Quantitative Analysis of Regulatory Discourses on Agricultural Genetic Engineering: An Exploration and Empirical Application of Critical Theory

A Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

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DEDICATION

This is dedicated to my family — Leela, Hanna, David, Mom, Dad, Rick, Miriam, Lori, Alex, Charlotte, Todd, Tracy, Aaron, Ross, Ginger and McCall — for their never-ending love, support, and encouragement.

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Dad, you finally got a doctor in the family!

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ABSTRACT

QUANTITATIVE ANALYSIS OF REGULATORY DISCOURSES ON AGRICULTURAL GENETIC ENGINEERING: AN EXPLORATION AND PRACTICAL APPLICATION OF CRITICAL THEORY

This dissertation takes a multidisciplinary approach to examining public policy. On one level, the dissertation is a case study of the use of methodological triangulation to understand the values and beliefs of people within a regulatory system associated with a complex social issue: modern biotechnology/genetic engineering. On another level it is a deep exploration and a practical application of Habermas' Theory of Communicative Action.

Q methodology was used in combination with semi-structured interviews and a traditional survey to characterize the values, attitudes, and beliefs of individuals from U.S federal regulatory agencies that oversee agricultural and food biotechnology: the U.S. Environmental Protection Agency, U.S. Food and Drug Administration and the U.S. Department of Agriculture. For comparative purposes, the study also included two individuals from consumer advocacy organizations and environmental science and policy students from George Mason University, who participated in a pilot study that was included in the final analyses.

Q method identified 6 distinct discourses within the 31 participants. The dominant discourse, which accounted for 19 of the 31 participants, is characterized by strong support for biotechnology, the existing regulatory system, and statements asserting purposive-rational validity claims, and a rejection of normative validity claims. The results of the survey found considerable consistency among participants from regulatory agencies in their attitudes and beliefs as measured by items from the New Ecological Paradigm, Normative Belief, and Schwartz's value cluster scales. Support for unrestricted scientific research and general optimism toward technologies were identified as significant predictors of support for biotechnology.

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FORWARD AND OVERVIEW

> "Finding solutions to environmental problems involves more than simply gathering facts and understanding scientific issues of a particular problem. It also has much to do with our system of values and issues of social justice. To solve our environmental problems, we must understand what our values are, and which potential solutions are socially just. Then, we can apply scientific knowledge about specific problems and find acceptable solutions." (Botkin and Keller, 2000:viii.)

This dissertation takes a multidisciplinary approach to examining public policy. On one level, the dissertation is a case study of the use of methodological triangulation to understand the values and beliefs of people within a regulatory system associated with a complex social issue: modern biotechnology/genetic engineering. On a second level, it uses this methodological approach to differentiate between the economic and critical theory predications of the influence of stakeholders on bureaucracies. On yet another level, it provides a schematic for theoretical continuity between social theory and the biological and social sciences, and with social science methodology.

The first three sections of this dissertation provide a general background into the primary subject matter of the empirical research: value, norms, and beliefs associated with genetically modified organisms. The dissertation begins with an introduction to the controversy over the use of modern genetic engineering-modern biotechnology in agriculture and food technology and a discussion of the rapid expansion of the use of this technology within a very short time-period. Section 2 provides an overview of how genetically modified organisms are regulated in the United States and elsewhere. In section 3, I review the results of public opinion research in the United States and Europe, and research on the factors that seem to influence people's attitudes, values, and beliefs about genetically modified organisms.

Section 4 initiates an extended interlude from the topical area of biotechnology and begins multi-level investigation of critical social theory and its foundation in natural sciences. I start with a short discussion of the problem of integrating science and individual and cultural values in public policy and government decision-making. I introduce Habermas' Theory of Communicative Action and its importance for understanding value formation. The section continues with a spiraling excursion to establish theoretical continuity between the biological, psychological, and social sciences. I discuss — from both cognitive (information processing and storage) and physiological (biophysical and neurological) perspectives — how the Theory of Communicative Action is anchored in the coevolution of human language, consciousness, values, and culture. I argue, therefore, for the importance of theoretical continuity between natural and social sciences.

Section 5 builds on the empirical and theoretical groundwork I lay in Section 4. I explore more deeply language's role in the development, maintenance, and reproduction of social norms and culture. I discuss how language enabled humans to coordinate actions effectively in large social groups, enabled role specialization and differentiation, and provided a scaffold for further genetic and cultural coevolution. Having established the evolutionary connection among consciousness, language, culture, and values, I return to

Habermas to explore relationships among science, values, and politics in contemporary society. I conclude by arguing for a pragmatic, discursive — communicatively based — rationality that emerges through ideal communication about empirical and value-laden information.

Section 6 reconnects my empirically grounded theoretical discussion on social values to social science methodologies. I discuss the strengths and limitations of social science methodologies in characterizing social values, discuss the influence of social values on environmental risk assessment and science generally, and provide a critique of economic valuation. I continue along this pathway in Section 7, where I discuss the application of economic theory and critical theory to science and bureaucracies.

Section 8 begins the process of describing my primary approach: Q methodology. I provide an overview, case study, and several examples of Q methodology in environmental policy research. Section 9 describes my methodological approach in detail. I present and discuss the results of the study in section 10. Section 11 includes my conclusions and suggestions for additional research.

The numerous appendices include research and other dissertation materials and data.

1. THE AGRICULTURAL BIOTECHNOLOGY DEBATE

"Biotechnology" is generally considered a broad term that refers to any process or technology involving biological systems (Grun et al., 2004). Modern biotechnology is often used to refer to the manipulation of genetic materials using techniques such as recombinant DNA (rDNA) (Pew, 2004b). In this document, I treat synonymously the terms "agricultural biotechnology" and "agricultural bioengineering:" applying rDNA techniques to create new crop and food varieties. Often, the products of modern biotechnology techniques are referred to as genetically engineered (GE) or genetically modified organisms (GMOs), plants, crops, or foods. Notably, while the terms "genetic engineering" and "genetically modified" frequently are used interchangeably, survey research shows that the public perceives these terms differently (see footnote 16).

More than 15 years after the introduction of the first genetically modified plants into the environment, the acceptability of genetically engineered plants, animals, and foods containing the products of modern biotechnology/genetic engineering is still the focus of an ongoing international debate.[1] Modern biotechnology has been the subject of

[1] There are far too many academic studies, government and non-government reports, web sites, and news articles on the benefits and risks of biotechnology to review comprehensively, and there would be little value to such an endeavor because there is a high degree of redundancy supporting various positions. For illustrative overviews (con, pro, and "neutral"), see: Acosta and Chaparro 2008;Bren 2003;Carpenter et al.

media attention, including televised documentaries (Palfreman, 2001) and opinion polls (several of which are discussed below). Disputes over the planting of genetically modified crops have made their way to the U.S. Supreme Court (Supreme Court of the United States, 2010). The debate has at times become a centerpiece of international trade (Pruzin, 2003) and food aid policy (Winter, 2004).[2] Disagreement about potential health and economic benefits, ecological and health risks, risk management strategies, government oversight, accountability, intellectual property rights, and the moral acceptability of biotechnology still abounds among the scientific and regulatory communities, agricultural interests, consumer and environmental groups, and the public. Proponents of modern agricultural biotechnology, including the U.S. government, argue that current scientific studies and regulatory processes are adequate to protect public health and the environment, that modern biotechnology will reduce the cost of production, improve the quality and quantity of food, and help feed the world while also reducing agriculture's pressure on the environment. Many who oppose modern agricultural biotechnology argue that little is known about the long-term impacts of genetically modified organisms on the environment or human health, that reported

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2001;Consumers International 1997; 2005; 2010;Ervin et al. 2000;Gregory et al. 2001;Oliver 2001;Pew 2004a; 2004b;Thompson 2000;Wolfenbarger and Phifer 2000.

[2] On 4 March 2004, Roger Winter, an Assistant Administrator at the United States Agency for International Development, testified before the United States House of Representatives Committee on International Relations (Winter 2004) "Finally, I must inform you that as of March 7, 2004, USAID has ceased all further food aid shipments to Port Sudan due to the GOS' [Government of Sudan's] insistence that US commodities be certified free of genetically modified organisms.… The United States is the major donor of food aid to Sudan, providing some 70 percent of the World Food Program's total pipeline for the country. The majority of US-donated food aid enters the country through Port Sudan, including 40 percent of all food aid intended for southern Sudan."

benefits have either not been realized or are not worth the potential risks, that patenting plants and animals is unfair, and that genetic engineering is morally unacceptable.

Finucane and Holup (2005) argue that different cultural values may underlie differences in how people in the Unites States, Europe, and developing countries perceive the risks from genetically modified foods. One report suggests that the "arguments are embedded in the context of broader and deeper conflicts over development, globalization, and the role of technology in agriculture" (Pew, 2004a:3). Agar (2003:600) observes: "The debate about [genetically modified] food is really many different debates. Popular discussion frequently juxtaposes points that have no direct bearing on each other. People respond to the case for the potential of [genetic engineering] to reduce global hunger with complaints about the increasing influence of multinationals. Defenders of [genetic engineering] assume that all the concerns about genetic engineering and nature's integrity can be answered by pointing to the lack of hard scientific data supporting a threat by [genetically modified] crops to the environment."

Explosive Growth of Agricultural Biotechnology[3]

Agriculture is a constant struggle against pests, disease, and adverse environmental conditions to increase the profit, yield, and the quality of the food supply. Plant pests and disease have resulted in famines and economic losses throughout history. The Irish potato famine in the 1800s caused the death of over one million people. From

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[3] Except as otherwise cited, the source of information contained in this section is National Research Council 2000.

1991 to 1996, wheat and barley head blight (*Fusarium graminearum* and *F. Poae* fungi) caused approximately $3 billion in damages. Nematodes cause about $7 billion per year in U.S. crop losses. Fungal mycotoxins continue to pose human health hazards.

Humans have employed a variety of scientific techniques to combat plant pests and diseases and to improve crop yield and quality. For example, sulfur fumigation was used as early as 1000 B.C. and ants were used in 324 B.C. to control pests. During the Roman Empire, crop rotation, irrigation, and manure application were employed to improve yields. By the 1600s, farmers were using Arsenic to control pests. In 1938, the soil bacterium *Bacillus thuringiensis* (Bt) was developed as a microbial pesticide and in the 1940s synthetic pesticides became widely used. In the 1960s, the concept of integrated pest management was promoted to reduce the impact of chemical pesticides by using a variety of "natural" pest control techniques.

Scientific advances also led to improved methods for the selection and hybridization of plants with desirable traits. In the 1860s, Gregor Mendal described the process of heredity by hybridizing varieties of peas (*Pisum sativum*) for flower, seed color, seed and pod shape, flower position, and plant height traits. In 1905, Roland Biffen showed that resistance to rust fungus in wheat can be passed on to later generations. These early scientific breakthroughs provided the foundation for the techniques of "conventional" biotechnology that include:

- Artificial crosses, where pollen is transferred between sexually compatible plants
- Chemical or x-ray mutagenesis to induce genetic variation
- Tissue culture techniques that enable seeds to be rescued and grown in tissue culture when crosses yield viable embryos but non-viable endosperm

- Cell fusion, a technique that uses protoplast technologies (cells removed from tissues and their cell walls removed) to combine genomic material from non-sexually compatible plants
- Somaclonal variation, a method for inducing genetic variation during the tissue-culture process with phenotypic outcomes similar to chemical or x-ray mutagenesis.

By 2000, the impacts of conventional biotechnology were already significant. Pest- and disease-resistant crops developed through conventional techniques included blight-resistant corn (*Zea mays*), rust-resistant wheat (*T. aestivum*), and aphid-resistant alfalfa (*Medicago sativa*). Approximately 50 percent of all potato cultivars (*Solanum demissum*) had blight resistance derived from the Mexican potato. Conventional breeding of corn resulted in yields increasing from five metric tons per hector in 1967 to eight metric tons per hector in 1997. Cereal harvests increased 1.3 percent per year. Since 1960, world food production doubled and agricultural productivity from land and water tripled because of conventional biotechnology.

While conventional biotechnology yielded remarkable benefits, it has its limitations. First, it may take decades to develop a new crop variety using conventional breeding techniques, and the development process is very labor intensive. In addition, beneficial traits can be linked to undesirable traits (e.g., disease susceptibility). For example, U.S. corn yields decreased significantly in the 1960s and 1970s because of the susceptibility of male-sterile corn grown to a new leaf blight fungus (*Helminthosporium maydis*).

To address these limitations, agricultural scientists turned to recombinant DNA (rDNA) techniques, also known as genetic engineering, genetic modification, and modern biotechnology. The development of this new technology for inducing variation into plants was extremely rapid. Scientists discovered the first restrictive enzymes in 1968, and by 1973, plasmid and viral vectors for engineering organisms. DNA sequencing methods were developed between 1975 and 1977. In 1983, *Agrobacterium tumefaciens* was first used to carry genes into plants and the first successful transgenic plants were developed using agrobacterium methods in 1985. From 1987-1999, methods such as electroporation and particle-gun transformation were developed, which do not rely on microbial vectors for transferring new genetic material into plants.

The use of genetic engineering techniques to produce genetically modified organisms (GMOs) has several advantages over conventional techniques. Conventional methods transfer large amounts of genetic material: half of the haploid genome from each parent. For Arabidopsis (a small flowering plant that is widely used as a model organism in plant biology), 70 million DNA bases (Mb) are transferred; for bread wheat, 8000 Mb. Because such a large amount of genetic material is transferred using conventional techniques, the linking of desirable and undesirable traits can be problematic. With (rDNA) technology, only a few genes and flanking regulatory sequences are transferred, usually no more than 20 kilobases. As a result, variability in offspring can be reduced and uncertainty about linked traits can be almost eliminated. The time and labor needed to produce a new variety using rDNA techniques is also significantly less than that required using conventional techniques. Unquestionably the most controversial difference between conventional and rDNA techniques, and also the characteristic that gives rise to the most promising benefits, is that only genetically engineering allows the reliable transfer of genetic material from unrelated plants and even from organisms from different taxonomic kingdoms. For example, genes from bacteria, viruses, chickens, and moths have been added to potatoes.

The rapid development and commercialization of agricultural applications of rDNA technology has provided society little time to consider and accept GMOs. While estimates of the extent of commercialization differ, all consistently reflect the explosive expansion of genetically modified crops. The first genetically modified commercial crops were planted in 1995. Already by 1999, over 60 percent of the U.S. food supply was thought to contain genetically modified ingredients (Bereano and Kraus, 1999). By 2004, 57 genetically engineered plants were available for human consumption in United States (USFDA, 2011).[4]

Data from the U.S. Department of Agriculture (USDA) illustrate that the planting of genetically engineered crops continued to grow throughout the first decade of the 21st century. By 1998, USDA reported 15 percent of the cotton and 18 percent of the corn planted in the United States were derived from seeds that were genetically modified using rDNA technology with genes to produce Bt toxin for pest-resistance (USDA, 2010b). By 1999, more than 40 percent of the acres in the United States planted for corn, upland

[4] The Food and Drug Administration (FDA) proposed a regulation to "require that developers submit a scientific and regulatory assessment of the bioengineered food 120 days before the bioengineered food is marketed" (Food and Drug Administration 2001). Subsequently, FDA issued guidance but no binding regulations.

cotton, and soybeans were planted used genetically modified seeds. By 2010, almost 90 percent of these crops were genetically engineered (Figure 1).

Worldwide, the planting of genetically modified crops grew from 4.3 million acres in 1996 to about 100 million acres in 1999; approximately eight percent of the total worldwide acreage of major crops. In 1999, 81 percent of these crops were planted in the United States; however, more than 40 different genetically modified crops were planted in eight developed and four developing countries (Bereano and Kraus, 1999). In 2010, an estimated 366 million acres of genetically engineered crops were planted in 29 countries, marking an 87-fold increase in area planted since 1996, and thirteen counties planted more than one million acres (James, 2010).[5] Between 1996 and 2010, almost 2.5 billion cumulative acres of genetically engineered crops are estimated to have been planted worldwide, an area equivalent to almost ten percent the land mass of the United States (International Service for the Acquisition of Agri-biotech Applications, 2011).

[5] Countries planting more than 1 million acres of genetically engineered crops in 2010 were (in decreasing order) USA, Brazil, Argentina, India, Canada, China, Paraguay, Pakistan, South Africa, Uruguay, Bolivia, Australia, and the Philippines.

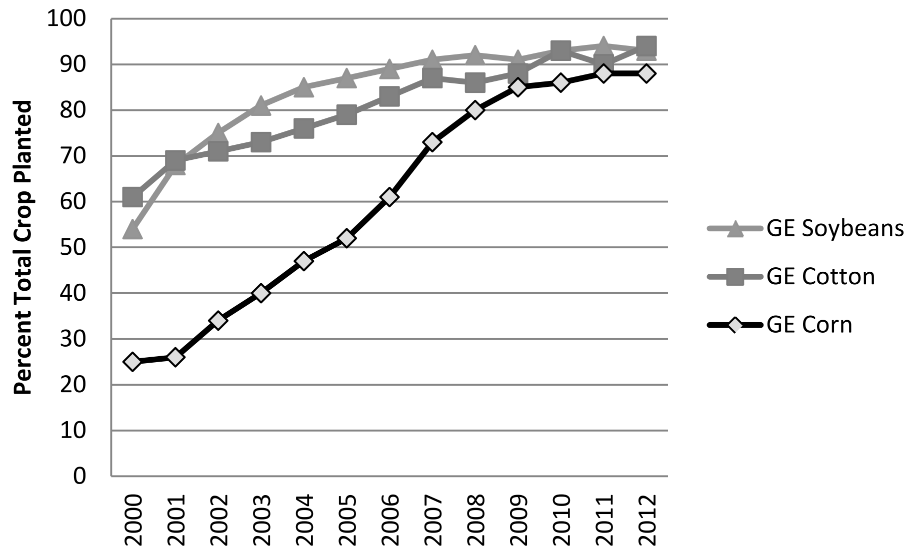

Figure 1. Growth of genetic engineered major crops (corn, upland cotton, and soybeans) in the United States: 2000-2012
(Data from USDA, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008a, 2009, 2010a, USDA, 2012)

2. OVERSIGHT AND REGULATION OF GENETICALLY MODIFIED ORGANISMS

The nature of government oversight and regulation for genetically modified crops and food varies greatly among U.S. government agencies and among the United States, Europe, and international frameworks. The different oversight approaches reflect different missions, public sentiment, and political considerations and result in both dramatically different outputs of agencies and rates of expansion of genetically modified crops and foods.

United States

U.S. laws distribute the responsibility for regulating genetically modified organisms among the U.S. Environmental Protection Agency (EPA), the USDA, and the FDA (Table 1). This “Coordinated Framework for the Regulation of Biotechnology” (OSTP, 1986) is based on the principles that (1) biotechnology techniques are not inherently risky, (2) biotechnology should not be regulated as a process, and (3) biotechnology products should be regulated in the same way as products developed using other technologies.

The U.S. policy considers existing law generally adequate and regulates products, not processes. It assumes that genetically modified organisms are not fundamentally different from non-genetically modified organisms. This position was supported by the

National Research Council (National Research Council, 2000). The U.S. approach is considered a “science-based risk approach” that utilizes available information and expert opinion to assess whether a genetically modified organism poses unacceptable risks, and if so, how to mitigate those risks through the regulatory and approval process.

