Canada and 84% in the U.S.) that biotechnology research is the next frontier of human endeavour, a frontier that will lead to significant quality of life benefits.

- Both Canadians and Americans believe that, although there may be some unknown risks, technologies like biotechnology are an inevitable part of the future, so all we can do is make sure that its uses are as safe as possible.

Stem Cell Research

There is widespread awareness of stem cell research among populations in both Canada and the United States. Awareness and familiarity is actually higher in the US where a number of factors have pushed it in the national spotlight of late. This is an issue that has saturated public opinion as much as any issue of new technology/innovation has that we have tested in recent years.

Specifically, the US election campaign, and the efforts of Christopher Reeve and Michael J. Fox to promote such research have given the issue a lot of profile. From a public opinion perspective, this makes it a unique and interesting area of emerging technology.

Owing to this profile, in the US, focus groups reveal that stem cell research has become the "poster child" of biotechnology, whereas in Canada stem cell research tends to be seen as just one of a range of associated areas of research and technological development that fall under the biotechnology umbrella.

Unlike other areas of technology discussed in these focus groups, the general public tend to hold similar levels of knowledge and interest in stem cell research as found among "Involved" Canadians/Americans.

Many people believe that there are very important, and very compelling benefits that are likely to derive from stem cell research. The main reason for the high levels of support for stem cell research is that stem cells hold the promise of allowing researchers to grow specialized cells or tissue, which could be used to treat injuries or disease.

Yet stem cell research is controversial because the best source of stem cells is human fetal tissue. Harvesting the stem cells destroys the embryo, which many see as ethically questionable.

In terms of how it will benefit our society, both Canadians and Americans reflect similar opinions: 43% of Canadians believe that it will have a substantial benefit, a quarter say it will have some benefit and another quarter say it will have a moderate benefit. Compared to that, 46% of Americans believe that stem cell research will have a substantial benefit to our society, one in five say it will have some benefit and another two in five say it will have a moderate benefit.

When it comes to assessing the risk of stem cell research, the numbers are quite similar between both countries but are also quite low. Most believe there is only moderate to minimal risk involved with this technology. One in five Canadians feel that there is some or substantial risk, while a full 39% believe there is only a moderate amount of risk, one in five believe it has not much risk attached to it, and a full 22% say it has no risk at all. As for U.S. opinion, again only 12% say it poses a substantial risk on their society and 9% say it poses some risk, while a third see some risk in it, one in five see a moderate risk and a quarter see no risk at all.

Focus groups and survey research reveal that there are subtle but important differences of opinion on the morality of stem cell research. Twice as many Americans (12%) as Canadians (6%) find it flat-out morally unacceptable, more Canadians (38%) than Americans (31%) find it morally questionable –the mid-point on the five-point scale-, while the same numbers (32%) in each country say it is acceptable and 17% and 18% say it is somewhat acceptable. US focus groups revealed that there is a larger core of individuals who adamantly oppose stem cell research on ethical grounds.

When asked about their overall view of stem cell research, Canadians and Americans differed slightly. While approval for stem cell research is high in both countries, generally more Canadians would like to see tighter government regulations accompanying this approval, while Americans believe they are fine they way they are. This is consistent with earlier findings that reveal lower levels of overall confidence in regulatory and ethical oversight in Canada than the US.

Overall, approval but with a more tightly controlled and regulated process was the position that garnered the broadest consensus of Canadian views about stem cell research at 45%, while 36% approve with the usual level of regulations. This leaves 28% who disapprove, of whom 4% say they would not approve under any circumstances. In the U.S., a plurality of 41% of Americans approve of stem cell research with the usual levels of government regulations, while 32% would like to see it be more tightly regulated. Opposition is higher here than in Canada: 37% disapprove, of whom 8% under no circumstances.

In the survey and focus groups, other methods of collecting stem cells for research were tabled with participants. The results were markedly different, and in one case, the implication was a marked difference in overall support for stem cell research.

Other methods of collecting and conducting research using stem cells:

- **Creating embryos in a lab for the purpose of extracting stem cells.** The creation of embryos in a lab to create stem cells is much ***less*** acceptable than the use of embryos from fertility clinics – consistent in both Canada and in the

US. The primary reason was that in this case, the explicit purpose of the creation of life is to destroy it. In the case of taking stem cells from fertility clinics, the purpose is to "use it for research rather than destroying it", which is seen to be less ethically problematic for people.

- **Extracting stem cells from umbilical cords post-birth.** The other scenario tested in the groups involved extracting stem cells are drawn from umbilical cords post-birth. This scenario proved to change the entire dynamic of the assessment significantly, particularly in Canadian groups but also in American groups. Most of those who disapproved of stem cell research initially changed to approving of such research in this scenario, as for them there was no longer an ethical concern involved (as long as the mother consented to her umbilical cord being used for research). While there remained a handful of people who remained opposed to the technology on ethical grounds (because stem cell research was too close to "playing god"), this was a very small number (under one in ten participants overall).

When asked about this "umbilical cord" scenario with scientists able to get all stem cells they need for research from umbilical cords and no longer from embryos that were not going to be used in fertility treatments, a much larger group in both countries (50% in Canada and 55% in the U.S.) approved of the technology with the current regulations in place, and another four in ten Canadians and three in ten Americans would approve if it were more tightly regulated. In this scenario, only 11% of Canadians and 13% of Americans indicated opposition to it.

Pharmacogenetics

Personalized medicine, or pharmacogenetics, involves the study of how an individual's genetic makeup affects the body's response to drug treatments. It involves the development of drugs based on an individual's genetic profile. Understanding an individual's genetic makeup is thought by many scientific researchers to be the key to creating more effective, personalized drugs. This module was only tested in Canada and not in the U.S.

Familiarity of this technology is at a substantially lower level than it is for biotechnology. Only 31% of Canadians are familiar with the term pharmacogenetics, 36% say they are not very familiar and a third is not at all familiar. Moreover, slightly more than half of Canadians (54%) have not read, seen or heard anything regarding pharmacogenetics.

When it comes to discussing the topic, there is also a significant lack of participation: 78% of Canadians have not discussed the topic in the past, while only 22% have. Of that 22%, 15% say they have frequently, 44% say occasionally and 41% say once or twice.

A moderate view of the risk and benefits appears to dominate with Canadians regarding the topic of pharmacogenetics. One in five see it as having substantial benefit, 28% as some benefit, while the largest group is somewhere in the middle, with 41% believing it will benefit society "moderately". When it comes to risk, again,

the largest group (52%) believes it poses a moderate risk, while a quarter (25%) believe it poses hardly any or no risk a all, compared to 17% who say it poses a substantial or some risk to society at large.

On the question of morality, again, they seem to stand somewhere in the middle, with half finding it "morally questionable", perhaps indicating their reluctance to have a real stance, given as they are not very familiar with it. On the other hand, those who find it morally acceptable to some degree or another outweigh those who find it morally unacceptable 4:1.

Opinions on safety, regulations and trust in scientists also reflects this uncertainty with the topic: About half of Canadians are moderately confident in the system as well as in scientists, while 14% are confident in the system and twice as many, 30%, are confident in scientists.

Overall, on the ballot question, most (46%) lean towards approving of personalized medicine if it were more tightly controlled and regulated, while a quarter approve as long as the usual levels of government regulation are in place. About a quarter would only approve under exceptional circumstances, while 3% won't approve under any circumstances.

Genetically Modified Food

Genetically modified food is the aspect of biotechnology that continues to lag other areas of emerging technology in terms of support and perceived overall benefits. Unlike other technologies, where most have at least a modestly positive reaction, in Canada a majority (55%) have a negative reaction (compared to a plurality of 44% in the U.S.), while only 13% of Canadians and one in five Americans have a positive reaction.

Familiarity with GM food is quite high, with a majority in both countries saying they are very or somewhat familiar with this area of technology. Only about one in ten say they are not at all familiar with GM food. More Canadians (15%) than Americans (9%) have heard a lot about the subject in the last three months, while most have only heard a little or nothing at all. Contrary to biotechnology, it is a topic more commonly and frequently discussed in Canada than in the U.S.

When it comes to risks and benefits, most Canadians and Americans see genetically modified food as having a moderate benefit, but significant risk. There is a core group of about one in five in Canada and slightly less in the U.S., who believe GM food are of no benefit to society at all, but pose a substantial risk. Four in ten say it has a moderate benefit to society, while about the same number say it poses a moderate level of risk. Overall, Canadians are more likely than Americans to believe it does not benefit society and that it poses some level of risk.

The gap between the two countries is also quite substantial when it comes to the morality of GM food. In terms of moral or ethical aspect of this research, 47% of Canadians feel this kind of research is morally questionable and 32% feel it is morally

acceptable. At the same time, 39% of Americans feel genetically modified food research is morally questionable and a full 43% say it is morally acceptable.

Less then half of Canadians (45%) do not feel confident in the safety and regulatory approval systems governing genetically modified foods while 18% are confident and 36% moderately so. More Americans (20%) feel confident, while 41% of Americans feel moderately confident and 36% are not confident about this type of research. Again, people are generally more confident in the scientists involved in this type of research, than they are in the regulatory systems.

Overall, on the survey's ballot questions, as the above analysis suggests, Canadians are more hesitant then Americans to approve of GM food. Only 18% would approve with the current regulations in place (compared to 27% of Americans who feel the same), while a third in each country would approve if regulations would e tightened up. At the same time, a full one in five Canadians and only slightly less Americans say they do not approve of GM food under any circumstances, while 27% and 23% say they would only approve under very special circumstances. British Columbians are especially likely to disapprove of GM foods, and in both countries, men are more likely to approve than women.

GM Trees

Biotechnology applications are being explored in forestry to improve forest regeneration and protection, and create value added forest products. Canadians and Americans are almost entirely unaware of the research that is taking place in this area. Some of these applications involve the genetic modification of trees, where single genes are inserted or modified to obtain desired traits such as improved growth or disease tolerance. Other applications involve genetic selection, where trees that have certain traits are identified, selected and reproduced using conventional breeding techniques. Work in this area remains at the early research stage; no such applications have been approved for use in Canada at this time. This module was only tested with a Canadian audience.

In terms of familiarity with genetically modified tress, 45% of Canadians are not at all familiar with the term and 29% are very or somewhat familiar. A similar number is reported for familiarity with genetic identification and reproduction of trees: 46% of Canadians say that are not at all familiar and 25% are.

A set of applications for this technology was tested to see which application would be most accepted by the Canadian public. They were both tested for genetic modification and genetic identification and selection (without actual modification). Overall, Canadians do make some slight, but important distinctions between these two areas.

The majority of Canadians feel that GM trees will benefit society: 12% believe that benefits will be substantial, 25% believe there will be some benefit and a third believes there will be a moderate benefit. In terms of risk, most Canadians see genetic modification of trees as a moderate risk (45%), while three in ten believe it poses little to no risk and slightly less than a quarter (23%) say it poses substantial or some risk.

Canadians do tend to see more benefits of genetic selection and identification: about a quarter say the benefits will be substantial and another quarter believes there will be some benefit. About the same number, however as those who see GM trees as a risk, also see this technology as risky.

Ultimately, on the ballot questions, the results indicate that there are actually some differences between genetic modification and genetic identification and selection applications. Overall, little over a quarter supports the uses of GM trees with the usual levels of government regulations in place, while four in ten would approve with tightened regulations; 22% disapprove and would only approve under special circumstances, while one in ten does not approve under any circumstances. For genetic identification and selection slightly more find the technology acceptable, both under current regulatory arrangements under tighter regulations, 22% disapprove but would allow research under certain circumstance, and one in ten do not approve.

Nanotechnology

Nanotechnology involves the application of science and engineering at the atomic scale. It involves the construction of tiny structures and devices by manipulating individual molecules and atoms, which have unique and powerful properties. These structures can be used in medicine and biotechnology, in energy and the environment, and in telecommunications.

Some examples of nanotechnology that were discussed in the focus groups include the use of molecules that have properties that enable the production of drinking water by extracting salt from seawater, the use of implantable surgical devices that can measure things like blood pressure on a continuous basis, or the use of special nano-molecules in fabrics like wrinkle resistant pants.

After hearing an explanation in the survey, familiarity with nanotechnology was reported as being relatively low: 35% of Canadians are familiar with the technology, while 26% are not very familiar and a full four in ten are not at all familiar. Americans are slightly more likely to have heard of it, with 42% familiarity.

The focus group discussions revealed a slightly different context. On an unaided basis in the introduction to the focus group discussions, nanotechnology was frequently raised as a "revolutionary" technology, and people tended to be more favourably disposed to this area than biotechnology. While not all knew much about this technology, those who did have some knowledge tended to have great interest in the potential of this technology.

Nanotechnology applications that were most often recalled were:

- The ingestible camera;
- Implantable devices to regulate things like insulin levels;
- Implantable monitors that allow people to be tracked anywhere they go; and,
- Less invasive surgeries.

On an unaided basis in the groups, most didn't raise negatives about this type of technology. The main negative that is raised on an unaided basis regards potential privacy implications of nanotechnology applications. This was of particular concern in the United States, where there were strong fears raised about the powers assigned to government under the US Patriot Act. Nanotechnology was viewed as a field that could be utilized for purposes under the Patriot Act that made some respondents very uncomfortable.

Ultimately, the groups suggest that nanotechnology is positioned as the "next big thing" in terms of technology that is likely to affect our lives.

Most see nanotechnology as something that is very much here today, not science fiction, even if some of the applications seem like they were first identified in science fiction years ago. When people discuss applications like the ingestible camera or less invasive surgeries, they see these applications as being in current use, with more new technologies like them not far behind.

In both countries, benefits are seen to be quite promising; about half see benefits to nanotechnology and another third see moderate benefits. On the other hand, in the survey, a relatively small group (17% in Canada and 14% in the U.S.) believe there are risks involved with this technology. About half believe the risk to be moderate and 26% and 31% respectively see little to no risk at all. In focus groups, there were more detailed discussions about risks, where environmental risks were seen as being significant and of some concern. However, the discussion dynamic was different than some biotechnology applications, where in concert with significant benefits many applications are seen as creating very significant risks.

In addition, moral issues tend not to be a major driver of opinion on nanotechnology. It is unacceptable to only a very small number -less than one in ten in each country.

North Americans do see the benefit of nanotechnology to the economy: 36% of Canadians and 42% of Americans see major benefits, while another 48% and 42% see modest benefits. Canadians are more likely to want their government to be actively involved in the funding of nanotechnology research. Only 14% of Canadians and 20% of Americans would not like their government to be involved at all.

Overall, the ballot question results reveal a high degree of support for, and interest in the development of nanotechnology applications. Americans once again feel more supportive of technology with current regulations in place, while more Canadians would like to see the technology more tightly regulated. While 35% of Canadians approve of the technology with its current regulations in place and 44% approve of nanotechnology with more stringent controls, 43% of Americans approve of it as-is, while 35% would like to see it being more tightly controlled and regulated. Only 18% in each country does not approve.

Gene Banks/Genetic Research

Many health and medical researchers are learning more about the ways in which genetic information determines how and why certain people develop disorders and

illnesses by studying genetic information from large groups of people, using databases called gene banks.

Genetic information is seen as something that will play a significant role in the future of health research in North America. Two thirds of Canadians (65%) and Americans (66%) feel genetic information will play a very important role in the future in health research in their country, while virtually all of the remainder see it as somewhat important.

When asked whether the benefits of knowing more about their genetic information outweigh the drawbacks, a strong majority leans towards the benefit of knowing: 77% of Canadians said that the benefits outweigh the drawbacks and 19% said that the drawbacks outweigh the benefits. This is up significantly from last year, when 64% believed the benefits were greater. Three quarters (76%) of Americans also said that the benefits outweigh the drawbacks –up from 70% last year- and 21% said that the drawbacks outweigh the benefits.

When asked if they were to have a genetic test and were asked to contribute the information to a database that would be used for health research if their identity was stripped from the research database, close to half said they would be very willing. These numbers were also up from last year: 45% of Canadians said they would be very willing and 36% said somewhat willing, while 49% of Americans said they would be very willing and another third said they would be somewhat willing. Both Canadians and Americans are however slightly less eager to donate a genetic sample and health history information to a genebank to be used for health research, even if their identity would be stripped: Three in ten Canadians and a third of Americans would be very willing to do so, while four in ten would be somewhat willing.

During a series of questions that involved participants choosing between cures and treatments that may or may not be important in the 21st century, a majority of Canadians and Americans believed that biotechnology will be one of the most important sources of health treatment and cures for the future.

A staggering 83% of Canadians said that biotechnology will lead the way towards significant treatments in the 21st century, while 81% of Americans felt the same.

Similar high levels of numbers were also revealed when asked the same question about nanotechnology as being the next cure in the 21rst century: 76% of Canadians said that nanotechnology will be important as a source of health treatment and cure for the future, while 71% of Americans felt the same.

In all, this data reveals a broadly held sense that many of these technologies will provide important and demonstrable benefits to society, particularly in the area of health.

Conclusions

The overall findings of this research program are that people continue to broadly embrace most emerging technologies, as long as the benefits of those technologies are worth pursuing, that risks can be managed, and that moral considerations minimized for most members of society.

Most of the spheres of research investigated in this study tend to be embraced by Canadians and Americans alike. In particular, the field of nanotechnology appears to be on the brink of becoming the "next big thing" in emerging technology, an area that offers much of the promise that biotechnology has but with fewer (perceived) risks, and with no significant moral dimension involved. That said, people would continue to assess applications in all of these spheres on a case-by-case basis, with consideration of whether the benefits truly do outweigh the risks involved in each case.

At the same time, it is clear that there is a weakening sense of confidence in the regulatory and oversight structures in place to govern these technologies, which leads many people, particularly Canadians (and females specifically) to demand tighter controls and regulations on these technologies as they advance further. These trends do not bode well for the advance of harmonized and streamlined regulatory systems, as those kinds of efforts might run contrary to where the population tends to want regulatory controls to go.

Predicting Approval and Discussion of Genetically Modified Foods in Canada and the United States.

William K. Hallman
Food Policy Institute, Rutgers University

Abstract

While the effects of the media to amplify or attenuate perceived risks has been studied empirically (with varying conclusions), few researchers have examined the second channel identified by Kasperson et al. (1988) as critical to the Social Amplification of Risk, that is, informal personal networks. Using data collected in the most recent wave of comparative surveys of Canadian and American attitudes toward biotechnology (collected by the Canadian Government in January, 2005), this paper reports on differences in Canadian and American views about GM foods, and examines the likelihood that individuals holding relatively positive or negative views have discussed the technology with others.

Introduction

The Social Amplification of Risk Framework (Kasperson & Kasperson, 1996; Kasperson et al., 1988; Pidgeon, 1999; Pidgeon, Kasperson, & Slovic, 2003; Renn, 1991) presents two assumptions about the ways in which hazards interact with psycho-social and cultural factors to influence public responses. The first is that social dynamics influence both how risks are represented, processed, and communicated. The second assumption within this framework is that risk events (and perceived risks in general) have a 'signal value' that is propagated through a social network, creating 'ripple effects' resulting in secondary social, psychological, and economic impacts. The framework suggests that these secondary impacts are influenced both by the direct physical consequences of the risks themselves and by the interaction of psychological, cultural, social, and institutional processes that amplify or attenuate public experience of a risk (Burns et al., 1993; Renn et al., 1992).

Critical to the social amplification framework is the social experience of the risk. Individuals come to understand risks directly through personal experiences, which can provide feedback to either amplify risks that are perceived as alarming, or attenuate risks that are perceived as reassuring. Alternatively, individuals with little or no direct personal experience with a particular risk experience that risk indirectly by receiving information about it from external sources. Typically then, most people learn about new or unknown risks through either the news media or through informal personal networks (Kasperson et al., 1988).

In keeping with this framework, researchers have looked at media coverage as the key to amplification or attenuation of perceived risk, arguing that television, press, and Internet coverage are typically the portals through which most people learn about risk events (Slovic, 2000; Kasperson et al., 1989). These approaches often examine the amount of press coverage, including the total number of stories related to particular risk events and the duration and half-life of the coverage of risk events, then compare these to individual lay perceptions of these risks. (See for examples: Burns et al., 1993; Eldridge, & Reilly, 2003; Kone, & Mullet, 1994).

Several studies have examined the extent and role of media coverage and the debate over biotechnology in general (Nisbet, & Lewenstein, 2002; Ten Eyck et al., 2001; Ten Eyck & Williment, 2003; Priest, 2001), and media coverage of genetically modified (GM) foods specifically (Frewer et al., 2002; McInerney et al., 2004). Moreover, in their study of the media and GM foods, Frewer et al. (2002) found that in the United Kingdom, peoples' perceptions of the risk associated with GM foods correspondingly increased during the highest levels of media reporting about genetically modified foods, but were subsequently reduced as reporting levels diminished. They suggest that this provides good evidence of the effects of the media within the Social Amplification of Risk Framework (Frewer et al., 2002).

Yet, while the ability of the media to amplify or attenuate perceived risks has been studied empirically (with varying conclusions), few researchers have examined the second channel identified by Kasperson et al. (1988) as critical to the Social Amplification of Risk, that is, informal personal networks. Using data collected in the most recent wave of comparative surveys of Canadian and American attitudes toward biotechnology (collected by the Canadian Biotechnology Secretariat), this research

reports on differences in Canadian and American views about GM foods, and examines the extent to which individuals holding relatively positive or negative views of the technology have spoken with others about GM foods.

Methods

Computer Assisted Telephone Interviews (CATI) were completed with a randomly selected sample of 2000 Canadian and 1200 American adult respondents (18 and older) during January and February 2005. The margin of error was ± 2.2% for the Canadian sample and ± 2.8% for the U.S. sample. Interviews were conducted in either English or French according to the preference of the respondent.

Results

Positions on Genetically Modified Food

To compare the attitudes held by Canadians and Americans concerning their acceptance of GM foods, participants were asked to indicate which of four positions best captured their view. More than a quarter (27%) of Americans, but only 18% of Canadians said that they approved of the use of GM foods 'with the usual levels of government regulation and control in place'. Nearly equal percentages of the Canadians (34%) and Americans (33%) surveyed said that they approved of genetically modified food 'if it is more tightly controlled and regulated'.

More Canadians (27%) than Americans (23%) said that they did not approve of genetically modified food 'except under very special circumstances'. Similarly, 20% of Canadians and 16% of Americans reported that they did not approve of GM food 'under any circumstances' (See Table 1). Overall, significantly fewer Canadians than Americans say they approve of GM food under current circumstances.[1]

Table 1: Respondent Positions with Regard to GM Food by Country and Total

Overall, which of the following best captures your views about genetically modified food?	Canada N=992	United States N=1183	Total N=2175
I do not approve of genetically modified food under any circumstances	19.9%	15.9%	17.7%
I do not approve of genetically modified food except under very special circumstances	27.4%	23.3%	25.2%
I approve of genetically modified food if it is more tightly controlled and regulated	34.3%	33.5%	33.8%
I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place	18.4%	27.3%	23.3%

[1] ? 2(3, N=2175)= 26.67, p<0.001.

Predictive Model of Key Positions on GM Food

A multinomial logistic regression was executed to examine key demographic and attitudinal predictors of respondents' positions on GM foods. Variables were selected based on both the number of respondents (some questions were only asked of half of the samples, so these could not be included in the analyses), and the hypothesized relationship between each predictor and particular positions.

The model initially contained demographic predictors including: country (Canada/U.S.), gender, age, education, income, dichotomized employment status (employed/not employed), and how often the respondent had attended a service at a place of worship. Measures of media consumption such as how often the respondents had watched TV news reports, read newspapers or magazines, or accessed news on the Internet during the week prior to the interview were also included.

The initial model also included measures of attitudes toward technology and biotechnology in general, including: reactions to the word 'technology'; reactions to the word 'biotechnology'; awareness of biotechnology in the media; familiarity with biotechnology and its applications; perceptions of the safety and approval processes for biotechnology; perceptions of the moral and ethical oversight of biotechnology; how often the respondent had actively sought out information about biotechnology research, applications, ethical guidelines, or studies that have been carried out to evaluate safety; and how often the respondent had actively sought out ways to voice his or her opinions or values about biotechnology research or implications of such research.

The initial model was constructed using GM food-specific questions including: reactions to the term "genetically modified food", familiarity with GM food, awareness of GM food in the media, how often the respondent had talked about GM food with others, perceived benefits of GM foods, perceived risks of GM foods, and perceptions of the moral and ethical aspects of GM food research.

Each of the variables was recoded so that increasing values indicated increasing levels of the construct being measured. A forward stepwise Wald regression was used to construct a final model useful for examining the significant main effects of the demographic and attitudinal variables to predict an individual's level of approval of GM foods. The reference category for the regression was the position "I approve of the use of GM foods with the usual levels of government regulation and control in place".