Table 1. U.S. biotechnology regulatory framework

Agency	Jurisdiction	Laws
U.S. Department of Agriculture	Plant pests, plants, and veterinary biologics	Plant Protection Act
U.S. Food and Drug Administration	Food, feed, food additives, veterinary drugs, human drugs, and medical devices	Federal Food, Drug, and Cosmetic Act
U.S. Environmental Protection Agency	Microbial and plant-pesticides, new uses of existing pesticides, and novel microorganisms	Federal Insecticide, Fungicide and Rodenticide Act; Federal Food, Drug and Cosmetic Act; Toxic Substances Control Act

U.S. Environmental Protection Agency

Under the Federal Insecticide, Fungicide and Rodenticide Act (Fifra, 1996) EPA does not regulate the genetically engineered plant itself. Rather, EPA regulates plant incorporated protectants (USEPA, 2001), which are the “pesticidal substances produced by plants and the genetic material necessary for the plant to produce the substance” (USEPA, 2007). Under the Federal Food, Drug and Cosmetic Act (Food Quality Protection Act, 1996), EPA establishes tolerance limits for substances, including pesticides, in food and feed. Under the Toxic Substances Control Act (Tsca, 1976), EPA regulates the use of new organisms or new uses of microorganisms with DNA from dissimilar source organisms (inter-generic).

Authorization procedures under these laws are similar. Assessment of environmental and health risks are required under each law. The assessments are based on data submitted to EPA by the registrant (including toxicity testing) and information in the scientific literature (USEPA, 2003a, USEPA, 2003b). EPA's scientists review data on potential effects of a plant incorporated protectant, toxicity, allergenicity, skin and eye irritation, cancer, birth defects, and reproductive and neurological system disorders. Studies often also are peer reviewed by an independent scientific advisory panel. The EPA's written policy:

> "… encourages the development and use of biopesticides… Since biopesticides tend to pose fewer risks than conventional pesticides, the EPA generally requires much less data to register a biopesticide than to register a conventional pesticide. In fact, new biopesticides are often registered in less than a year, compared with an average of more than three years for conventional pesticides." (USEPA, 2003b)

Between 1996 and April 2011, EPA registered approximately 174 plant incorporated protectants in genetically modified plants (Figure 2).

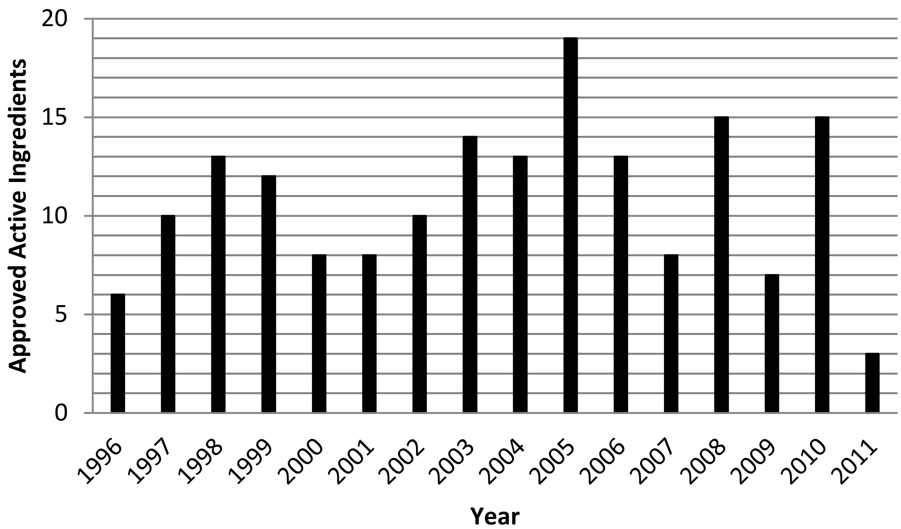

Figure 2. New biopesticide active ingredients approved by the EPA: 1996-2011
(USEPA, 2011)

U.S. Food and Drug Administration

The U.S. Food and Drug Administration (FDA) regulates novel foods under the Federal Food, Drug, and Cosmetic Act to control foods “adulterated” with added substances, including natural substances. FDA reviews the overall composition of nutrients and toxicants in genetically modified plants and the characteristics of food products, not new methods to produce them. The FDA strongly encourages companies to develop information and to consult with FDA to determine if a formal regulatory review is warranted based on the stability of the genetic material in the introduced plant, compositional and nutritional quality, and the potential for toxicity and allergenicity (USFDA, 1992).

By March 2001, almost 50 genetically engineered plants completed the consultation process with the FDA and were available for human consumption in United States. While the rate of consultations recently decreased, more than 80 genetically engineered plants had completed the consultation process by the end of 2011 (Figure 3). The FDA does not require labeling. To the consumer, genetically modified foods and foods derived from genetic engineering in the United States are indistinguishable from conventionally produced food (Shoemaker et al., 2003). Consequently, a USDA report concluded that already by 2006 “U.S. consumers have been eating foods that contain [genetically modified] ingredients (corn meal, oils, sugars) for the past 10 years while remaining largely unaware of their [genetically engineered] content” (Fernandez-Cornejo et al., 2006:1).

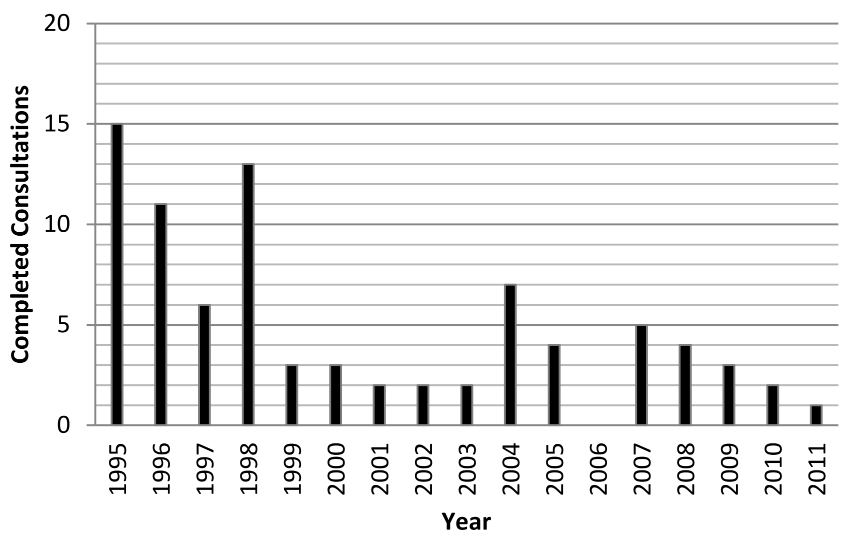

Figure 3. Completed FDA consultations on bioengineered foods: 1995-2011
(Data from USDA, 2011b)

U.S Department of Agriculture

The Animal and Plant Health Inspection Service (APHIS) of the USDA establishes procedures for "introducing" a regulated article in the United States. The regulations include procedures for permits, notifications, and non-regulated (e.g., commercial) status for the import or movement of organisms that are listed as, or altered by, plant pests. The USDA regulates genetically engineered organisms under the Plant Protection Act (Title IV Plant Protection Act, 2000)[6] using a two-tiered system that includes a notification and a permit procedure. Under the notification procedure, a genetically engineered plant may be introduced (including importation, interstate movement, or environmental release) without a permit by notifying USDA that the genetically engineered organism meets certain criteria, including (USDA, 2008b):

- It is not listed as a noxious weed;
- The introduced genetic material is stably integrated in the plant genome;
- The function of the introduced genetic material is known and its expression in the regulated article does not result in plant disease;
- The introduced genetic material does not produce an infectious entity or substances likely to be toxic to non-target organisms, or produce products intended for pharmaceutical or industrial use;
- The introduced genetic sequences are unlikely to create any new plant virus;
- The plant has not been modified with genetic material from an animal or human pathogen.

If a plant does not meet USDA's criteria, a firm must submit scientific information to USDA for review to obtain a permit. All regulated introductions of

[6] The Plant Protection Act of 2000 (Title IV Plant Protection Act 2000) combined the authorities of several previous acts, including the Noxious Weed Act, the Federal Plant Pest Act, and the Plant Quarantine Act.

genetically engineered organisms must be authorized by APHIS under either its permitting or notification procedures. If a developer has sufficient evidence that a genetically engineered organism “poses no more of a plant pest risk than an equivalent [non-genetically engineered] organism, the developer may petition APHIS to determine non-regulated status for the [genetically engineered] organism.” If the petition is approved, the organism may be introduced without additional USDA regulatory oversight (USDA, 2011a). As of 2011, the USDA had allowed the introduction of more than 15,760 genetically engineered crops in the United States, the vast majority through the notification process (Figure 4).

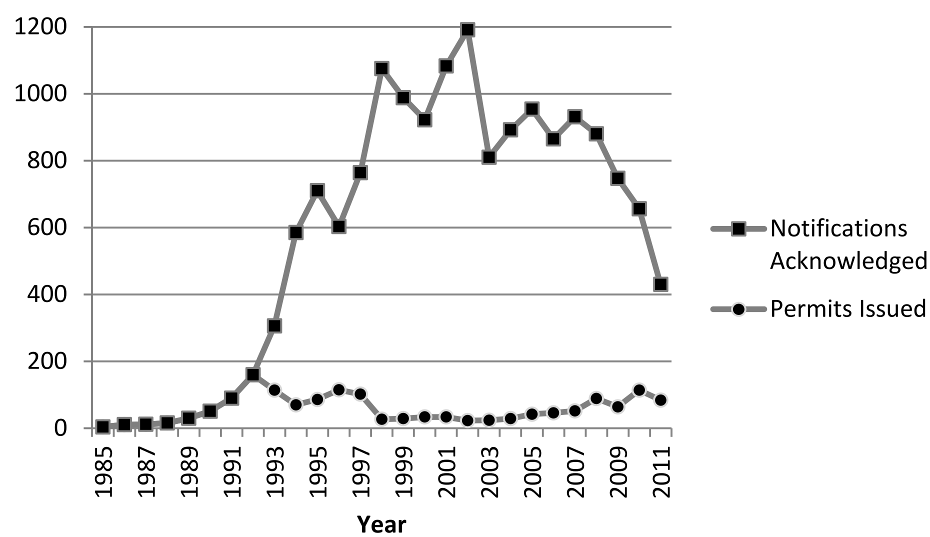

Figure 4. Number of permits issued and notifications acknowledged by USDA for release of genetically modified organisms: 1995-2011
(Data from USDA, 2011b)

Europe

In contrast to the United States, only a relatively few (about 38) genetically engineered plants had been authorized in Europe by 2011, and there are very few food products containing genetically modified ingredients in Europe (European Commission, 2011a) (Figure 5). The differences between the growth of genetically engineered crops in the United States and Europe reflect differences in public opinion (discussed later in this dissertation), regulatory approaches and policies on GMOs, and the political influence of "green" parties in Europe's representative legislatures. Americans also have charged that European policy is a form of "agricultural protectionism" (Bereano and Kraus, 1999).

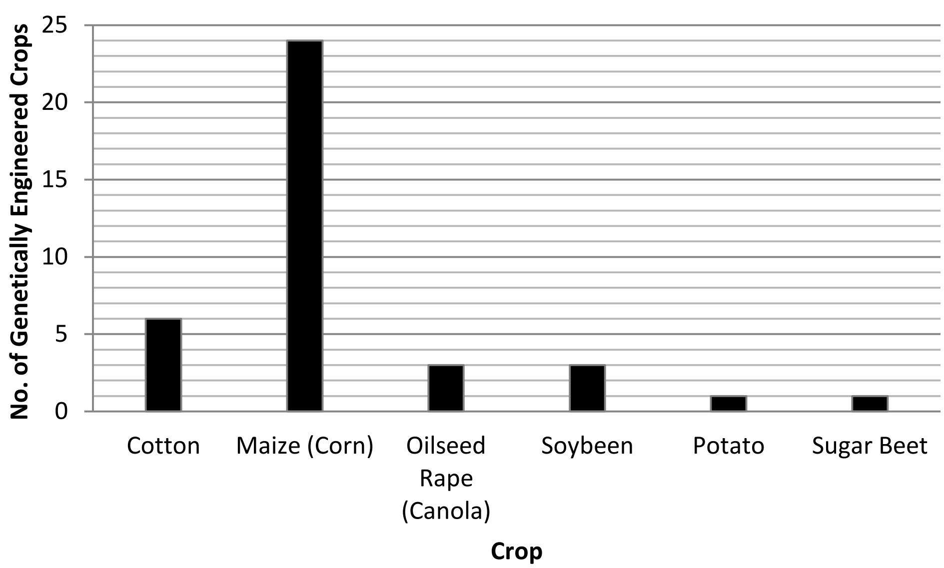

Figure 5. Number of genetically engineered crops authorized by the European Union
(Data from European Commission, 2011a)

In June 1999, the European Union Environmental Council imposed a *de facto* moratorium on commercial releases of genetically engineered crops and foods within the European Community. The moratorium was in response to increased European public concern in the fall of 1996 that was associated with the introduction in Europe of genetically modified soya, the news of the successful cloning of a sheep ("Dolly") in February 1997, and lingering concerns associated with Bovine spongiform encephalopathy (BSE) and European integration (Bauer, 2005c). The moratorium was lifted by the European Union in 2001 and replaced with a new directive (European Community, 2001) and a series regulations (European Community, 2002, European Community, 2003, European Community, 2008)[7] that require:

- Adherence to the "precautionary principle" to "ensure that all appropriate measures are taken to avoid adverse effects on human health and the environment which might arise from the deliberate release or the placing on the market of GMOs;
- Consideration of societal, economic, traditional, ethical, and environmental factors and the feasibility of controls;
- Respecting the requirements of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity;
- Case-by-case environmental risk assessments;
- Monitoring of potential cumulative long-term effects after the deliberate release of GMOs or placing them on the market or in products;
- A step-by-step approach to increasing the scale of a release, but only if evaluation of the earlier steps in terms of protection of human health and the environment indicates that the next step can be taken;
- Field testing at the research and development stage in ecosystems that could be affected; and
- Labeling of products derived from or containing GMOs.

[7] See also the earlier Directive 90/220/EEC, amendments to Directive 90/220/EEC adopted by the European Parliament on 12 April 2000, the amendment of Annex III by Directive 97/35/EC, the Novel Food Regulation 258/97, and regulation numbers 1139/98, 49/2000, and 50/2000.

In 2001, the European Commission authorized a new process for genetically modified organisms that replaced a cumbersome country-specific process with a "one-door – one key" process. The current process requires a scientific assessment by the European Food Safety Authority on environmental, human, and animal risk, procedures for ensuring the traceability of genetically modified organisms, and the labeling of feeds and foods containing genetically modified organisms (European Commission, 2001a). In Germany, where no food producers process genetically modified food that would require labeling, food producers have developed extensive quality systems and pay additional costs for raw materials, analytical testing, and personnel to ensure their supply chain and products are free of ingredients that include or are derived from genetically modified organisms (Hirzinger and Menrad, 2005). In addition, six European countries (Austria, France, Greece, Hungary, Germany and Luxembourg) currently provisionally restrict or prohibit genetically modified organisms under a safeguard clause (Article 23) of Directory 2001/18/EC (European Commission, 2011b).

Importantly, the different approaches to regulating genetically modified organisms in Europe and the United State reflect more than differences in scientific requirements, which are actually very similar. Rather, they are grounded in "differing social values and political conditions for agriculture" (Ervin, et al., 2000:6-7). The "science-based risk approach" in the United States places the weight of evidence on the government — the underlying assumption being that release of a genetically modified organism is substantially safe unless there is strong evidence it will cause harm. The European Union's precautionary approach reverses the burden of evidence, with the underlying assumption that release of a genetically modified organism into the environment or included in food should be allowed only if there is substantial evidence that it is safe.

International Policy

The most significant international instrument on genetically modified organisms is the Convention of Biological Diversity (United Nations, 1992a). Articles 15, 16, and 19 of the 1992 Convention on Biological Diversity specifically address international policy for biotechnology. Article 15 of the Convention recognizes “the sovereign rights of States over their natural resources,” and the need to share their benefits. Article 16 requires that “access to and transfer of technology to developing countries shall be provided and/or facilitated under fair and most favorable terms, including on concessional and preferential terms where mutually agreed ….” Article 19 of the Convention addresses the handling of biotechnology and distribution of its benefits, including developing countries’ participation in research. Article 19 also calls for consideration of “a protocol setting out appropriate procedures, including, in particular, advance informed agreement, in the field of the safe transfer, handling and use of any living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity.” The most important provisions of the Convention regarding biotechnology include:

- The requirement that countries adopt regulations to conserve their biological resources;
- The legal responsibility of governments for the environmental impact in other countries of activities within their jurisdictions, including those of private corporations;

- Through the Global Environmental Facility, financial and technical assistance and capacity building to developing countries for implementing the Convention
- Transferring technology to developing countries on a preferred basis;
- Participation in biotechnology research and fair access to benefits derived from biotechnology research by countries providing genetic resources;
- Compensation to developing countries for extraction of their genetic resources.

The Convention was signed by 168 countries and regional entities. As of 2011, there are 193 parties to the Convention (countries that have ratified, accessed, accepted, approved, or where the Convention is in force as a result of succession by a newly independent state) (Convention on Biological Diversity, 2011b).[8]

Pursuant to Article 19, the Conference of the Parties to the Convention on Biological Diversity held its Second Ordinary Meeting, November 6–17, 1995 in Jakarta, Indonesia and established an open-ended working group to draft a protocol on biosafety. The working group was charged specifically with "focusing on transboundary movement of any living modified organism resulting from modern biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity [and] appropriate procedure for advance informed agreement" (Convention on Biological Diversity, 1995). The working group met six times between July 1996 and February 1999.[9] Following the sixth meeting, the workgroup submitted a draft protocol for

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[8] The United States originally signed the Convention of Biological Diversity but did not become a Party, despite the opinion of many that the Convention is "the best overarching tool to protect species, habitats, and ecological processes important to human well-being," and that the United State arguably already implements most if not all of its provisions (Snape 2010:6).

[9] In chronological order, the meetings were 22–26 July 1996, Aarhus, Denmark; May12–16, 1997, Montreal, Canada; October 13–17, 1997, Montreal, Canada; February 5–13, 1998, Montreal, Canada; August 17–28, 1998, Montreal, Canada; and February 14 –19, 1999, Cartagena, Colombia.

consideration by the Conference of the Parties, which held its First Extraordinary Meeting to consider the biosafety protocol, February 22–23, 1999, in Cartagena, Colombia. Negotiations over specific provisions of the protocol were contentious and the protocol was not completed during this first meeting. The Conference of the Parties decided to resume consideration of the protocol in Montreal, January 24–29, 2000. This second meeting was preceded by regional and interregional informal consultations July 1, 1999 in Montreal, September 15–19, 1999 in Vienna Austria, and January 20–23, 2000 in Montreal. On January 29, 2000, the Conference of the Parties met in Montreal and adopted the Cartagena Protocol on Biosafety (Decision EM-I/3). The protocol opened for signature at the United Nations Environmental Program Office at Nairobi May 15–26, 2000, and at United Nations Headquarters in New York from June 5, 2000 to June 4, 2001. It entered into force on September 11, 2003 (Convention on Biological Diversity, 2011a) and as of 2011 was in force in 160 states and government organizations (Convention on Biological Diversity, 2011b).[10]

The objective of the Biosafety Protocol is to "protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology." The protocol calls for advance informed agreements between exporting and importing countries "to ensure that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms

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[10] The United States is not a Party to the Convention on Biological Diversity and therefore cannot become a Party to the Cartagena Protocol on Biosafety (U.S. Department of State 2003b).

into their territory." The protocol (Convention on Biological Diversity, 2011a) specifically refers to the precautionary principle 15 of the Rio Declaration on Environment and Development (United Nations, 1992b), and established "a Biosafety Clearing-House to facilitate the exchange of information on living modified organisms and to assist countries in the implementation of the Protocol."

3. PUBLIC OPINION

Biotechnology has received significant media attention in both the United States (Ten Eyck, 2005) and Europe (Bauer, 2005a). Newspaper coverage of biotechnology in the United States has been characterized as generally neutral or positive (Miller et al., 2003). While strong vocal opposition continues from environmental advocacy organizations, public interest groups, and organic farmers, overall public concern in the United States appears to be somewhat muted when compared to the volume of the debate in Europe. A review of public opinion research conducted over the last 15 years in the United States and Europe provides an overview of the nature of the debate on modern biotechnology.

United States

Despite robust media coverage,[11] focus groups and polls indicate that Americans' interest in and awareness of food biotechnology has been consistent and relatively low. Hallman and Metcalfe (1994) conducted a telephone survey in 1993 of 604 New Jersey residents on their beliefs and attitudes toward agricultural biotechnology. Almost half (48 percent) of the participants reported they had read at least something about genetic engineering and 91 percent reported that they were knowledgeable about how food was

[11] See Bauer et al. 2001. Also see Ten Eyck 2005

grown or produced. Slightly more respondents reported that genetically modified organisms pose no threat (46 percent) than believed that they could reproduce and harm the environment (40 percent). The vast majority of respondents (84 percent) believed that genetically modified fruits and vegetables should be labeled to allow consumers to make informed purchasing decisions. While a majority of respondents seemed generally supportive of genetic engineering, it is clear that few really understood the technology well enough to make informed opinions. Only 28 percent [correctly] reported that they had eaten a fruit or vegetable produced through conventional cross-fertilization or cross-breeding, 17 percent [incorrectly] believed they already had eaten a genetically modified fruit or vegetable (none yet were available at the time of the survey), and 50 percent believed that conventional plant hybridization and animal cross-breeding were morally wrong.

Participants in national focus groups sponsored by the FDA in 2000 indicated "uneven knowledge and understanding" of biotechnology (Levy and Derby, 2000). Most participants anticipated some potential benefits of biotechnology, including "feeding the world's hungry, improving agricultural production to make it cheaper and easier to grow crops, and making possible new varieties of foods with desirable characteristics such as improved taste, appearance or nutritional characteristics." Many focus group participants were concerned, however, about "unknown long-term health consequences," and that "consumers are being used as Guinea pigs." Some participants also expressed concern that the government might not "have the ability to counteract the powerful profit motives of industry and producers," and over the "lack of public information and public input to a major development in the quality of their food supply"(p.8). Qin and Brown (2006) observed similar results among participants in focus groups on genetically modified salmon.

Finucane and colleagues (2000) conducted a national telephone survey between September 1997 and February 1998 of approximately 1, 200 individuals in the United States to investigate gender and racial differences in risk perception. The survey asked respondents to rate their perception of risk to participants and their families from 13 hazardous activities and technologies, risks to the general public from19 health and safety hazards, and risk to the public from eight potential food hazards, including genetically engineered crops.[12] The survey also asked a series of questions on demographics, socio-political factors, and worldviews. The results indicated that men overall, and particularly white men, significantly and consistently perceived lower risks than white women, non-white men, and non-white women. Men were about 10 percent less likely than women to indicate a high risk for crops genetically engineered to resist pests. Race also appears to be a factor in risk perception as non-whites typically ranked hazards as high risks significantly more often than did white respondents; about17 percent more frequently for genetically engineered crops. Finucane and colleagues attributed their results to white males having a greater trust in technology and less trust in government than the other

[12] The eight food hazards were eating fatty foods, hormones/antibiotics in meat, pesticides in food, bacteria in food, crops genetically engineered to resist pests, food imported from other counties, eating red meat, and getting Mad Cow disease from eating beef.

groups studied. White males also indicated stronger “hierarchal, individualistic, and anti-egalitarian views” (p. 170).

Teisl et al. (2002) published results from six demographically selected focus groups held in three cities U.S. cities: Orono, Maine; Columbus, Ohio; and Phoenix, Arizona. Like Levy and Derby, Teisle, and colleagues found that most participants had little knowledge of genetic engineering. Many confused modern biotechnology with conventional crossbreeding and use of hormones and growth stimulants. Participants also reportedly underestimated the variety and amount of genetically modified foods in the United States. In addition, while some participants reportedly “seemed upset because they felt that they should have known this information [about the prevalence of genetically modified foods],” other seemed “comforted” because they “combined the fact that [genetically modified] foods are prevalent with the notion that they had not heard or known of anyone getting sick as positive news” (p.7). Almost all participants reportedly supported mandatory labeling, “because consumers have a right to know what goes into their bodies. However, this feeling was not unanimous; some participants felt that if the food was tested as safe to eat then it should not need a label” (p.8).

Between December 2002 and February 2003, Ten Eyck (2005) conducted a national telephone survey of 855 respondents. A large majority of the respondents (71 percent) agreed that modern biotechnology would provide benefits in the production of foods (increase their protein, keep longer, or improve the taste). More than 75 percent of the respondents agreed that agricultural biotechnology could decrease the use of pesticides and increase food output. Interestingly, 55 percent also indicated that food biotechnology posed some risk.

From 1999 to 2005, a small majority of Americans (51 to 53 percent) consistently rejected the notion that “foods produced using biotechnology pose a serious health hazard to consumers” (Gallup, 2011, Gallup News Service, 2000). The number of Americans who responded that these foods pose a serious health hazard increased insignificantly from 27 percent in 1999 to 33 percent in 2005, coinciding with a 7 percent decrease in the percentage of Americans expressing no opinion (Table 2).[13]

Table 2. Americans' belief that foods produced using biotechnology pose a serious health hazard to consumers: 1999-2005
(+/- 4%)

	1999	2000	2001	2003	2005
Poses a serious health hazard	27%	30%	30%	34%	33%
Does not pose a serious health hazard	53%	51%	53%	54%	54%
No opinion	20%	19%	17%	12%	13%

(Data from Gallup, 2011)

Gallup polls indicate that support in the United States for the use of biotechnology in food or agriculture dropped between 1999 and 2005. About 51 percent of Americans expressed support for food and agricultural biotechnology in 1999, decreasing to about 45 percent in 2005. In 1999, 41 percent moderately or strongly responded against the use

[13] Gallup’s typical sample size for its national telephone polls is 1,000 adults, with a margin of error +/- 4 percent (Gallup 2010). Consequently, these reported changes in Americans’ opinions about genetically modified organisms may be statistically insignificant.

of biotechnology in food and agriculture, with reported opposition to its use rising from 10 percent in 1999 to 45 percent in 2005. A swing in the center resulted in increased reported opposition to biotechnology: a decrease in Americans who expressed moderate support for biotechnology and an increase in those expressing moderate opposition. The percent of Americans who responded they were strongly opposed or strongly supported the use of biotechnology changed little over this period (Table 3). Gallup polls also indicate that approximately 40 percent of Americans followed food biotechnology closely or somewhat closely in the news, while 60 percent did not follow biotechnology too closely or at all (Table 4).

Table 3. Americans' support for the use of biotechnology in agriculture and food production: 1999-2005

	1999	2000	2001	2003	2005
Strongly support	9%	12%	9%	9%	9%
Moderately support	42%	36%	43%	38%	36%
Moderately oppose	25%	23%	24%	27%	29%
Strongly oppose	16%	18%	14%	18%	16%
No opinion	8%	11%	10%	8%	10%

(Data from Gallup, 2011)

Table 4. Extent to which Americans follow the news about biotechnology: 2001-2003

	2001	2003	2005
Very closely	11%	9%	9%
Somewhat closely	34%	32%	31%
Not too closely	33%	34%	35%
Not at all	21%	25%	25%
No opinion	1%	*	*

(Data from Gallup, 2011)

According to a 2001 survey (Blizzard, 2002), only about 30 percent of Americans responded that they actively tried to avoid foods produced using biotechnology. Groups most likely to report that they avoided genetically modified foods included non-whites (39 percent), Americans with incomes between $20,000 and $29,000 a year, and those with no more than a high school education (36 percent). To put this in context, however, the survey results indicated that 39 percent of Americans avoided foods grown with pesticides, 62 percent avoided fat, 50 percent avoided artificially sweetened foods, and 52 percent did not even think about genetically modified foods.

In a 2008 national telephone survey, however, 53 percent of Americans reported they would be not very likely or not at all likely to buy food labeled as genetically modified. The majority (56 percent) of respondents reported they had heard at least something about genetically modified ingredients in food, and 87 percent of the respondents believed that foods containing genetically modified foods should be labeled as such (CBS News/New York Times, 2008). In an unscientific 2011 MSNBC internet poll, over 96 percent of the 45,554 respondents indicated that labeling of genetically modified foods is “an ethical issue — consumers should be informed so they can make a choice” (MSNBC, 2011).[14] Yet, only 9 percent of respondents to a 2010 telephone survey ranked genetically modified crops as the man-made health hazard that worried them most, far less than respondents who were most concerned over hormones and antibiotics

[14] Internet polls such as this frequently lack external validity, are subject to significant participant self-selection and bias, and are designed to provide symbolic representation: “Audiences of poll rituals are also political participants because they see their own interests represented by the poll” (Kent et al. 2006 303).

in meat and dairy products (29 percent) or second-hand smoke (25 percent) (CBS News/New York Times, 2010).

The agriculture technology industry sponsored a series of opinion polls between 1997 and 2010 (IFIC, 2001, IFIC, 2006, IFIC, 2007, IFIC, 2008, IFIC, 2010).[15] These surveys indicate that Americans generally remain uninformed about food biotechnology, reporting that about half of Americans have insufficient knowledge to have either a favorable or an unfavorable opinion or to have a preference. Approximately 60 percent of respondents indicated they heard of or read little or nothing about biotechnology, or do not know of any foods produced through biotechnology that are currently in supermarkets.

A 2005 poll comparing sentiments in the United States, Canada, and Europe found people in the United States more apt than either Canadians or Europeans to believe that genetically modified foods are useful for society, morally acceptable, and pose minimal risk. Americans also expressed greater confidence in their regulatory arrangements than either Canadians or Europeans (Gaskell et al., 2006).

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[15] The results of these industry-sponsored surveys indicate higher support for biotechnology than suggested by the results of other polls; however, the organization's research has been strongly criticized. Notably, questions regarding consumer preferences are couched in terms of purchasing genetically modified foods that convey particular benefits, such as better taste or nutritional value. One watchdog organization stated: "*IFIC* [International Food Information Council] *is a public relations (PR) organization funded by junk (and toxic) food companies and chemical companies… that information supplied by IFIC often comes directly or indirectly from the manufacturer and is often blatantly and provably inaccurate. The company which conducted the "carefully-worded" survey, Wirthlin Group … is conducting research to determine ways to manipulate consumers and lawmakers in Europe and the U.S.… They recently won the Olgivy Award for "research excellence in support of creative and successful advertising campaigns." It looks like Monsanto and their well-paid associates are sparing no expense to create an inaccurate image of genetically-manipulated foods*" (Mindfully.org 1999).

Europe

The European Commission uses the Standard Eurobarometer Surveys to "take[s] the temperature of public opinion in the [European Union] on a broad range of topics and provide[s] revealing insights into the perceptions and needs of European citizens" (European Communities, 2003). Questions on biotechnology were included in surveys conducted in 1992, 1993, 1996, 1999, 2003, 2005, and 2010 (European Commission, 2001b, Gallup Organization; Hungary, 2003, Gaskell et al., 2003, Gaskell, et al., 2010, Gaskell, et al., 2006, INRA Europe, 2000). The results of these surveys indicate generally consistent but complex European public attitudes toward biotechnology and science.
As illustrated in Figure 6, while Europeans generally and consistently responded optimistically that most new technologies would improve rather than adversely affect their way of life, the overall trends indicate relative distrust for biotechnology and genetic engineering, [16] which consistently fell near the bottom of the list of technologies evaluated in the surveys. In fact, Europeans generally responded more pessimistically about only nuclear energy.

[16] The two terms "biotechnology" and "genetic engineering," did not appear together in individual questionnaires; rather, half the questionnaires included one term and the other half the other term. It is interesting to note the difference in the responses to "biotechnology" and "genetic engineering" throughout the survey. The differences in scores may reflect nuances in translation and/or individuals' subjective semantic associations for these terms.

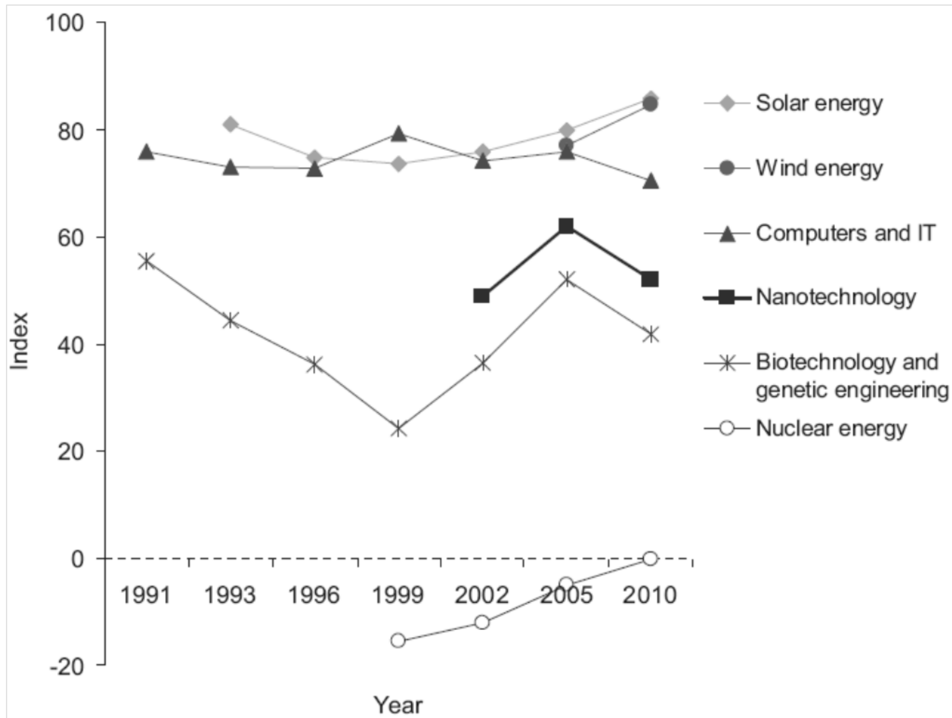

Figure 6. Index of European optimism of six technologies
(figure from Gaskell et al., 2011, Gaskell et al., 2010:18)

Positive scores indicate more optimists than pessimists. The index is calculated by subtracting the percentage of pessimists from the percentage of optimists, and dividing the difference by the cumulative percentage of optimists, pessimists, and those who say the technology will have no effect. Individuals who responded “don’t know” were excluded.

The percentage of Europeans who responded that biotechnology would improve their lives dropped from 50 percent in 1996 to 41 percent in 1999, which represented the lowest point in Europeans’ optimistic responses about biotechnology. From 1999 through 2005, Europeans overall optimistic responses for biotechnology rose to 52 percent, with all but one country showing an increase. By 2010, responses indicating confidence in biotechnology dropped again (Table 5), but due to an increase in the percentage of people who responded they were pessimistic about biotechnology and genetic engineering, the percentage that responded they were optimistic remained nearly constant at 53 percent. Only three countries show increased in responses indicating optimism over this period: Finland, Greece, and Cyprus. With the exception of 1999, the percentage of optimistic responses has held relatively constant, around 50 percent.

Table 5. Percent of Europeans responding they were optimistic and pessimistic that biotechnology would improve their lives

	1991	1999	2005	2010
Optimists	50%	41%	52%	53%
Pessimists	11%	23%	12%	20%
No effect	Not asked	Not asked	13%	7%
Don't know	39%	36%	22%	20%

(Data from: Gallup Organization-Hungary, 2003, Gaskell, et al., 2003, Gaskell, et al., 2010, Gaskell, et al., 2006, INRA Europe, 2000)

The 1996 survey found that only 11 percent of people within European Union countries responded they "feel adequately informed on biotechnology;" 35 percent mistakenly responded that "ordinary" non-genetically modified tomatoes do not contain genes, and 39 percent responded they would sign a petition against biotechnology. Only 22 percent of Europeans indicated they would buy genetically modified fruits or cooking oil made from some genetically modified soy. A slight majority of respondents (53 percent) indicated they would be willing to pay more for non-genetically modified food. Less than half (45 percent) responded they felt that government adequately regulates biotechnology. Only 3 percent listed national public authorities as being their most reliable source of information on biotechnology. Gender, age, income, education, religiousness, socio-professional variables, and the frequency that respondents discuss modern biotechnology affected survey responses. Results varied considerably among the 15 European Union nations.

The survey conducted in 1999 found a similar pattern of socio-demographic variables associated with European Union citizens' outlook for new technologies.[17] Average scores were higher (i.e., more optimistic) for men than women, decreased with age, increased with income and education, and were highest for students and managers. European Union citizens who claimed to be extremely religious were relatively supportive of biotechnology. Those who considered themselves "anti-religious" responded most positively about genetic engineering; people who considered themselves "not really religious" had an a slightly lower average score. People with incomes in the first quartile were the most positive about biotechnology. Average support for genetic engineering was less among those with incomes in the second quartile than respondents with incomes in the third or fourth quartiles. In addition, the survey found that people who speak frequently about genetic engineering are more negative than those who have only spoken about the topic only a couple of times.

The 1999 survey also revealed marked differences in the kinds of biotechnology applications and issues most salient to respondents (Table 6).

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[17] Statistical significance was unreported.

Table 6. Salience of biotechnology applications among Europeans - 1999

Biotechnology Application	Salience
Animal cloning and human beings	43%
Scientific research – health – technological development	33%
Do not know	28%
Genetically modified food	28%
Ethical or philosophical questions	16%
Environment	08%

(Data from INRA Europe, 2000)

When asked their opinions about more specific applications of and issues with biotechnology, people from European Union nations generally felt positive about scientific research related to health and the environment, but more negative about cloning, genetically modified foods, and ethical or philosophical questions. European Union nations again differed in the influence of socioeconomic variables on support for modern biotechnology.

Results for 1999 found that people from European Union nations generally had a poor understanding of biotechnology and perceived genetically modified foods as more risky and less morally acceptable than other biotechnology applications. The survey asked a series of nine true-false questions to gauge respondents' level of knowledge about biotechnology. A majority of Europeans knew the correct response to only three questions. The survey also asked about the usefulness, risks, and morality of, and whether development should be encouraged for, each of seven biotechnology applications.[18]

[18] The seven biotechnology applications evaluated were: 1) improve food taste/nutrition, 2) gene transfer for pest resistance in crops, 3) detecting hereditary diseases, 4) cloning animals for production of

Europeans did not support further development of only one of these seven applications: biotechnology to improve food taste/nutrition. While the weighted average responses indicated people from European Union countries considered all seven applications risky, Europeans felt most strongly about the risk associated with use of biotechnology for improving food taste/nutrition.

On average, Europeans agreed that three biotechnology applications were morally acceptable: detecting hereditary diseases, developing genetically modified bacteria for cleaning up hazardous chemicals, and the production of pharmaceuticals. Europeans were almost neutral (slightly accepting) on the morality of therapeutic cloning of human tissue and gene transfer for pest resistance in crops. They considered the use of biotechnology morally unacceptable when used to improve food taste and nutrition and for cloning animals for production of medicines/vaccines. Europeans strongly agreed with statements such as "even if animal cloning has advantages, it is basically against nature" and "[genetically modified] food threatens the natural order of things." The rejection of biotechnology in foods was consistent across European Union nations.

Eurobarometer 55.2 and the Candidate Country Eurobarometer 2002.3 examined European public opinion on science and technology in 2002.[19] As indicated in Table 7,

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medicines/vaccines, 5) therapeutic cloning of human tissue, 6) production of pharmaceuticals, and 7) developing genetically modified bacteria for cleaning up hazardous chemicals.