Table 2: Observed and Predicted Classification of Respondent Positions with Regard to GM Food

Observed	Predicted				
	I do not approve of genetically modified food under any circumstances	I do not approve of genetically modified food except under very special circumstances	I approve of genetically modified food if it is more tightly controlled and regulated	I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place	Percent Correct
I do not approve of genetically modified food under any circumstances	143	79	26	2	57.2%
I do not approve of genetically modified food except under very special circumstances	58	234	99	10	58.4%
I approve of genetically modified food if it is more tightly controlled and regulated	7	86	347	99	64.4%
I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place	2	23	136	228	58.6%
Overall Percentage	13.3%	26.7%	38.5%	21.5%	60.3%

N= 1579

The resulting model converged in nine steps and accounted for 61% of the variance (Nagelkerke Pseudo R^2) in predicting which respondents were likely to endorse the four positions. The model was able to correctly classify the stated positions of 60% of the respondents (See Table 2).

The final predictive model included: reactions to the term "genetically modified food", perceived benefits of GM foods, perceived risks of GM foods, perceptions of the moral and ethical aspects of GM food research, reactions to the word 'biotechnology',

perceptions of moral and ethical oversight of biotechnology, how often the respondent watched local TV news, awareness of GM food in the media, and education.

Table 3: Parameter Estimates for Predicting Respondent Positions on GM Foods

Parameter Estimates

37. Overall, which of the following best captures your views about genetically modified food? [a]		B	Std. Error	Wald	df	Sig.	Exp (B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
I do not approve of genetically modified food under any circumstances	Intercept	6.879	1.020	45.496	1	.000			
	Education	-.208	.095	4.779	1	.029	.812	.674	.979
	Reaction to 'Biotechnology'	-.237	.177	1.789	1	.181	.789	.557	1.117
	Adequacy of Ethical Oversight	-.343	.153	5.015	1	.025	.710	.526	.958
	Reaction to 'GM Food'	-2.389	.310	59.222	1	.000	.092	.050	.169
	Amount Heard about GM Food	.183	.193	.907	1	.341	1.201	.824	1.753
	Benefits of GM Food	-1.131	.133	72.313	1	.000	.323	.249	.419
	Risks of GM Food	1.280	.135	90.288	1	.000	3.598	2.763	4.686
	Moral Acceptability	-1.029	.124	68.525	1	.000	.357	.280	.456
	Watch National News on TV	.044	.048	.843	1	.359	1.045	.951	1.149
I do not approve of genetically modified food except under very special circumstances	Intercept	6.594	.779	71.676	1	.000			
	Education	-.005	.076	.005	1	.943	.995	.856	1.155
	Reaction to 'Biotechnology'	-.309	.146	4.479	1	.034	.734	.552	.977
	Adequacy of Ethical Oversight	-.285	.127	5.041	1	.025	.752	.586	.964
	Reaction to 'GM Food'	-1.800	.174	107.309	1	.000	.165	.118	.232
	Amount Heard about GM Food	.173	.159	1.177	1	.278	1.188	.870	1.623
	Benefits of GM Food	-.764	.108	49.597	1	.000	.466	.377	.576
	Risks of GM Food	.753	.105	51.184	1	.000	2.122	1.727	2.608
	Moral Acceptability	-.607	.102	35.495	1	.000	.545	.446	.665
	Watch National News on TV	-.022	.039	.327	1	.567	.978	.907	1.055
I approve of genetically modified food if it is more tightly controlled and regulated	Intercept	2.606	.588	19.659	1	.000			
	Education	-.010	.060	.029	1	.865	.990	.881	1.112
	Reaction to 'Biotechnology'	.073	.117	.386	1	.534	1.075	.855	1.352
	Adequacy of Ethical Oversight	-.458	.099	21.466	1	.000	.632	.521	.768
	Reaction to 'GM Food'	-.637	.122	27.056	1	.000	.529	.416	.672
	Amount Heard about GM Food	.368	.124	8.825	1	.003	1.445	1.133	1.842
	Benefits of GM Food	-.187	.085	4.888	1	.027	.829	.702	.979
	Risks of GM Food	.360	.078	21.118	1	.000	1.434	1.229	1.672
	Moral Acceptability	-.260	.079	10.771	1	.001	.771	.660	.901
	Watch National News on TV	.052	.030	2.934	1	.087	1.054	.992	1.119

a. The reference category is: I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place

N= 1579

The parameter estimates can be seen in Table 3. The results suggest that those who perceive more risks associated with GM food are more likely to say that they 'disapprove except under very special circumstances' or that they 'disapprove under any circumstances'. Conversely, respondents with more positive reactions to the term "genetically modified foods", those who view GM food research as morally acceptable, and those who perceive more benefits associated with GM foods are less likely to say that they 'disapprove except under very special circumstances' or that they 'disapprove under any circumstances'. Similarly, those who express more confidence in the ethical oversight of biotechnology, and more positive reactions to the term

"genetically modified foods" are most likely to endorse the reference position that they 'approve of the use of genetically modified foods, as long as the usual levels of government regulation and control are in place' and so are less likely to adopt the other positions. However, those who say they have heard more about GM foods and those who perceive more risks associated with GM foods are more likely to endorse positions other than the status quo (i.e. with the usual levels of government regulation and control in place).

Those who perceive more benefits associated with GM foods, and those who view GM food research as ethical are less likely to endorse positions that indicate disapproval of GM food or that would require approval only after the imposition of more regulation. Moreover, those with more education and more positive reactions to the term "biotechnology" are less likely to categorically disapprove of genetically modified food under any circumstances. The variable corresponding to television news consumption remains in the model but only approaches significance, so its effects should be interpreted cautiously.

While these predictors are consistent with both expectations and previous research, there are several remarkable aspects to the final predictive model. First, it does an effective job in predicting an individual's specific position on GM foods, using very few variables. The model is also remarkable in terms of the variables it does *not* include. While there are clearly significant aggregate differences between Canadian and American attitudes about biotechnology and GM foods, the respondent's country of origin does not add significant predictive value to the model. In fact, the respondent's country of origin accounts for only about 1% of the variance in predicting that person's position on GM foods. As such, whether a person is from the United States or Canada appears to be less important than his or her overall awareness of the technology and his or her perceptions of the risks, benefits, and ethical considerations associated with that technology.

Similarly, gender differences in attitudes toward biotechnology and GM foods in particular have been noted in previous studies including those in Canada (Einseidel, 2000), Europe (Gaskell et. al., 2003), the United States, (Hallman et al, 2002, 2003, 2004), and Korea (Govindasamy et al., 2004). However, while there are clear gender differences in awareness and beliefs about the risks, benefits, and ethics associated with biotechnology, on its own, gender only explains roughly 3% of the variance in predicting which of the four positions a respondent is likely to endorse. Thus, while gender remains an important variable in understanding how people think about biotechnology, it appears to be less important than understanding key attitudes in predicting individual positions.

Is Support or Opposition to GM Foods: Predictive of Support for other Emerging Technologies?

In judging the prospects of each of eight developing technologies to "improve our way of life", "make our way of life worse" or "have no effect on our way of life" in the next 20 years, both Canadians and Americans are relatively optimistic about the potential impact of genetically modified foods. It appears, however, that attitudes about GM foods are only moderately correlated with responses to the other similarly

'advanced' technologies (see Table 4). Not surprisingly, respondents' attitudes about foods created using biotechnology are most highly correlated with attitudes about the prospects of biotechnology in general. Interestingly, respondents' beliefs about the prospects of GM foods to "improve our way of life" are found to be highly correlated with those of nuclear power rather than with other biotechnologies such as stem cell research or even nanotechnology.

Table 4: Correlations between Attitudes about GM Foods and other Technologies to "Improve our Way of Life"

Correlations

		8.8) Do you think it will improve our way of life in the next twenty years: Genetically modified foods
8.1) Do you think it will improve our way of life in the next twenty years: New 'hybrid' car engine technologies	Pearson Correlation	.071**
	Sig. (2-tailed)	.000
	N	2913
8.2) Do you think it will improve our way of life in the next twenty years: Computers and information technology	Pearson Correlation	.178**
	Sig. (2-tailed)	.000
	N	2970
8.3) Do you think it will improve our way of life in the next twenty years: Biotechnology	Pearson Correlation	.357**
	Sig. (2-tailed)	.000
	N	2831
8.4) Do you think it will improve our way of life in the next twenty years: Stem cell research	Pearson Correlation	.212**
	Sig. (2-tailed)	.000
	N	2832
8.5) Do you think it will improve our way of life in the next twenty years: Nuclear energy	Pearson Correlation	.306**
	Sig. (2-tailed)	.000
	N	2893
8.6) Do you think it will improve our way of life in the next twenty years: Cellular phones	Pearson Correlation	.218**
	Sig. (2-tailed)	.000
	N	2957
8.7) Do you think it will improve our way of life in the next twenty years: Nanotechnology	Pearson Correlation	.229**
	Sig. (2-tailed)	.000
	N	1862

**. Correlation is significant at the 0.01 level (2-tailed).

GM Foods as a Topic of Conversation?

The survey respondents were asked whether, prior to the survey, they had ever talked about GM foods with anyone. The results which can be seen in Table 5 suggest that Canadians have discussed GM foods significantly more often than their American counterparts[2]. Specifically, only 41% of Canadians say they have never discussed GM foods. More than half (53%) of the Americans interviewed said that they had never had a conversation about GM foods. An equal percentage (19%) of Canadians and Americans said that they had discussed GM foods 'once or twice'. However, a greater percentage of Canadians (30%) than Americans (21%) say they have talked about GM foods 'occasionally', and more Canadians (10%) than Americans (6%) say they have talked about the issue 'frequently'.

Table 5: Respondent Discussions about GM Food by Country and Total

Before this interview, have you ever discussed genetically modified food with anyone?	Canada N=999	United States N=1197	Total N=2196
Never	41.1%	53.1%	47.7%
Once or Twice	19.0%	19.3%	19.2%
Occasionally	29.5%	21.3%	25.0%
Frequently	10.3%	6.3%	8.1%

However the differences in the frequency of discussions of GM foods extend beyond the differences between Canada and the U.S. There are also regional differences within the respective countries as to the frequency of discussions. Response categories were collapsed into two groups: the low frequency group, which included respondents who had 'never' had a conversation about GM foods and those who had talked about them only 'once or twice'; and the high frequency group, including respondents who had discussed GM foods 'occasionally' and 'frequently'. When examining the regional differences it is apparent that those living in British Columbia (47%) and Quebec (43%) were most likely to be in the high frequency group. In contrast, those in the Atlantic region of Canada were least likely to have had a similar number of conversations (only 26% in the high frequency group)[3] (See Table 6).

Table 6: Respondent Discussions about GM Food Dichotomized by Region

Before this interview, have you ever discussed genetically modified food with anyone?	Low Frequency	High Frequency
British Columbia	52.3%	47.7%
Alberta	64.9%	35.1%
Saskatoon/Manitoba	60.3%	39.7%
Ontario	61.1%	38.9%
Quebec	56.7%	43.3%
Atlantic	74.0%	26.0%

N= 999

[2] ? ^{2}(3, N=2196)= 42.15, p<0.001[0].
[3] ? ^{2}(5, N=999)= 11.92, p<0.05

Using similarly dichotomized data, regional differences in the percentage of U.S. respondents who reported having discussed GM foods with others also emerged (See Table 7). In the United States, those living in the Pacific region were most likely to have discussed GM food 'occasionally' or 'frequently' (39% in the high frequency group). Those in the West South Central region (including Arkansas, Louisiana, Oklahoma, and Texas) were least likely to have had a similar conversation (only 18% sin the high frequency group[4]. Those in the Pacific region of the U.S. are most similar in their response frequencies with those in Saskatoon/ Manitoba and Ontario while those in the Atlantic region in Canada are most similar to the majority of other regions in the U.S. in reporting their GM food discussion frequency. Thus, our results suggest that there are inter-country differences as well as intra-country differences in the frequency of discussions of GM foods. In other words, differences exist not only between countries but both within and across regions of Canada and the United States with only half of the regions in Canada showing similarity to the U.S in the frequency of their discussions about GM foods.

Table 7: American Respondent Discussions about GM Food Dichotomized by Region

Before this interview, have you ever discussed genetically modified food with anyone?	Low Frequency	High Frequency
East North Central	76.4%	23.6%
East South Central	75.0%	25.0%
Middle Atlantic	74.1%	25.9%
Mountain	68.1%	31.9%
New England	75.0%	25.0%
Pacific	60.8%	39.2%
South Atlantic	70.6%	29.4%
West North Central	73.7%	26.3%
West South Central	81.7%	18.3%

N= 1197

Correlates of Conversation

To more thoroughly characterize those more likely to talk about GM foods with others, ordinal correlations (gamma coefficients) were calculated between how often respondents reported having discussions about GM foods and their demographic and attitudinal characteristics. Separate analyses were run on the samples collected in the United States and Canada.

[4] $?^2(8, N=1197)= 16.71, p<0.05$.

Table 8: Correlations between Respondent Demographics and Frequency of Discussion of GM Food by Country

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
Age of respondent	-.086* (991)	-.051 (1186)
What is the highest level of schooling that you have completed?	.283** (994)	.276** (1191)
Can you please tell me your total household income for everyone in your household?	.156** (882)	.159** (1056)
In the past year, how often have you attended a service at a place of worship?	-.057 (990)	-.041 (1184)

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

In both countries, the results show that increased frequency in discussions of GM foods is modestly associated with greater education and income (See Table 8). In Canada, talking more about GM foods is modestly associated with younger age. In both the U.S. and Canada, relatively weak to modest correlations were found between more discussion of GM foods and increased consumption of news on television, in the press, on the radio, and on the Internet. As might be expected, in both countries there were moderate correlations between talking about GM foods and the number of times respondents reported that they had actively sought out information about biotechnology. A comparable association was also found between the number of times respondents said that they had actively sought out ways to voice their opinions or values about biotechnology research or its implications (See Table 9). Similar moderate associations were found in both countries between increased discussion frequency and for both self-rated familiarity with biotechnology and with the number of stories the respondents reported having heard about biotechnology in the three months prior to the interview (See Table 10).

Table 9: Correlations between Information Seeking and Sharing, Media Consumption and Frequency of Discussion of GM Food by Country

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
How often have you actively sought out information about biotechnology research, applications, ethical guidelines, or studies that have been carried out to evaluate safety?	.469** (998)	.469** (1194)
How often have you actively sought out ways to voice your opinions or values about biotechnology research or implications of such research?	.488** (998)	.447** (1195)
Over the past week, how many days did you: Watch the national news on television?	.051 (999)	.006 (1196)
Over the past week, how many days did you: Watch the local news on television?	-.069* (999)	-.065* (1196)
Over the past week, how many days did you: Listen to talk radio about news issues?	.134** (997)	.171** (1195)
Over the past week, how many days did you: Read the front section of a national newspaper?	.172** (998)	.187** (1194)
Over the past week, how many days did you: Read the front section of a local newspaper?	-.005 (999)	.029 (1194)
Over the past week, how many days did you: Read a newsmagazine?	.222** (996)	.212** (1195)
Over the past week, how many days did you: Read the news on the Internet?	.163** (997)	.210** (1196)

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 10: Correlations between General Attitudes toward Biotechnology and Frequency of Discussion of GM Food by Country

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
When you hear the word technology, do you have a positive reaction, neutral reaction, or a negative reaction?	.038 (995)	-.043 (1182)
When you hear the word biotechnology, do you have a positive reaction, neutral reaction, or negative reaction?	.027 (977)	.123** (1161)
Over the last three months, have you heard about any stories or issues involving biotechnology?	.477** (985)	.499** (1179)
Would you say you are familiar with biotechnology?	.457** (997)	.542** (1196)
In general, would you say you strongly support, somewhat support, somewhat oppose or strongly oppose the use of products and processes that involve biotechnology?	-.074 (942)	.080 (1112)
In terms of safety and regulatory approval processes for biotechnology products, do you tend to think that rules and systems in place are strict?	-.171** (877)	-.011 (1075)
In terms of moral or ethical oversight, do you tend to think that rules and systems in place here for biotechnology are strict?	-.153** (887)	.008 (1100)

However, while each of these associations were consistent across the two countries and are in the expected directions, these findings also highlight interesting differences between the two countries and the relationships between respondents holding positive or negative attitudes toward biotechnology and how often respondents said they had talked about GM foods. For example, in the United States, respondents with more positive reactions to the word 'biotechnology' were likely to have had more conversations with others about GM foods. In contrast, Canadian respondents were likely to have had more conversations about GM foods if they held more pessimistic views of the adequacy of the safety and regulatory approval processes in place for biotechnological products or if they thought the rules and systems in place to ensure moral ethical oversight over biotechnology were lax.

Similarly, as shown in Table 11, there are strong associations in both countries between how often the respondents reported having discussed GM food issues and their self-rated familiarity with GM foods and with having heard more stories about GM foods. There are, however, real differences between the countries in the attitudinal correlates of having spoken about GM foods.

Table 11: Correlations between Attitudes toward GM Food and Frequency of Discussion of GM Food by Country

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
Do you think it will improve our way of life in the next twenty years: Genetically modified foods	-.176** (959)	-.050 (1114)
When you hear the phrase 'genetically modified food' do you have a positive reaction, neutral reaction, or a negative reaction?	-.194** (996)	.005 (1194)
Would you say you are very, somewhat, not very or not at all familiar with genetically modified food?	.706** (997)	.796** (1195)
Over the last three months, have you read, seen or heard a lot, a little, or nothing about issues involving genetically modified food?	.667** (998)	.646** (1197)
How beneficial do you think genetically modified food research will be to our society?	-.110** (985)	.056 (1169)
How much risk does genetically modified food pose for our society?	.264** (981)	.124** (1169)
In terms of the moral or ethical aspect of this research, how do you view this kind of research?	-.081* (992)	.077* (1173)
Overall, which of the following best captures your views about genetically modified food?	-.206** (992)	-.013 (1180)

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

For instance, in Canada, those reporting having had more conversations with others about GM foods were more likely to hold pessimistic views of the technology. Canadians were more likely to have talked about GM foods if they had less positive views of the prospects for biotechnology to improve our way of life in the next twenty years. They were also more likely to have talked with others if they saw fewer benefits and more risks associated with GM foods and if they viewed biotech research as morally or ethically problematic. Finally, treating the four positions on GM foods as an ordinal variable, Canadians who talked the most with others about GM foods were more likely to disapprove of the technology.

In contrast, American respondents were also more likely to have talked about GM foods with others if they saw more risks associated with the technology, however the correlation is less than half of that in the Canadian data. Interestingly, although the associations are weak, while the Canadians interviewed were more likely to have talked with others about GM foods if they viewed the research associated with it as morally or ethically *unacceptable*, the American respondents were more likely to have talked about the issues if they saw research on GM foods as morally *acceptable* (See Table 11).

In a related pattern of findings, Canadians who had talked the most with others about GM foods were less confident in the safety and regulatory approval systems governing

the technology, more likely to say that the government does not do enough to study and monitor the impacts of biotechnology products, and less likely to trust that biotechnology research firms will follow strict ethical guidelines. In comparison, Americans who saw biotech research as leading to improvements in the quality of life talked about GM foods more often (See Table 12).

Table 12: Correlations between Attitudes toward Biotechnology and Frequency of Discussion of GM Food by Country – Split Half Samples

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
How confident would you say you are in the safety and regulatory approval systems governing genetically modified foods?	-.282** (491)	-.091 (588)
How confident would you say you are that genetically modified food is in safe hands?	-.107 (492)	-.039 (575)
Decisions should be based on expert advice vs. views of average citizens	-.109 (488)	-.049 (575)
Decisions should be based on scientific evidence of risk vs. moral and ethical issues	.095 (493)	-.112 (573)
Government does not do enough vs. effective job of studying and monitoring the impacts of biotechnology products	-.168* (465)	-.004 (548)
Biotechnology research has not been vs. has been considerate of my interests, values, and beliefs	-.138 (468)	-.012 (562)
I do not trust vs. trust biotechnology research will follow strict ethical guidelines	-.290** (493)	-.110 (579)
Until more is known about the risks, government should slow the use of Biotechnology	-.006 (504)	-.084 (589)
Authorities should inform people about Biotechnology, and let them decide for themselves whether they want to use products developed using these techniques	-.050 (504)	.081 (591)
If the best available scientific evidence says that a particular use of Biotechnology is safe, it should be allowed?	-.075 (501)	.078 (587)
Biotechnology research represents the next frontier of human endeavour, a frontier that will lead to significant quality of life benefits for all ?	-.092 (496)	.152* (588)
Although there may be some unknown risks, technologies like Biotechnology are an inevitable part of the future, so all we can do is make sure that its uses are as safe as possible?	-.020 (507)	-.016 (593)

Table 13: Correlations between Trust in Credibility of Information by Organization and Frequency of Discussion of GM Food by Country

How often have you discussed GM Food?	Canada Gamma (N)	United States Gamma (N)
How much would you trust that information to be credible: The world health organization, which is part of the united nations	-.013 (726)	-.022 (1186)
How much would you trust that information to be credible: Greenpeace	.085* (740)	.012 (1126)
How much would you trust that information to be credible: The nature conservancy of Canada	.104* (685)	n.a.
How much would you trust that information to be credible: Environmental groups	.122** (724)	-.025 (1188)
How much would you trust that information to be credible: David Suzuki	.141** (691)	n.a.
How much would you trust that information to be credible: Government scientists	-.001 (746)	-.123** (1187)
How much would you trust that information to be credible: Scientists that work for biotechnology companies	-.147** (765)	-.131** (1188)
How much would you trust that information to be credible: Senior executives of biotechnology companies	-.293** (740)	-.210** (1186)
How much would you trust that information to be credible: University scientists whose work is funded by government grants	.144** (744)	-.027 (1188)
How much would you trust that information to be credible: University scientists whose work is funded by biotechnology companies	-.102* (753)	-.125** (1184)
How much would you trust that information to be credible: Scientific journals	.206** (744)	.047 (1182)
How much would you trust that information to be credible: Private television networks	-.103* (748)	-.193** (1190)
How much would you trust that information to be credible: Public television networks like CTV (In Canada)/ CBS (In the USA)	.043 (742)	-.004 (1186)
How much would you trust that information to be credible: Print media (newspapers and magazines)	-.021 (768)	-.106** (1185)
How much would you trust that information to be credible: Political leaders	-.100* (779)	-.192** (1188)
How much would you trust that information to be credible: Religious leaders	-.214** (723)	-.230** (1189)

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Finally, Canadians had more conversations about GM foods with others if they said they had more trust in Greenpeace, The Nature Conservancy, environmental groups, scientific journals, university scientists working on government grants, and David Suzuki. Americans had more discussions about GM foods if they mistrusted the credibility of government scientists, and information printed in newspapers and magazines. Respondents in both countries were more inclined to have had conversations about GM foods if they mistrusted the information provided by anyone associated with the biotechnology industry, including senior executives of biotech companies, scientists who work for biotechnology companies, and even university scientists whose work is funded by biotechnology companies. Respondents in both countries were also more likely to have talked about GM foods if they said that they mistrusted the information provided by political and religious leaders and by private television networks (See Table 13).

Predicting How Often People Have Talked with Others about GM Foods

While there are some interesting associations between how often people have talked with others about GM foods and particular demographic and attitudinal characteristics, most of these correlations are rather modest. As such, each of the individual predictors offers little basis with which to identify the groups of people most likely to have spoken with others about GM foods.

Therefore, a binary logistic regression model was constructed to identify the groups of respondents who are most likely to have discussed GM foods. Response categories were collapsed into two groups: the low frequency group, which included respondents who had 'never' had a conversation about GM foods and those who had talked about them only 'once or twice'; and the high frequency group, including respondents who had discussed GM foods 'occasionally' and 'frequently'. The initial model included all of the demographic and attitudinal predictors presented in Tables 8, 9, 10, 11, and 13 as well as gender and whether the respondent was Canadian or American. The measures presented in table 12 were only administered to half of the Canadian and American samples, and as such, were dropped from the analysis.

Each of the variables was coded so that increasing values indicated increasing levels of the construct being measured. A forward stepwise Wald regression was used to construct a final model useful for examining the significant main effects of the demographic and attitudinal variables to predict who is in the high frequency group, that is, who has talked GM food most often.

The resulting model converged in ten steps and accounted for 48% of the variance (Nagelkerke Pseudo R^2) in predicting which respondents have discussed GM foods most often. The model was also able to correctly classify 90% of the respondents in the low frequency group, and 61% of respondents in the high frequency group (See Table 14).