[19] Eurobarometer 55.2 and the Candidate Countries Eurobarometer 2002.3 focused on Europeans' experience and perception of science and technology, including biotechnology. Eurobarometer 55.2 surveyed 16,029 people between May 10 and June 15, 2002 from the 15 European Union member states. The Candidate Countries Eurobarometer surveyed 12,247 people in November 2002 from 13 countries

the results from the candidate countries were similar to those from European Union countries, with a few exceptions.

Table 7. European public opinion on science and technology

	European Union (percent agreeing)	Candidate Countries (percent agreeing)
GMOs are dangerous	54	52
Do not want genetically modified food	71	68
GMOs may have a negative effect on the environment	59	51
Want to have the right to choose	95	85
Want to know more about this kind of food before eating it	80	86
Well informed about science and technology	33	27
Interest in science and technology	45	35
Interest in developments in medicine	60	51
Interest in developments in the environment	52	46
Interest in economics and social sciences	22	32
Scientific information is too pessimistic	37	42
Journalists are poorly trained to report on science	53	70
Science changes our way of life too fast	61	67

(European Commission, 2001b, Gallup Organization-Hungary, 2003)

The extent to which people from candidate and European Union countries felt well informed about science and technology was similar. People from both European Union and candidate nations felt informed about sports, culture, and politics, but poorly informed about science and technology, and economics and finance. People from candidate countries, however, were relatively uninterested in science and technology; ranking science and technology above only economics and finance and politics among five issue areas. As in European Union countries, medicine and the environment were the

applying for European Union membership: Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, and Turkey.

two scientific/technical disciplines of most interest to people from candidate countries. People from candidate countries responded that they were more interested in economics and social sciences than people from European Union countries.

The survey identified small differences among people from European Union and candidate countries in their sources of scientific information. Television was by far the preferred source of scientific information in both European Union and candidate countries (60 percent and 71 percent, respectively) and 41 percent of people from candidate countries preferred radio to the printed press (27 percent) as their secondary source of scientific information. Preferred sources of scientific information were generally consistent across European Union nations: 37 percent preferred radio and 27 percent prefer the press.

An overwhelming majority of Europeans in both European Union and candidate nations generally supported and were optimistic toward science and technology, but nearly half felt that science and technology could not solve all problems, and there was large variability among countries. Europeans from both European Union and candidate nations felt scientists had high social esteem (second only to doctors) and the greatest credibility among seven occupational categories.[20] Majorities in both European Union and candidate countries felt that while science is morally neutral, scientists share

[20] The seven occupational categories are scientists, medical doctors, environmental protection associations, journalists, government representatives, consumer organizations, others (spontaneous) and companies.

responsibility for the use of their discoveries and scientists should conform to ethical standards.

Eurobarometer 58.0 indicates that by 2002 European opposition to agricultural biotechnology may have stabilized.[21] After declining for almost a decade to a low of 41 percent in 1999, Europeans did not appear to have significantly changed their opinions about biotechnology in 2002, when 43 percent indicated they were optimistic (the reported change is within the confidence limits of the survey, around +/- 3 percent). Pessimism about biotechnology did appear to fall over this period, however, from a high of 23 percent in 1999 to 17 percent in 2002. Noteworthy is the finding that almost all European Union countries moved in the same direction, all with positive indices for the relative proportion of optimistic to pessimistic individuals. Europeans' support for biotechnology was most closely associated with age, technology optimism, belief in economic progress, trust in government, and involvement with biotechnology.

The trend in optimism toward the general concept of biotechnology, however, did not transfer to genetically modified food or crops. Opposition to genetically modified foods remained strong, with a majority of Europeans indicating that they felt it to be not useful, too risky, morally unacceptable, and that it should not be encouraged. Curiously, Europeans' opposition toward genetically modified crops was not as strong as their opposition to genetically modified foods. While most Europeans still felt that genetically

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[21] The representative survey of approximately 16,500 respondents (approximately 1000 in each of the 14 European Union member states) was conducted September-October 2002.

modified crops were risky, they also saw them as potentially useful, were not morally opposed to them, and encouraged their development. One interpretation of this data is that Europeans may have been more concerned with health than environmental issues. These findings are consistent with those of Qin and Brown (Qin and Brown, 2006), who found that the provision of detailed information about biotechnology (genetically modified salmon) led focus group participants to envision more consequences and benefits than participants in focus groups that did not receive the detailed information. They also support Schwartz's norm activation theory, which predicts that the moral norms that will be most activated are those that have the most direct envisioned consequences for people (Schwartz, 1968).

An analysis of questionnaire responses from 36,510 consumers from the United Kingdom who participated in the "public debate" revealed that respondents fell into three significant attitudinal clusters (Table 8)[22]

Table 8. GMO-related attitudinal clusters found in UK "public debate"

Cluster No./Name	Percent Respondents
Implacably opposed to GM	47 percent (16,996)
Somewhat opposed to GM	32 percent (11,789)
No fixed position on GM	12 percent (4,240)

(Heller, 2003a)

[22] An independent analysis suggested that the "extent of outright opposition to [genetically modified] food and crops amongst the UK population is probably lower than indicated in the GM Nation [public debate]." The analysis also found that participants in the debate were not representative of the general U.K. public in terms of either their demographics or their perspectives on genetic engineering (Horlick-Jones et al. 2006).

Clusters 1 and 2, while both broadly anti-genetically-engineered-organisms (“agreeing with the potential risks of GM, and disagreeing overwhelmingly with the potential benefits of GM”) differed in the relative strength and breadth of their opposition (Heller, 2003a). Participants in Cluster 1 agreed with participants in Cluster 2 about the potential risks to the environment, long-term health effects of genetically modified food, lack of confidence in government regulation, and skepticism about profit driven development. Participants in Cluster 1 formed a greater consensus across all questions than those in Cluster 2 and were more likely to strongly agree or strongly disagree with a statement. Participants in Cluster 3 were more positive than participants in either Cluster 1 or Cluster 2 about the potential benefits of genetically modified organisms, especially benefits in medicine and in the developing world. Compared to participants in Clusters 1 and 2, participants in Cluster 3 were less likely to have participated actively in the public debate and had greater proportions of participants younger than age 34 and older than 65. More men than women comprised Cluster 3, while women were the majority in Clusters 1 and 2.

The results of the 2010 Eurobarometer survey indicate a continued public uneasiness toward genetically modified foods (TNS Opinion & Social, 2010a), as shown in Table 9.

Table 9. European attitudes toward genetically modified foods – 2010

Are fundamentally unnatural	70 percent
Makes them feel uneasy	61 percent
Should not be encouraged	61 percent
Is unsafe for their health and that of their family	59 percent
Is unsafe for future generations	59 percent
Pose an unacceptable risk	58 percent

(TNS Opinion & Social, 2010a)

The result of the European public opinion research indicates that attitudes and perceptions about science and biotechnology are varied and extremely complex, both within and among nations. These attitudes are likewise associated with a number of socio-demographic variables, such as age, gender, education, employment, level of scientific knowledge, religion and religiousness, and therefore may reflect different individual and cultural value systems.

Influences on Public Opinion

A number of studies focused on understanding survey results and public opinions on genetically modified organisms. Several have addressed issues such as methodological bias, lexicon, media influence, perceptions of risks and benefits, knowledge of science and biotechnology, trust in industry and environmental groups, and confidence in government and regulators. Several studies document racial and gender differences in environmental health risk perceptions: white men consistently perceive risks significantly lower than women and non-white men (Finucane and Holup, 2005, Finucane, et al., 2000, Flynn et al., 1994). In these studies, white men were better educated, had higher household incomes, and were politically more conservative than other groups. Public perception of high food-related risks also has been related to the perceived severity and awareness of the hazard, and smallness of quantities need for and the immediacy of adverse effects, the perceived unnaturalness of the food, and a lack of knowledge concerning an issue (Fife-Schaw and Rowe, 1996).

Horlick-Jones et al. (2006:282-83) argued that surveys may overestimate the extent of outright opposition to genetically engineered foods and crops; when considering deployment of a new technology, the mere action of asking individuals — who have no well-conceived stake in an outcome or familiarity with issues and arguments — may result in responses that lean toward cautiousness. Surveys in Europe show that the use of different terms yields different results that are statistically significant (Gaskell, et al., 2010; also see note 12). Results from focus groups (Levy and Derby, 2000) and textual analysis of newspapers in the United States (Miller, et al., 2003) indicate that while the terms "genetically engineered," "genetically modified," and "bioengineered" all acceptably describe the technology, each term conveys a somewhat different connotation, with biotechnology perceived as the least negative.

In the United States, surveys indicate that consumers' generally view genetically engineered foods and crops as inherently different and potentially more risky than conventionally bred foods. Consumers prefer different labels for foods produced using biotechnology and have different perceptions of risk, depending on the nature and specificity of perceived consumer benefits. One argument for labeling genetically modified foods and foods containing genetically modified ingredients is that it would increase consumers' "illusion of control" and thereby reduce their perception of risk.

Results from a study by Frewer and colleagues (1996), however, found that realistic exposure of consumers in the United Kingdom to genetically modified foods does not increase their acceptance: genetically engineered foods were considered less natural than conventionally engineered foods. In addition, purported tangible health and environmental benefits had a more positive influence on consumers' likeliness to purchase genetically engineered food than did lower prices or increased shelf life. Similarly, the perception of risk by consumers in the United States was not changed significantly by the provision of information about specific benefits (Brown and Ping, 2003). Qin and Brown (2006) found comparable results among focus group participants.

Differences in the public's perception of biotechnology in the United States and Europe may have several origins (Hallman, 2001). European confidence in governments' ability to protect their food supply has been shaken by a variety of crises, including bovine spongiform encephalopathy (BSE or mad cow disease) (Joss, 2005), Dutch pig plague, Belgian dioxin contaminated chicken and Coca Cola, and hoof and mouth disease. Europeans also have strong cultural ties to their agricultural practices and cuisine and are resistant to potential threats to their cultural identity. Preserving cultural diversity and the cultural identity of European food and European agriculture may provide a strong basis for European rejection of biotechnology (Palfreman, 2000). It is also possible that many European legislatures do not consider biotechnology as economically essential, and perhaps even detrimental to local economies. Since most agricultural biotechnology companies originate in the United States or are multinational, Europeans may fear biotechnology as being economically invasive without domestic political accountability.[23]

In Europe, the organization and influence of environmental groups may increase the salience of potential risks from biotechnology, while in the United States, the intensity of information campaigns about the potential risks associated with the technology appears somewhat subdued. The environmental movement in Europe has also been very much more successful in gaining political representation than it has in the United States (Brossard and Nisbet, 2006). In some European countries, there is significant Green Party representation in their legislatures, while there has never been a Green Party representative in the U.S. Congress, and few in state legislatures. More extreme environmental positions, e.g., “hard greens” generally viewed as anti-industry and anti-technology, also may have greater public support in Europe than in the United States.

The lack of support for the biotechnology industry from small farmers with traditional influence on national regulatory authorities may contribute to the success of the efforts by European environmental groups to impede agricultural biotechnology. The decline of traditional family farms in the United States also may facilitate the influence of industry relative to environmental groups’ opposition to agricultural biotechnology, thereby increasing the influence of large biotechnology firms on key regulatory agencies

[23] According to a European Union study, the agricultural biotechnology sector was undergoing “a rapid globalization and consolidation process ... characterized by a large number of mergers, acquisitions and joint ventures” (European Union 2001).

and politicians.[24] The different historical and current land-use patterns in the United States and Europe also may contribute to different environmental values. For example, in the United States, agricultural land may be viewed by many as outdoor “food factories,” while in many European countries lacking large natural open spaces, agricultural land is considered potential wildlife refuges.

A study by Areni et al. (1999) provides evidence for the influence of agricultural history and culture on the acceptability of genetically modified crops. They found that the controversy over genetically modified rice in the Philippines revolves around food security, health and ecological risk, ethics, and intellectual property rights. They also suggest that the failure of the “Green Revolution,” introduced into the Philippines in 1969 to address poverty and social problems, has undermined Filipinos’ confidence in new technologies generally and the institutions that promote them. Areni and colleagues’ survey of opinion leaders in the Philippines revealed important differences in the perspectives among government officials and politicians, non-governmental organizations, and scientists from private companies about Bt rice. Non-governmental organizations and networks were generally opposed to agricultural biotechnology, feeling that the risks were high and the potential benefits low. Government officials were “ambivalent” (split) on their perception of risks and benefits, but generally agreed that

[24] The declining influence of small farmers and the increasing influence of large agricultural business (although not related to biotechnology) is reflected in an August17, 2001, article in the Washington Post (Lancaster 2001). The article describes how large agricultural corporations are successfully lobbying Congress to provide subsidies to large corporate livestock operations for managing animal waste. The original $200 million USDA program, established to help small farmers with 2500 or fewer animals, would increase to $1.2 billion, with operations of any size eligible for up to $50,000 in assistance per year.

genetic engineering can address both agronomic problems and structural problems associated with the Philippines rice industry. The final group, dominated by scientists from private companies and international research organizations, was modestly favorable toward biotechnology.

Based on recommendations by the independent Agricultural and Environment Biotechnology Commission, the United Kingdom Secretary of State for the Environment, Food, and Rural Affairs sponsored a public debate, surveys, and a series of workshops in 2003. The purpose of this public debate was to provide a “chance for the British people to come forward and say what they felt about a new technology – genetic modification – and commercial growing of genetically modified crops in this country” (Heller, 2003b:10). Participants in the debate expressed concern over:

- Citizens’ and consumers’ ability to determine the future of their food and environment (specifically, the need for precaution, the possibility of depriving the ability to choose “an organic future,” and the risk of contamination by genetically modified organisms);
- Big business and “multi-nationals” influence over governments, science and research, and the media;
- Impacts on developing countries;
- The power and influence of the United States, for example, on international bodies such as the World Trade Organization;
- Value judgments about the best future for society and the environment;
- Rights to change the course of nature and to impose the consequences of such changes on people and other species that lack sufficient power to resist them.

Before initial in-depth deliberative workshops, biotechnology was not very salient among the participants. At the conclusion of a second workshop, however, the majority of participants expressed misgivings over biotechnology, even after acquiring substantial and balanced information on biotechnology though the workshop process (Corr Willbourn Research and Development, 2003).

An important finding from this work was that the public in the United Kingdom viewed genetically modified organisms as a combination of scientific, environmental, economic, political, and ethical issues, all of which were important:

> “They do not regard science and scientific method, or economics and economic analysis, or academics or politicians, or any other discipline as a single source of evidence and guidance. The public seek and trust expertise and authorities which accords with their own arguments and values” (Heller, 2003b:18).

Several researchers have studied the role media may play in shaping European public opinion on biotechnology. Bonfadelli (2005) observes that few people actually have any experience with biotechnology because it is so complex and abstract. Consequently, most people will obtain their information on science and technologies from modern mass media. The effect of mass media on public perception depends not only on the content of the information provided, but also on the context within which it is delivered, “the passivity of news producers, the amount of news information available, and the intentions of the audiences” (Bauer, 2005c:12). Media may change public opinion (socialization effect) or confirm and attract extant opinions (reinforcement or selection effect). Media influences the “collective passions” of the public over an issue, which affects how we perceive both issues and their potential solutions (Bauer, et al., 2001:35).

Brossard and Nisbet (2006) conducted a poll in June and July 2001 of 1,500 residents of New York State. They asked respondents about their support for and the sources from which they acquired information about agricultural biotechnology, including local and national newspapers; scientific magazines; television science programs; television news; and non-profit organization, university, and activist-run internet sites. In addition to demographic data, they also asked respondents about their general and scientific education, ideology, deference to scientific authority, reservations about the impacts of science, and degree of trust in the sponsors of biotechnology (including representatives from industry, government officials, and university scientists).

The results showed that older individuals, men, and more highly educated respondents tended to defer (either directly or indirectly) to scientific authorities and expressed trust in sponsors and knowledge about and support for agricultural biotechnology.[25] Income was positively related to a greater variety of information sources, negatively related to concerns over the impacts, and indirectly related to increased knowledge about and support for agricultural biotechnology. Attention to newspaper articles and heterogeneity of news sources were only weakly and indirectly related to support for agricultural biotechnology. Attention to television news had neither a direct nor an indirect relationship with support for agricultural biotechnology. While the absence of a direct media influence on support for agricultural biotechnology was surprising, the indirect influence of media was consistent with the Orientation–Stimulus–Orientation–Response (O–S–O–R) model:[26]

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[25] The level of education is related to deference to scientific authority, which appears to be used a heuristic that leads to support for biotechnology.

[26] According to the O–S–O–R model, "[the first] 'O' represents long-term socialized value predispositions. The 'S' represents the stimulus of media consumption and attention across types of news outlets and other information sources. [The second] 'O' signifies intervening orientations or behaviors between stimulus and

> “The more attention citizens paid to media coverage of agricultural biotechnology (with the exception of TV news), the more they knew about the science specific to the debate. And the more they knew about the science of agricultural biotechnology, the more supportive they were of the technology.” (Brossard and Nisbet, 2006:43).

Knowledge about biotechnology had a far smaller impact on support for agricultural biotechnology than did deference to science, trust in institutions, and general feelings about the impact of science, which among the general public likely serve as heuristics for pre-forming and orienting value prepositions. Of these, deference to science had the most significant influence on support for biotechnology. The more positivistic conceptualization of science in the United States than in Europe may explain some of the differences between U.S. and European public opinion on agricultural biotechnology.

Besley and Shanahan (2005) analyzed a poll of 888 respondents from New York State between 10 March and 1 July 2003. Their findings generally are consistent with those of Brossard and Nisbet: a positive relationship between support for agricultural biotechnology and age, education, gender, conservatism, biotechnology awareness, and trust in institutions and scientists. Their results, however, suggest a small but significant positive influence of television news, science television, and entertainment television in support of agricultural biotechnology.

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outcome, such as knowledge and trust, or generalized reservations about science. The ‘R’ represents the final outcome of both sets of orientations and the communication stimuli, in this case, public views about agricultural biotechnology” (Brossard and Nisbet 2006:27).

Ten Eyck (2005) compared content analyses of newspaper articles (New York Times and Washington Post) with the results of the 2003 national public opinion telephone survey discussed earlier. He found that a large majority of Americans (78.1 percent) had heard about modern biotechnology and 65.4 percent had discussed the topic. Respondents reported that they most frequently received information on biotechnology from television (58.1 percent), newspapers (49.3 percent), and the Internet (27.7 percent). The survey also asked respondents about their trust in the main actors associated with biotechnology. Ten Eyck found little relationship between respondents' trust in the main actors and the frequency with which newspaper articles mentioned the main actors, and a complex and mixed relationship between media coverage and support for biotechnology. From this, Ten Eyck concluded, "people do have the ability to interpret information in their own way" (Ten Eyck, 2005:312) and are not just passive receivers of media content.

Bauer and his colleagues (2001) conducted a detailed content analysis of articles on biotechnology in elite newspapers in Europe, the United States, and Canada. They analyzed the intensity of coverage, genre and writing formats, argumentative frames, themes, and actors. Their analysis identified the following genre and writing formats:

Latest news	Editorial
Investigative reporting	Outside commentary
Interview	Reviews of books, films, etc.
Column	Other

Their content analysis also identified the following categories of main argumentative frames,[27] themes ("basic classes of application of biotechnology"), and actors.

Frame	Main Theme	Main Actor
Progress	Biomedical ('red')	Independent science
Economic prospect	Agrifood ('green')	Interest groups, NGOs
Ethical	Generic research	Politics
Pandora's Box	Economics	Moral authorities
Nature/nurture	Moral issues	Media/public opinion
Public accountability	Public opinion/policy	Business
Globalization	Regulation	International
Runaway	Genetic identity	EU
	Cloning	Other

As Bauer and colleagues explained, argumentative frames provide a "discursive space" for elaborating and orienting an argument and usually involve a metaphor for highlighting central points:

> "… a frame is often associated with an actor who favours a particular frame because it offers an argumentative advantage in the public debate. Frame analysis shows that public controversies are as much about how to argue a topic as about disagreements within a particular frame. With different framing the topic appears in a different light, hence sponsors compete in elaborating frames which show their take on a topic most clearly." (Bauer, et al., 2001:40)

The results of the content analysis of leading newspapers revealed that prior to 1996/1997, the highest percentage of articles "celebrated biotechnology in terms of

[27] Bauer and colleagues characterize the frames as follows: "progress" involves scientific, technical or cultural advancement; "economic prospect" includes articles about profitability and investments; "ethical" involves value judgments that are "'too important to be left to the scientists and the engineers"; "Pandora's box" codes articles that urge caution; nature/nurture reflects genetic breakthroughs related to human characteristics, such as sexual preferences; "public accountability" addresses responsibility and involvement in decision-making; "globalization" concerns national standing in research and development; and "runaway" reflects the sentiment that "the public debate is helplessly lagging, leaving little freedom of choice" Bauer et al.:40-41.

progress and economic prospects" with the main focus on biomedicine, agrifood, general genetic research, and identity-related issues such as genetic fingerprinting or genetic testing. After 1997, the percentage of articles that focused on progress and economic prosperity decreased, while the percentage increased for articles dealing with precaution (Pandora's box), public involvement and accountability, international competition and globalization, and concerns that the public has been left out of the decision making and it is too late to do anything (slippery slope). In addition, while varying significantly across countries, after 1997 there was a substantial overall increase in the percentage of articles that focused mostly on the potential risks of agricultural and food biotechnology; articles before 1997 discussed both potential benefits and risks.[28] On the other hand, most articles about biomedical biotechnology consistently discussed only potential benefits.

The content analysis also revealed a number of notable associations between actors and biotechnology themes, and between themes and argumentative frames. The analysis showed that of the main actors, scientists, businesses, and politicians predominated about 80 percent of the articles, while NGOs and interest groups were featured in only about 5 percent. These numbers cast some doubt on the public role of

[28] Brossard and Nisbet point out that the news media in the United State began to convey negative impressions of agricultural biotechnology in response to a study on the impact of genetically modified crops on the Monarch Butterfly in 1991 and to the contamination of the food supply by StarLink corn (a genetically modified corn that was not approved for human consumption) in 1999. Neither of these two events precipitated prolonged or high profile media coverage as stories about ethical issues or technology risks. Rather, the press generally relegated these stories to business and science correspondents who treated the events as industry and regulatory issues.

activists in inflaming the European debate over genetically modified crops and foods after 1997.

Biomedical applications were most closely associated with science and scientists; cloning most closely associated with moral authorities (such as the Vatican or national or international ethics committees) and public opinion; and agricultural and food biotechnology with businesses, interest groups, and regulatory authorities. Biomedical applications of biotechnology themes were closely related to progress and nature/nurture frames. Cloning was associated with ethical arguments. Agricultural and food biotechnology was most closely associated with discussions of economic prospects, globalization, or public accountability. Little changed in these associations across the two time periods studied, with one notable exception: after 1997 agricultural and food biotechnology moved closer to the runaway and Pandora's box discourses, likely reflecting the increased controversy over genetically modified crops and food.

The results of Bauer and his colleagues also illuminated significant differences between the United States and Europe in the increased number of biotechnology-related newspaper articles (Figure 7). Only the United Kingdom had more articles on biotechnology in leading newspapers (652 articles) than the United States (419 articles) over the 1992-1996 period. Like all other countries studied, the number of articles in the United States on biotechnology increased (to 652) in the 1997-1999 period. As illustrated in Figure 7, however, the increase in coverage in the United States was relatively small compared to the increase in coverage in Europe and Canada. Five countries (Austria, Germany, France, Italy, and the UK) had overall more articles on biotechnology than the

United States in the 1997-1999 period. For example, Germany and Greece experienced approximately a 600 and 750 percent increase in coverage, compared to only a 56 percent increase in the United States.

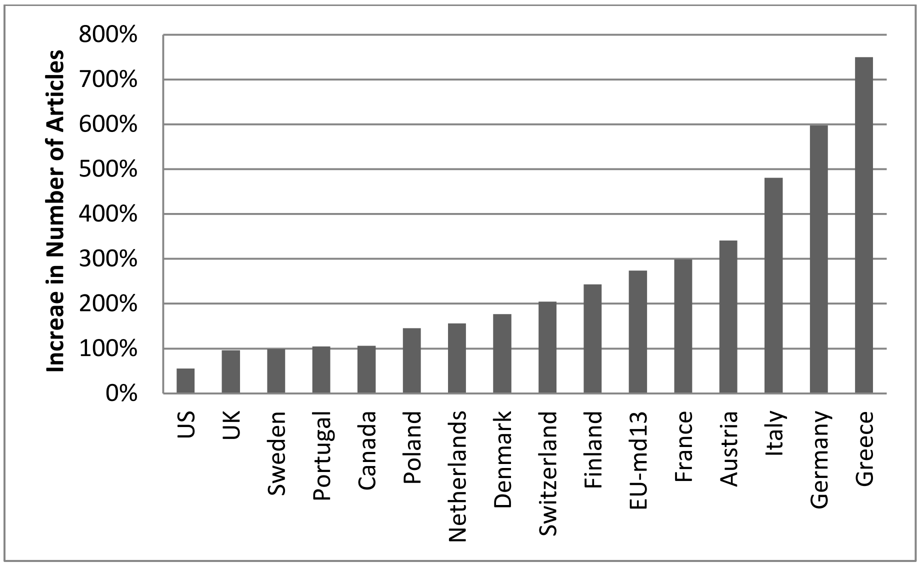

Figure 7. Percent increase in number of newspaper articles on biotechnology from 1992/1996 to 1997/1999 in Europe and North America
(Data from Bauer, et al., 2001)

In addition to the increase in the number of articles on biotechnology over the two periods studied in Europe, the content analysis revealed an overall increase in article length, cross-references to genes and genetic engineering, and in the diversity of formats (for example, changing from mostly articles coded as “latest news” to articles coded as columns, editorials, and commentaries). The length and diversity of article formats remained relatively consistent in the United States over the two time periods analyzed.

Bauer (2005c:6) described biotechnology as a social movement, “the outcome of and input into social processes,” which are characterized by:

- Mobilization of support (such as state funding, researchers, capital, and public sentiment) through “imagination, scenarios, and reasoned arguments”;
- Many diverse projects without fixed common goals or historical necessity (“the future is open”);
- Large numbers of actors in the biotechnology movement who interact with the public sphere to influence and shape attitudes and perceptions and who compete with each other for public attention and favorable regulations.

As illustrated in Figure 8, Bauer sees the public sphere as a “communication system … where interested actors mobilize attention in public arenas: in the arenas of regulation and policy-making, in the outlets of the mass media, and in the locations of everyday conversations and perceptions.”An advantage of Bauer’s model is that it is safeguards against reductionist research and interpretations by recognizing that public perception, media coverage, and public policy are not isolated from each other; rather, they co-occur and are interrelated. Surveys not only serve as a synoptic measure of public opinion but, as “published observations, they become important inputs to the public opinion process.”

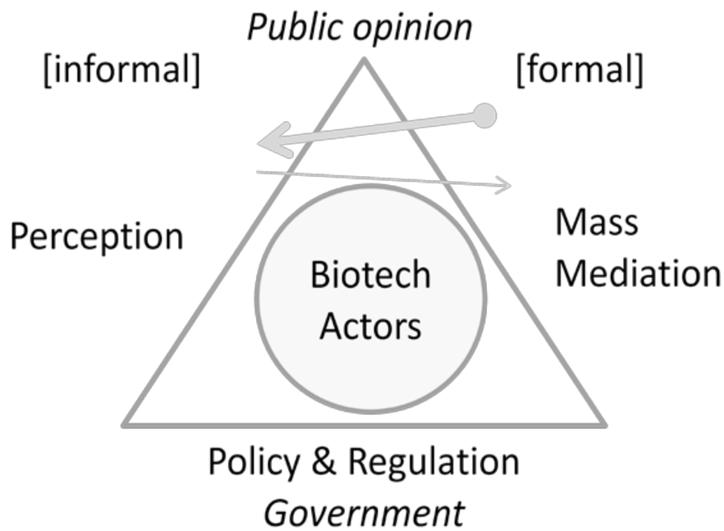

Figure 8. Heuristic for researching the public sphere of technology
(From Bauer, 2005c)

These aspects of the public sphere usually differ in both their attention cycle and content. When they do coincide, media may influence public perception asymmetrically though the timing, distribution, and the framing of information and attitudes. This infrequent co-incidence results in an amplification or resonance that:

> "… not only selects issues from a multitude of alternatives, reflected in the fluctuating salience of biotechnology in the mass media, but also re-presents [sic] these selected issues in a particular light of framing, argumentation and imagery that inform attitudes to biotechnology," (Bauer, 2005c:9)

The way in which the public perceives risk — how risk is socially amplified or attenuated —results from an interaction between the nature of the potential threat and the communication about it, and the socio-cultural context within which the risk event is experienced and the information received:

> "… risks are interactive phenomena that involve both the biophysical and social worlds. Risk involves threats of harm to people and nature but also to other things or ends that people value, such as community or political freedom. As the joint product of impacts on human health and nature and perturbations in social systems and value structures, the human experience of risk is simultaneously an experience of potential harm and the ways by which institutions and people process and interpret these threats. These interpretations generate rules by which society and its subgroups should select, order, and explain signals concerning the threats emanating from human activities." (Kasperson and Kasperson, 1996:96)

The volume of the risk communications, whether it is disputed, dramatized/sensationalized, and whether it carries any symbolic connotations, all influence how risk is received within an institutional and socio-cultural context. Social, institutional, and cultural context influence how risk information is "interpreted, it's meaning diagnosed, and values attached" (Kasperson et al., 1988:185). Social, institutional, and cultural heuristics and values simplify an individual's process of evaluating and determining how to respond to risks. Risk perception also is believed to be influenced by an individual's core values, which also influence the salience and integration of information encountered in the media and other experience, the framing of issues, and development of more specific attitudes (Stern et al., 1999).

In the 1990s, Bauer led an international research project that used both content analysis and attitude surveys to assess the intensity, salience, and structure of opinions represented in the media and public discourse, and the relationship between media and public opinion on biotechnology (Bauer, 2005a).[29] One team of researchers evaluated the effect of the intensity of media coverage on European public opinion. A second research effort evaluated whether changes in media coverage moderated knowledge gaps, and also studied relationships among media coverage, knowledge about genetic engineering and biotechnology, and demographic variables. A third effort evaluated the role of the media in the public's distinction between and attitudes about biotechnology and genetic engineering associated with medicine and attitudes associated with food and agricultural biotechnology (the "red/green debate"). All three of the research projects discussed below shared a common database[30] and used a combination of approaches to analyze multiple empirical foci:

- Mass media: analysis of elite newspapers from 1973 to 1999;
- Public perception: surveys in 1996 and 1999; and
- Focus groups in participating countries.

Importantly, research teams mutually understood that no components of the empirical model illustrated in Figure 8 — policy-making, public opinion, and media coverage — stand in isolation from any other: each is an input, output, and moderator of the others.

As part of Bauer's international research project on modern biotechnology in the public sphere, Gutteling (2005:23) tested Allan Mazur's observation that "the rise in

[29] The project encompassed 12 European countries: Austria, the United Kingdom, Denmark, France, Finland, Germany, Greece, Italy, the Netherlands, Portugal, Sweden, and Switzerland.
[30] The study used public opinion data from Eurobarometer 46.1 (1996) and 52.1 (1999). Data selected from each survey included attitudes to four applications of biotechnology, knowledge of biotechnology, newspaper readership, message discrimination and prior engagement with biotechnology, and socio-demographic information.

reaction against a scientific technology appears to coincide with a rise in quantity of media coverage, suggesting that media attention tends to elicit a conservative public bias." He compared attitudes toward biotechnology among readers and non-readers of elite newspapers in Europe and correlated public opinion with the intensity and content of coverage across 12 European countries. The results did not support the hypothesis that readership is "systematically related to the attitude toward biotechnology." In 10 of the 12 European countries (Denmark and the Netherlands were the exceptions), readers of elite newspapers were more supportive of biotechnology than nonreaders. Readers of both elite newspapers and popular newspapers, however, generally saw greater risks associated with biotechnology than did nonreaders. In addition, Gutteling found little evidence to support a relationship between the intensity of media coverage and public opinion on biotechnology.

Bonfadelli (2005) explored the hypothesis that better educated, socio-economically advantaged people will acquire knowledge from media at a faster and qualitatively higher rate than people with less education and lower socio-economic status. Contrary to the ideal, that media can reduce information asymmetries in society, the knowledge gap hypothesis predicts that the media contributes to an ever-widening gap between rich and poor. Researchers disagree, however, whether empirically observed gaps are due to differences in both the direct effect of education on knowledge about biotechnology and an independent indirect influence of education on general interest and motivation (deficit model), differences in education on biotechnology leading to knowledge gaps (difference model), or that motivation and education interact and mediate biotechnology knowledge acquisition (contingency model). To study the knowledge gap hypothesis, Bonfadelli used survey data from 17 European countries (1996 and 1999 Eurobarometers), similar surveys conducted in the United States and Canada, and content analysis of the press coverage between 1992 and 1999 on biotechnology. Importantly, 1996 has been characterized as a "watershed year," when European public opinion about modern biotechnology shifted markedly following introduction into Europe of Monsanto's Roundup Ready Soya in August 1996, and the publication of the cloning of Dolly the sheep in February 1997 (Bauer, et al., 2001).

Bonfadelli's results show only a modest level of knowledge about biotechnology among Europeans, which was significantly lower than the knowledge levels found in the United States or Canada. The correlation between education and knowledge about biotechnology is high, consistent with the knowledge gap hypothesis. No consistent relationship was observed between knowledge about biotechnology and the intensity of media coverage. Respondents who reported receiving media information on biotechnology, however, scored about 25 percent higher in their level of knowledge than those without access to media information. In general, knowledge about biotechnology increased over time and correlated strongly with the differences in national education rankings. Bonfadelli also found a statistically significant relationship between educational level and interpersonal communication about biotechnology. The results support the deficit model in that both education and motivation appear to be working independently in the same direction, with education having significantly more influence on knowledge about biotechnology than motivation. While overall knowledge increased, knowledge gaps in 10 of 12 countries decreased despite significantly increased media coverage between 1996 and 1999. The greatest decreases in knowledge gaps were in countries with only modest increases in media information, however, and knowledge gaps increased in those countries with the largest increase in media coverage of biotechnology. Taken together, Bonfadelli's findings generally support the knowledge gap hypothesis.

Bauer (2005b) examined the effect of the media on attitudes, public opinion, and regulation in Europe and the cultivation of a distinction that developed in the 1990s between bio-medical biotechnology ("red" biotechnology) and biotechnology in food and agriculture ("green" biotechnology). Bauer observed that the choice of terminology (such as old or new, red or green biotechnology) is not just semantic; the different terminologies for recombinant DNA technology reflect and enable different worldviews:

> "For example, the old/new distinction is popular among stockbrokers. Venture capitalists favor the new over the old in search of future profits, while regulators and lawmakers tend to operate conservatively and assimilate the supposedly new to existing and traditional regulations unless pressed to do otherwise" (Bauer, 2005b:65)

The cultivation hypothesis argues that long-term exposure to media content influences public perceptions and worldviews by influencing the symbolic classification of objects and issues. Symbolic classification[31] involves both the inherent ability to make distinctions and the cognitive activity of making perceptual judgments:

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[31] See: Needham 1979.

> "…perception is an intelligent activity that is motivated, and subject to learning and social influence. Concepts are meaningful because of emotional preferences, behavioral tendencies, and social commitments. Thus attitude gives importance to what is referred to; it focuses attention, and evokes and sustains social community. The capacity to make distinctions is universal. By contrast, the symbolic meaning of many a distinction, its connotations, and whether the classification is bi-polar, a triad, or of higher order, may be socially and historically contingent." (Bauer, 2005b:68)

Consequently, the magnitude of differences in attitudes is an index of the "sharpness" of conceptual distinctions and difference in worldview.

Bauer argues that the public learns about new technologies, such as biotechnology, initially in articles printed in the middle pages of quality (or elite) newspapers. As public interest increases, articles move to the front pages and are covered by television, which rapidly and more broadly disseminates the information to a wider public. Thus, readers of elite newspapers were the first members of the public exposed to information on biotechnology. While newspaper articles contain more detailed and extensive content than television, images "control attention, memory, and arousal, and are stronger than written arguments" (Bauer, 2005b:70) and thereby may moderate any cultivation effect of newspapers.

Bauer expected to see significant perceptual differences associated with high press content between red and green biotechnology and readers and nonreaders of elite newspapers. To assess any cultivation effect, Bauer used the data from the 1996 and 1999 public opinion surveys in 12 European countries and analysis of press coverage over the periods 1992-1996 and 1997-1999.[32] Bauer found that press coverage on biotechnology increased dramatically in the late 1990s in all countries studied, with a media four-fold increase. To evaluate the content of the press coverage over these two periods, Bauer used a randomized selection of 7,400 elite press articles that were coded for theme (topic of biotechnology, such as “green agri-food, or red bio-medical biotechnology”) and rated on a 5-point scale (positive or negative connotation). Red (medical) biotechnology was the first order theme in 23.3 percent of the articles and green (agri-food) biotechnology in 18.5 percent.[33]

To demonstrate a cultivation effect, Bauer needed to show: (1) a higher correlation and co-variance between public perceptions and media coverage for those who read elite newspapers than those who do not, and (2) an increased convergence (correlation) of public perception and press coverage over time and among countries. The results of the content analysis showed that overall press contrast increased significantly over the two periods: coverage of green biotechnology became more negative after 1996, while press coverage became more positive for red biotechnology. However, the increase in contrast was inconsistent. Press coverage contrast increased significantly in nine of the 12 countries, reflecting increased differentiation. Contrast decreased in three counties, indicating some assimilation (blurring) of red and green biotechnology. The analysis of

[32] The 12 countries included in the study were Austria, Denmark, France, Finland, Germany, Greece, Italy, the Netherlands, Portugal, Switzerland, Sweden, and the United Kingdom.
[33] Other first-order themes included generic research (10.9%), economics (6.6%), moral issues (2.0%), public opinion (6.1%), regulation (5.7%), genetic identity (12.1%), cloning (5.7%), and other (8.6%).

survey data indicated that public perception was more positive for red biotechnology than for green in both surveys. Public support for agricultural/food biotechnology and medical biotechnology decreased in the late 1990s, however, and the public's view of green biotechnology went more negative than did the public's view of red biotechnology. These results point to increasing perceptual differentiation of worldviews.

Across Europe, both readers and non-readers of elite newspapers increasingly differentiated between red and green biotechnology; however, the results from both the 1999 and 1996 surveys show only insignificant perceptual differences after controlling for sex, education, and prior engagement. The picture appears a little different when comparing data from individual countries. Only 2 of the 12 countries surveyed (Germany and Austria) showed significant perceptual differences in 1996; 6 were significant in 1999. Importantly, only three of the countries with significant difference in 1999 (Switzerland, Sweden, and Greece) moved in the expected divergent direction. The other three countries (Denmark, Austria, and The Netherlands) showed decreasing perceptual distances between readers and non-readers. A regression of changes in press coverage and changes in public perception indicated a significant convergence of press coverage and public perception ($r=0.44$; $n=12$): changes in press coverage accounted for about 20 percent of the changes in public perception. In addition, there was a strong correlation between changes in press coverage and changes in the perception of readers of elite newspapers ($r=0.52$; $n=12$). Further, when four outlier countries were removed from the regression, the correlation increased to $r=0.9$ ($n=8$). This effect was absent (with and without outliers) among non-readers, who although differentiated between red and green biotechnology, were not significantly influenced by the elite press. These results pointed to a significant aggregate cultivation effect: “A differentiating press drives a differentiating elite perception; an assimilating press discourse leads to an assimilating elite perception” (Bauer, 2005b:83).