Table 14: Observed and Predicted Classification of How Often Respondents Reported Talking about GM Foods

	Low Frequency (Discussed GM Food 'Never' or 'Once or twice')	High Frequency (Discussed GM Food 'Occasionally' or 'Frequently')	Percentage Correct
Discussed GM Food 'Never' or 'once or twice'	1157	137	89.4%
Discussed GM Food 'Occasionally' or 'Frequently'	263	411	61.0%
Overall Percentage			79.7%

N= 1968

The final predictive model included: country of origin, level of education, the amount the respondent had heard about biotechnology, their reaction to the term 'GM Food', self-rated familiarity with GM foods, the level of perceived risks of GM foods to society, perceived moral acceptability of GM food research, how often the respondent had sought information about biotechnology, how often they had sought opportunities to express their opinions and values, and interestingly, how often they listened to talk radio.

The parameter estimates of the model can be seen in Table 15. The results suggest that Canadians are twice as likely to be in the high frequency group as their American counterparts. In addition, respondents who had discussed GM foods most often were those with more education, had heard more about biotechnology, had a greater self-rated familiarity with GM foods, thought that GM foods pose a greater risk to society, rated biotechnology less morally acceptable, have sought out more opportunities to find out information, and express their opinions about GM foods and listen to talk radio more often.

Table 15: Parameter Estimates for Predicting How Often Respondents Reported Talking about GM Foods

							95.0% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Country	.701	.126	30.762	1	.000	2.017	1.574	2.584
Education	.122	.049	6.090	1	.014	1.129	1.025	1.244
Amount Heard about Biotechnology	.286	.128	4.958	1	.026	1.330	1.035	1.711
Reaction to 'GM Food'	1.411	.118	143.939	1	.000	4.098	3.255	5.160
Self-rated familiarity with GM Food	.955	.118	65.446	1	.000	2.599	2.062	3.275
Risks of GM Food	.203	.058	12.303	1	.000	1.226	1.094	1.373
Moral Acceptability	-.135	.055	5.902	1	.015	.874	.784	.974
How often Sought out Information about Biotechnology	.316	.070	20.518	1	.000	1.372	1.197	1.573
How often Sought out Ways to Voice Opinions	.298	.074	16.067	1	.000	1.347	1.165	1.559
How often Listened to Talk Radio	.069	.701	9.566	1	.002	1.071	1.026	1.119
Constant	-9.261	.541	293.536	1	.000	.000		

N= 1968

Conclusions

The results of this investigation are consistent with the Social Amplification of Risk Framework. They suggest that particularly in Canada, individuals who believe that they know a great deal about biotechnology and GM foods in particular, and who hold negative views of the technology are most likely to talk about the issue with others and to seek other opportunities to voice their opinions. As such, these individuals may serve to amplify the perceived risks of GM foods within their informal social networks.

Further, considering the importance of 'voiced' approval or disapproval of GM foods, it is interesting to note that while there are significant differences between Canadians and Americans in terms of their frequencies of discussions our results found that a person's is county of origin appears to be less important than their overall awareness of the technology and their perceptions of the risks, benefits, and ethical considerations in predicting their approval of GM foods.

While these findings may have some policy implications, additional research is needed to ascertain the influence these individuals actually have on their social networks. While the individuals themselves report having had frequent conversations about GM foods with others, the nature of those conversations and the preexisting views of the audience receiving the information are unknown. So the potential for the negative information to be sent through these networks and 'amplify' the risks of GM foods is uncertain. However, given the potential for these 'informed, negative' sources to persuade members within their social networks and the potential amplification of

perceived risks, additional research to better understand the nature and influence of these individuals is likely warranted.

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Time Series Analysis of the Relationship Between Canadian News Media and Public Opinion Regarding Biotechnology Issues.

Andrew Laing
President, Cormex Research

Introduction

As part of its mandate to provide senior government officials with a broader understanding of issues and public attitudes towards biotechnology applications, the Canadian Biotechnology Secretariat (CBSec) commissioned two research projects: semi-annual public opinion polling that began in September 1999 and, a year later in September 2000, an ongoing media content analysis of Canadian news coverage of biotechnology topics. Both studies were designed with different purposes in mind: the public opinion polling component was used by policy advisors with various government departments and agencies to gauge public attitudes towards biotechnology issues and applications, while the media analysis reports kept officials apprised of current developments in biotechnology, and provided issue and stakeholder tracking over time.

Now entering their fifth year and with over 20,000 data points each, the two studies offer a rare opportunity to explore the relationship between news media and public opinion on an important science and technology issue. An initial attempt (Laing 2004) to explore correlations between the media content analysis project and the public opinion survey data indicated a number of correlations between awareness and volume

of media exposure, as well as tone of coverage and the level of support for biotechnology applications, processes and products. However, due to the lack of sufficient survey data intervals over time (between seven and eight surveys), these correlations could not be reported within an acceptable level of statistical significance. The most recent survey conducted in January/February 2005 is now included and should provide sufficient data to determine whether certain correlations appear within an acceptable level of statistical significance.

There are many advantages in studying media influence on public opinion in this context. By providing a greater understanding about the influence of the media in public opinion formation on the topic of biotechnology, it provides senior communications officers and issues managers with important information that, until now, has not been available. Empirical evidence from the data already supports a position that government should encourage more public debate and understanding around biotechnology issues. As Pollara/Earnscliffe (December 2002, 6) noted, "better communication [has] increased knowledge among interested people about these technologies, [and] is contributing to the 'maturing' of the issues in the minds of many." An examination of the media influence on public opinion formation also addresses the hypotheses examined by Mazur (1981) regarding the influence of media on "technical controversies" and scientific issues, in which he suggested that volume of media attention directly correlates with changes in public opinion about a scientific or technical issue.

News media and public opinion: Background and major trends

Public Opinion Surveys

To date, the Canadian Biotechnology Secretariat has commissioned thirteen public opinion polls since 1999.[5] Beginning in 2003, a U.S. component was added, such that the Spring 2003, Spring 2004 and Spring 2005 data sets were divided between Canadian and U.S. respondents. However, only four tracking questions have been asked in successive public opinion surveys that can be used for time-series analysis, providing only three types of responses that can be measured against media coverage:

1) the level of public **awareness** of or exposure to biotechnology topics and issues, as measured by whether respondents had heard about a biotechnology story or issue in the last three months;

2) the public's **attitudes** toward biotechnology, as measured by two variables: respondents' *reaction* (positive, neutral or negative) when they hear the term 'biotechnology', and respondents' *support* for products and processes that involve biotechnology; and,

3) the level of public **knowledge** or **familiarity** with biotechnology, as measured by whether respondents indicate whether they are "familiar" with biotechnology.

[5] See Appendix 1 for more details on the opinion polls, and Appendix 3 for questions and other information.

On these three areas of attitude tracking, results have pointed to three trends: 1) a **gradually declining awareness** of biotechnology issues as discussed by the media or friends and family; 2) a **gradually rising acceptance** of biotechnology applications and practices, and 3) a **gradually rising familiarity** with biotechnology topics and issues. Over the course of the public opinion surveys, the positive response rate to whether respondents have "heard about any stories or issues involving biotechnology" has experienced an average rate of decline of 0.6 percentage points (*M*=45.3%, *SD*=.05, N=10). Respondents stating that they tend to have a positive reaction when they hear the term 'biotechnology' has risen by an average of 0.5 percentage points (*M*=32.9%, *SD*=.03, N=11), while the percentage of respondents indicating they are very or somewhat supportive of biotechnology processes and products has experienced the greatest change, with an average rate of increase of 1.5 percentage points (*M*=60.4%, *SD*=.05, N=9) since the question was tracked in September 2000. Respondents claiming they are very or somewhat familiar with biotechnology has climbed at an average rate of 0.7 percentage points (*M*=56.1%, *SD*=.06, N=11).

The survey results and follow-up focus group testing has prompted a number of observations that qualify these three trends, particularly regarding levels of support for biotechnology. Regarding attitudes towards biotechnology, the percentage of respondents expressing a negative reaction has also climbed over the course of the surveys, but at a slower rate, rising by 0.3 percentage points (*M*=15.5%, *SD*=.03, N=11) and has consistently been only half the percentage of respondents that have had expressed a positive reaction to the term 'biotechnology'. The share of respondents expressing opposition to biotechnology products and processes has been declining by 1.1 percentage points (*M*=29.7%, *SD*=.04, N=9). Moreover, while there has been consistently more support for biotechnology than criticism throughout the series of surveys, acceptance of biotechnology has been more prevalent among Canadians that are better educated and more engaged in and aware of public policy issues. Pollara/Earnscliffe (March 2003, 5) observed that "among those more highly educated, with higher incomes, as well as among younger Canadians, [respondents believe] that biotechnology will be central to Canada's future economic success." Finally, while Canadians have tended to offer more support for biotechnology applications than opposition, they "resist offering systemic views on biotechnology applications" (Pollara/Earnscliffe June 2002, 6), choosing instead to change their level of support based on the type of application and the perceived associated risk/benefit involved. As a consequence, public support has tended to be stronger in health applications, and weakest in areas applying to GM foods and crops where there remain strong reservations among many parts of the population.

Media content analysis

The media content analysis component began in September 2000, and involves daily monitoring and coding of news media coverage in 14 major Canadian newspapers, four news magazines, 60 radio stations, and 44 television stations reaching Canadian audiences. While the study contains over 40 different variables that have been tracked over time, including region, source of coverage, type of media, disease/health care issue, government agency/actor mention, stakeholder presence and position and key messages (regarding the presence of health and safety concerns, moral/ethical

concerns and government regulation of biotechnology), there are three main variables that will be used to test the strength of the correlations between media coverage and public opinion:

1) the **type of media** reporting on biotechnology issues (*i.e.*, print, radio or television);

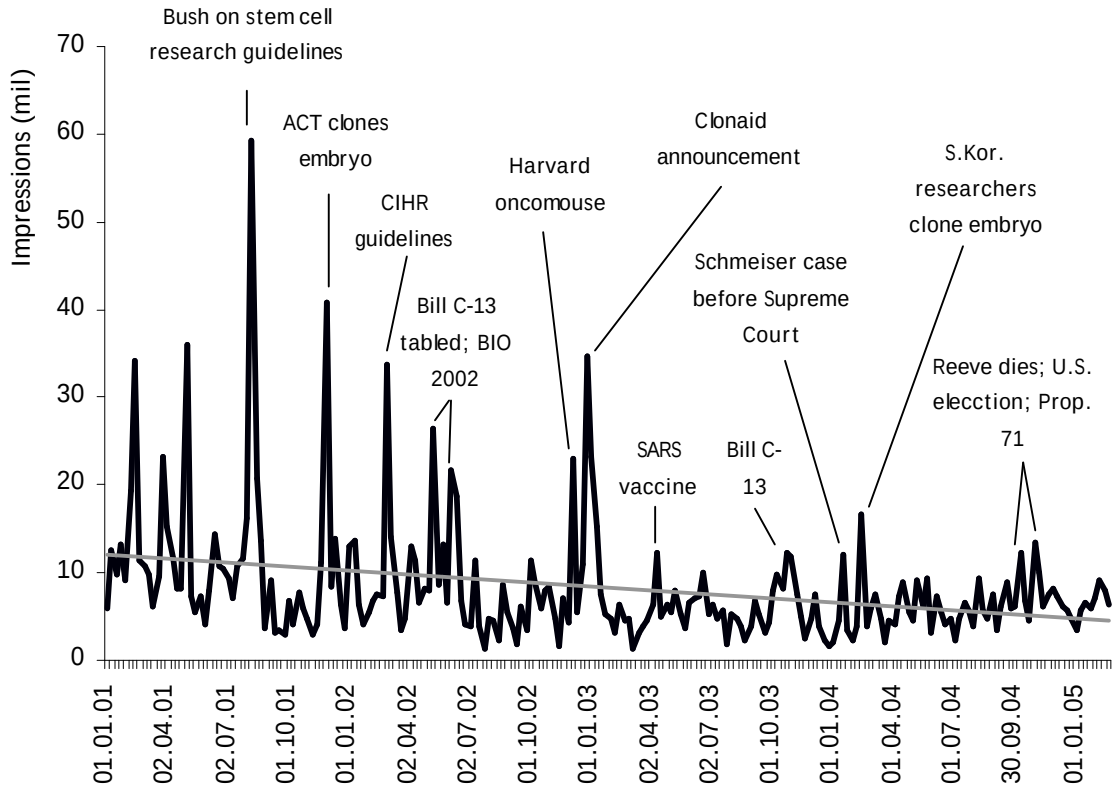
2) the **major topic** of the news item (*i.e.,* whether it addresses a health-related application of biotechnology, such as stem cell research or genomics, a food or crop application, or an industry and general science issue, such as the financial performance of biotechnology companies, or patent regulation); and finally

3) the **tone** toward the biotechnology application (*i.e.*, whether the news item portrays the application of biotechnology in a favourable, unfavourable or neutral/balanced context).[6]

Similar to the public opinion survey results, the media content analysis study has also pointed to several broad trends about how the Canadian news media has covered biotechnology in the last five years, as illustrated in Figure 1. First, the volume of news media coverage dedicated to biotechnology issues has been in decline since Summer 2001 when coverage peaked as a result of a combination of inordinate attention to protests over GM foods and GM crops, as well as the debate over stem cell research (led by coverage of the Bush administration's decision to limit federally-funded embryonic stem cell research to existing stem cell lines). Since Summer 2001, the 'spikes' in media coverage produced by high-profile events have become both less pronounced and farther apart in occurrence, resulting in a 1.8% overall average rate of decline in monthly audience exposure of biotechnology over a fifty month period beginning in January 2001. The decline has been more evident in coverage generated by television (a 4.3% average rate of decline in audience exposure) and radio (3.2%) than in newspapers (a 1.1% rate of increase, reflecting greater attention to industry and financial stories involving the Canadian biotech sector that has compensate for the drop in coverage of food and health applications). Second, the decline has tended to originate from both health- related topics such as stem cell research and cloning stories (2.8% average monthly rate of decline), as well as GM foods, GM crops and GM food labelling (2.4% average monthly rate of decline) more so than industry and financial stories, which have tended to increase in the Canadian media by 1.1%. Finally, coverage portraying the application of biotechnology in a favourable context has been on the rise (2.4% average monthly rate of increase), while negative coverage emphasizing concerns or problems with the introduction of biotechnologies has been on the decline (2.9% average monthly rate of decrease). In short, there has been an overall trend towards less "quantity" of media coverage, but with a corresponding improvement in the "quality" as defined by the level of support and positive portrayals of biotechnology applications.

[6] The Canadian broadcast sample was based on summaries of full transcripts. As a result, while topic and media type can be identified, tone of coverage was not assessed for radio and television coverage.

Figure 1: Weekly audience exposure from Canadian media coverage of biotechnology: January 2001 – March 2005



N=19,918 items. Based on print, radio and television coverage of biotechnology topics on a weekly basis between January 1, 2001, and February 28, 2005. Measured in audience impressions (millions).

Methodology

To reiterate, the public opinion surveys commissioned since 1999 and the media content analysis study of biotechnology point to a number of trends. With the Canadian public, there has been a declining awareness, coupled with rising support for biotechnology; with the Canadian media, there has been declining attention to biotechnology topics, coupled with a rising level of positive coverage and declining negative coverage concerning its applications. Is there a statistical relationship between these media and public opinion trends? Data from both studies are combined to test three hypotheses:

H1 There is a positive correlation between volume of news coverage as and public awareness of biotechnology issues.

H2 There is a positive correlation volume of news coverage and public opposition to biotechnology products and process, as well as unfavourable reaction to the term 'biotechnology'.

H3 There is a positive correlation between the tone of news coverage of concerning biotechnology's benefits versus its risks, and the level of public support for biotechnology products and processes, as well as a the reaction to the term 'biotechnology'.

There are several methodological elements of note regarding the testing of these hypotheses. First, two polls were conducted in Fall 1999 and Spring 2000 before the start of the media analysis study, and two polls were conducted on special topics that have less utility for this type of analysis,[7] leaving nine surveys on which to base findings: Fall 2000, Spring 2001, Fall 2001, Spring 2002, Fall 2002, Spring 2003, Fall 2003, Spring 2004 and Spring 2005. Moreover, not all questions were included and/or worded the same in all nine surveys.[8]

Second, the examination of the public opinion polls is restricted to a target demographic comprised of respondents that have a higher tendency to consume news coverage, which tends to include those who are older and better educated than the general populace. As a result, this study focuses on a "target demographic" that includes only respondents that are both 25 years of age or older, and have completed high school. [9] A review of the opinion surveys bears this out: exactly 52% of all respondents indicated that they had not heard anything about biotechnology issues within the last three months of being surveyed. However, among the target population group of older, better-educated respondents, the response rate rises (50%-Yes, 48%-No, 2%-DK/refused), and drops noticeably for the non-target group (Yes-33%, No-65%, DK/refused 2%). Testing for the influence of the media on public opinion formation requires that the study be restricted to the subgroup that will actually be exposed to the media.

Third, a further enhancement to the study was the incorporation of audience demographic data to weight each media item by expected audience reach. Each news item was weighted by the number of audience members expected to be exposed to it, depending on the outlet and, in cases of broadcast news items, time that it aired.[10]

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[7] The survey conducted in March 2003 focused largely on attitudes towards a single topic: genetic information and privacy, while a further survey conducted in late March 2004 focused on emerging technologies.

[8] The Fall 2003 survey, in asking the tracking question regarding awareness, asked respondents if they had heard any news about "any Canadian discoveries in the field of biotechnology", and is omitted from analysis involving the tracking of respondent awareness.

[9] The NADBank 2003 readership survey indicates that 89% of respondents who read a newspaper within the last seven days have at least a high school education – a similar demographic found in the surveys (almost 90%), but higher than the Canadian population (the 2001 census indicates that 23% of the population between ages 25 and 64 has attained less than a high school education). Furthermore, news audiences tend to be older: according to the NADBank 2003 survey, 88% of those who have read a newspaper over the last seven days were age 25 years or older. Cf. *Education indicators in Canada: Report of the Pan-Canadian Education Indicators Program 2003*, Statistics Canada.

[10] The audience databases applied in the course of this study were NADBank (2003) in examining newspaper coverage, BBM Bureau of Measurement (Fall 2001 sweeps) for all radio,

Figures given in the charts are measured based on the aggregate number of audience members potentially exposed to a news item, expressed in the report as "impressions".

Finally, media content analysis data was divided into nine samples, each consisting of the total audience exposure within a 90-day window from the point at which the field work for each opinion survey concluded. This sample was based on the initial question surrounding awareness, in which respondents were asked if they had heard any story or issue about biotechnology in the last three months.[11]

Results

The most direct approach of determining whether correlations exist between media coverage and public opinion is by focusing on levels of *awareness*. This involves comparing whether respondents (again, within the target news audience demographic) had heard any stories or issues about biotechnology within the specified 90-day time frame. Percentage of positive responses to the survey question of whether respondents had heard a biotechnology story or issue in the last 90 days were plotted as standardized scores, as well as total audience exposure within the 90 day period prior to the end of the survey's field work. The results indicated a moderate positive correlation between volume of news coverage of biotechnology and indications that the respondent had been exposed to a biotechnology story or issue, although the result falls short of statistical significance due to the shortage of data points (r=0.57, p=.14).

There were several factors that increased the strength of the correlation. First, restricting the media sample to television audience exposure yielded a stronger correlation that was statistically significant (r=.70, p=.05) compared to either print or radio coverage, suggesting that recall of biotechnology stories may be stronger in association with television coverage. Second, the correlation tended to be stronger when the media time frame was shortened to sixty days prior to the end of the survey period rather than the 90 days suggested by the questionnaire (r=.63, p=.10). What had the most notable impact, however, was the *topic* of the biotechnology story. When coverage was restricted to only health-related coverage, the correlation between the media and survey data diminished significantly (r=.43, p=.29). However, when restricted to only food-related coverage, the strength of the correlation rose noticeably (r=.87, p<.005). Moreover, negative media coverage also indicated a stronger correlation between total coverage and whether the respondent had heard about a biotechnology story (r=.68, p=.06). This finding suggests that when respondents are asked whether they have heard about a recent story or issue about "biotechnology" (and assuming that such information originated from mainstream

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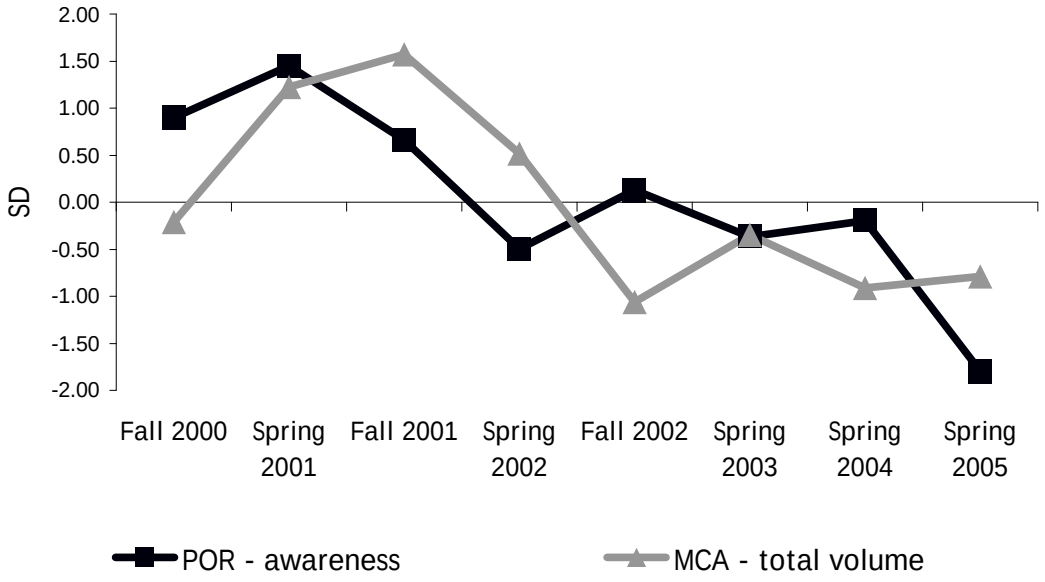
as well as local and regional television, and Nielsens Media Research TV findings (Fall 2002 sweeps) for national television as well as Toronto-area television.

[11] A media sample comprised of total audience exposure over both a 30-day and a 60-day window were also juxtaposed against the main tracking variables from the public opinion study. Applying the 30-day window produced more erratic results and led to few significant correlations between the media content and the public opinion results. There was relatively little difference between the 60-day window and the 90-day window.

media news sources), they are likely recalling a story or issue concerning the more controversial topics of GM crops, GM foods or GM food labelling more than a health or industry related subject, or a story that portrays an application of biotechnology in a negative context.

Figure 2: Audience Exposure
Print, radio and television coverage of biotechnology within ninety days of each survey plotted against percentage share of respondents indicating that they had heard a biotechnology story or issue: Fall 2000 to Spring 2005 survey, by standard deviations.

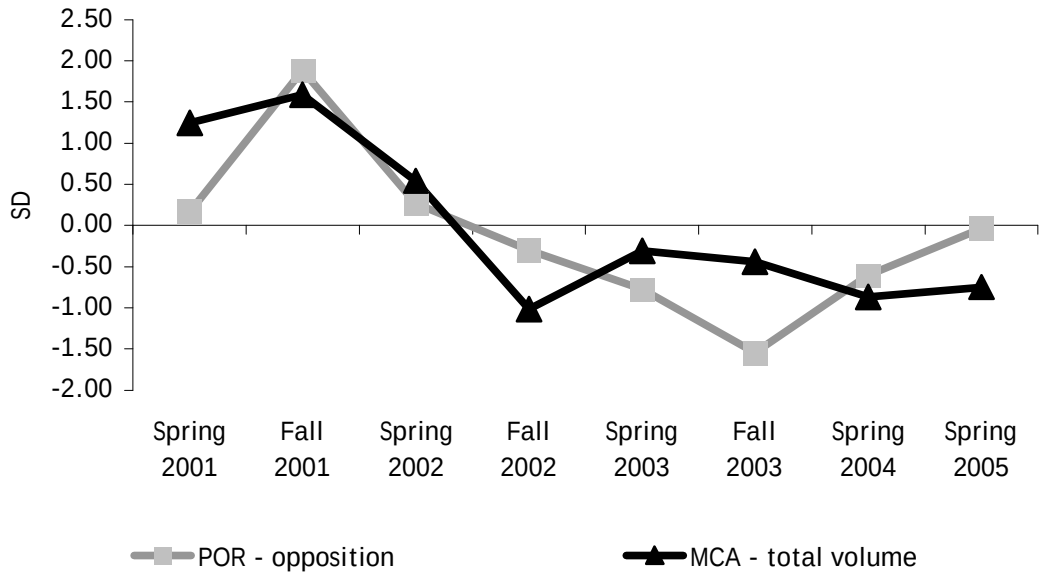


"POR - awareness" refers to eight public opinion research surveys; N=6871 Canadian respondents among target population group only. "MCA – total volume" refers to total audience exposure within a 90-day period after each public opinion survey; N=862 million audience impressions. Public opinion source: Earnscliffe, Pollara, Decima. Media content analysis source: Cormex Research.