Bauer’s international research project provided important results on the elite press’ influence on European public opinion about modern biotechnology:

- Public opinion may not be strongly influenced by the intensity of media coverage;
- The media actually may contribute to a widening of a knowledge gap over biotechnology, especially between the more and less educated;
- The nature of media coverage may play a role in shaping European worldviews on biotechnology.

The results of public opinion and media research indicate that the public is not of one mind about individual biotechnologies and the influences on public opinion is varied and complex. Culture, politics, historical events, and individual variables (age, gender, education, life history) surely play roles in shaping individual opinions. Consequently, if the overall objective of public opinion research is to inform public policy or business decisions, research should strive to characterize the diversity of opinions, world views and frames, and beliefs about risks and benefits: “Unless the source of the disagreement is understood, policies and interventions will be misguided” (Fischhoff and Fischhoff, 2001:157).

Fischoff and Fischoff (2001) similarly observed that individuals differentiate among different types and applications of biotechnology. Therefore, researchers must be precise in defining those aspects of biotechnology that they are asking respondents to address. Likewise, in interpreting responses, researchers must seek to understand responses from the perspective of the respondents and not assume respondents share the same interpretation as the researchers. These two considerations also are related to a respondent's level of knowledge about biotechnology. The more people know about a particular class of technology, the finer the distinction they may make between specific individual technologies and applications. Responses to survey or interview will reflect how the questions intersect with a respondent's understanding and level of knowledge about a particular technology.

Even when the research precisely defines the technology, respondents who lack specific knowledge may use a generalized view of the overall technology class, or pick a particular application of a technology with which they are most familiar, as the basis for their responses. In addition, respondents' attitudes may reflect their overall trust in institutions responsible for the technology development and deployment, public and environmental protection, or which position they advocate (business, academia, government, non-governmental and advocacy organizations). Increased knowledge about a biotechnology, however, does not necessarily promote support for a technology (Corr Willbourn Research and Development, 2003). Individuals may support a strong regulatory framework to compensate for limited knowledge about a technology. Finally, public attitudes toward biotechnology reflect an individual's evaluation criteria, such as perceived risks and benefits (and their distribution) and consistency with one's cultural norms, beliefs, morals, and ethics.

4. CONSCIOUSNESS, CULTURE, AND LANGUAGE

In the previous sections, I have described what is currently known about biotechnology, its explosive growth and the controversy that surrounds the it. In the next several sections, I step away from genetic engineering itself and delve into the social problem that it represents: how society and its institutions should respond to the pace of technological change that is an attribute of our modern world. How society makes rational decisions, develops norms, and justifies action are core issues for philosophy, political and organizational science, economics, and sociology. I approach this research in the tradition of what Dunlap described as “cautious constructionism,” acknowledging and referencing both social and environmental factors, and by doing so, attempting to address one of the major criticisms of American environmental sociology, “that it remains highly atheoretical” (Dunlap, 2001:55).

Overview of Meta-Theoretical Approach

Habermas’ “Theory of Communicative Action” (Habermas, 1984, 1985) provides a rich and comprehensive approach to this problematic from a variety of analytic levels, and it is within this theoretical framework that I develop my proposed research. I provide here a rough sketch of what I consider some of the some salient features of the Theory of Communicative Action as related to my research, augmented and refined with my own ideas and those of other researchers and theorists. In my distillation of this theory, I have deliberately omitted several details and arguments, and I fully acknowledge that my limited competency does not do justice to Habermas' seminal work.

The raw materials for the empirical research proposed for my dissertation are operationally identified individual value structures, statistically analyzed to characterize societal and organizational cultural values associated with modern biotechnology, as related specifically to agriculture and foods, which I then compare to examine the prediction of social theories on the incentive structures of government bureaucracies. As such, it is appropriate that I describe the processes by which I understand value formation, reproduction, and maintenance in society, and how these relate to my proposed methodology. I begin with an excursion into first principles of theories of linguistic and cultural evolution because these provide the bedrock on which Habermas' social theory rests. I link Habermas' conceptualization of socio-linguistic-perceptual development with contemporary anthropological theories based on data from archeology, paleontology, comparative anthropology, and primate studies. I discuss Habermas' concept of the "lifeworld," the differentiation of society that began with enlightenment, and then transverse into a general discussion of the roles of and influences on government in liberal capitalistic democracies. Throughout this section, I augment Habermas' general theoretical framework with a selection of empirical and theoretical research that I see as moving along the same trajectory. In this manner, I incrementally lay a foundation on which I ground my research methodology and toward which I direct my analytical questions.

Language, Culture, and Society

> "In communicative action, beyond the function of achieving understanding, language plays the role of coordinating the goal-directed activities of different subjects, as well as the role of a medium in the socialization of these very subjects." (Habermas, 1985:5)

Habermas grounds his *Theory of Communicative Action* on the premise that language and discourse are the is the primary social steering media: language constitutes the fabric of culture, binds society together, coordinates the actions of individuals and groups, and is the primary means through which cultures evolve, spread, and reproduce themselves across generations. The "Theory of Communicative Action" builds on the linguistic theory of George Herbert Mead (1863-1931), the sociology of Emile Durkheim (1858-1917), and the cognitive developmental theory of Jean Piaget (1896-1980). Accordingly, Habermas views consciousness, language, culture, and society as mutually co-embedded phenomena, collectively coevolving through a punctuated continuum of path-dependent perceptual differentiations of the world. Consciousness and language are social in that they depend on and are achieved only though recognizing, interacting with, and understanding the social and physical world that is external to the conscious "self."

Both evolutionarily and developmentally, humans first achieve communication through physical gestures, posture, and simple vocalizations, and later, increasingly sophisticated vocalizations ultimately leading to grammatical verbal speech. In children, the development of language requires an ability to differentiate increasingly between the "self" and the physical and social external world, i.e., between the world of things and the subset of that world that includes other people. A consequence of and accompanying this differentiation is self-awareness, consciousness of the interaction of the self with the external world. The self also interacts reflexively, a development that co-occurs with the objectification of the self. The developing child represents itself as an entity; ergo, the self becomes objectified. According to Piaget, this objectification of the internal and external world is the consequence of a process where:

> "… the universe is built up into an aggregate of permanent objects connected by causal relations that are independent of the subject and are placed in objective space and time. Such a universe, instead of depending on personal activity, is on the contrary imposed upon the self to the extent that it comprises the organism as a part in a whole. The self thus becomes aware of itself, at least in its practical action, and discovers itself as a cause among other causes and as an object subject to the same laws as other objects." (Piaget, 1954: section 1, paragraph 4)

Once 'self-aware,' the developing individual perceives reality through a lens that further differentiates a subjective internal world and the objects (both physical and social) comprising an external world, and perceives spatial and temporal differences between discrete physical and social objects in the external world. Interaction with this differentiated world becomes teleological in that it involves premeditated (i.e., conscious, intentional, and goal-directed) manipulative efforts aimed at achieving some desired outcome: a change in the state of the internal physical world (e.g., one's body, the movement of a limb), the external physical world, and/or the external social world. Manipulation of an objective external physical object requires some form of physical interaction. Manipulation of the external social world can be achieved physically (e.g., pushing someone), through communication oriented toward achieving a reflexive behavior response in others (such as when sounding a generalized alarm), or through coordination of effort with others achieved through communicative acts oriented toward "reaching understanding with one another with a view to consequences" (Habermas, 1985:10).

Along the pathway toward language (both phylogenetically and ontogenetically), initial communicative efforts are predominately accomplished though simple gestures and vocalizations.[34] The progressive transition from "gesture-mediated to symbolically mediated interaction" requires an "attitude of addressing the other" (Habermas, 1985:13). For communication to be successful, i.e., achieving a common understanding, both speaker and hearer must be able to anticipate a certain response from one another. The conscious "self" must correctly interpret and, importantly, anticipate how a social "other" would understand and respond to self's communicative gestures (physical and/or vocal). "Other" must also understand self's communicative intent within the context of the physical and social environment and respond appropriately and with an expectation of self's subsequent response to other. Other's response could be in the form of a communicative or non-communicative (action-oriented) response, or both:

> "When they take this "attitude of addressing the other" toward themselves as well, they learn the communication roles of hearer and speaker; each behaves toward the other as an ego that gives an alter ego something to understand." (Habermas, 1985:13)

[34] Habermas also explicitly accepts this premise : "The conjecture is that they [hominoids] possessed a language of gestures and a system of *signal calls*" [italics in original] Habermas 1979a:117

The development and reinforcement of common rubrics for communication (i.e., rules for grammar, lexicon, and syntax) require both speaker and hearer to anticipate and react to one-another's expression of disappointment and disapproval if the communicative effort fails and understanding is not achieved, or expressions of satisfaction and approval if the communicative effort is successful. This feedback, the capacity for critical response (i.e., expressions of approval/satisfaction and disapproval/disappointment and the capacity to anticipate them), provides the incentives and reinforcement for the learning of rules and meaning conventions for the use of symbols, a necessary step in the both evolution and ontogenetic development of both grammatical speech and normatively bound behavior.

Implicit in each speech act is one or more claims of validity. The validity claim may be in the form of an objective truthfulness, the appropriateness of something based norms or values, or the sincerity of what one communicates. Validity claims of can be disputed, resolved, and understanding achieved through a process of argumentation that is free of coercion, and process leaving to interpersonal understanding.

The Evolutionary Basis for Language's Role in Culture and Society

At this point, I digress somewhat from Habermas' theory *per se.* To further anchor the Theory of Communicative Action, I make an excursion into coevolution (phylogeny) of human language, consciousness, and culture from both cognitive (information processing and storage) and physiological (biophysical and neurological) perspectives. Habermas only alludes to this in "The Theory of Communicative Action." This is not due to a lack of familiarity with the subject, nor to what has been described as sociologists' general rejection of reductionism and hereditarianism, as part of a general strong constructionism effort to "distinguish social and cultural environments from physical and biological environments" (Dunlap and Catton, 1979:245). Habermas' interest in human biological evolution is the extent that it provides pre-adaptations that give rise to socialization. In fact, in an earlier work Habermas specifically addresses the evolutionary biological basis for human social consciousness and socio-cultural evolution:

> "In the last generation anthropology has gained new knowledge about the long (more than four million years) phase during which the development from primates to humans, that is, the process of hominization, took place; beginning with a postulated common ancestor of chimpanzees and humans, the evolution proceeded through Homo erectus to *Homo sapiens*. This hominization was determined by the cooperation of organic and cultural mechanisms of development. On the one hand, during this period of anthropogenesis, there were changes – based on a long series of mutations – in the size of the brain and in important morphological features. On the other hand, the environments from which the pressures for selection proceeded were no longer determined solely by natural ecology, but through the active, adaptive accomplishments of hunting bands of hominids. Only at the threshold to *Homo sapiens* did this mixed organic-cultural form of evolution give way to an exclusively social evolution. The natural mechanism of evolution came to a standstill. No new species arose. Instead, the exogamy that was the basis for the societization of *Homo sapiens* resulted in a broad, intraspecific dispersion and mixture of the genetic inheritance. This internal differentiation was the natural basis for a cultural diversification evidenced in a multiplicity of social learning processes. It is therefore advisable to demarcate the sociocultural stage of development – at which alone social evolution takes place (i.e., society is caught up in evolution) – from not only the primate stage – at which there is a still exclusively natural evolution (i.e., the species are caught up in evolution) – but also from the hominid stage – at which the two evolutionary mechanisms are working together, the evolution of the brain being the most important single variable." (Habermas, 1979a:116-17, italics in original)

Habermas neither explores in detail nor accepts *de facto* the co-evolution of human communication and consciousness; rather, he builds out from this and intentionally focuses on the subsequent socio-cultural derivatives. Importantly, grounding the *Theory of Communicative Action* in a biological foundation, Habermas' also insulates his theory against charges of relativism. The following passage from Erich Fromm's afterword to George Orwell's "1984," could as easily been about Habermas as Zamyatin, Orwell, and Huxley:

> It must be noted that the three authors [Zamyatin, Orwell, and Huxley] do not take the simple position of psychological relativism which is common to many sociologists today; they do not start out with the assumption that there is no such thing as human nature; that there is no such thing as qualities essential to man, and that man is born as nothing but a blank sheet of paper on which any given society writes its text. They do assume that man has an intense striving for love, for justice, for truth, for solidarity, and in this respect they are quite different from the relativists." (Fromm, 1977:318)

Human Consciousness and Language[35]

> "[I]t is not enough to concentrate solely on the molecular and cellular components and their interactions. Nor, at the other end of the spectrum, is the study of higher cognitive functions sufficient: It is often too remote to provide comprehensible mechanistic insight. The leap from cells to thought seems almost infinitely complex, yet every growing child manages to make it. Somewhere in this middle ground, between molecular components and psychology, lie the means by which familial and educational experiences intersect with developmental biology to shape cognitive abilities and personalities." (Stern and Hines, 2005)

While specifically addressing the relationship between the biological brain and conscious thought, the above quotation also captures well the chasm that seems to separate natural and biological sciences from the social science (and to an even greater degree, the humanities). Until recently, many natural scientists dismissed the social sciences as not really science at all. For the most part, practitioners of social sciences,

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[35] My previous academic training and professional experience being primarily in the natural sciences, I was curious about the extent to which contemporary research on human evolution is consistent with Habermas' social theory. In the following sections I discuss relevant empirical and theoretical issues from several inter-related perspectives. First, I want to update the foundation of Habermas' theoretic work from first premises, and by doing so, stabilize it with the broader, multidisciplinary environmental policy disciplines. To this end, I summarize relatively recent theories and research findings — that are beginning to provide a coherent blueprint of the co-evolution of human consciousness, language, and culture — to build a foundation for a multi-layer critique of contemporary public policy analyses and decision-making. Second, I sketch a relatively continuous transition between the biological, psychological, and social sciences. Despite the salience of these relationships among many social and political philosophers and theorists, in my experience, most contemporary environmental scientists and policy practitioners generally appear unaware of its significance or dismiss its relevance to their particular applications. I believe the limited attention paid to the development of and relationships between consciousness, language, and culture underlies many of the epistemological and practical methodological differences among various theories, practices, and disciplines contributing to environmental policy and policy systems analyses. Third, by grounding my analytical methodology on a foundation built up from the evolution of human subjectivity, I address and intend to assuage potential criticism (primarily from natural scientist skeptics) of the legitimacy of my methodology and research topic within environmental public policy. Thus, I both will draw attention to the coalescence of theory and empirical research and lay a foundation for a human evolutionary perspective of public policy and policy systems analyses that places sociology on the same firm scientific footing as other environmental sciences – more generally than economics – in analyzing and informing policy.

including economics, ignore or even actively reject the need for theoretical continuity with the natural sciences, and many in the humanities are concerned with any effort to evoke scientific understanding to replace or supersede normative questions (Pippin, 2009). Yet, the need to span historically distinct (and often antagonistic) disciplines is attracting greater and more influential attention, prompting Alan Leshner, Chief Executive Officer of the American Association for the Advancement of Science, to call for "both biological and behavior research, separately and in combination"(Leshner, 2007).

Despite the centrality of language to critical social theory, historically there was much disagreement over how and why human language evolved, and language's relationship to human consciousness, culture, and concepts of rationality. Until recently, even the legitimacy of language and consciousness as topics of scientific inquiry has been questioned (Bever and Montalbetti, 2002, Chalmers, 2002, Holden, 2004, Nielsen and Day, 1999).[36] While culture receives some attention for its role in environmental values, especially within the sub-disciplines of human ecology and environmental sociology,

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[36] The "… origin of human language has been an evanescent topic in the history of ideas for many centuries. It pops up in philosophical debates as a conceptual exercise on the nature of humanity and then, just as capriciously, disappears from the intellectual scene" (Bever and Montalbetti 2002:1565). Moreover, although the idea that mental traits evolve as a result of natural selection dates back more than 100 years to William James, and despite enormous advances in evolutionary biology and the neurosciences, "the nature of consciousness remains to many a perplexing and mysterious puzzle" (Nielsen and Day 1999:3). Chalmers adds that, "… consciousness was shunned by researchers studying the brain and the mind. The prevailing view was that science, which depends on objectivity, could not accommodate something as subjective as consciousness" (Chalmers 2002:92).

researchers infrequently discuss the specific role of language and its implications for economic and environmental policy analyses.

As it turns out, the evolutionary theories of contemporary anthropologists, archeologists, comparative biologists, and linguists, although they may vary on specifics, lend support to Habermas' conception of the perceptual relationship between consciousness, language, culture, and society, which as previously mentioned, provides the foundation for the *Theory of Communicative Action*. Perhaps equally important, however, is that Habermas' social theory provides an interesting perspective from which to understand human evolution, with potentially significant research implications.

In recent years, a consensus appears to be building on what constitutes consciousness and on the relationship between consciousness and language. It is generally accepted that human consciousness and language are closely related, and that the complexity of and relationships among human consciousness, language, and culture demarcates humans from other primates. While other species possess various degrees of cognitive and communication abilities, social intelligence, and possibly theory of mind (Pennisi, 1999, Pennisi, 2006, Zimmer, 2003), Hauser, Chomsky and Fitch (2002:1569) observe that human communication differs from that of other species in that it is "hierarchical, generative, recursive, and virtually limitless with respect to its scope of expression." Premack (2004) argues that recursion, the ability to recombine mental elements, is uniquely human and may underlie aspects of human intelligence.[37] Other species may display traits that could be characterized as conscious, but syntactic language is clearly a distinguishing feature of human consciousness.

For the purpose of advancing a multidisciplinary research agenda, Hauser, Chomsky, and Fitch (2002:1571) conceive of the human faculty for language as composed of a:

> **Faculty of Language – *Narrow sense*** (FLN) that is restricted to the internal "abstract linguistic computational system," and a
>
> **Faculty of Language – *Broad sense*** (FLB) that encompasses the FLN but also includes "sensory-motor" and "conceptual-intentional" systems.

Hauser and his colleagues view FLN as the primary locus for recursion, i.e., the ability to generate an almost infinite number of discrete expressions from a set of finite elements, that are mapped to sensory-motor and conceptual-intentional interfaces and "process and elaborate this information in the use of [human] language" (Hauser, et al., 2002:1571). According to Hauser and colleagues, while humans share FLB traits and functions with other vertebrates, FLN is uniquely human. They do not argue that FLB is the same across species. To the contrary, while homologous FLB mechanisms exist in other animals, these authors suggest that natural selection has modified FLB in humans so that it has unique traits.

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[37] Arbib disputes the idea that recursion is distinctly human. He notes that both mountain gorillas and monkeys possess the ability to "refer their next action not only to sensory data but also to the state of execution of some current plan" (Arbib 2005:108).

The concept of FLN relates closely to a human's particular form of consciousness. Arbib observes, "… as awareness piggy-backs on all manner of neural functions, so too must it piggy-back on language, thus reaching a subtlety and complexity that would otherwise be impossible. Thus, consciousness is not "merely a function of language." The particular form and level of complexity of human consciousness, however, would not be possible without language. Language is what distinguishes human consciousness "from whatever form of consciousness may be experienced by other creatures" (Arbib, 2001:201-02).