Testing of the second hypothesis that media coverage correlates positively with public opposition to biotechnology products and processes also pointed to a relationship between public opinion formation and news media coverage. While there was evidence of a correlation between *awareness* and media coverage of biotechnology, the question of whether an actual correlation existed between *opposition* or *support* for biotechnology and the type of media coverage the subject attracts was more problematic because it raised the more complex issue of how attitudes towards biotechnology are formed rather than simply how respondents become aware or gain knowledge of an issue. Moreover, how attitudes towards a subject are formed can be influenced by many factors other than media coverage.

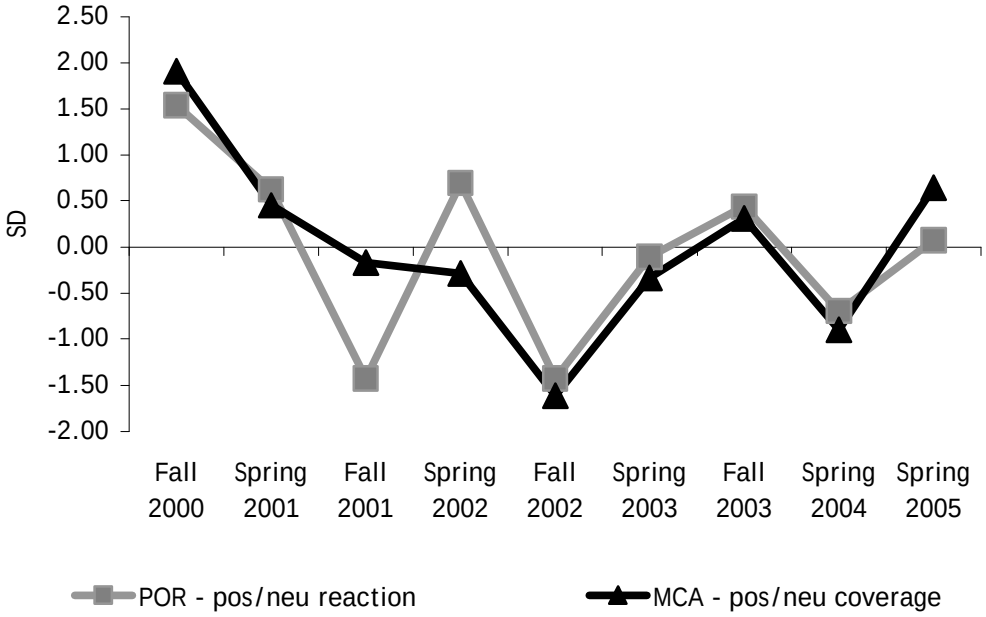
Figure 3: Audience Exposure

Audience exposure generated by media coverage of biotechnology within 90 days of each survey plotted against percentage of respondents indicating that they oppose the use of products and processes involving biotechnology: Spring 2001 to Spring 2005, by standard deviations.



"POR - support" refers to eight public opinion research surveys; N=6722 Canadian respondents among target population group only. "MCA – total volume" refers to total audience exposure within a 90-day period after each public opinion survey; N=852 million audience impressions. Public opinion source: Earnscliffe, Pollara, Decima. Media content analysis source: Cormex Research.

Figure 4: Audience Exposure
Generated by positive/neutral newspaper coverage of biotechnology within 90 days of each survey plotted against percentage of respondents indicating either a positive or neutral reaction when they hear the term 'biotechnology': Fall 2000 to Spring 2005, by standard deviations.

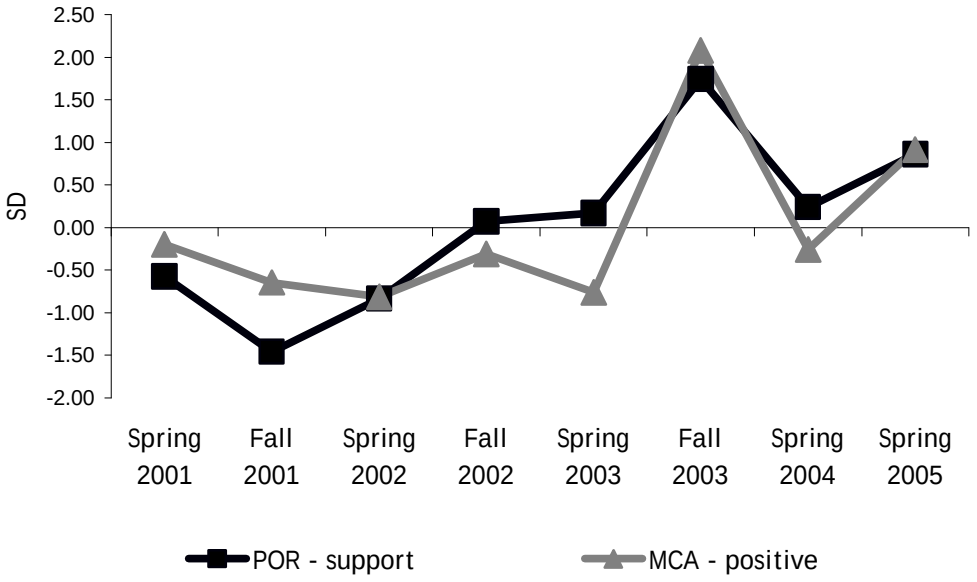


"POR – pos/neu reaction" refers to nine public opinion research surveys; N=7663 Canadian respondents among target population group only. "MCA – pos/neu" refers to total print media audience within a 90-day period after each public opinion survey of positive and neutral coverage of biotechnology applications only; N=448 million audience impressions. Public opinion source: Earnscliffe, Pollara, Decima. Media content analysis source: Cormex Research.

Despite these caveats in any attempt at looking at relationships between media coverage and public attitudes, the analysis did yield several correlations that support the second hypothesis. As shown in Figure 3, opposition to biotechnology products and processes showed a significant positive correlation with total media exposure devoted to the topic (r=.73, p=.04) as coverage of biotechnology declined. Similar to the issue of awareness, this positive correlation intensified when the sample was restricted to only television news coverage of biotechnology (r=.81, p=.015). The positive correlation was also evident when the sample was restricted to coverage of health-related applications (r=.72, p=.045), as well as with a combination of food and health applications (r=.74, p=.035). The relationship weakened with only the addition of food-related issues (r=.61, p=.11), but still remained noteworthy. The correlation suggests that as media interest in biotechnology wanes, it removes a key negative influence on how the public perceive the subject. Media coverage of biotechnology in 2000 and 2001 tended to be more visible (attracting television as well as print media coverage), and more focused on concerns raised by GM foods and crops, as well as certain controversial health-related applications such as stem cell research and

human reproductive cloning. The negative correlation along this variable (support for biotechnology applications compared to volume of media coverage over time) was stronger along most indicators than the positive correlation between opposition to biotechnology and media attention.

Figure 5: Audience Exposure
Audience exposure generated by positive newspaper coverage of biotechnology within 90 days of each survey plotted against percentage of respondents indicating that they support the use of products and processes involving biotechnology: Spring 2001 to Spring 2005, by standard deviations.



"POR – support" refers to eight public opinion research surveys; N=6722 Canadian respondents among target population group only. "MCA – positive" refers to total print media audience within a 90-day period after each public opinion survey of positive coverage of biotechnology applications only; N=73 million audience impressions. Public opinion source: Earnscliffe, Pollara, Decima. Media content analysis source: Cormex Research.

It should be noted that the other tracking variable for public attitude – the question of whether the respondent had a positive, neutral or negative reaction when they heard the term 'biotechnology' – proved to be less indicative of a correlation with changes in the volume of media exposure. There was no correlation between negative coverage or any other variable and whether a respondent had a negative reaction towards the term, nor was there any correlation between a positive reaction from respondents and any of the variables tracked for media exposure. This lack of relationship among the main "positive" and "negative" terms used in both studies raises questions about whether the third hypothesis can be confirmed. The lack of correlation may point to problems with the measuring instrument itself; specifically, the question of what

comprises a "negative" reaction by the respondent to the term biotechnology, and whether there is an opposite "positive" portrayal towards biotechnology in the Canadian media that corresponds with the "positive" portrayal in which applications are described in ways that benefit Canadians. Negative coverage often includes a wide range of media reports that include items that discredit the science behind the announcement, raise ethical/moral concerns, condemn a form of government regulation, and raise issues about public health and safety.

Nonetheless, the one notable relationship that did occur was a correlation between a combination of positive and neutral print media coverage, and a similar combination of positive and neutral reactions to the term biotechnology (r=.80, p=.01), as illustrated in Figure 4. This partly supports the third hypothesis: that support for biotechnology products and processes may correlate with how such applications are presented in the news media. There was a significant *positive* correlation when the media sample was confined to only those stories published within a 90-day window that highlighted the benefits of biotech research, rather than concerns. Favourable media coverage and support for biotechnology correlated positively (r=.85, p=.008). While there was also a notable positive correlation between unfavourable media coverage and opposition to biotechnology, the correlation was not statistically significant (r=.57, p=.14), as well as negative correlations between tone of coverage and support/opposition to products and processes. As illustrated in Figure 5, support for biotechnology products and processes has been generally rising over the sample period, and witnessed a spike in support during the Fall 2003 survey undertaken in December 2003. This coincided with a similar upward trend followed by a spike in favourable coverage witnessed between late September and mid-December. The volume of positive media coverage during the 90 days preceding the end of the survey period for the Fall 2003 sample was three times higher than the average over the previous five survey periods. The spike in favourable coverage was a product of several events: the reintroduction of Bill C-13 on human reproductive technologies, coverage of public opinion surveys indicating rising levels of acceptance among Canadians of biotechnology, and several 'good news' applications, such as the announcement by Edmonton researchers of a GM plant that can be used to detect landmines.

Discussion

The time-series analysis combining public opinion and media content analysis of biotechnology yielded three main findings. First, there appeared to be a correlation over time between awareness of recent biotechnology events and issues and media coverage of the subject. Public awareness of recent biotechnology events was comparatively high during the initial surveys conducted in 2000 and 2001 when media coverage was at its most intense in Canada. After this period, media interest in biotechnology issues declined, as did respondent awareness of recent biotechnology stories. Further analysis indicated three important conditions regarding awareness. First, that correlations intensified when only television news coverage was examined, suggesting that television, either as a source of news or in its presentation, may have more impact on Canadians. Second, there tended to be a higher correlation with negative news coverage than with either total media coverage or with positive and/or neutral coverage. Finally, correlations strengthened when only news involving GM food and GM crop stories were included, suggesting that Canadians tend to associate

"biotechnology" with agricultural applications more so than health, industry and general science. These latter two correlations raise an important communications issue as media coverage of GM foods and GM crops tends to highlight negative aspects in applying biotechnology more so than health applications or coverage of industry and science news. Between September 2000 and February 2005, approximately 20% of biotechnology coverage associated with GM foods and crops was negative, compared to 4% for health and 3% for industry and science applications. Only 9% of GM food and crop coverage has been positive over the same period, while positive coverage has comprised 21% of health-related applications, and 19% of industry and science news. As noted above, Pollara/Earnscliffe has found similar patterns: Canadians are generally more supportive of health-related applications, and more concerned about GM food and crop applications.

The second main finding is that opposition to biotechnology applications also tends to positively correlate with media attention, much as Mazur has concluded. The correlation with opposition to biotechnology applications again tends to be more sensitive to the amount of television coverage directed at the application more so than print media coverage. Furthermore, the question of "support" or "opposition" to biotechnology products and processes also tended to be more sensitive to changes in the overall volume of media coverage than the more general question of how a respondent "reacts" when they hear the term 'biotechnology'.

Finally, analysis indicated that both support for and reaction to biotechnology tended to follow closely changes in the amount of media coverage that highlighted the benefits or social concerns raised by biotech applications. This correlation appeared both in the tracking of positive/neutral respondent reaction to the term 'biotechnology' and positive/neutral print media coverage, and in respondent support for biotechnology products and processes and positive media coverage of biotechnology. However, negative coverage and opposition to products and processes, while also indicating a significant correlation, was one which fell below statistical significance, possibly due to a lack of data points available for comparative purposes (r=.57, p=.14, N=8).

This latter correlation indicates a very important qualification to Mazur's conclusion about the impact of media coverage of 'technical controversies' on public attitudes. While there was evidence of a correlation between the overall volume of media coverage and general opposition to biotechnology, there was also evidence that support for biotechnology products and processes, and respondents' overall reaction to this field, improved as the tenor of coverage in Canada towards biotechnology has improved. There has been a definite media trend in Canada towards less negativity in coverage surrounding biotechnology in the last several years, a trend that has reflected a lower presence in the media of stakeholder groups opposed to biotechnology, a decline in sensationalist reporting, and the resolution of certain contentious issues, such as the federal government's passage of a bill governing human reproductive technologies, the conclusion of the Monsanto v. Schmeiser case regarding patent rights, and Monsanto's decision to pull development of its Roundup Ready wheat product. Mazur's research provided little allowance for the tenor of coverage surrounding the introduction of a technology to the public, suggesting that public opposition is always present, and that any drop in opposition is only a reflection of a drop in the media's attention to the issue. The study of the relationship of media

coverage and public attitudes involving biotechnology suggests that positive coverage can actually influence the level of support for a technology.

It is worth raising at this point several caveats about these conclusions. First, to cite an oft-used phrase in statistics: correlation does not equal causation. The presence of a correlation between a variable in the media study and a variable in the survey research indicates only that there is evidence of a relationship between the two variables, and that the three hypotheses indicating a relationship between media coverage and public opinion polling on this topic cannot be rejected, not that one caused the other. Second, the evidence of an effect is not present in the public at large, but within a sizeable demographic of better-educated, older Canadians that tend to be greater news consumers. This connection between news media consumption and attitude should be tested further using specific questions about news consumption from respondents, rather than relying on constructing a 'news' demographic among respondents within a public opinion poll.

Future Directions

Within the narrow subject area of science and technology, there has been little research into the relationship between media coverage and how it contributes, or fails to contribute, to an informed public. This lack of research is partially a reflection of how communications as a field has tended to focus on political, social and economic issues in studying media influence rather than areas of science and technology. Yet topics of technology often provide a unique opportunity to examine the broader issue of media influence because, unlike many of the topics that fall under the social/political/economic category, such as voting behaviour, most members of the public only encounter certain topics of technology and science through the media. While the influences of biotechnology are ubiquitous in everyday life, their individual and social effects are rarely made known except through the mediated space provided by news organizations. Topics such as research using embryonic stem cells, pesticide-resistant crop varieties, the mapping of the human genome and other topics are made visible to the public through the media.

The rare opportunity provided by the federal government polling and media analysis data on this subject bears out the possibilities of further examining the relationship of media coverage and public opinion formation, and could have particular consequences for policy formation and how we understand the dynamics of public opinion formation over the life-cycle of an issue involving an emerging technology. Although it was partially a function of the design and purpose of the government-sponsored polls, the public opinion data did not, by itself, indicate reasons *why* changes were taking place in the level of awareness, support and familiarity with biotechnology applications. Moreover, the changes that were observed within the tracking variables, in isolation, may not be considered significant. When such changes are compared with similar changes in the volume, topic composition and tone of media coverage, however, the changes in public awareness and support of biotechnology in Canada come into clearer focus, and certainly bear more study.

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Mazur, Allan. (1981). *The dynamics of technical controversy*. Washington DC: Communications Press.

Appendix 1: Public Opinion Surveys

Poll	Researcher	Sample period	Respondents	Margin of error
Fall 1999	Pollara/Earnscliffe	17/09/99 – 02/10/99	1515 Cdn.	+/-2.4%
Spring 2000	Pollara/Earnscliffe	31/01/00 – 4/02/00	1000 Cdn.	+/-3.0%
Fall 2000	Pollara/Earnscliffe	15/09/00 – 01/10/00	1512 Cdn.	+/-2.6%
Spring 2001	Pollara/Earnscliffe	15/03/01 – 24/03/01	1200 Cdn.	+/-2.8%
Fall 2001	Pollara/Earnscliffe	26/09/01 – 04/10/01	1200 Cdn.	+/-3.1%
Spring 2002	Pollara/Earnscliffe	19/03/02 – 30/03/02	1200 Cdn.	+/-2.8%
Fall 2002	Pollara/Earnscliffe	03/10/02 – 14/10/02	1200 Cdn.	+/-2.8%
Spring 2003	Pollara/Earnscliffe	20/03/03 – 29/03/03	1000 U.S. 600 Cdn.	+/-3.1% +/-4.0%
Fall 2003	Pollara/Earnscliffe	04/12/03 – 16/12/03	1000 Cdn.	+/-3.1%
Spring 2004	Decima/Earnscliffe	18/03/04 – 30/03/04	781 U.S. 778 Cdn.	+/-3.5% +/-3.5%
Spring 2005	Decima/Earnscliffe	14/01/05 – 06/02/05	1200 U.S. 2000 Cdn.	+/-2.8% +/-2.2%

Appendix 2

Product-moment correlations examining media coverage of biotechnology by major tracking questions in public opinion surveys

Table 1: Public opinion and media coverage by major topic

PUBLIC OPINION	MEDIA GM food/crops	HealthFood & health
Heard about biotech story in last three months	.872***	.429	.569
Opposed or strongly opposed to biotech	.608	.717**	.741**
Supports or strongly supports biotech	-.692*	-.819**	-.846**
Reacts negatively when biotech mentioned	.208	-.124	-.055
Reacts positively when biotech mentioned	.125	-.245	-.176
Positive or neutral reaction when biotech mentioned	-.316	-.024	-.095

Note. Values represent product-moment correlations.
****p<.005*
***p<.05*
**p<.1*

Table 2: Public opinion and media coverage by tone

PUBLIC OPINION	MEDIA Negative	Positive/neutral	Positive
Heard about biotech story in last three months	.684*	-.549	.181
Opposed or strongly opposed to biotech	.571	-.554	.048
Supports or strongly supports biotech	-.507	.846***	.187
Reacts negatively when biotech mentioned	-.010	.012	-.560
Reacts positively when biotech mentioned	.201	.176	.294
Positive or neutral reaction when biotech mentioned	.014	.119	.802***

Note. Values represent product-moment correlations.
****p<.005*
***p<.05*
**p<.1*

Table 3: Public opinion and media coverage by type of media

	MEDIA		
PUBLIC OPINION	**Newspapers**	**TelevisionAll**	**media**
Heard about biotech story in last three months	-.038	.701*	.567
Opposed or strongly opposed to biotech	.198	.809**	.732**
Supports or strongly supports biotech	.037	-.895***	-.745**
Reacts negatively when biotech mentioned	-.099	-.131	-.130
Reacts positively when biotech mentioned	.194	-.177	-.078
Positive or neutral reaction when biotech mentioned	.267	.014	.060

Note. Values represent product-moment correlations.
****p<.005*
***p<.05*
**p<.1*

Appendix 3

Information regarding the data from the media content analysis study and the public opinion polls

The following report compares the results of public opinion research into biotechnology issues produced by Decima Research, Pollara Research and Earnscliffe Research and Communications with media content analysis of biotechnology issues in Canada conducted by Cormex Research. Both studies were commissioned by the Canadian Biotechnology Secretariat.

Media

The media component consists of coverage in 14 major Canadian newspapers, four news magazines, 60 radio stations, and 44 television stations beginning in September 2000. Coverage derived from online news sources (Infomart, LexisNexis, Newsscan, Factiva) using a Boolean search string to obtain news mentioning biotechnology topics. News coverage was weighted based on audience reach derived from NADBank, BBM Bureau of Measurement and Nielsens Media Research. Media sample included news published within a 90-day period prior to the last day of each opinion survey. Sample comprised of 9,962 news items.

Public opinion

The public opinion polling component consists of 13 public opinion surveys conducted annually or bi-annually in September 1999. The report focused on a target audience demographic of respondents that were 25 years of age or older and with at least a high school education, reflecting the typical news audience member. Public opinion polls consisted of a sample of 13,205 Canadian respondents.

Public opinion tracking questions regarding biotechnology on awareness, familiarity, reaction and support.

When you hear the word biotechnology, do you have a positive reaction, neutral reaction, or negative reaction?
1 Positive reaction
2 Neutral reaction
3 Negative reaction
4 Don't know/Refused

Over the last three months, have you heard about any stories or issues involving biotechnology?
1 Yes
2 No
3 Don't know/Refused

Would you say you are familiar with biotechnology?
1 Very familiar
2 Somewhat familiar
3 Not very familiar
4 Not at all familiar
5 Don't know/Refused

In general, would you say you strongly support, somewhat support, somewhat oppose or strongly oppose the use of products and processes that involve biotechnology?
1 Strongly support
2 Somewhat support
3 Somewhat oppose
4 Strongly oppose
5 Don't know/Refused

A Comparative Analysis of Public Opinion:
Canada, the USA and the European Union.

George Gaskell and Jonathan Jackson
Methodology Institute: London School of Economics

In this section of the report we look at data from the IBS 2005 surveys in the US and Canada, and comparable questions in the Eurobarometer survey on 'Social values, science and technology' conducted with representative samples from the 25 member states of the European Union. This Eurobarometer, funded by DG Research of the European Commission, was fielded in November and December 2004 with a sample size of 25,000. Because the findings of this survey are not yet in the public domain, results are for information only and should not be cited.

This report covers three sets of analyses:

- Transatlantic time series comparisons of optimism about the impact of biotechnology over the next twenty years;
- Transatlantic time series comparisons of optimism about the impact of nanotechnology over the next twenty years; and,
- Segmentation of the publics on the basis of opinions about the role of scientific evidence and moral and ethical considerations in decision-taking, and whether such decisions should be in the hands of experts or the public.

1. Biotechnology 1996-2005: Transatlantic Comparison

Respondents were asked: 'I am going to read a list of areas in which new technologies are currently developing. For each of these areas, do you think it will improve our way of life in the next twenty years, it will have no effect, or it will make things worse? How about…biotechnology [along with computers and information technology, nuclear energy, nanotechnology, mobile phones and new energy sources to power cars]?'

In Canada and the US the response alternatives were: will improve our way of life, will have no effect, will make things worse and (DK). In Europe the response alternatives were: very positive impact, fairly positive impact, fairly negative impact, very negative impact, [no impact] and [DK]. For the purposes of analysis we have combined very and fairly positive in the EB survey to correspond to 'improve out way of life' in the IBS 2005 survey, and fairly and very negative to correspond to 'will make things worse'.

Table 1 shows the raw percentages. People in the US are somewhat more optimistic than are people in Canada (+3%). However this difference is within the confidence limits of the survey design. In Europe, by comparison to North America, there are fewer people who think biotechnology will improve our way of life and more who think it will make things worse. But, as will be shown in the next analysis, these transatlantic differences are less pronounced than in previous years.

Table 1: Optimism and Pessimism for Biotechnology 2005

	Don't know	Will improve	No effect	Will make things worse
Canada 2005*	7%	69%	11%	13%
US 2005*	7%	72%	8%	13%
EU 2005**	13%	65%	2%	19%

* asked about "biotechnology"
** asked about "biotechnology and genetic engineering"

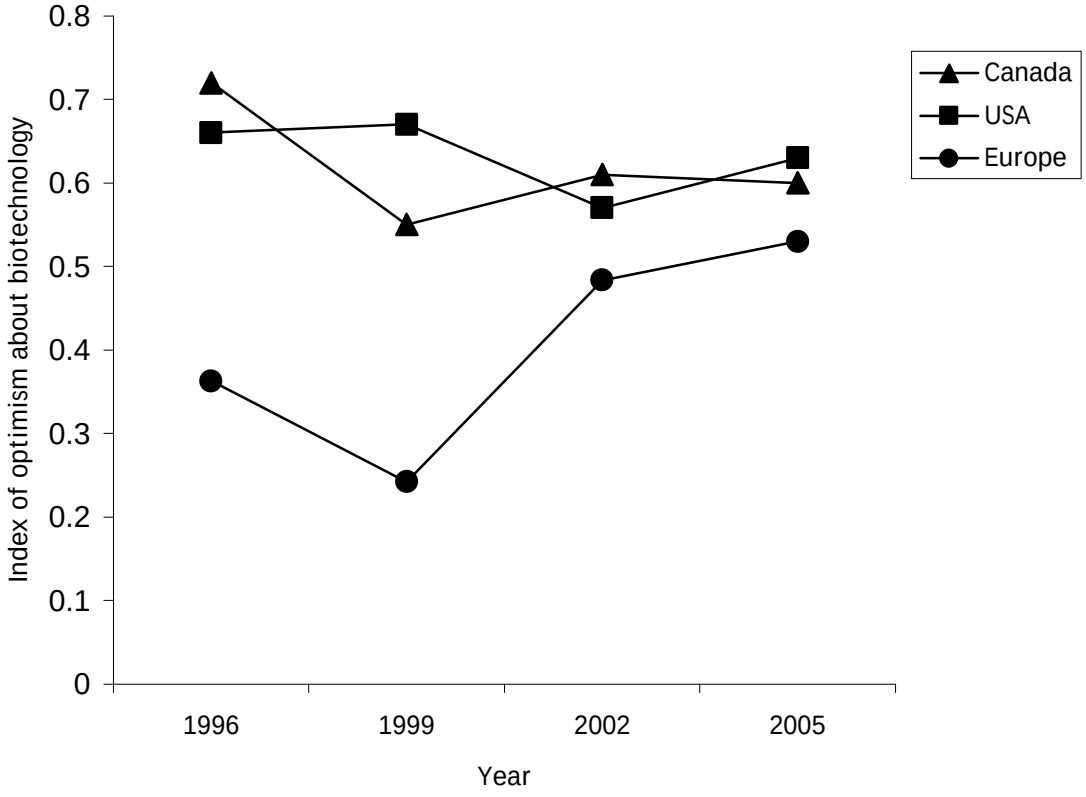
The question concerning optimism and pessimism about biotechnology has featured in the series of transatlantic surveys since 1996. To provide a basis for time series comparison we used an index: the percentage of pessimists is subtracted from the percentage of optimists and the result divided by the combined percentage of optimists, pessimists and those who say the technology will have no effect. In excluding the "Don't know" responses, this index is based on only those respondents who expressed an opinion. A positive score reflects a majority of optimists over pessimists, a negative score a majority of pessimists over optimists and a score around

zero more or less equal percentages of the two. As the percentage of 'no effect' respondents increases so the index shrinks towards zero.