To help conceptualize human consciousness, Arbib distinguishes between the brain state, mental state, and language. The brain state consists of the combined output of individual neurons (i.e., the activity state) and the strength of connection and firing patterns between neurons (i.e., synaptic states). The mental state represents an abstraction of the brain state at about the same level as, but not identical to, language (Arbib, 2001:199) and may be synonymous (or nearly so) with Hauser and colleagues' concept of FLN. Arbib illustrates the difference between the brain state, mental state, and language in the following examples:

> "I may see a face without being able to place it. The words "I've seen that person before — but where?" do not exhaust the mental state, for the latter includes the experience of facial features that we cannot put into words. If and when I recall the face, "Oh yes, during intermission at the opera last Saturday," the transition may be inexplicable at the "mental level," involving subtle neural processes that retrieved a memory of the scene involving that face, a representation rich enough to ground recognition of the context, with the subsequent return to the "mental level." The point here is that brain states are immensely complicated and causally complete, whereas mental states are relatively simple and thus only sometimes causally efficacious. In this regard logic is not the essence of the mental, but is rather a crystallization of the limiting case where decisions and inferences can be

> made via inferential chains at the mental level without recourse to the brain's greater patternings. Again, if we admire a sunset, our mental state involves our awareness and aesthetic appreciation of the rich patterning of red, orange and purple in the cloud formations banked above the horizon. The words "Look at that!" may then suffice to help a friend share aspects of that mental state without in any way reducing that state to those three neutral words. But the extent of that aesthetic appreciation does not begin to exhaust the complexity of the brain states which flash through the brain millisecond by millisecond as we enjoy the scene." (Arbib, 2001:199)

In Arbib's first example, words are not used for the purposes of interpersonal communication, but are part of and an expression of subjective thought, abstractions of the current mental state that itself is an abstraction of the brain state. In the second example, the words are used only to draw another's attention to a scene that the listener is expected to appreciate, based on a common understanding of aesthetic preferences. Arbib also makes clear that the brain and mental state are not dualistic, "with the mind monitoring the activity of the brain to extract highlights." Instead, the activity of the brain captures the mental state, "forming some sort of précis of the broader neural activity and memory structures" (Arbib, 2001:199-200). What is important to emphasize is that in Arbib's examples language is both the product of and conveys a culturally-derived inter-subjective understanding at about the same level as Arbib's mental state. It is also interesting to note that Arbib's concept of the brain state is similar in many ways to Habermas' concept of the "lifeworld." For Habermas, as I discuss later, the lifeworld represents the social-cultural-lingual "taken for granted" background that underpins successful communication and from which individuals draw upon salient aspects that reference particular situations and dynamics.

Consciousness appears not the result of any individual neurological region or circuit; rather, complex integrations and computations among many different brain regions form what Arbib calls “schema.” Large numbers of neural schema must interact in committing an organism to action. At higher levels, more abstract schema provide the functional basis for thought and language. The totality of schema within an individual organism provides for behavioral continuity in similar situations. To illustrate the role of schema in language and social coordination, Arbib uses the following analogy:

> “When we use a screwdriver our body ends at the end of the screwdriver, not at the end of the hand; when we drive a car, our body ends at the rear bumper, not at our buttocks. Analogously, as creatures developed as social animals (and this account is not restricted to humans), the body might end not at the extremities of the physical body, but extend to incorporate aspects of other members of the group. However, coordinating others is a more subtle matter than just directing an arm or slightly adapting the hand to control a tool. The social animal has to find a way of expressing some précis of its mental state, of its richness of schema activity, so that it may then impinge upon others so that their behavior may be coordinated. With increasing richness of social interactions, though still at a prelinguistic stage in our evolutionary story, there would come the ability to form a précis of schema activity that is not necessarily relevant to deciding what to do next, but is relevant in terms of coordination with others.” (Arbib, 2001:206)

Arbib calls the bridge between schema and consciousness a “communication plexus,” a gesturable representation of intended future movements (as distinct from current movements) that can both coordinate schema to direct action and at times monitor older schema, serving not only to communicate intention to members of a group, but also to plan and coordinate within the brain itself (Arbib, 2001:207). The earliest communication among our hominoid ancestors likely was a simple pantomime of the action an individual was about to take, “an accidental release of the motor plan from inhibition," sufficient to alter the behavior of others in the group. Selection favored individuals and groups that could both release and correctly interpret "prefixes of action" and this co-evolved process comprises consciousness.

Arbib is making a bold statement, but consistent with a foundation supporting Habermas' Theory of Communicative Action. Although language and consciousness are not identical, increased linguistic complexity must be related causally to an increasing capacity for perceptual differentiation, self-reflection, abstraction, and social coordination, yielding an increasingly complex social-consciousness. In this way, language is a primary organizational format for human consciousness, and by extension, the primary means for social coordination and integration, and cultural reproduction.

Co-evolution of Human Consciousness, Language, and Culture

Consciousness, language, and culture are complex, co-embedded, inseverable, and co-evolved phenomena. As Nielsen and Day (1999:93-94) commented:

> "… [as] physical traits evolve differentially to benefit animals dependent on their specific environmental niche so too must "mental" characteristics. It is important to note that this does not imply a kind of Cartesian dualism whereby mind and body evolve separately but rather that both are similarly subject to the principles of evolutionary theory. It is thus plausible to expect that consciousness will be represented in degrees of variation related to the particular survival and reproductive demands of separate animal species.… [Consciousness] must have, according to the processes of natural selection, undergone change throughout the course of evolution, emerging in different forms where needed to assist the organism in its capacity to best "fit" its environment… to co-ordinate an increasingly complex world for an increasingly complex organism."

The basic processes of evolution with regard to development of the brain are much the same as with any other organ: genetic mutation introduces variations in the brain that result in new neural nuclei, region-specific cell proliferation, and new or changed connections. The phenotypic expression of mutations that result in changes in the organization of brain and behavioral variations are subject to selective pressers. Selection results in differential representation of neurological and behavioral phenotypes within a population, eventually becoming dominant within the population and, if reproductively isolated, a new species. Neural and behavioral phenotypes that arise over the course of evolution, however, are the result of selective pressures on larger systems, not on the sub-system itself: "the genetic code may not specify adult forms so much as the processes of self-organization in cell-assemblies which can yield 'normal' connectivity in the adult raised in a normal environment. Further, the environment that fosters adaptive self-organization may be as much social as physical in nature"(Arbib, 2001:196).

These new behaviors can yield differential reproductive advantages within the natural and/or cultural environments. Using population modeling, Lachlan and Feldman (2003) demonstrated how cultural traits such as language can co-evolve with genes that express biological predispositions for communication traits. Their relative influence on one another (i.e., of genes and culture) depends on the nature of the genes (e.g., restrictive or enabling a broader range of signal recognition) and the relative benefits conferred by alternative cultural traits.

Selection can operate indirectly on localized neural structures and neural systems through schema. Selection also can act directly on schema through behavioral phenotypes. Newly evolved schema can interact to link, coordinate, and control simpler (e.g., perceptual and motor) schema. In addition, new schema and new patterns of schema interactions, built up over the life of an individual organism, "provide an enriched environment for the older parts of the brain," yielding "new possibilities for further evolution, whether evolution of brain regions over a biological scale or the evolution of schemas over an individual time scale" (Arbib, 2001:205-06). For example, competition among neurons has been shown to result in neurons with greater activity having a larger number and higher rate of neuron branch formations than neighboring neurons with lower activity (Ottersen, 2005). Arbib is careful to emphasize that schema are not localized brain structures; rather, they involve "subtle patterns of 'cooperative computation' between brain regions which form a schema" (Arbib, 2001:202).

Arbib also is not suggesting genotype determines behavior. An individual organism's experiences, including social interactions, shape behavior:

> "What needs stressing here is that the genome does not come neatly packaged in terms of separate sets of genes for separate nuclei of the brain, nor does each nucleus control its own set of behaviors…. [B]ehavioral phenotypes are not the result of "brain genes" alone; rather, they express both the brain's inherent organization, and the learning that has shaped it through the experiences of the individual organism, and these are determined in great part by the social milieu in which the organism is raised. For many species, this "social milieu" is hard to disentangle from the biology, but for primates we can discern a variety of "rituals," "practices," and "tribal customs" that constitute a body of culture constrained by, but in no sense determined by, the biological make-up of the social group. Thus as we come to analyze the evolution of the hominids, culture comes to play an important role even in biological evolution, as well as being itself subject to change and selection," (Arbib, 2001:200-01)

In this brief discussion, I explained why language, consciousness, and culture are inseparable, interdependent complex. They are the result of co-evolution where

- Natural (Darwinian) selection operated at many levels of biological organization (e.g., sub-cellular, cellular, cellular systems, and morphology), contributing to
- The emergence of new behavioral phenotypes and cultural evolution, which in turn provided
- New selective pressures simultaneously back on the brain and on mental states, and
- All of which were subject to further selection.

Through this process, early man evolved the necessary neurological, anatomical, and cultural adaptations that enabled the emergence of human language:

> "Co-evolution of communication and representation was essential for the emergence of human language. Both representation within the individual and communication between individuals could provide selection pressures for the biological evolution of language-readiness and the biological and cultural evolution of language, with advances in the one triggering advances in the other." (Arbib, 2002:229-80)

Theories, research, and models of human cognition, language, and culture should be integrated. They should seek to explain both how and why humans and primates diverged from our common pre-hominoid ancestors, in terms of the transition to a human consciousness characterized by language and culture.

Neurological Substrate for Consciousness and Communicative Action

Many neurological, cognitive, social, and physical capabilities that appear critical for human language are found in other animals. Therefore, they likely represent pre-adaptations that evolved in response to conditions other than those solely favoring the selection of traits responsible for what we recognize as human grammatical/syntactical language. For example, their arboreal origins endowed our hominoid ancestors with the ability to manipulate objects with mobile fingers and view objects in color, detail, and three dimensions, yielding a rich sensory environment that their newly evolved outer brain cortex synthesized into multi-dimensional mental models of the objective world. The world of our primate ancestors appeared increasingly complex relative to the world experienced by other animals. As Pfeiffer (1978:382) stated:

> “The result was a partial taking apart or fragmenting of the environment. It became less of a continuum, less an uninterrupted expanse of blurred and merging forms, and more a system of distinct and more numerous items.”

Likewise, Pfeiffer suggests that the linguistic capability of contemporary experimental primates is evidence that early language consisted of more verbs than nouns, and therefore was directed at the activities of others. This again is consistent with a social theory of the origin of human language and consciousness, but inadequate to explain the origin of grammatical-syntactical speech that contemporary primates lack. Moreover, while consistent with Habermas’ concept of perceptual differentiation that I discussed previously, it is important to note that other hominoids likely shared this cognitive capacity and it certainly is found among contemporary primates. Thus, while the ability to differentiate the objective and social world is unquestionably a necessary pre-adaptation, by itself, it is clearly inadequate as a basis for the co-evolution of consciousness, culture, and language in the human lineage.

The evolution of language and speech required neurological and morphological adaptations beyond those found among ancestral hominoids or contemporary primates. Verbal speech required the development of complex vocalizations necessary to convey language, a capacity for vocal learning, and a vocal tract with a wide phonetic range (Fitch, 2000:258). In addition, human syntactic language required the cognitive capability to recognize, represent, and communicate complex concepts and rules to encode them. These in turn required that social selective pressures be transmitted culturally and reproduced in successive generations.

According to Arbib, prior to language development in *Homo sapiens*, hominoids evolved a language-ready brain with the neurological capacity for complex imitation, symbolization, parity,[38] intentional communication, translation of hierarchical structure to temporal ordered actions, recollection of past and imagining of future events, prolongation of infant dependency (paedomorphy), and socialization. Once these genetically determined traits evolved, the further development of human language was "a cultural/historical process that required little or no further change from the brains of early *Homo sapiens*" (Arbib, 2005:108).

Arbib and colleagues base their theory for the evolution of a language-ready brain on the discovery of "mirror neurons" that act as "observation/execution matching systems" in parts of primates' anterior intraparietal sulcus (AIP) and ventral premoter area F5.[39] These mirror motor neurons fire not only when a monkey is grasping, tearing,

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[38] Arbib describes "parity" as "What counts for the speaker (or producer) must count for the listener (or receiver)" (p. 108) Ibid. This appears to be synonymous to Habermas' concept of intersubjective understanding.

[39] I present a significantly abbreviated discussion of Arbib's mirror systems theory. Arbib also discusses and cites research implicating additional brain areas involved in action recognition, imitation, and language, including areas of the pre-supplementary motor area, premoter cortex, posterior parietal cortex,

or manipulating an object, but also when a monkey is observing another monkey engaged in these manual actions. Sounds of actions and facial gestures also cause discharge of some primate mirror neurons (Rizzolatti and Craighero, 2004). The mirror neuron system also links the observer and the action, is critical for understanding intentional actions, and thereby provides a neurological basis for communicative cooperation (Arbib, 2005, Rizzolatti and Arbib, 1998):

> "Mirror neurons represent the neural basis of a mechanism that creates a direct link between the sender of a message and its receiver. Thanks to this mechanism, actions done by other individuals become messages that are understood by an observer without any cognitive mediation…. The mirror-neuron system represents the neurophysiological mechanism from which language evolved." (Rizzolatti and Craighero, 2004:183)

In this way, the mirror neuron system provides a functional capacity to share a common meaning, which is an essential capacity for language development. It may create a neurological 'awareness' that involves the cooperation of many brain systems.

The evolution of a language-ready brain required at least two further transitions beyond a simple mirror neuron system. The first was a transition from the primate's object-related mirror system to a more open system capable of imitation via a mirror neural system that responds to pantomime and intransitive action, a capacity not found in contemporary primates (Rizzolatti and Craighero, 2004). According to Arbib (2002), imitation involves not only the ability to observe and repeat an action that already exists

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basal ganglia, and Wernicke's area. For a more comprehensive discussion, including supportive and dissenting peer commentary and author's responses. Ibid.

in the observer's behavioral repertoire, but also the ability to parse complex movements into familiar and less familiar components, and then execute a composite of familiar and variations of familiar actions. As I discussed previously, acquiring skills in this manner involves the formation of new schema – by composting schema already available in the animals repertoire, applying schemas (new and existing) to novel situations (Arbib, 2001), and tuning schema to new conditions, "to the point that the unity of the new schema may over-ride the original identity of the components" (Arbib, 2002).

For communicative action, feedback between actor and observer is critical to knowing that the observer was attentive to the actor's actions. When observing an action, spinal cord inhabitation normally selectively blocks motor neurons, preventing the observer from performing the observed action. When the observed action is especially interesting, however, the pre-motor systems may generate a brief prefix of the observed action/movement. This movement can be recognized by the actor and affect both individuals:

> "The actor will recognize an intention in the observer, and the observer will notice that its involuntary response affects the behavior of the actor. The development of the capacity of the observer to control his or her mirror system is crucial in order to emit (voluntarily) a signal. When this occurs, a primitive dialogue between observer and actor is established. This dialogue forms the core of language. The capacity to notice that one has emitted a signal and associating it with changes of the behavior of others might or might not have developed simultaneously. However, there is no doubt that, once established, this new association should have yielded enormous benefits of adaptive value for the group of individuals that started to make use of it, providing the selective pressure for the extension of communicative capacities to larger groups. This new use of the mirror system, at both individual and species levels, marks the beginning of intentional communication." (Rizzolatti and Arbib, 1998:190-91)

Neural imaging studies provide evidence for mirror neurons in humans' superior temporal (STS), the inferior parietal lobule, and Broadman's areas (BA) 44 and 45 of the inferior frontal gyrus, which overlap with Broca's area and plays an important role in human language (Figure 9). Homologous areas in macaques observed using Positron Emission Tomography (PET) were activated when monkeys were presented with recordings of species-specific vocalizations, indicating the importance of this area for perceiving, generating, and representing meaning for vocalizations (Gil-da-Costa et al., 2006). Rizzolatti and Arbib (1998) and Rizzolatti and Craighero (2004) also found evidence for mirror neurons in BA 6, 8, and 9 in the lateral pre-motor cortex. These areas overlap with areas thought to be involved with higher-level reasoning (Coricelli and Nagel, 2009) and "self-referential and introspectively oriented mental activity" as part of "the processing of such representations that embody aspects of the self" (Gusnard et al., 2001).

Importantly, Broca's area in the human brain likely is analogous to primate area F5, the loci of mirror neurons in primates. These findings provide evidence that the common ancestor of man and monkey possessed a neural system – the mirror system – for matching hand movement observation and execution: they illuminate a neurological mechanism in both primates and humans for action recognition (Arbib, 2001, Gallese and Goldman, 1998). In addition, the STS is an active component of a neural network activated in "theory of mind" experiments, where neural imaging is conducted while people perform tasks that require them to "infer what others are thinking" (Zimmer, 2003), such as during strategic reasoning (Coricelli and Nagel, 2009).

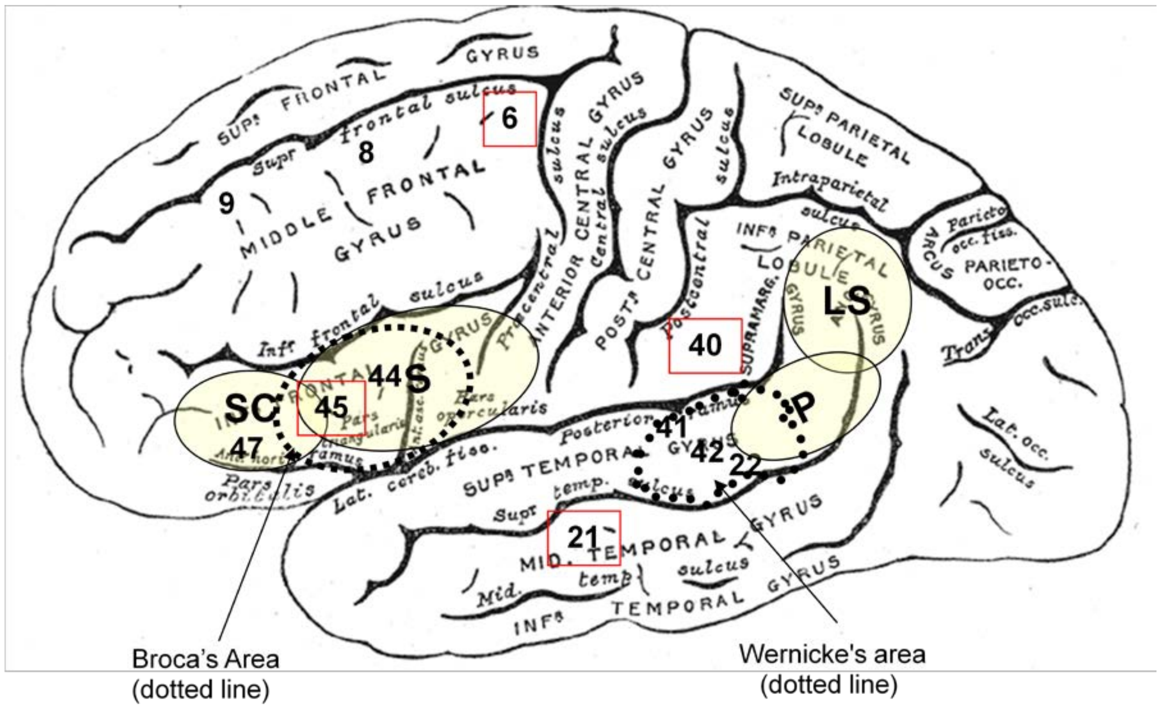

Figure 9. Lateral surface of left cerebral hemisphere, viewed from the side. Brain illustration from Gray (1918). Language areas are indicated by yellow/shaded ovals: S (Syntax), SC (Sentence Comprehension), L-S (Lexico-Semantics), and P (Phenology) (from Sakai, 2005). Numbers indicate Brodman’s Area. Numbers with red boxes (BA 6, 21, 40 and 45) are Bradman’s areas thought to contain mirror neurons that respond to observations of object-directed behavior (Gallese and Goldman, 1998).