The time series plot (Figure 1) shows very similar profiles for Canada and the US for the period 2002-2005. It also indicates a striking rise in optimism in Europe since 1999, such that by 2005 European opinion appears to be converging towards that of Canada and the US.

The increase in optimism may be attributable to the de facto moratorium on the commercial exploitation of genetically modified crops, which was introduced in 1998/1999, taking the steam out of what had been a heated debate over GM crops and food in Europe from 1996. Time will tell whether the new regulations for GM crops, and the introduction of labelling of GM foods in the shops, will lift Europe's deadlock over these applications of biotechnology, or whether there is a return to the controversies of 1996-1999.

Figure 1: Index of Biotechnology Optimism, Transatlantic Comparisons 1996-2005



2. Nanotechnology 2002-2005: Transatlantic Comparison

Nanotechnology was first introduced to the Eurobarometer and the US surveys in 2002, with the same question being fielded in the IBS 2005 survey in Canada and the US and the Eurobarometer 2005. In 2002 there was remarkable contrast between European and American views on nanotechnology (Table 2). There were no differences in the response categories 'no effect' and 'will make things worse'. However, 50% of people from the US said nanotechnology 'will improve' our way of life in comparison to 29% of people from Europe. This was mirrored by 'don't know' responses, where 35% of people from the US said 'DK' against 53% of people in Europe.

We have provided one explanation for these transatlantic differences (Gaskell et al. 2005), namely people in the US assimilated nanotechnology within a set of pro-technology cultural values. By contrast, in Europe there was more concern about the impact of technology on the environment, less commitment to economic progress and less confidence in regulation. These differences in values were reflected in media coverage, with more emphasis on the potential benefits of nanotechnology in the US than in the UK.

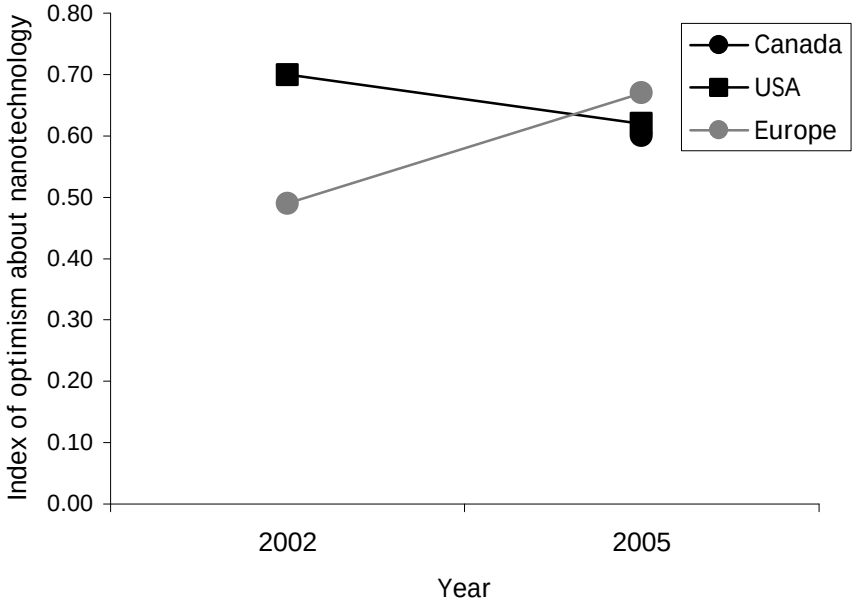
Table 2: Optimism and pessimism for nanotechnology, 2002-2005

	Don't know	***Will improve***	***No effect***	***Will make things worse***
US 2002	*35%*	*50%*	*12%*	*4%*
US 2005	*35%*	*46%*	*13%*	*6%*
Canada 2002	*n/a*	*n/a*	*n/a*	*n/a*
Canada 2005	*43%*	*39%*	*13%*	*5%*
EU 2002	*53%*	*29%*	*12%*	*6%*
EU 2005	*40%*	*48%*	*4%*	*8%*

Data for 2005 show, as with biotechnology, evidence of convergence between the publics of the US and Europe, seen clearly in Figure 2, which is based on the index of optimism. There was a slight decline in the index of optimism in the US and a rise in Europe such that, by 2005 Europe is more optimistic than Canada and the US.

Optimism for nanotechnology in Canada, assessed for the first time in 2005, is at almost the same position as the US.

Figure 2: Index of nanotechnology optimism, transatlantic comparisons 2002-2005

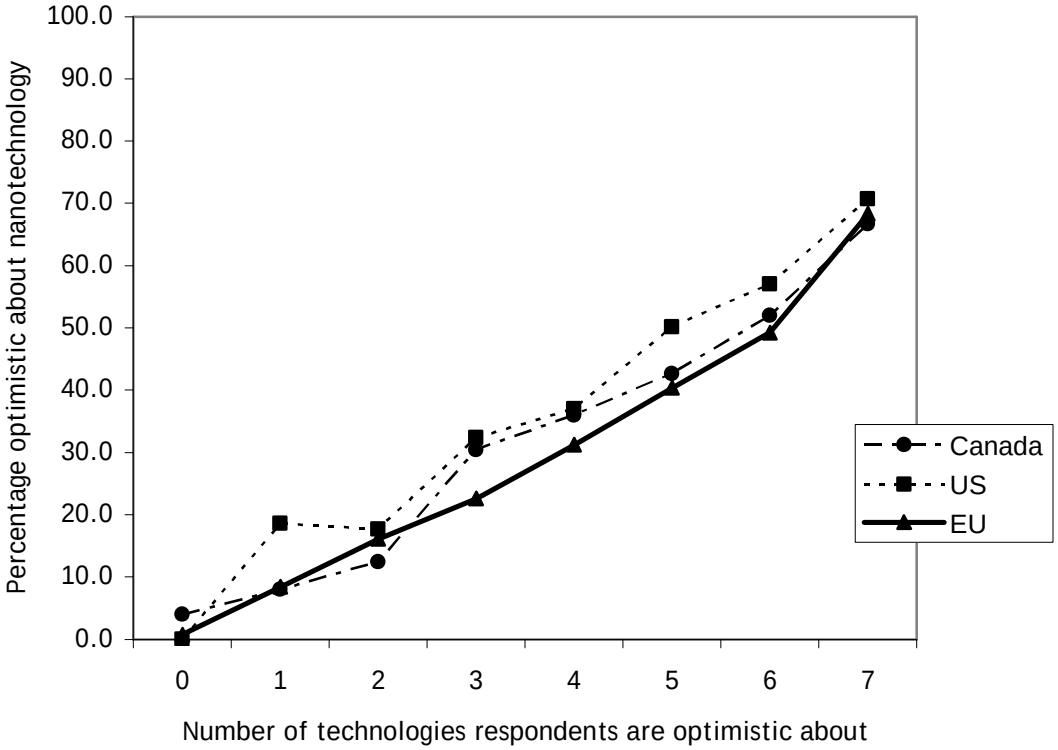


Looking at the optimism index for biotechnology and nanotechnology we see very similar figures for Canada (0.60 and 0.60 respectively) and the US (0.63 and 0.62 respectively). For Europe by contrast, the optimism index for biotechnology is 0.53 and for nanotechnology 0.67. It appears that concerns that nanotechnology would be seen by the public as posing similar risks to biotechnology have not materialised. However, as shown in Figure 3, people's level of optimism about nanotechnology is closely related to their more general sense of optimism about a range of other technologies.

We created an index of general technological optimism by counting the number of technologies, out of a list of 8 (all technologies from the IBS 2005 and a restricted list from the EB 2005), that people agreed would "improve our way of life in the next 20 years". For the purposes of the following analysis this index of technological optimism excluded nanotechnology.

Figure 3 plots the number of technologies about which people are optimistic, against the percentage of respondents who say they are optimistic about nanotechnology for each level. It would appear that nanotechnology, although still relatively unfamiliar, is viewed in the light of a general schema towards technologies: the more optimistic are people about a range of other technologies, the more they are likely to be optimistic about nanotechnology.

Figure 3: General Technological Optimism and Nanotechnology Optimism: Transatlantic Comparison 2005



3. Segmentation of the publics: Scientific versus moral and ethical criteria; Expert versus public decision taking

In recent debates about science and technology two themes have taken on increasing significance. Firstly, should decision-making be left to the experts or should there be 'public engagement'? Secondly, should decisions be based solely on sound scientific evidence or informed by moral and ethical considerations? To capture the publics' views on these matters, the two following questions were asked in the IBS survey:

(a) Decisions about [Biotechnology/ Nanotechnology] should be based mainly on the views and advice of experts OR Decisions about [Biotechnology/ Nanotechnology] should be based mainly on the views of average [Canadians/Americans]. Which of those two positions is closest to your own?

- Decisions should be based on expert advice;
- Decision should be based on views of average citizens; or
- [Don't Know/No Response]

(b) Decisions about [Biotechnology/ Nanotechnology] should be based mainly on the moral and ethical issues involved OR Decisions about [Biotechnology/ Nanotechnology]

should be based mainly on the scientific evidence of risk and benefit. Which of those two positions is closest to your own?

- Decisions should be based on moral and ethical issues;
- Decision should be based on scientific evidence of risk and benefit; or,
- [DK/NR]

To analyse these questions we collapsed the split ballot, thus ignoring whether the target was nanotechnology or biotechnology. This allowed us to make a direct comparison with the EB survey in which people were asked the same questions about technology in general.

With these two questions we can divide the public into four groups reflecting characteristically different principles of technological decision taking (Figure 4). Thus for example, those who believe that decisions should be based on expert advice and taken on the scientific assessment of risks and benefits are described as technocratic (top-left). In the bottom-right are the so-called moral populists, those who believe that decisions should be taken using moral and ethical criteria and based on the views of the average citizen.

Figure 4: Segmentation of Public Opinion on Principles of Technological Decision Taking

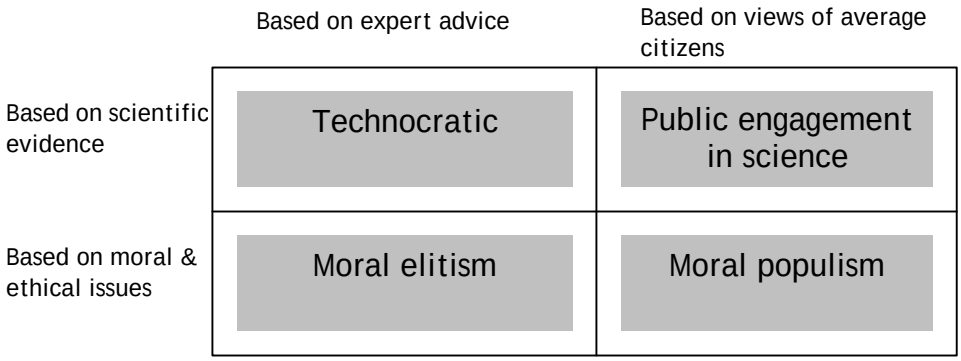


Table 3 shows the relative distribution of people in the three regions opting for one of the four principles of technological decision taking.

Table 3: The Distribution of Public Opinion on Principles of Technological Decision Taking

	US	Canada	Europe
Technocratic decisions	54%	49%	52%
Public engagement in science	11%	14%	10%
Moral elitism	22%	22%	22%
Moral populism	14%	15%	15%

Before commenting on Table 3 a caveat is in order. The response alternatives offered pressed respondents to make a choice between the pairs of options offered by the interviewer. In effect, respondents understood that they had to make a choice. In this sense the questions are akin to a referendum: there is no scope for saying "well, I would like a bit of both." In reality it would be perfectly reasonable to have a bit of both: scientific assessment informed by ethical and moral considerations; a reliance on experts who attend to public opinion. So the percentages in the table should not be taken to reflect the nuances of public opinion on these issues. Rather they show what the public think when the chips are down.

And here there are some striking findings. A majority of people in each region opt for the technocratic approach – scientific evidence and expert judgement. Public engagement in science (scientific evidence with the public making decisions), advocated by some commentators on science and technology, attracts only 10% in Europe, 11% in the US and 14% in Canada. Moral elitism (decisions based on moral and ethical criteria made by experts) attracts 22% support in each region. Attracting around 15% in each region is moral populism – decisions based on moral and ethical criteria, made by the public.

When the chips are down, around two-thirds opt for a scientific basis to decision taking; just fewer than three-quarters opt for decisions made by experts. This could be taken as a vote of confidence in science and various forms of expertise. However it is interesting that one-in-five opt for moral elitism. Is this a signal that the public want scientists to be more aware of the social and ethical considerations of technological innovation?

We now turn to an exploration of the ways in which the principles of technological decision taking are associated with other views about technology. For example, are the technocrats more or less optimistic about technology than the other groups?

Figure 4: Plotting Principles of Technological Decision-Taking and Technological Optimism

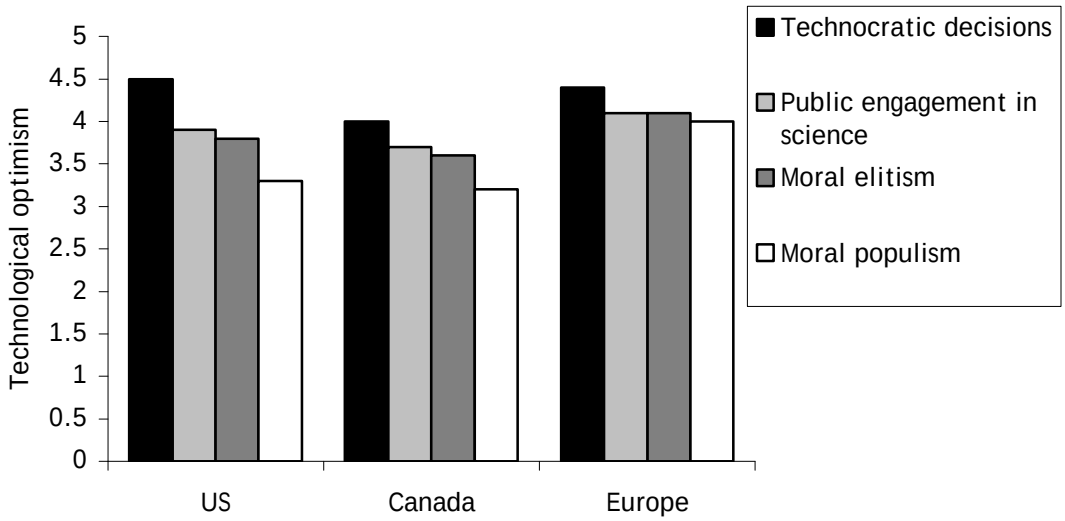


Figure 4 shows that in all three regions the technocrats are indeed more optimistic about the contribution of technologies to society than the other groups. The least optimistic are the moral populists. In Europe the difference in technological optimism between the technocrats and the moral populists is fairly small. By contrast, in the US and to a lesser extent Canada, the difference is much more apparent. While the association between a preference for technocratic decision-taking and optimism about technology seems reasonably easy to explain, it would be interesting to explore in more detail the socio-demographic characteristics of the moral populists and how these relate to wider views about technology.

We now take this form of analysis further and look at two specific technologies: stem cell research and GM foods. The precise wordings of the questions on these technologies differ between the IBS and the Eurobarometer surveys, as do the response alternatives. However, this is not problematic as we are interested in the ways in which those opting for different principles of technological innovation view the acceptability of the two technologies.

In the IBS survey respondents were asked: "which of the following best captures your views about stem cell cloning (GM foods)?"

- *I approve the use of stem cell research, as long as the usual levels of government regulation and control are in place*
- I approve of stem cell research if it is more tightly controlled and regulated
- *I do not approve of stem cell research <u>except</u> under very special circumstances*
- *I do not approve of stem cell research under <u>any</u> circumstances*

In the Eurobarometer respondents were asked: "Now we are turning to the issue of what science and technology may be developing in the future. I am going to read out a

list of possible future applications of science and technology for the next 20 years. For each new technology, please tell me if you approve the use of this technology?" The two target technologies were described as follows

- "Cloning human stem cells from embryos to make cells and organs that can be transplanted into people with diseases"; and,
- "Developing genetically modified crops for farming to increase the variety of regionally grown foods".

The response alternatives were: (I approve)

- In all circumstances;
- Only if it is highly regulated and controlled;
- Only in exceptional circumstances; and,
- Never.

In order to make some sense of the data we start with some speculations about the motivation behind the technocratic, public engagement, moral elitist and moral populist positions. It seems not unreasonable to assume that the technocrats are content with the current regulatory frameworks based on scientific evidence and expert advice. Hence we would expect this position to be associated with relatively high approval ratings of the two target technologies. However, as we have shown, significant minorities are concerned about scientific evidence and scientists' advice as the basis for regulation. Some would prefer to hear the public voice rather than expert opinion (public engagement). Others would prefer to hear that moral and ethical issues guide regulation rather than scientific evidence (moral elitism). And finally there are those for whom the public voice and moral and ethical issues are to be privileged (moral populism). These latter three groups, we may assume, are not content with the status quo, and as such we expect them to offer lower levels of approval for stem cell research and GM foods than the technocrats. It is an empirical question as to which of the three groups will offer least support. But in the context of the association between technological optimism and the *principles of decision-taking* groups (Figure 4), we might expect the moral populists to be most likely to reject the applications.

Let us turn to the data. Comparing Canada, the US and Europe, we find both similarities and some interesting differences. Across the three regions, for the technocrats and the moral populists we find a relatively consistent pattern of responses for both stem cell research (Table 4) and GM foods (Table 5). The technocrats are more likely to approve with least constraints. Equally, the moral populists are more likely to reject the two applications. However, these contrasts are more marked for Canada and the US than they are for Europe, particularly for approval 'in all circumstances.'

Table 4: Approval of Stem Cell Research and Principles of Technological Decision Taking

		Technocratic decisions	Public engagement in science	Moral elitism	Moral populism	Total
U.S.	I approve the use of stem cell research, as long as the usual levels of government regulation and control are in place	**56%**	18%	50%	**15%**	36%
	I approve of stem cell research if it is more tightly controlled and regulated	34%	35%	35%	23%	33%
	I do not approve of stem cell research except under very special circumstances	8%	35%	10%	42%	22%
	I do not approve of stem cell research under any circumstances	**2%**	13%	5%	**21%**	9%
Canada	I approve the use of stem cell research, as long as the usual levels of government regulation and control are in place	**53%**	24%	36%	**12%**	36%
	I approve of stem cell research if it is more tightly controlled and regulated	38%	51%	55%	49%	46%
	I do not approve of stem cell research except under very special circumstances	7%	21%	5%	24%	13%
	I do not approve of stem cell research under any circumstances	**3%**	5%	5%	**15%**	5%
Europe	In all circumstances	**14%**	12%	9%	**10%**	13%
	Only if it is highly regulated and controlled	48%	44%	42%	33%	45%
	Only in exceptional circumstances	20%	23%	24%	22%	21%
	Never	**17%**	21%	25%	**35%**	22%

Table 5: Approval of GM Food and Principles of Technological Decision Taking

		Technocratic decisions	Public engagement in science	Moral elitism	Moral populism	Total
US	I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place	**36%**	21%	24%	**16%**	27%
	I approve of genetically modified food if it is more tightly controlled and regulated	40%	33%	33%	24%	35%
	I do not approve of genetically modified food except under very special circumstances	18%	29%	21%	29%	23%
	I do not approve of genetically modified food under any circumstances	**7%**	18%	22%	**32%**	15%
Canada	I approve the use of genetically modified food, as long as the usual levels of government regulation and control are in place	**23%**	13%	18%	**17%**	18%
	I approve of genetically modified food if it is more tightly controlled and regulated	39%	31%	33%	28%	34%
	I do not approve of genetically modified food except under very special circumstances	27%	28%	32%	23%	27%
	I do not approve of genetically modified food under any circumstances	**11%**	28%	17%	**32%**	21%
Europe	In all circumstances	**10%**	9%	8%	**7%**	9%
	Only if it is highly regulated and controlled	38%	32%	28%	30%	34%
	Only in exceptional circumstances	19%	21%	21%	18%	19%
	Never	**34%**	38%	43%	**45%**	38%

Looking more closely at Canada and the US, for stem cell research the loss of belief in science (moral elitists) reduces the extent of support far less than the loss of belief in experts (public engagement). By implication, in Canada and the US the perceived absence of public participation is a greater concern than is the absence of moral and ethical considerations in the regulation of stem cell research. For GM foods loss of belief in either scientific evidence or in experts appears to have more or less an equivalent impact in terms of declining support for this application.

Perhaps the best way to look at the European data is to combine the response alternatives 'in all circumstances' and 'only if it is highly regulated and controlled.' Moral elitism leads to a greater decline in approval than does public engagement for both stem cell research and GM foods. By implication, in Europe the perceived absence of moral and ethical considerations in legislation is a greater concern than is the absence of public participation.

Conclusions

To sum up, the majority of people retain confidence in scientific evidence and expert advice. Associated with this position are greater approval ratings for the development of controversial technologies. By contrast those who have lost faith in both science and expert advice as the basis for regulation are most likely to reject the development of controversial technologies. Tentatively, we conclude that the IBS and Eurobarometer data point to differing concerns among albeit small sections of the public about the technocratic approach to decision taking. In Europe the absence of moral and ethical dimensions to regulation – more so than the absence of public engagement – leads to greater rejection of technological innovation. By contrast in Canada and the US, we find a mixed pattern. For stem cells, moral and ethical concerns are less important than the need for public engagement in support for new technologies. For GM foods, the need for public engagement and for moral and ethical dimensions to regulation has rather similar impacts on levels of approval.

In conclusion, that a considerable minority of people in Canada, the US and Europe entertain some doubts about the legitimacy of the sound science approach to regulation underlines the need to develop and strengthen the science in society agendas with their emphasis on ethics and public engagement.

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International Audiences For News of Emerging Technologies:
Canadian and U.S. Responses to Bio- and Nanotechnologies.

Susanna Hornig Priest
College of Mass Communication and Information Studies
University of South Carolina

Abstract

Major nations in the contemporary world are almost all multicultural. New approaches are needed to think about audiences, subcultures, and publics in such a context. Cultural differences persist but may not correspond to national boundaries. For example, persistent differences between the U.S. and Canada in opinions about biotechnology can be traced through comparative survey data collected by the Canadian government in 2003, 2004 and 2005. Previous research has attributed these differences to differential distributions within each country of subgroups characterized by different perspectives on the inherent value of science, on whether decisions in this area should be driven by ethics or by utilitarian concerns, and on who should make those decisions. Public controversies over biotechnology reflect these differences. The most recent available wave in a series of comparative Canada-U.S. surveys, with data from January 2005, allows the extension of this analysis to nanotechnology, as well as to various biotechnology applications, and makes possible for the first time the exploration of potential differences in source credibility, media consumption and social distance (from developers) characteristic of these groups.

Canadian and U.S. Responses to Bio- and Nanotechnologies

The multicultural character of contemporary nations, even advanced industrial nations, poses challenges for policy development and democratic decision-making. It also poses challenges for how we think about both opinion publics and media audiences. Sharing a long border, a dominant national language (English), and considerable cultural history, the U.S. and Canada are often seen as forming a single homogenous culture. Both countries are economic world leaders that have created affluent industrial economies based on technological innovation and free-market policies.[12] However, persistent (if relatively small) differences between the U.S. and Canada in opinions about at least one set of technological developments, those involving biotechnology in a variety of applications, can be traced through comparative survey data collected by the Canadian government in 2003, 2004 and 2005 (Table 1).

Table 1: Differences in Canadian and U.S. Support for Biotechnology, 2003-2005

	2003	2004	2005
Overall Support, Canada	63.3%	62.9%	66.1%
Overall Support, U.S.	69.5%	67.6%	70.9%

Table shows the proportion of respondents who somewhat or strongly support the use of "products and processes that involve biotechnology."

This study extends the analysis of such differences to nanotechnology, the world's most recent "big science" investment, as well as to additional biotechnology applications, and it also investigates the relationship between source credibility, media consumption, social distance (perceived commonality of interests and values with technology's developers), nationality, and membership in one of several distinct attitudinal subgroups or "publics" for news of emerging technologies.

Differences in attitudes toward science and technology are not attributable to individual differences in knowledge alone (Sturgis and Allum 2004) but likely reflect other underlying differences in values and beliefs, including dimensions that may be shared among members within a culture or subculture. This underscores the observation that biotechnology, which has become contentious in forms as diverse as genetically modified food and stem cell research, also has cultural and political dimensions, as do other emerging technologies including nanotechnology. The movement to abandon the "science literacy" model, based on the assumption education will erase resistance to technological development, and more fully engage "the public" with science and technology decision-making (Gregory and Miller 1998) must take into account these differences. Diverse "publics" in both Canada and the U.S. bring distinct values, expectations and assumptions, both to their engagement with science and technology and to their interpretation of media messages.

[12] However, at $29,800 Canada's per capita gross domestic product does not reach that of the U.S. at $37,800 (see CIA 2005).

In the past, the news media have often been blamed for exacerbating negative public responses to new technological innovations (for example, in Mazur 1981); however, other critics are equally likely to blame them for ignoring risks rather than for exaggerating them needlessly (for example, see Negin 1996). Social amplification theory (Pidgeon et al. 2003) has attempted to provide a framework for understanding how societies respond to risk information, but does not directly address the dynamics of the audience-media interface, which are not always well understood, and are not generally adequate to predict whether the amplification or attenuation of risks is more likely to take place in a given case (setting aside for the moment the substantial challenge of deciding which risk is being exaggerated and which understated). For the most part, although we do know a lot about individual-level risk perceptions based on work pioneered by Slovic (1986, 2000) and others, we know less about the social and cultural dynamics and are therefore left to infer attenuation when we feel a risk is understated, and amplification when the opposite occurs.

While it now seems common sense to propose that different cultures might respond to risk information differently (as suggested by many scholars, notably Douglas and Wildavsky 1982), studies that provide empirical evidence to address how cultural (or subcultural) differences might affect such responses, especially the interpretation of media messages, remain relatively rare. While it is generally understood among media scholars that people react differently to messages, and that in fact they are active information-seekers and information-processors under many circumstances, better understanding of differential cultural and subcultural (specific "publics'") responses to information about emerging technologies and their benefits and risks is still needed and should help illuminate the dynamics of media-audience interactions more generally. A comparison of Canadian and U.S. responses to emerging bio- and nanotechnologies, made possible by the availability of recent comparative survey data, should help fill this void.

Previous research has attributed U.S.-Canadian opinion differences for biotechnology to differential distributions within each country of subgroups characterized by different perspectives on the inherent value of science, on whether decisions in this area should be driven by ethics or by utilitarian concerns, and on who should make those decisions (Priest 2005). In other words, rather than conceptualizing either Canadian or U.S. culture as a monolithic whole and individual U.S. citizens as being slightly more likely to embrace particular new technologies than their Canadian equivalents, it has proven more productive to think in terms of subgroups making up the populations of both of these pluralistic societies but distributed differently in each country, creating different opinion climates. Some of the opinion differences between Canada and the U.S. on biotech are attributed in this model to a larger U.S. public committed to both expert risk/benefit decision-making and to the inherently beneficial character of bioscience and biotechnology, rather than to the presence, size or activities of opposition groups. But this work has also found that the most numerous group in each country consists of those committed to expert risk/benefit decision-making but not assuming a particular outcome in a given case, i.e., they do not assume the outcome will always be in favor of the technology.

The most recently available wave of Canadian Government survey data comparing the U.S. and Canada with respect to emerging biotechnologies, that from 2005,[13] allows the extension of this kind of analysis to nanotechnology, as well as to a new range of biotechnology applications, and additionally makes possible the exploration of potential differences in source credibility and media consumption characteristic of these various groups, as well as their perception of social distance or value congruence with the developers of these technologies. In this analysis,[14] the usefulness of understanding the "general" public for science and technology as composed of a variety of distinct publics (alternatively conceptualized as different audiences or subcultures) with different mindsets, who are likely to apply different values and schema to their readings of news about emerging technologies, is affirmed.

The Publics for Risky Technologies

In short, it is useful to think in terms of publics rather than "a public" for news about risky technologies. This understanding draws indirectly from Miller's (1986) identification of the limited "attentive public" and "interested public" for science but explicitly rejects the implication that these are the only audiences of special interest when considering the relationship among media content, public opinion, and ultimately public policy for science and technology. In fact there are clearly multiple publics vis-à-vis science and technology policy, with distinct attitudinal patterns. The approach allows for recognition of the cultural commonality of the two neighboring advanced industrial societies under study but, in addition, reflects and to some extent accounts for their differences.

Drawing from the previous typology reported in Priest (2005), survey respondents were divided into five categories: those who believe experts should make decisions about technology policy based on risks and benefits ("utilitarians"), those with the same belief but who additionally tend to classify a range of technologies as likely to have a positive rather than a negative effect on quality of life in future ("true believers"), those who believe experts should make decisions about technology policy based on moral or ethical dimensions ("moral authoritarians"), those who believe ordinary people should be able to decide on the basis of risks and benefits ("democratic pragmatists"), and those who believe ordinary people should be able to decide on the basis of morality or ethics ("ethical populists").

[13] Based on an international random telephone survey of 2000 respondents in Canada and 1000 in the United States during January 2005. Some questions were based on split samples, so that not all respondents have been asked all questions about either nanotechnology or biotechnology.

[14] The present study is one a series of analyses based on the survey data, commissioned by the Canadian Biotechnology Secretariat, and coordinated through the University of Calgary (Alberta).

Table 2: Comparison of Membership in "Publics", 2004-2005

	Priest 2005		Current	
	Canada	U.S.	Canada	U.S
"True believer"	10.7%	24.1%	23.3%	34.7%
Utilitarian	29.6%	28.1%	25.5%	19.2%
Moral authoritarian	26.1%	23.3%	22.1%	21.6%
Ethical populist	20.9%	13.1%	14.8%	13.8%
Democratic pragmatist	12.6%	11.5%	14.3%	10.7%

Table 3: Relative Contributions of Nationality and "Public" to Attitudes on Nanotechnology and Biotechnology

	F value, Country	Signif.	F value, "Public"	Signif.
Biotech is the next frontier, will improve quality of life	2.122	.145	55.936	.000
Nanotech is the next frontier, will improve quality of life	5.518	.019	48.339	.000
General biotech support, products and processes	9.554	.002	107.672	.000
Nanotechnology will be beneficial	0.860	.354	66.093	.000

Table 2 shows the distribution of these five groups in each of the two countries, based on data for decision-making preferences (assessed for either nanotechnology *or* biotechnology[15]) and an overall index of optimism or pessimism with respect to a broad range of technologies. Table 3 shows, using analysis of variance, that overall differences of support for both biotechnology and nanotechnology are more clearly a function of subcultural or "public" group membership than of nationality. In fact, the pattern is even clearer for nanotechnology, arguably reflecting the relative importance of attitudinal predispositions in a newer area of technology for which a lower percentage of the public has had the opportunity to become informed about the technology. In such cases, it is logical to speculate that background assumptions and predispositions may have an even greater influence on popular assessments.

[15] The sample was split for a number of the questions. Therefore, the Ns for specific questions can vary from the 3200 total. Decision-making preferences were asked of each respondent; however, about half the respondents answered this question only with respect to nanotechnology specifically and half only with respect to biotechnology specifically.

Table 4: Distribution of "Publics" from Table 2 Within Canadian and U.S. Regions

	"True Believers"	Utilitarians	Moral Authoritatians	Ethical Populists	Democratic Pragmatists
Canada					
British Colombia	19.0%	30.4%	20.6%	18.6%	11.3%
Alberta	27.6%	20.5%	21.6%	15.6%	15.1%
Sask/Man	32.1%	20.6%	16.0%	19.1%	12.2%
Ontario	27.3%	24.8%	22.0%	12.4%	13.6%
Quebec	16.0%	28.4%	23.2%	15.4%	17.1%
Atlantic	21.5%	22.8%	27.5%	13.4%	14.8%
Total	23.3%	25.5%	22.1%	14.8%	14.3%
United States					
E N Central	32.6%	19.3%	24.9%	11.0%	12.2%
E S Central	20.5%	19.2%	27.4%	23.3%	9.6%
Mid Atlantic	39.5%	17.0%	17.0%	14.3%	12.2%
Mountain	35.3%	19.9%	24.3%	14.7%	5.9%
New England	50.0%	17.7%	11.3%	9.7%	11.3%
Pacific	34.8%	19.6%	21.4%	14.3%	9.8%
S Atlantic	31.8%	21.6%	19.5%	14.4%	12.7%
W N Central	40.3%	18.1%	22.2%	15.3%	4.2%
W S Central	34.4%	16.7%	26.0%	9.4%	13.5%
Total	34.7%	19.2%	21.6%	13.8%	10.7%

Table 4 shows regional distributions of the five "publics" groupings in each country. While the results for the U.S. are not statistically significant (based on a chi-square test for distributional differences), the highest proportions of "true believers" are in New England and the West North Central region, and the highest proportions of "moral authoritarians" are in the East and West South Central regions, with a higher than average proportion of "ethical populists" in the East South Central region as well. In Canada, the chi-square results are significant at $p<.001$, with the highest proportions of "true believers" in Alberta, the Saskatchewan/Manitoba region and Ontario; the highest proportions of "utilitarians" are in the British Columbia and Quebec, and the highest proportions of "moral authoritarians" are in the Atlantic region.

Media Consumption, Source Credibility and Social Distance

Surprisingly, no meaningful differences were found in media consumption among these various groups. For the two countries combined, all five groups most commonly

reported watching national television news seven times in the last week, all five most commonly reported watching local television news seven times in the last week, and all five most commonly reported reading a local newspaper seven times in the last week. The modal response was zero times for every group for listening to talk radio, reading a national paper, reading a news magazine, and reading news on the Internet. While these observations are neither measurements nor a formal test of a hypothesis, and the news consumption patterns are not identical for all groups, these results do tend to undermine the idea that differences in responses to new technologies could be associated with major differences in media consumption patterns. However, there are also differences worth noting; in particular, "true believers" on average do read newspapers and use the Internet for news somewhat more often than any other group (an average of 1.7, 3.7, and 2.3 days per week versus 1.4, 3.4, and 1.8 average days per week for all respondents combined).

The differences in terms of patterns of credibility, however, are much more striking. Using principal components factor analysis as a way of simplifying patterns of response to 14 questions[16] about how much respondents would trust information from a variety of sources to be credible: government scientists, scientists that work for biotechnology companies, senior executives of biotechnology companies, university scientists funded with government grants, university scientists funded by biotechnology companies, scientific journals, private television networks, public television networks, print media, political leaders, and religious leaders. Three factors emerged: *scientific credibility*, with the highest positive loading for scientists working for biotechnology companies, a positive loading for biotechnology executives, and little other difference apparent related to a the scientist's employer; *environmentalist credibility*, with high positive loadings for environmental groups and Greenpeace and the highest negative loadings for scientists who work for biotechnology companies, university scientists funded by biotechnology companies, and government scientists; and *religious/political credibility*, with religious leaders loading most positively, followed by political leaders[17] (Table 5).

[16] Data from an additional two credibility questions asked only in Canada were eliminated.

[17] The correlation between religious leader and political leader credibility in Canada is .321 and in the U.S. it is .279; both figures are statistically significant at the 0.01 level. For the ethical populist cluster, the figure is .239 (still significant at $P \leq 0.01$), the lowest of any cluster group. In other words, for all groups, political and religious leader credibility are related, although for ethical populists, the relationship is less strong. Religious leader credibility is higher than political leader credibility for this group and for moral authoritarians.

Table 5: Factor Analysis for Credibility Responses

	Scientific	Environmental	Religious
World Health Organization	.573	.129	-.370
Greenpeace	.432	.577	-.165
Environmental Groups	.482	.569	-.108
Governmental Scientists	.644	-.359	-.071
Biotech Company Scientists	.639	-.389	.091
Biotech Company Execs	.609	-.280	.310
Grant-funded University Scientists	.638	-.256	-.313
Biotech-funded University Scientsts	.670	-.364	-.008
Scientific Journals	.593	-.128	-.383
Private Television Networks	.629	.284	.170
Public Television Networks	.617	.292	-.101
Print Media	.607	.264	.200
Political Leaders	.531	-.032	.471
Religious Leaders	.215	.161	.695

Table 6: Factor Scores by Membership in "Publics"

	Scientific	Environmental	Religious
"True believer"	+.378	-.318	-.171
Utilitarian	+.074	+.009	-.171
Moral authoritarian	-.123	+.076	+.162
Ethical populist	-.517	+.316	+.322
Democratic pragmatist	-.022	+.167	-.006

When factor scores are calculated for individual respondents and then aggregated by membership in one of the "publics," a striking pattern emerges (Table 6). "True believers" have positive scores on scientific credibility, negative scores on environmental credibility, and somewhat negative scores on religious/political credibility. "Utilitarians" do not lean strongly either way on scientific and environmental credibility, although they also have somewhat negative scores on religious/political credibility. "Moral authoritarians" have somewhat negative scores on scientific credibility and somewhat positive scores on religious credibility. "Ethical populists" have positive scores on *both* environmental and religious/political credibility, with an extremely negative score on scientific credibility. Finally, "democratic pragmatists" have somewhat positive scores on environment.

Finally, the issue of "social distance" from these technologies' developers was addressed through the use of the following question:

> I believe that [biotechnology or nanotechnology] research has been carried out in consideration of my interests, values and beliefs OR I believe that these types of technologies have not been developed in consideration of my interests, values, and beliefs?

Biotechnology was used as the example for about half the respondents, and nanotechnology for the remainder. The results indicate that 70.0% of "true believers" answer that the technology in question was developed in consideration of their interests, values, and beliefs, regardless of whether the question addresses biotechnology or nanotechnology. For "ethical populists," however, 66.1% for nanotechnology and 62.4% for biotechnology *do not* feel this way. Overall results are 41.7% who *do not* feel this way and just 50.0% who do for nanotechnology, and 41.0% who *do not* feel this way for biotechnology and 53.5% who do (Table 7).

Table 7: Has Nanotechnology Been Developed With Your Interests at Heart?

	Nanotechnology		Biotechnology	
	Yes	No	Yes	No
"True believer"	70.0%	21.4%	70.0%	25.5%
Utilitarian	50.4%	41.3%	57.8%	33.9%
Moral authoritarian	39.0%	50.5%	44.9%	49.6%
Ethical populist	24.9%	66.1%	33.1%	62.4%
Democratic pragmatist	45.5%	49.5%	54.7%	40.5%
Overall	50.0%	41.7%	53.5%	41.0%

Discussion

The fact that these groups are differentially distributed in Canada and the U.S. appears to be at least a partial explanation of differences between the two countries in popular responses to nanotechnology, as well as biotechnology, suggesting also that the groupings are not unique to one technological context. While the media consumption habits of all five groups described are in some respects nearly identical, arguing against a strict "media effects" interpretation, patterns of source credibility and perceptions of social distance from technology's developers suggest radically different interpretations of news and information are more than likely. A slim majority of respondents feels that technologies such as biotechnology and nanotechnology are being developed with them in mind. Those who do feel this way are concentrated, not surprisingly, in a group that anticipates significant benefits from these technologies and that believes information coming from the scientific community. However, others

(especially "ethical populists" but also "moral authoritarians," to a lesser degree) appear alienated from technology's developers and more likely to accept information from religious, political, or environmental sources.

Drawing from Hall (1980), it is possible to argue that what he calls "oppositional" readings of news can represent and reflect resistance to a dominant ideology. For news of science and technology, this appears to be associated with subcultural ("public") membership more closely than with national identity. Certainly, members of the different "publics" described here will read and respond to this news in different ways. As advanced industrial societies, Canada and the U.S. have economies in which some citizens feel well-served by modern technological systems, while others do not. This is unlikely to be a function of how well the news system, or the school system, or informal science education institutions such as museums and science centers explain science. Efforts to "engage the public," to be successful, will need to be more conscious of these different audiences and their tendency to see science and technology in different lights.

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A report on Canadian and American news media coverage of nanotechnology issues.

Andrew Laing
President, Cormex Research

Introduction

Nanotechnology is not only a new technology, it is a new concept to many people. Since few work directly with nanotechnologies, most individuals are introduced to the technology through a variety of channels operating outside of the scientific community. These channels include popular culture vehicles such as *Star Trek* and Michael Crichton's novel *Prey;* business activities such as initial public offerings promoted by such as companies as NanoSys; government-led initiatives such as the U.S. National Nanotechnology Initiative and legislation such as the 2003 American 21st Century Nanotechnology Research and Development Act, as well as web sites, blogs, internet chat rooms and, of course, the mainstream news media. In combination, these mediated sources of information will likely shape how a very new science such as nanotechnology is ultimately understood by the public and how it is accepted (or rejected) by different groups within society.

The experience of the media and the general public regarding the early debate around biotechnologies such as stem cell research and genetically-modified foods provides a useful starting point to determine how media and public opinion may develop over time on the issue of an advanced technology. The concept of nanotechnology

currently is arguably similar what biotechnology was over a decade ago in that it is a technology that: a) has been frequently characterized as having far-reaching implications for health, science, industry and general economic development; b) is a subject that many among the general public are unfamiliar with;[18] and c) despite its many applications, the general public will rarely be aware of its presence in products and services. This context raises the importance of the media over other channels in influencing public perceptions and levels of awareness and acceptance of a new technology. In fact, important stakeholders have already recognized the role of early communications. The U.S. National Nanotechnology Initiative recently stated in a report that as "more and more new nanotechnologies are publicized and actually appear in the marketplace, the variable degree of social acceptance will become ever more important. Indicators to measure social acceptance of nanotechnology will be needed in the following areas: economic, political, religious and cultural" (Roco et al., 2001).

The purpose of the following paper is to examine one segment of the media – the news media – over a brief period in both the United States and Canada in order to provide researchers with an understanding of how the news media have covered this issue. The report will compare Canadian versus American media coverage in three areas: level of overall attention devoted to nanotechnology, the choice of news frames and placement of nanotechnology within the newspaper, and to what degree the benefits and risks of nanotechnology are presented to audiences. The approach should provide a basis to examine whether at this very early stage of introducing nanotechnology to Canadian and American audiences, the news organizations of each country are providing useful content from which to foster public understanding and debate over the technology.

Methodology

The sample consisted of fifteen Canadian and twelve U.S. print publications published during calendar 2004. A boolean search string was designed to extract all mentions of "nano" and its derivatives (nanotechnology, nanoparticle, nanotubes, etc.) and was applied to online search engines (Lexis-Nexis, FPInfomart, Cedrom-SNI and Factiva). The search yielded 942 news items, of which 381 (40%) were coded as applicable to the survey. Applicable items were those that contained at least one statement about nanotechnology; items with less than a statement were deemed to provide too little information about the technology to readers. The news item was the unit of analysis. News items were deemed inapplicable if: a) they used the term "nanosecond" as a colloquialism (3%); b) they used the term in obituaries, calendar of events or appointment notices (2%); c) the terms were cited in a table of contents or list (5%); d) they only cited a nano measurement, such as nanometers or nanograms (14%); e) or they contained only a one- word reference to nanotechnology (35%). By itself, it is

[18] A public opinion poll among 3200 Canadian and American respondents found that only 6% indicated they were "very familiar" with nanotechnology, and a further 32% stated they were "somewhat familiar". In comparison, 60% said they were somewhat or very familiar with biotechnology, and 75% stated they were somewhat or very familiar with stem cell research. Source: Canadian Biotechnology Secretariat. January 2005 Canada/U.S. Poll. 235 Queen Street, Ottawa, Ontario.

worth noting that over half of all mainstream media references to nanotechnology present the reader with no information about the term.

Each item was coded for a series of standard bibliographical variables (date of publication, type of news item, page number and placement, and reporter), as well as whether the item identified a clear individual and/or social benefit associated with nanotechnology, or a clear risk or concern. Seven broad benefits and seven risks or concerns were identified.[19] Two coders were used for the analysis, and reached an average intercoder reliability agreement using Krippendorff's *alpha* of 0.75.

As well as reporting the volume of news items, the results were also weighted based on the number of audience members that each news item might have reached. Audience reach for Canadian publications was determined using the NADBank 2003 total audience reach figures, while Audit Bureau of Circulation figures for 2003 were used for American publications. Moreover, in order to provide greater weight to more prominent and extensive news items on nanotechnology, each item's audience weighting was scaled using a nine-point rating determined by the extent and page placement of the mention of nanotechnology. Unless otherwise stated, figures used in the paper citing "audience exposure" are based on these weighted audience reach figures, given in number of impressions (number of potential readers of each news item on nanotechnology).

Results

Level of media attention to nanotechnology

Certainly the most notable characteristic that can be stated about media coverage of nanotechnology is the lack of it, with the survey indicating less interest in the subject than other comparable areas of scientific research, such as biotechnology. On average, Canadian and American news outlets surveyed averaged slightly more than one news item of substance on nanotechnology a month. To put that in context, a survey of thirteen Canadian newspapers in 2004 saw an average of three items per month on stem cell research (over eight items per month in the United States in twelve newspapers surveyed); and over two items on genetically-modified foods and crops in both Canada and the United States.

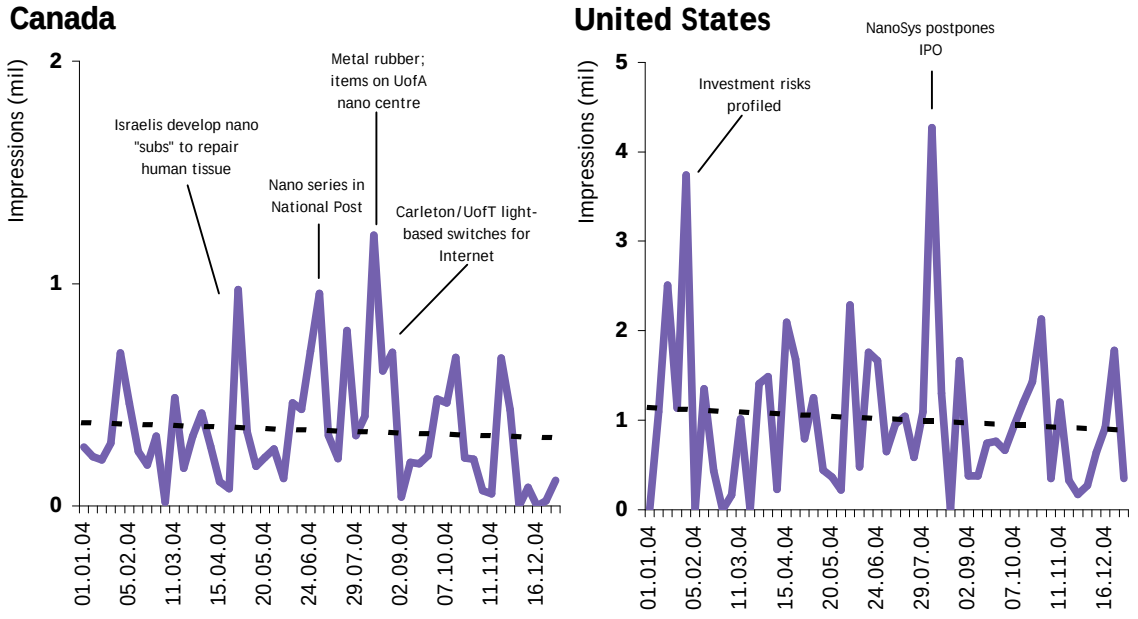
In a comparison of Canadian versus U.S. media coverage of nanotechnology, several indicators suggested that the Canadian mainstream print media provided more coverage of nanotechnology than their American counterparts. Canadian newspapers surveyed averaged 15.5 items during 2004, with a median score of 16, compared to an average of 13.3 news articles for U.S. newspapers with a median score of 12. Eight of the thirteen Canadian dailies surveyed published at least sixteen items on nanotechnology, compared to four of the twelve surveyed in the United States.

[19] Benefits associated with nanotechnology included: Health, Environmental, Defense use, IT/Communications, Economic/business, Materials/products, and Science/research. Risks or concerns associated with nanotechnology included: Health, Environmental, Security/terrorism, Moral/ethical, Investment, Legal/regulatory, Societal/cultural.

Canadian news outlets also tended to cite nanotechnology more prominently than U.S. media outlets: 51% of news items mentioning nanotechnologies in Canadian newspapers cited it prominently (nanotechnology was the main subject of the article), compared to 42% of items surveyed in the United States. Nanotechnology also triggered slightly more debate from media opinion leaders in Canada, as over 8% of the Canadian sample consisted of op-ed articles, columns, editorials or letters to the editor, compared to only 3% of the U.S. sample.

An important factor behind the higher coverage in Canada was the attention to nanotechnology by U.S. and Canadian wire-services and their pick-up among major newspapers, particularly in the CanWest chain. Items from staff writers accounted for 55% of the sample of Canadian news items, but over 90% in the U.S. papers surveyed. Canadian dailies such as the *Vancouver Sun*, the *Saskatoon Star Phoenix*, the *Calgary Herald* and the *National Post* reprinted wire items, particularly from CanWest reporters such as Margaret Munro and Sarah Staples, that resulted in above-average coverage of nanotechnology. In the U.S., while coverage was high in the *New York Times* and the *Wall Street Journal*, the only major regional paper that provided more than 16 news items was the *Boston Globe*. Many factors may have contributed to the fact that compared to Canadian outlets, U.S. media outlets picked up relatively few wire-copy stories on nanotechnology stories, but the result was that Canadian media outlets, by sharing news items and/or picking up Canadian Press and CanWest wire-copy (as well as Reuters, Associated Press and Dow Jones), tended to provide more overall media exposure to its audiences on this subject than major U.S. papers.

Figure 1: Coverage over time
Print media coverage of nanotechnology issues in Canadian and U.S. news outlets in 2004 plotted by week. Coverage measured in millions of audience impressions.



In both Canada and the United States, there was no indication that media interest in nanotechnologies was increasing. In both countries, media exposure over the course of 2004 trended downwards, with a slightly steeper decline observed in the U.S. than in Canada. Due to the relatively short twelve-month time frame, it cannot be stated with any certainty that media interest in nanotechnology is declining, but the study showed no indication of a strong interest in the area. When coverage did peak, it tended to result from profiles of scientific discoveries in Canadian outlets, while U.S. coverage peaked from business and market news pertaining to companies involved in nanotechnology.

Framing nanotechnology stories

An initial review of the coverage suggested that there existed at least six broad news frames (three major and three minor frames) in how the media presented news about nanotechnology to its readers. The three major frames, which comprised 86% of the sample, included the following:

1) **Profiling new technologies** The dominant news frame consisted of profiles of new technologies and/or research in which nanotechnology was applied for some purpose, which comprised 47% of the items surveyed. Examples of stories included the use of nanobumps in hip replacement surgery, nanoparticles used in stain resistant clothing, nanotechnology used to make 'metal rubber', nanotubes used to create a 'space elevator', and the Central Intelligence Agency's use of nanotechnology to create a new series of biosensory equipment. This news frame tended to rely on scientists and researchers involved in nanotechnology as the primary source of information, and also tended to focus on the application's benefits for an individual or for society; only 3% noted any risk with the use of nanotechnology, while 90% highlighted a specific benefit.

2) **Societal risk/benefit discussion** A second major news frame involved a broader risk/benefit discussion about nanotechnology, which accounted for 21% of the items surveyed. This category also involved researchers and experts as a key source, but would invariably balance their more favourable views of nanotech research with other stakeholders (such as bioethicists, environmental advocates) that highlighted potential risks about nanotechnology. Reports tended discuss nanotechnology broadly, giving little or no attention to specific applications. Over 54% of coverage identifying some risk associated with nanotechnology fell within this category.

3) **Business and market news** Over 18% of coverage focused on business or market news involving companies specializing in or using nanotechnology. Reports within this news frame tended to use business officials or industry analysts as the main source of information, and focused on issues such as financial and share price performance and equity market issues. Business and market news tended to provide very limited information about nanotechnology, as only 34% of total items sampled in this news frame discussed its benefits, and 27% discussed the risks associated with nanotechnology (and most cases, it was the investment risks and benefits that were discussed).

The three minor news frames, accounting for the remaining 14% of news items sampled, were: 4) **profiles of institutes or facilities** focusing on or involved in nanotechnology (8%); 5) the **economic impact** of nanotechnology investment in terms of employment and infrastructure investment for a country or region (5%), and 6) **regulatory, legal and/or patent issues** arising from nanotechnology (1%).

There was a notable difference between Canadian and U.S. media in their choice of news frames. Canadian media outlets demonstrated a much higher concentration of stories that profiled specific nanotechnology applications and research than American outlets, which tended to focus predominantly on business and market news concerning nanotechnology. As shown in Table 1 below, almost 59% of Canadian audiences exposed to a news item on nanotechnology in 2004 saw a story that fell under the first news frame profiling specific nanotechnology applications and research. Business and market news comprised only 6% of total audience reached by Canadian coverage, while economic benefits of nanotechnology accounted for less than one percent. In the United States, the business and market news frame led with 34% of total U.S. audience exposure, with economic benefits adding an additional 6%. The profile of new technologies accounted for a significant share of total audience exposure at 27%, but much less than in Canada. Items that took a broader, societal risk/benefit approach to the topic comprised 28% of total audience exposure in Canada, and slightly less (21%) in the United States.

This tendency to focus on the impact of nanotechnology on business by the U.S. media was reflected in part by where the news about nanotechnology appeared within the newspaper. In Canada, 53% of news items accounting for 47% of total audience exposure appeared in the front section of newspapers that either dealt with general news or were part of weekend feature sections, while 26% of items comprising 36% of total audience exposure appeared in the business section. In the United States, it was reversed, with 51% of items accounting for 54% of audience exposure appearing in the business sections, while the general news sections contained only 26% of total news items comprising 28% of total audience exposure. American publications tended to allocate a higher share of total exposure to lifestyle, health and science sections than Canadian newspapers surveyed, which often covered the same type of story (the news frame involving the profile of leading technologies) in the general news section. Nonetheless, it reinforced the fact that U.S. media devote proportionately more attention to business and financial news involving nanotechnology than Canadian outlets. The *Wall Street Journal* and its focus on business stories does skew U.S. media coverage, but even excluding it from the analysis undertaken above, 35% of American audiences exposed to a news item on nanotechnology would have seen either the business/market news frame (27%), or the economic benefits news frame (8%), more so than profiles of nanotechnology applications (32%). Furthermore, 47% of that audience exposure would have come from the business sections of newspapers.

Table 1: News frame by country
Percentage share of total print audience exposure of nanotechnology issues in Canadian and U.S. news outlets in 2004 by major news frame.

News Frame	Canada	U.S
Technology/research profiled	58.7%	27.4%
Business/market news	6.4%	33.8%
Risk/benefit discussion	27.8%	21.0%
Economic impact	0.4%	6.4%
Facilities/institutes	6.5%	5.6%
Regulatory/legal/patent	0.2%	5.8%
	100.0%	100.0%

Table 2: Newspaper section by country
Percentage share of total print audience exposure of nanotechnology issues in Canadian and U.S. news outlets in 2004 by section of newspaper in which item appeared.

Newspaper section	Canada	U.S
Business	36.10%	52.20%
News	47.40%	27.60%
Life/health/science/technology	4.20%	15.40%
Arts & entertainment	5.00%	2.10%
Other (community, auto, careers, etc.)	7.20%	2.70%
	100.0%	100.0%

Risk versus benefits of nanotechnology

Media coverage of nanotechnology tended to emphasize the benefits of nanotechnology to a much greater extent than the risks associated with it. Almost 71% of the news items surveyed noted at least one benefit associated with nanotechnology; conversely, only 18% of news items noted a risk. The most common benefit was associated with improvements to materials, products and

construction/manufacturing processes (34%), followed by health benefits (22%), IT/communications (18%), and science and research (13%); other benefits saw distinctly less coverage, including employment (7%), security and defense (3%), and the environment (2%). Risks associated with biotechnology tended to focus on three areas: investment (35%), broad societal or cultural (including the science fiction concept of 'grey goo' expounded in Crichton's book *Prey* - 25%) and health (19%), with other risks and/or concerns each comprising less than 6% of the sample.

Once again, there was a marked difference in what Canadian audiences were exposed to compared to American audiences in terms of news coverage portraying the benefits of nanotechnology relative to its risks. In Canada, 86% of the news reports accounting for 91% of total audience exposure expressed a benefit, compared to only 52% of the items accounting for 68% of audience exposure in the United States. Admittedly, Canadians were also exposed to more news coverage highlighting the risks of nanotechnology compared to Americans, but not to the same degree of the imbalance observed in the relative audience reach of nanotechnology's benefits. As shown in Table 3 below, 24% of total news coverage reaching American audiences expressed a risk associated with nanotechnology, only slightly lower than 33% of Canadian audiences. As a result, Canadian audiences throughout the sample period were much more likely to be read a news report highlighting a benefit of nanotechnology, and were only slightly more likely to review a report highlighting a risk.

Table 3: Risks and benefits of nanotechnology by country
Percentage share of total print audience exposure of nanotechnology in Canadian and U.S. news outlets in 2004 by whether a risk or benefit of the technology is noted.

Risks	**Canada**	**U.S**
No risks	66.9%	75.8%
Noted briefly	12.2%	12.8%
Noted prominently	20.9%	11.3%
	100.0%	100.0%

Benefits	**Canada**	**U.S**
No benefits	9.4%	31.2%
Noted briefly	35.8%	40.1%
Noted prominently	54.8%	28.7%
	100.0%	100.0%

There was less of a difference between Canadian and U.S. news outlets in the type of benefit recognized than in the amount of coverage that actually highlighted a specific benefit. Materials and products were the major benefit noted in both countries (36% in Canada, 32% in the U.S.), followed by health benefits (22% in Canada, 21% in the U.S.), and IT/communications (15% in Canada, 23% in the U.S.). The most notable difference was, again, in the U.S. focus on business and investment benefits (20% of audience exposure noting a benefit) compared to Canada, where it accounted for only

4% of total audience reach. The benefits to science and research conducted in Canada comprised 20% of total audience reach in the country, compared to only 2% in the United States. A similar business bias occurred in the examination of the type of risk associated with nanotechnology: in the United States, over 62% of the total audience that were exposed to news items highlighting a risk saw a report on the *investment* community's risk from nanotechnology – an area that accounted for only 17% of Canadian coverage addressing a nanotechnology risk. The Canadian media instead highlighted broader societal risks (34%) and health risks (33%).

Discussion

A central issue that is raised by a comparative review of media coverage in Canada and the United States is whether the public is being well served by the type of coverage they are witnessing on this issue. As Susanna Hornig Priest (2001) concludes in her analysis of the role of the media in informing the public on issues of biotechnology, the ideal is that which promotes the widest possible public debate on issues of emerging sciences; news that presents science as a *fait accompli* or that provides largely one-sided or unidirectional messaging neither promotes the science in the long-term, nor does it support democracy. Looking at the issue of nanotechnology, do the results suggest that at this early stage, Canadians or Americans are being well-served in their presentation of the science?

While the question cannot be answered definitively, the review would suggest that Canadian audiences are being much better served by the type of coverage of nanotechnology offered by Canadian newspapers than U.S. audiences. There are a higher number of news items that cover nanotechnology more prominently than U.S. outlets. More importantly, Canadian outlets are much more likely to present nanotechnology as a news story appearing in the general news sections of the newspaper, thus reaching a broader audience than U.S. outlets, that place a much higher share of coverage in the financial pages that would reach a more restricted business-oriented audience. Canadian media tend to employ a news frame that highlights the innovation of nanotechnology, explaining the science in more detail and highlighting benefits to individuals and society, while still producing a higher share of coverage that also notes the risks associated with it. Some of the biggest peaks in Canadian coverage of nanotechnology over the course of 2004 included stories about:

- How Israeli researchers developed prototypes of 'nanosubs' that can diagnose and treat cancer, drawing positive commentary from both Israeli and Canadian health researchers;
- A three day series in the *National Post* on nanotechnology in early July that included a profile of the University of Alberta's new nanotechnology centre;
- Coverage of 'metal rubber' and other nanotechnology news in mid-August; and,

- A widely-carried report on nanoscale light switches developed by University of Toronto and Carleton University researchers.

It is interesting to note that Canadian coverage has not necessarily been the result of more activity in Canada surrounding nanotechnology research. Only 28% of Canadian coverage of nanotechnology reaching domestic audiences focused on events or activities that occurred solely within Canada; one-third incorporated both Canadian and foreign sources, while coverage focusing entirely on foreign sources (overwhelmingly from the United States) accounted for 38% of audience exposure. Fully 22% of Canadian audience exposure came from foreign wire services such as Reuters, Dow Jones and Associated Press; in fact, 9% of Canadian coverage of nanotechnology was derived from AP, compared to just 2% in American papers surveyed.

The tendency of U.S. newspapers to report on nanotechnology from a decidedly business or economic news frame arguably offers the general public more meagre content in terms of understanding the broader issues surrounding the science and its benefits and risks. Even when risks and/or benefits are discussed in U.S. newspapers, they tend to highlight investment-related risks or benefits, and rely disproportionately on nanotech company executives and market analysts as sources of information. The biggest spike in terms of media coverage of nanotechnology in the U.S. in 2004 was caused by the speculation surrounding the proposed initial public offering by NanoSys that was later withdrawn by the company in mid-August. There may be a number of reasons why the U.S. news media display a bias towards business-oriented stories, but speculating on such questions go beyond the scope of this paper.

Conclusion

Certainly for the scientific community in Canada compared to the United States, the composition of media coverage of nanotechnology (if not the volume) must be viewed as a positive first step, producing an environment that highlights both the benefits of the science as well as giving a greater voice to researchers and advocates of nanotechnology. Conversely, in the U.S., audiences are provided with very little material that explains nanotechnology's benefits and/or risks to the broader public. As has been witnessed on both sides of the border over stem cell research and genetically modified foods and crops, the growing use of an advanced technology in society will eventually lead to more news media coverage, drawing an increasing number of stakeholders commenting on the issue, and raising more discussion and activity in regulating and constructing public and economic policies. Coverage offered by the Canadian media, while low in terms of volume, appears to offer a better platform from which to understand and discuss the implications of nanotechnology research and development than the current American approach.

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In the Public Eye:
The early landscape of nanotechnology among Canadian and US Publics.

Edna F. Einsiedel
University of Calgary

The next big technology is commandingly small – but is expected to underpin the next industrial revolution. Nanotechnology has been described as "an all-embracing term for various aspects of science and technology involved in the study, manipulation and control of individual atoms and molecules – making it possible to build machines on the scale of human cells or create materials and products with 'nano-scale' structures conferring highly desirable properties" (European Commission Research Directorate, 2002).

It is still early days in the public arena for nanotechnology but already, the skyrocketing public and private investments in this technology (Lux Research, 2005, in Baker and Aston, 2005) and increasing media attention (Gaskell et al., 2005) are early indicators of nanotechnology's promise and potential. *Business Week*'s March 2005 cover story on nanotechnology predicted that sales of nano-incorporated products would rise from $12.98B in 2004 to an estimated $507.74B U.S. in 2010 (Baker and Aston, 2005).

Stakeholders have shown early interest in commenting on this technology, with some suggesting a moratorium (ETC, 2003). At the same time, with a look over their shoulders at the biotechnology experience, nanotechnology champions have shown greater interest in the nature of the public sphere early on, including examinations of early public representations of this emerging technology (Royal Society and Royal Academy of Engineering, 2004) and encouragement of societal dialogue (see www.nanologue.net).

In this report, we will explore the following questions:

- What are the levels of awareness on and familiarity with nanotechnology?
- How is NT assessed with respect to perceived risks, benefits, and moral acceptability?
- How much confidence is associated with scientific and regulatory systems in overseeing this technology? What factors explain the extent of public confidence?
- What are the policy implications of these findings?

Methodology

Interviews were conducted by telephone during a three-week period in January 2005. A sample size of 1000 randomly selected adults was used in the US and a random sample of 2000 was used in Canada. The difference in sample size was accounted for

by the larger question set in Canada involving a longer list of new technologies. The larger sample size allowed for use of split samples for particular technologies. The sampling error for a sample size of 1000 is 3 percent while it is about 2 percent for an N of 2000. This means that in theory, the results should differ by no more than plus or minus three (or two) percent from what one would find from talking to every adult Canadian (or American). As with any survey, non-sampling errors can arise from measurement validity.

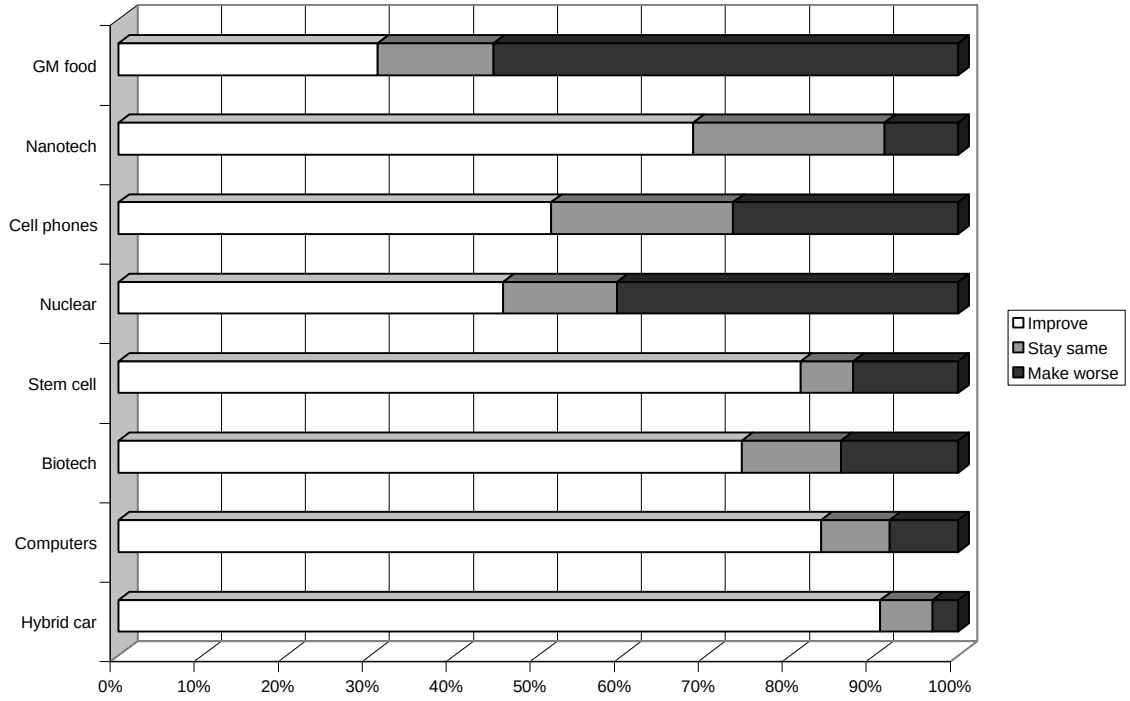
Results

Technology Optimism

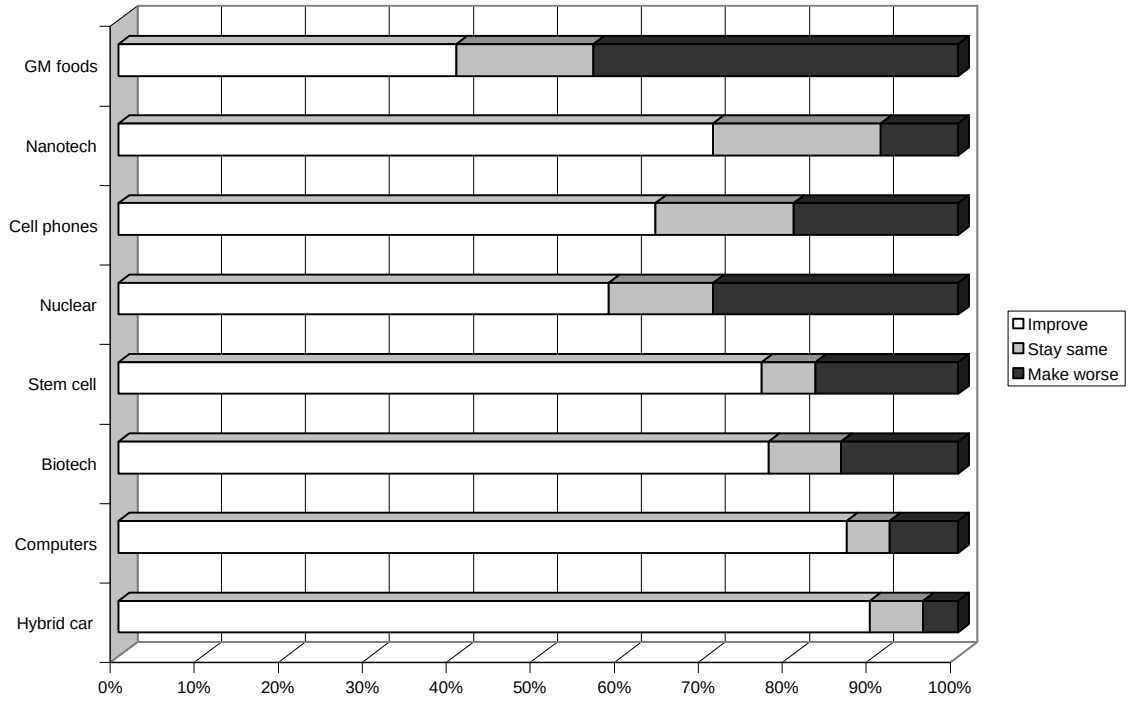
In order to provide a comparison across a variety of technologies, respondents were asked to provide an initial assessment of their general optimism (or pessimism) toward seven technologies. These included hybrid cars, computers and information technology, stem cell research, biotechnology, nanotechnology, cell phones, GM foods. Choices of these technologies were guided in part by the on-going interest in tracking particular technologies (in this case biotechnology and GM foods), by the coverage of several applications in this survey wave (including stem cell research and nanotechnology), and to provide a set of more familiar technologies as anchoring points of comparison (computers and information technology, cell phones, nuclear power).

Figure 1: Technology Optimism

Canada



U.S.



As shown in Figure 1, the majority in both countries are technology optimists; that is, most of these technologies are seen "*to improve our way of life in the next 20 years*", as opposed to having no effect or making things worse. The marked exceptions are nuclear power and GM food. Nanotechnology, as a new technology that most are not familiar with, enjoys the benefit of the doubt in this initial instance. An earlier study examining optimism for a similar set of technologies among Europeans and Americans showed the latter to be greater technology optimists than their transatlantic counterparts (Gaskell, et al., 2005). This study found that in 2002-2003, half of US respondents said NT would make things improve in comparison to only three in ten Europeans. Interestingly, in this same study, an analysis of media coverage during the preceding several years demonstrated more emphasis on NT's benefits in the US than in the UK newspaper (Gaskell, et al., 2005.)

The Specifics of Nanotechnology: Public Perceptions

Nanotechnology was introduced to survey respondents in the following way:

> *Nanotechnology involves the application of science and engineering at the atomic scale. It involves the construction of tiny structures and devices by manipulating individual molecules and atoms, which have unique and powerful properties. These structures can be used in medicine and biotechnology, in energy and the environment, and in telecommunications. Some examples of nanotechnology include the use of molecules to enable the production of drinking water by extracting salt from seawater, the use of implantable surgical devices that can measure things like blood pressure on a continuous basis, or the use of special nano-molecules in fabrics, like wrinkle-resistant pants.*

The choice of an appropriate description for the technology was based on the need to provide one that was reasonably accurate but was also balanced against the requirement of accessibility of the description to the general public. This description was provided at the point where a series of questions on the technology was about to be presented to the respondent. A contextual caveat is important here: because the respondents have now been provided with this description of what the technology is about, this framing context will provide a more specific understanding of the parameters around public views on this technology.

Awareness of NT was gauged on three dimensions: whether respondents were familiar with, had been exposed to, and had discussed the technology. US respondents were more likely to indicate familiarity, with a significant minority – four in ten – saying they were somewhat or very familiar. Among Canadians, about a third had the same view. About four in ten in both countries said they had had exposure from reading, seeing or hearing something about the subject. Only a quarter in both countries said they had discussed the subject with anyone (see Table 1).

Risks, Benefits, and Moral Acceptability

Given the limited awareness and familiarity, there are indications that publics in both countries are giving the technology the benefit of the doubt, with at least half

suggesting they see moderate risks but substantial benefits (Table 2). The cautiousness Canadians have for this technology is reflected in their judgment about its moral acceptability, with almost the same numbers saying they find NT morally acceptable as those maintaining it was morally questionable (46 and 42 percent, respectively).

In the British study for the Royal Society, this moral dimension in NT assessment was also in evidence and was explored further in focus groups. The discussions illustrated further this sense of moral discomfort which was tied to associations with not being "natural". In this sense, respondents were suggesting changes which do not necessarily occur in nature but were manipulations of nature; it also reflected the theme of "playing God" and carrying out something contrary to ethical norms (BMRB, 2004).

Table 1: Awareness of Nanotechnology

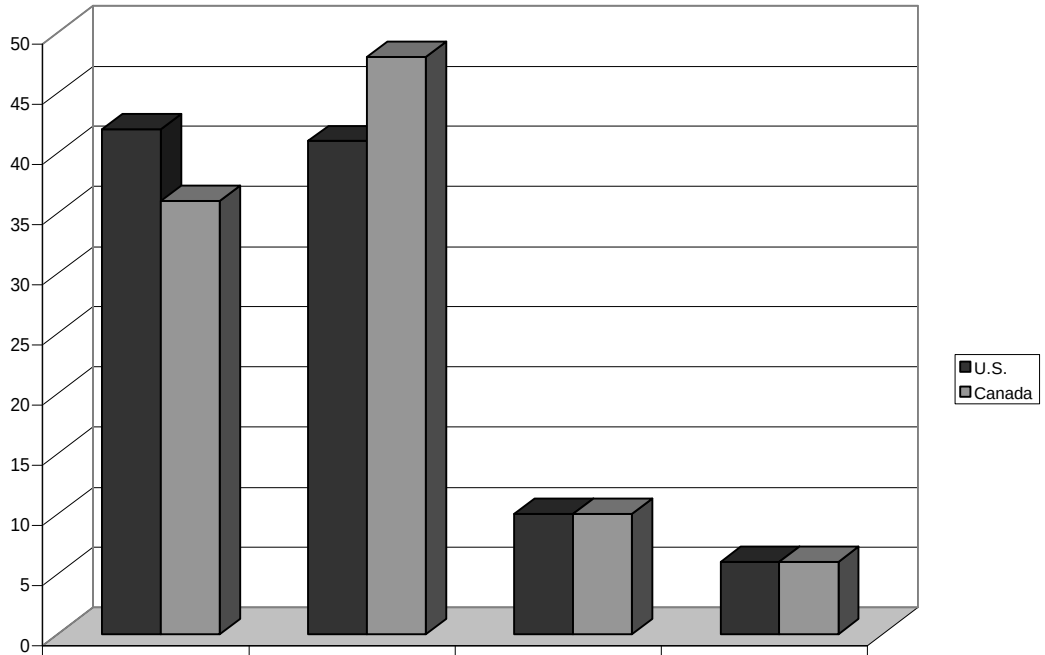
Awareness of Nanotechnology	Canada	U.S.
Familiarity: (somewhat, very familiar)	35%	42%
Exposure: Have you read, seen, or heard (a little to a lot)	38%	40%
Discussion: Have you ever discussed NT (% yes)	24%	27%

Table 2: Perceptions of Benefits, Risks, and Moral Acceptability

Benefits, Risks, and Moral Acceptability	Canada	U.S
Benefits		
Moderate	36%	37%
Substantial	51%	49%
Risks		
Moderate	51%	49%
Substantial	16%	13%
Moral Acceptability		
Questionable	42%	33%
Morally Acceptable	46%	54%

At the same time, Canadians are less optimistic than Americans about the economic benefits they project for this technology, with close to six in ten expecting modest or no significant benefits. Only about half of U.S. respondents share this view (see Table 3).

Table 3: Perceptions of Economic Benefits of Nanotechnology

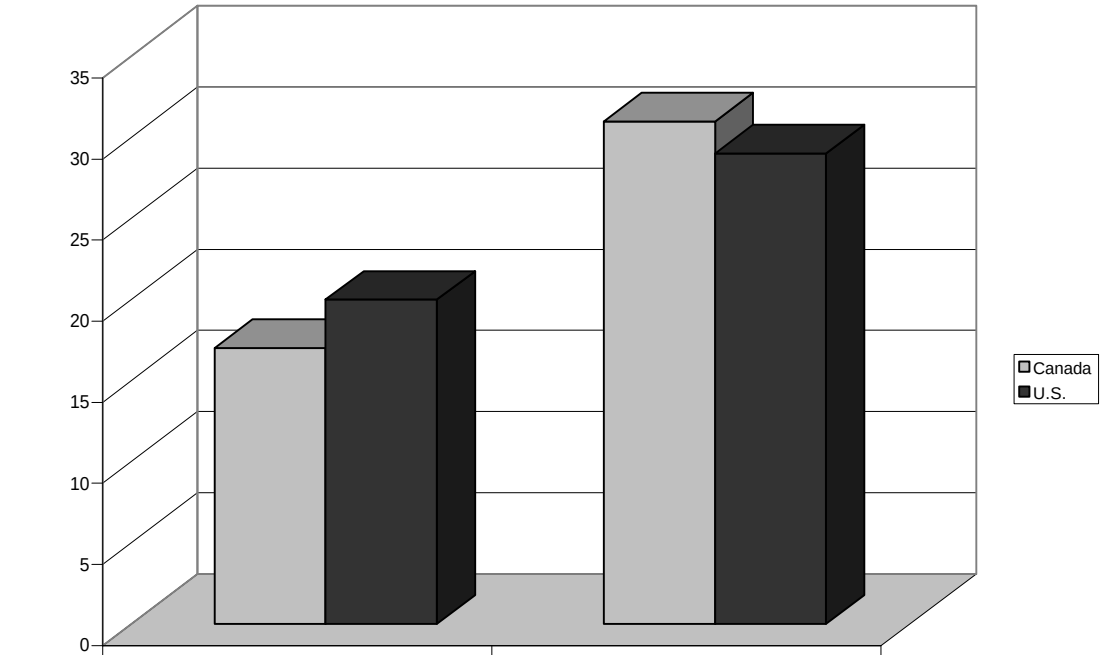


	Major	Modest	No significant	DK
U.S.	42	41	10	6
Canada	36	48	10	6

Confidence in the Oversight of Nanotechnology

Two types of questions were posed to respondents to assess their confidence in oversight for this technology: a more specific one on the safety and regulatory approval systems and one that was geared to confidence in scientists, positing the technology's being "in safe hands" (see Figure 2).

Figure 2: Confidence in Nanotechnology Oversight



	Regulatory System	In safe hands
Canada	17	31
U.S.	20	29

Regulatory system: "How confident would you say you are in the safety and regulatory approval systems governing nanotechnology?"

Scientists: "In terms of the scientists who are involved in research of these technologies, on a scale of 1-5, where 1 is not at all confident and 5 is extremely confident, where the mid point 3 is moderately confident, how confident would you say you are that nanotechnology is in safe hands?"
(% who are very confident, or those who gave a rating of "4" or "5" on this confidence scale)

The difference in response to these two questions – evident among respondents in both countries -- is striking. There is a doubling in the numbers who say they are confident when the technology is posited as being 'in safe hands (of scientists)', in comparison to confidence in the regulatory system. Scientists, of course, have been accorded higher levels of trust in studies of biotechnology – and government regulators have correspondingly garnered lower levels of trust -- so this finding is in line with these earlier studies.

Attitudes toward and Expectations for Nanotechnology

In this section, we discuss the expectations publics in the two countries have of NT. These expectations are discussed in the context of optimism about NT, the expected criteria to be applied, and expectations for government. We then explore the nature of these publics' overall assessment of nanotechnology and provide a more detailed investigation of explanatory factors for this overall assessment.

It is clear that a large majority in both countries have high expectations for this technology. It is seen to promise health treatments and cures and to lead to significant advances for quality of life (see Table 4).

We explored further some criteria publics apply to their assessments of NT. In this case, we investigated the notion of expert knowledge versus other criteria which publics might use for judging NT. As Table 4 illustrates, publics in both countries demonstrate their confidence in expert knowledge, with both groups maintaining the advice of *experts* rather than the views of the average member of the public ought to be utilized for decisions about the technology. Two thirds of both groups are also more likely to prefer reliance on scientific evidence of risks and benefits. The forced-choice nature of these questions posed intentionally to respondents makes it more difficult to provide a nuanced response so it is striking that at least three in ten express a preference for decisions to be based "mainly on the moral and ethical issues involved" rather than the scientific evidence of risk and benefit.

Also striking is the skepticism expressed by publics in both countries around the consideration and application of moral or ethical standards (presumably by those in control of the technology). Only a small majority in both countries express confidence that those in authority will ensure NT research will adhere to strict ethical guidelines. There is an expectation among more Canadians than Americans (73 versus 63 %) that a better understanding of risks ought to be achieved and until this happens, the use of NT *ought to be slowed down*. At the same time, little confidence is displayed about government doing an effective job in monitoring the impacts of NT products: two thirds of Canadians and close to six in ten Americans think not enough is being done by government in this area.

Table 4: Expectations for and Assessments of Nanotechnology

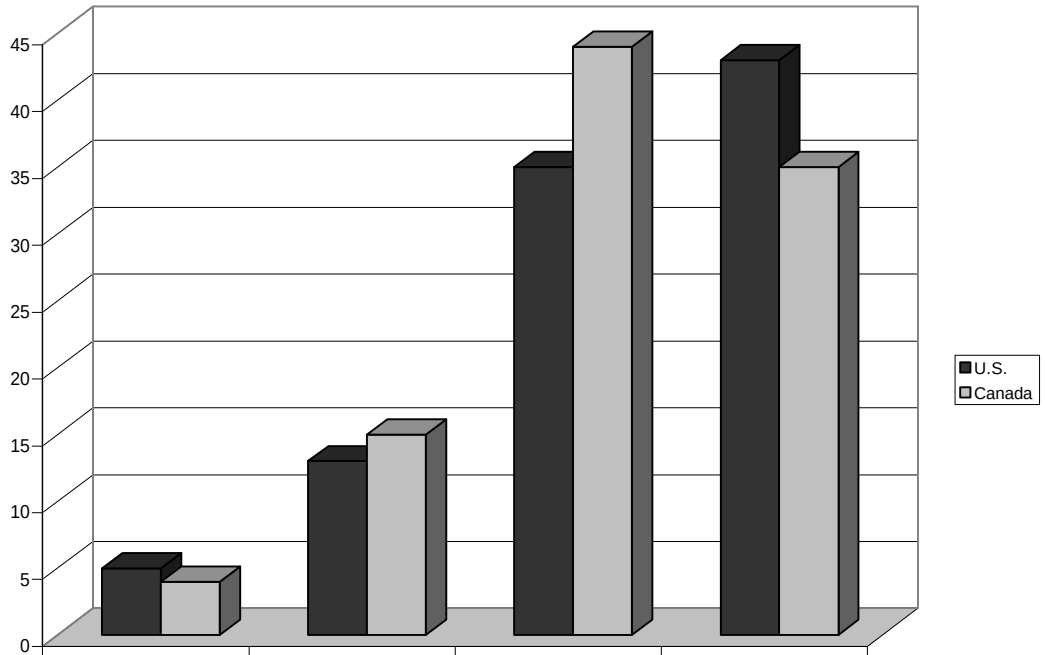
Expectations	Canada	U.S.
Optimism		
1.a. Nanotechnology will be one of the most important sources of health treatments and cures in the 21st century	76%	71%
1.b. NT probably won't be a significant source of health treatments and cures in the 21st centuty	20%	23%
2.a. NT research represents the next frontier of human endeavor and will lead to significant quality of life		
Agree	81%	80%
Disagree	15%	15%
Expected Criteria		
1.a. Discussions about NT should be based mainly on the views and advice of experts.	71%	74%
1.b. Decisions on NT should be based mainly on the views of average Canadians.	27%	21%
2.a. Decisions on NT should be based mainly on the scientific evidence of risk and benefit.	65%	65%
2.b. Decisions on NT should be based mainly on the moral and ethical issues involved.	31%	29%
3.a. NT research has been considerate of my interests.	47%	49%
3.b. NT research has not been considerate of my interests.	43%	37%
4. If the best available scientific evidence says that a particular use of NT is safe, it should be allowed.		
Agree	87%	84%
Disagree	12%	13%
5. Authorities should inform people about NT and let them decide for themselves whether they want to use products developed using these techniques.		
Agree	92%	93%
Disagree	9%	7%
Expectations for, Perceptions of Government		
1.a. I trust those in authority to ensure that NT research that takes place in the U.S./Canada will follow strict ethical guidelines.	57%	55%
1.b. I do not trust that those in authority… will follow strict ethical guidelines.	39%	41%
2. Until more is known about the risks of NT, government should slow the use of NT.		
Agree	73%	63%
Disagree	25%	33%

Although there is an expectation that the metric of risks and benefits ought to apply, this does not preclude use of other criteria including ethical standards in the development of technology. The broad range of criteria identified by various publics on the GM food issue is a good example (see, for example, Einsiedel, Jelsøe and Breck, 2001).

The principle of informed choice is also reflected in the near-unanimous expectation that almost all respondents voiced: the need for information in order to exercise the right to choose.

Finally, we explored the parameters for overall assessment of going forward or not going forward with NT. A reasonable general evaluation of NT is provided by the projected overall approval of the technology and the degree to which this approval is contingent on the degree of regulatory control. A summary question was posed to respondents: ***Overall, which of the following best captures your views about NT?*** The choices and the results are presented in Figure 3, with the choices reflecting the degree of control or 'laxity' preferred and a final option suggesting that regardless of control, this technology ought not to move forward.

Figure 3: Conditions for Overall Approval of Nanotechnology



	Never	Limited	Strict	Relaxed
U.S.	5	13	35	43
Canada	4	15	44	35

Relaxed: I approve the use of NT as long as the usual levels of government regulation and control are in place.

Strict: I approve of NT as long as it is more tightly controlled and regulated.
Limited: I do not approve of NT except under very special circumstances.
Never: I do not approve of NT under any circumstances.

As is evident in Figure 3, these results show that Canadians' approval of NT is dependent on tighter regulations while for Americans, overall approval rests on 'the usual levels of government regulation and control.' Again, it is highly likely that respondents are extrapolating from extant perceptions of regulatory performance rather than from awareness and familiarity of standards that are in place or are being considered for nanotechnology.

What factors help to explain this overall view?

We hypothesized that this summary judgment might be explained by a combination of personal, technological, and structural or institutional factors. By applying multiple regression, we investigated whether the following factors might account for this overall assessment: the individual's degree of societal involvement (a personal attribute), the perceived risks, benefits, and moral acceptability of the technology (the technology's attributes), and the degree of confidence in the regulatory system (an institutional attribute). The measure for involvement included questions relating to familiarity with the technology, exposure to media coverage on NT, discussion of the technology, and general newspaper readership. This analysis was carried out by controlling for three demographic variables: age, education, and gender.

As shown in Table 5, ***for Canadians, the most important predictor was institutional***, represented by confidence in the regulatory system. This was followed by the technology's attributes, with perceived risk and moral acceptability being stronger predictors than perceived benefit. The personal attribute of involvement was not significantly related to overall approval for respondents in both countries.

For US respondents, on the other hand, the technology's attributes were the best predictors for overall approval, particularly the expected benefits, perceived risks, and 'moral acceptability' of the technology. Again, the higher levels of confidence in the regulatory system among Americans could foreground attributes about the technology more easily in this instance.

Having said this, the fact that all these factors play a significant role in the overall assessment of nanotechnology suggests that public views and expectations, while guided by considerations of risks and benefits, are clearly influenced by the interaction of individual, technological, and institutional factors.

Table 5: Predictors of Overall Approval of Nanotechnology

Canada					
	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
Model					
(Constant)	1.916			11.305	<.001*
Confidence in Regulatory System	.224	.169	.280	9.493	<.001*
Moral Acceptability	.162	.024	.214	6.766	<.001*
Risk	-.149	.023	-.188	-6.468	<.001*
Benefit	.096	.024	.127	4.013	<.001*
Involvement	.026	.017	.044	1.56	.119
Sex	.079	.041	.051	1.896	.058
Education	.029	.015	.051	1.93	.054
Age	-.033	.014	-.063	-2.382	.017*
R-square=0.392 F(8,890)=71.746,p<.001*					
United States					
	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
Model					
(Constant)	1.475	.247		5.978	<.001*
Benefit	.233	.037	.285	6.336	<.001*
Moral Acceptability	.161	.034	.199	4.687	<.001*
Risk	-.148	.032	-.174	-4.584	<.001*
Confidence in Regulatory System	.122	.033	.145	3.684	<.001*
Involvement	-.022	.025	-.033	-.868	.386
Sex	.159	.062	.089	2.541	.011*
Education	.057	.025	.084	2.323	.021*
Age	-.004	.021	-.006	-.184	.854
R-square=0.411 F(8,520)=45.381,p<.001*					

Conclusions and Policy Implications

What does this early picture of nanotechnology and the publics in two North American countries tell us? Again, it is important to emphasize that despite limited familiarity and awareness among publics in both countries, the expression of opinions and assessments of nanotechnology occurs, with the likelihood that respondents are possibly drawing on heuristics they have stored in their mental maps of technology generally and the technologies they are familiar with.

That Canadians and Americans are generally optimistic about technology in general and about nanotechnology in particular is evident from these results. At the same time, there are differences between publics in both countries, with Americans generally more inclined to project more benefits and fewer risks and to see the technology as being more morally acceptable than questionable. These country differences have been in evidence in assessments of biotechnology (Gaskell et al., 2001) and are attributable in part to differences in confidence in the regulatory system.

Early trust in expertise has been demonstrable in this survey. At the same time, this trust has been shown not to be a 'blank check'; there are caveats and are seen as dependent on the nature of the application. (see Solter et al., 2003)

One important condition in this initial landscape is that nanotechnology is presented *in toto*, whose specific applications have not been provided to respondents. The difference in perceptions between "biotechnology" and "GM food" as a specific application, evident in Figure 1, illustrates this point. It is likely that as the technology evolves and its specific applications are presented in public fora, public representations will develop complexity and nuance over time.

The importance of – and limits to – the risk-benefit standard are evident in this early-stage picture. These criteria are obviously important in the assessment of publics in both countries. However, confidence in the regulatory system also plays an important role in projecting overall assessments and the nature of expected control. In the U.S., greater trust in the regulatory system makes for greater comfort in current systems of control; in Canada, on the other hand, the assessment of conditional approval contingent on stricter regulation could be a projection of a series of previous experiences with various technologies, including their oversight.

For policy makers and the networks of interests around policy-making, the implications are clear for governance of this technology. Issues of trust which embrace transparency and accountability are going to be important. As well, the on-going involvement of various publics will be critical (Einsiedel and Goldenberg, 2004). This includes wide dissemination of information in a broad range of channels to diverse publics. The U.S. National Nanotechnology Initiative, for example, has supported a range of programs for formal (e.g., materials for K-12 students) and informal education such as science center initiatives (Nanoscale Science and Engineering Subcommittee, 2004). Early public engagement through discussion and debate will similarly be critical. The European nanologue initiative is one example of this approach (www.nanologue.net). These points have already been recognized in a number of reports and policy documents. The UK Royal Society report, for example,

has recommended keeping in close touch with views of diverse publics, supporting public dialogue initiatives carried forward by public bodies, monitoring their performance and that of other public bodies to ensure public accountability, and engaging a wide range of stakeholders on an on-going basis (Royal Society and Royal Academy of Engineering, 2004).

The views of publics in these countries are clearly in their formative stages. The technology is also in its early days. What better time to engage different publics than the present, when technology is in its more flexible form?

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Appendix 1: Questionnaire for Nanotechnology

(E) I am going to read a list of areas in which new technologies are currently developing. For each of these areas, do you think it will improve our way of life in the next twenty years, it will have no effect, or it will make things worse? (Randomize)

1. New "hybrid" car engine technologies
2. (E) Computers and information technology
3. (E) Biotechnology
4. (E) Stem cell research
5. (E) Nuclear energy
6. (E) Cellular phones
7. (E) Nanotechnology
8. (E) Genetically modified foods

(END OF RANDOMIZATION)

[NANOTECHNOLOGY SECTION]

[SECTION SUR LA NANOTECHNOLOGIE]
The next part of this survey focuses on nanotechnology, which is an emerging technology.

Nanotechnology involves the application of science and engineering at the atomic scale. It involves the construction of tiny structures and devices by manipulating individual molecules and atoms, which have unique and powerful properties. These structures can be used in medicine and biotechnology, in energy and the environment, and in telecommunications. Some examples of nanotechnology include the use of molecules that have properties that enable the production of drinking water by extracting salt from seawater, the use of implantable surgical devices that can measure things like blood pressure on a continuous basis, or the use of special nano-molecules in fabrics like wrinkle resistant pants

1. Would you say you are very, somewhat, not very or not at all familiar with nanotechnology?

Very familiar
Très familière
Somewhat familiar
Plutôt familière
Not very familiar
Pas très familière
Not at all familiar
Pas du tout familière
[DK/NR]
[NSP/PDR]

2. Over the last three months, have you read, seen or heard a lot, a little, or nothing about issues involving nanotechnology research?

A lot
Beaucoup
A little
Un peu
Nothing
Pas du tout
[DK/NR]
[NSP/PDR]

3. Before this interview, have you ever discussed nanotechnology with anyone?

Yes
Oui
No
Non
[DK/NR]
[NSP/PDR]

[IF YES CONTINUE, OTHERWISE SKIP TO Q55]

4. Would you say you have discussed this issue frequently, occasionally, or once or twice?

Frequently
Fréquemment
Occasionally
A l'occasion
Once or twice
Une fois ou deux
[DK/NR]
[NSP/PDR]

[ROTATE THE NEXT TWO QUESTIONS, ON RISK AND BENEFIT]

5. I would like to understand the extent to which you think nanotechnology might benefit our society. Using a scale of 1-5, where 1 is no benefit and 5 is substantial benefit, and the mid-point 3 is moderate benefit, how beneficial do you think nanotechnology research will be to our society?

[1-5]
[1 à 5]
[DK/NR]
[NSP/PDR]

6. I would like to understand the extent to which you think nanotechnology might pose a risk to our society. Using a scale of 1-5, where 1 is no risk and 5 is substantial risk, with the mid point 3 being moderate risk, how much risk does nanotechnology pose for our society?

[1-5]
[1 à 5]
[DK/NR]
[NSP/PDR]

7. In terms of the moral or ethical aspect of nanotechnology, again using the 1-5 scale, where 1 means that nanotechnology is morally unacceptable, 5 means it is morally acceptable, and the mid point 3 means it is morally questionable, how do you view this kind of research?

[1-5]
[1 à 5]
[DK/NR]
[NSP/PDR]

8. In terms of economic benefits to [Canada/ the United States], would you say that nanotechnology will provide major benefits, modest benefits, or no significant benefits?

Major benefits
Des avantages importants
Modest benefits
Des avantages mineurs
No significant benefits
Pas de réels avantages
[DK/NR]
[NSP/PDR]

9. And how involved should government be in funding nanotechnology research, using a 1-5 scale where 1 means government should not be involved at all, 5 means government should be actively involved, and the mid-point 3 means that it should be moderately involved?

[1-5]
[1 à 5]
[DK/NR]
[NSP/PDR]

10. On a scale of 1-5, where 1 is not at all confident and 5 is extremely confident, where the mid point 3 is moderately confident, how confident would you say you are in the safety and regulatory approval systems governing nanotechnology? **[SPLIT SAMPLE]** In terms of the scientists who are involved in research of these technologies, on a scale of 1-5, where 1 is not at all confident and 5 is extremely confident, where the mid point 3 is moderately confident, how confident would you say you are that nanotechnology is in safe hands?

[1-5]
[1 à 5]
[DK/NR]
[NSP/PDR]

11. Overall, which of the following best captures your views about nanotechnology? [READ LIST] [CHOOSE ONLY ONE]

I approve of nanotechnology, as long as the usual levels of government regulation and control are in place
J'approuve l'utilisation de la nanotechnologie, à condition que la réglementation et les mécanismes de contrôle habituellement mis en place par le gouvernement soient appliqués.
I approve of nanotechnology if it is more tightly controlled and regulated
J'approuve l'utilisation de la nanotechnologie, à condition qu'elle soit plus sévèrement contrôlée et réglementée.
I do not approve of nanotechnology except under very special circumstances.
Je n'approuve pas l'utilisation de la nanotechnologie, sauf dans des circonstances exceptionnelles.
I do not approve of nanotechnology under any circumstances
Je n'approuve pas l'utilisation de la nanotechnologie, quelles que soient les circonstances.
[DK/NR]
[NSP/PDR]