Arbib points out that a major difference between humans, primates, and their common ancestors is the capacity for imitation. Arbib defines imitation as the ability to copy a movement that is “associated with a goal, and that initiation of the movement is accompanied by the creation of an expectation that the goal will be met” (Arbib, 2005:114). Contemporary monkeys possess a mirror system for grasping, but generally lack the capacity for imitation. Mirror neurons fire when a monkey sees (or recently saw) both a hand moving to grasp an object and the object, but not when a monkey sees either a hand movement or object in isolation (Arbib, 2005:112). Chimpanzees can imitate relatively short novel sequences after repeated observations, but only humans can imitate longer sequences after a single observation, providing the sequences are not too long and are relatively familiar, i.e. relative to the existing repertoire of movements/behaviors. Apparently, between the common ancestor of humans and monkey and humans and chimpanzees, the early mirror system, capable only of simple imitation, underwent further development leading to *Homo sapiens'* capacity for complex imitation (a capacity that mostly is lacking in primates).

The second transformation necessary for the development of verbal speech was from the inherent semantics of gesture-based communication to abstract sound meaning. Bosman et al. (2005:129) cite evidence of a vocalization mirror system that overlaps with speech production areas in the superior ventral premotor cortex. They argue that, "instead of a serial dependence of vocal communication upon gestural communication, both coevolved to a large extent; that is, both developed their own circuitry in parallel, with a high degree of interaction between the two systems." Other authors hypothesize an auditory component of the mirror neuron system, necessary to discriminate and attune to speech sounds (Kaplan and Iacoboni, 2005, Rauschecker, 2005).

Using neural imaging studies, Musso and colleagues (2003) concluded that Broca's area is responsible for the acquisition and processing of hierarchical (rather than linear) syntax found in all human language. Similar studies suggests that human mirror neurons possess properties lacking in primates, including the ability to become excited when observing action-forming or transient movements, not only complete actions (Sakai, 2005). Rizolatti and Craighero (2004) found evidence that hand/arm and oro-laryngeal movements used in producing speech are linked and share a common neural substrate, and that humans possess an echo-neuron system in speech-related motor centers that is activated when listening to verbal stimuli. Kaplan and Iacoboni (2005) discuss functional MRI findings that some motor neurons respond to sounds of actions equally as well as when visually observing the actions. They also found left cortex lateralization of auditory motor neuron responses to action sounds. Since this lateralization is lacking in primates, Kaplan and Iacoboni propose that auditory properties of motor neurons may have facilitated, rather than arose as a by-product of, language evolution.

Rizzolatti and Craighero (2004) concluded that the capacity for both verbal and non-verbal imitation involves Broca's area, the same neural circuit activated during action observation, resulting in a direct mapping of observed action and motor representation in the posterior part of the inferior frontal gyrus. Caetano and colleagues (2007) proposed that differences in the timing and intensity of neurological activity, measured by magnetoencephalography in the mirror neuron system and somatosensory cortex of people following their own and observed actions, provide a neurological basis for distinguishing between self and others, and contribute to the phenomonology of the sense of agency. Arbib also reviewed a number of studies that show significant overlap between human brain areas activated in action recognition and verb generation, and in observation, grasping behavior and speech production, "suggesting that action recognition and language production share a common functional architecture…" (Arbib, 2005:122-23).

These studies support not only Arbib's theory that the mirror system provides a neurological substrate for action recognition and goal-directed action, but also is an important neurological component of language and communicative action.[40] I speculate along the lines of simulation theory proposed by Gallese and Goldman (1998), that the mirror neuron system in humans provides part of the neurological substrate for the developmental linguistic and cognitive theories of Mead and Piaget, and ultimately empirical support for a theory of mind that necessarily underlies Habermas' Theory of Communicative Action.[41]

It is important to note, however, that the capacity for intentional communication that evolved in contemporary primates and our hominoid ancestors is necessary but likely insufficient to account for human self-awareness. While other organisms display various behaviors that could be described as intentional or conscious (Nielsen and Day, 1999), only humans can be characterized as reflexively aware of their own mental states, intentions, and actions; a phenomenological self-awareness that I propose requires

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[40] Arbib concludes "it was the extension of the imitation-enriched mirror system to support intended communication that enabled human societies, across many millennia of invention and cultural evolution, to achieve human languages in the modern sense" (Ibid.:123).

[41] Gallese and Goldman argue that the finding of mirror neurons supports simulation theory ("other people's mental states are represented by adopting their perspective: by tracking or matching their states with resonant states of one's own) rather than "theory theory" ("mental states are represented as inferred posits of a naive theory") (Gallese and Goldman 1998:493). Note that there is no consensus, however, on which of these competing theories best explains how an individual can infer the intentions or mental state of others. For dissenting views based mostly on epistemological arguments, see: Schulkin 2000. For a response to this critique, see: Goldman and Gallese 2000.

recursive and generative properties such as are characteristic of (but not limited to) language. I believe that as we sharpen our understanding of these systems we will identify neurological and mental substrates of human consciousness and begin to address the “hard question” raised by Chalmers (2002:92): “how [do] physical processes in the brain give rise to subjective experience?” i.e., why conscious experience necessarily accompanies human behavioral and cognitive functions.

Crick and Koch (2002) attribute consciousness to neuronal encoding and semi-hierarchical networking, culminating in pre-motor and motor structures where the information can be used for verbalization or other actions. Since motor neuron activity, including mirror neuron activity, is stimulated by the transmission of recoded information from neurons at higher levels of the sensory hierarchy that in turn were stimulated by the firing of sensory neurons, information at the motor/action execution level is not identical to the original sensory representation. Subjective meaning comes from the pattern of such connections (in Arbib’s term, schema) that encode related concepts. The more diverse the connections with the network of established related schema in the cortical system, the richer the meaning. This has important epistemological implications for communicative action because it is impossible to communicate the exact nature of subjective experience, rather, only differences between subjective experiences: “The implication is that we can never explain to other people the subjective nature of any conscious experience, only its relation to other ones” (Crick and Koch, 2002:95).

Evolution of a Language-Ready Brain

Based on the mirror system findings, Arbib (Arbib, 2001, 2002, 2005) hypothesized the capacity for language evolved via a seven-stage process:

1. Grasping an object
2. A mirror system for grasping an object
3. A "simple" imitation system
4. A "complex" imitation system
5. A manual-based communication system (proto-sign)
6. Speech (proto-speech)
7. Language

Arbib believes that pre-hominoids possessed the abilities outlined in stages 1 through 3. Evidence for stages 1 and 2 is the finding of mirror neurons and the capacity for action recognition in both contemporary primates and humans, providing the genetically encoded neurological basis for imitation.[42] Stage 3 represents the transition of the mirror system from single to compound actions and simple imitation. It is important to again note that as the mirror system is an observation/execution matching system, it enables both the release and recognition of pre-fixes of action. The mirror system found in contemporary monkeys and chimpanzees (which Arbib believes to have diverged from the hominoids around twenty million years ago and around five million years ago, respectively) is likely pre-adaptive for language, since contemporary primates possess these capabilities and language is not believed to have played a role in their evolution.

[42] Cerebral nuclei, thought responsible for vocal learning in some songbirds, are adjacent to brain areas that are active during limb and body movement. These findings are consistent with a motor/gestural theory for human language and suggest that neural precursors necessary for vocal learning evolved long before mammals (Feenders et al. 2008).

The pre-hominoid mirror system was likely important for imitation, infant observation of their own and other's motor behavior, and in learning how to physically interact with others.

According to Arbib, the key to the emergence of language readiness was the "extension of mirror systems from single actions to compound actions," which occurred in Stage 3 (Arbib, 2001:212). The mirror system provided the neurological capacity to "generate and recognize a set of actions," a prerequisite for a gesture-based communication system found later in Stage 5. Thus, while the common ancestor of chimpanzees and humans probably was capable of simple imitation, humans developed the capacity for complex imitation – the ability to assimilate rapidly, even in a single trial, new and lengthier sequences. Evidence for this assertion is found in the long and difficult learning process for chimpanzees' use of simple tools, e.g., use of a stone or wood "hammers and anvils" for cracking nuts, a skill often not fully mastered until adulthood (Arbib, 2002).

In Stage 4, the mirror system developed further, enabling more elaborate forms of imitation, which:

> "… depended on/provided evolutionary pressure for the elaboration of a whole complex of systems that integrated the F5 mirror system for execution/observation of single actions into a far larger system for the execution/observation of complex behaviors. Putting this another way… what marks hominids as distinct from their common ancestors with chimpanzees is the ability to rapidly exploit novel sequences as the basis for immediate imitation or for the immediate construction of an appropriate response, as well as contributing to the longer-term enrichment of experience." (Arbib, 2001:213)

These developments coincided with the enlargement of human speech-related areas of the frontal cortex. Fossil evidence suggests that enlargement of the frontal lobe areas associated with speech were already underway in *Homo habilis,* and possibly as early as Austropithecines, and according to Arbib, coincided with the transition from a mirror system capable of simple imitation to systems capable of more complex imitation.

Arbib suggests that the language-ready brain required the evolution of neural components that interact with, but lie outside of, the mirror system for grasping. These include components responsible for the ability for episodic memory, thought to be based in the hippocampus; for planning, associated with the frontal cortex (Arbib, 2005:109-10); and for vocal imitative behavior, associated with possible mirror neurons in the ventral premotor cortex and other areas associated with auditory control and vocal recognition (Bosman, et al., 2005). It is important to note that language is not encoded in the mirror system, rather, the mirror system adapts to process language.[43]

Stage 4 is critical in that it demarcates the genus Homo from earlier hominoids such as Australopithecus. Although *Homo erectus* possibly achieved Stage 4, the rapid cultural evolution observed in early *Homo sapiens* continued and accelerated it. Thus, while the brains for the first *Homo sapiens* were likely “language ready,” it is unlikely they possessed language in a modern sense. Williams (2005:147) emphasizes the

[43] Arbib points out that “the reliable linkage of brain areas to different aspects of language in normal speaking humans does not imply that language per se is “genetically encoded” in these regions…. The claim is not that Broca’s area, Wernicke’s area, and STS are genetically preprogrammed for language, but rather that the development of a human child in a language community normally adapts these brain regions to play a crucial (but not the only) role in language performance” (Arbib).

importance of the mirror system as a neural basis for social communication and suggests that it first evolved “within social cognitive neural systems to serve a mentalising [sic] function that was crucial to their praxic role in imitation and gestural communication.” The need to “convey and discuss invisible mental states” increasingly drove the evolution of language.

According to Arbib, the sequence from stage 4 to a system of manual gestures in Stage 5 involved:

> “(i) Pragmatic action directed towards a goal object;
>
> (ii) Imitation of such actions;
>
> (iii) Pantomime in which similar actions are produced in the absence of a goal object;
>
> (iv) Abstract gestures divorced from their pragmatic origins (if such existed)….
>
> (v) The use of such elements for the formation of compounds which can be paired with meanings in more or less arbitrary fashion” (Arbib, 2001:213).

Bridgman (2005), however, suggests that the capacity for hierarchical language derived from and coevolved with the capability to plan sequences of actions. Fitch (2005:132) argues that humans’ prelinguistic ancestors developed a protolanguage that was “more musical than linguistic … tied more closely with music and dance than pantomime and linguistic communication.” Ramachandran and Hubbard (2001:20) suggest that certain oral movements and vocalizations mapped in the motor areas of the brain are non-arbitrarily mapped to sounds and phonemic representations in auditory regions that are likewise non-arbitrarily linked to specific objects and events. This results in a “resonance or bootstrapping in the co-evolution of these factors,” and a “synaesthesia caused by cross-activation between two motor maps rather than between two sensory maps."[44]

By Stage 6, two distinct communication systems likely were functionally integrated. The manual-brachial system that evolved in Stage 5 "recruited" the orofacial vocal system (found in monkey F5 and human Broca's area), allowing the association of vocalization with manual gestures, an increasingly open referential character, and "the capacity for imitation of the underlying brachio-manual systems" (Arbib, 2001:214). Arbib further hypothesized that pathways evolved between the cingulate cortex (associated with emotion) and Broca's areas (associated with motor control), resulting in "rapid production and interweaving of elements of an utterance" (Arbib, 2001:215). Functional magnetic resonance imaging (fMRI) studies by Greene and colleagues (2004) indicate the dorsolateral prefrontal cortex and anterior cingulate cortex may play a role in arbitrating emotion and cognition in moral dilemmas, including Broadman's area 40, which is thought to contain motor neurons. Mallet et al (2007) provide evidence for a connection between the subthalmic nucleus, which may integrate motor, cognitive, and emotional components of behavior, and Broadman's Area 21 in left superior temporal sulcus, which also is thought to contain mirror neurons.

[44] "Synaesthesia is a curious condition in which an otherwise normal person experiences sensations in one modality when a second modality is stimulated. For example, a synaesthete may experience a specific colour whenever she encounters a particular tone (e.g., C-sharp may be blue) or may see any given number as always tinged a certain colour (e.g., '5' may be green and '6' may be red)" (Ramachandran and Hubbard 2001:4).

In addition to the subsystems identified by Arbib, it would seem that intentionality, imitation, and goal-directed behavior also require a capacity for envisioning one's self in the future. Szpunar et al. (2007) provided evidence for this. Using fMRI, they identified eight specific brain regions that have statistically significant greater activity during future thought than recollection of prior events. One of the areas identified (BA 6) also is believed to contain mirror neurons, and all of these regions are thought to be associated with imagining one's own body movements, spatial memory, and general attention. Szpunar and colleagues speculate that activation of these regions may be a function of the greater neural activity needed for stimulating novel sequences of actions than needed for a previously accessed store of action sequences. These findings seem consistent with Arbib's mirror systems hypothesis, and also seem to support Richard's (1989) physiomorphic model, discussed later.

The capacity for complex imitation provides the foundation for intentional gestural communication along the following sequence (Arbib, 2001:213):

1. Making goal-direct programmatic actions,
2. Imitating goal-direct actions,
3. Pantomiming similar action without a goal object,
4. Making abstract gestures that are not directly associated with a goal (For example, "In pantomime it might be hard to distinguish a grasping movement signifying grasping from one meaning a [graspable] raisin, thus providing an incentive for coming up with an arbitrary gesture to distinguish the two meanings,"
5. Associating meaning to combinations of abstract gestures.

Stage 6 results in the ability to produce and perceive sequences of vocal gestures, and thus constitutes language readiness in humans. However, language (Stage 7) itself required cultural changes. The transition from Stage 6 to 7, from language ready to syntactic language-programmed human consciousness, rests on the following four conclusions: (1) biological evolution yielded a human brain that was ready for but did possess language; (2) consciousness is a manifestation of the interactions of our brain, body, and physical and social environments, (3) consciousness has evolved dramatically since our brains and bodies reached their present forms, and (4) language enables us to organize, reflect upon, and share.

Culture played a critical role in the development of human language and consciousness: “A socially constructed linguistic environment is a necessary component in the appearance of speech… Culture is a socially constructed environment necessary for the appearance of our species’ typical phenotype” (Smillie, 1996:146). These concepts find support in the work of Kuhl and colleagues (2001). They concluded that the remarkable capacity of infants to detect units of speech must be a pre-adaptation for language acquisition, because this capacity is shared with other animals. However, human infants are born with the additional ability to detect language patterns and regularities, organize what they hear, recognize similarities, form categories for similar sounds, use statistical properties of input, and detect distribution and probabilistic properties of language. These capacities have not been shown in other animals. Kuhl et al. contend that an infant’s perception of audio input is actually “warped” by listening to ambient language to promote lingual perception, and therefore infants have perceptual systems that can be altered by experience. Not only are infants’ perceptions altered by native language, but parents universally adjust their speech when talking to an infant (speaking "parentese") by exaggerating differences between linguistic sounds.[45] Some research findings suggest infants' speech learning may be positively affected by parentese. Again, these findings support the co-embedded nature of consciousness, language, and culture.

Thus, to complete his model, Arbib tries to answer the following three questions (Arbib, 2001:210-11):

> "What were the biological changes supporting language-readiness?"
>
> "What were the cultural changes extending the utility of language as a socially transmitted vehicle for communication and representation?"
>
> "How did biological and cultural change interact "in a spiral" prior to the emergence of *Homo sapiens*?"

Arbib speculated that a limited form of manual communication existed in *Homo erectus*, and then developed rapidly as a consequence of cultural evolution after the emergence of *Homo sapiens*. Arbib also speculated that the transition to *Homo sapiens,* and to what we now recognize as "language," was preceded by the development of proto-speech in Stage 6.

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[45] The speaking of "parantese" may be akin to the "Lombard effect," where people have been shown to automatically adjust the loudness of their voices to counteract background noise, and may reflect a pre-adaptation to automatically adjust speech based on conditions (including the recipient) to improve communicative clarity (Kuhl et al. 2001).

According to Arbib's mirror system theory, evolution resulted in the emergence of Broca's area from the primate F5 area of the brain, evolving on top of the primate mirror system for grasping and integrating it with regions controlling orofacial, manual, and vocal gestures in purposeful communication (Arbib, 2005:106). The mirror systems thus became "embedded in a far larger system for execution, observation, and imitation of compound behaviors" (2001:215). The existence of this mirror communication system provided early hominoids the neural capacity for "a more open referential character," that could "exploit the capacity for imitation of the underlying brachio-manual system" and thereby enable "open-ended production and perception of sequences of vocal gestures." (Arbib, 2001:214). This communication system also provided the selective pressure for later anatomical specializations, such as the lowering of the larynx that enabled an expansion in the vocal range (Lieberman, 1973), which would result in a fully language-ready brain in *Homo sapiens* and the progressive development of language as a partner in cultural evolution in Stage 7.

If future research substantiates the mirror system in Broca's area in humans, it may be seen as the locus of Hauser and colleagues' FLN. However, the hypothesized recruitment and functional integration of the brachio-manual, orofacial, and emotional systems cast some doubt on the utility of their distinction between FLN and FLB. If, as the above discussion suggests, human consciousness and language are the product of the integration of motor, sensory, and computational neuron systems, it is reasonable to assume that integration itself played a significant if not predominate role in the co-evolution of human language and consciousness. In addition, the integration itself plausibly resulted in significant morphological and functional modifications at all levels of neurological organization, evolutionarily and ontologically. Although a more definitive characterization of this integration in humans will likely await the development of ethical and humane cellular and sub-cellular response sampling and detection techniques and analyses, the magnitude of such multi-system changes could obfuscate any practical distinction between FLN and FLB.

Chronology of the Co-evolution of Consciousness, Language, and Culture

I discussed in the previous sections the mechanisms by which human consciousness, language, and culture co-evolved. Here, as an implicit basis for an interdisciplinary research agenda, I provide a plausible chronology for this evolution, choreographed with current theories of cognitive, cultural, and language evolution.[46] This chronology is admittedly sketchy and speculative. I believe the developmental sequence I discuss is plausible; however, authorities differ on the timing of the emergence, extinction, and relationships between hominoid lines and their cognitive, communicative, and cultural attributes. It is understood that evolutionary change does not begin and end neatly at the temporal milestones I provide in the headings: they should be interpreted as

[46] Smillie emphasized the importance of a chronological approach to formulating evolutionary scenarios: “When we are forced to specify just when something took place in evolutionary time we can find ways of critically testing those “how possibly” explanation–stories of how something might possibly have been selected for. A specific chronology means that we can test a claim about the origin of a particular phenotypic feature against other concurrent events known to have occurred or to be taking place. We avoid those facile accounts that speak of selective forces operating on human ancestors in some vague and unspecified past” (Smillie 1996).

broad periods during which various phenotypes were likely extant. Although the development of physical, cognitive, and cultural phenotypes took place over many millennia, and despite limited physical evidence, advances in paleo-genetics and neuroscience may improve our understanding of the evolutionary path leading to modern human consciousness, language, and culture.[47]

Primate-Hominoid Common Ancestors: Circa 20 million years ago
(Before 2,000,000 years ago: Pre-hominoids; Australopithecus)

Early hominoids' use of crude stone, bone, and wood tools provided them greater access to higher quality and riskier food resources that fueled the energy demands of their larger brains, but also required increased social cooperation, e.g., for hunting and scavenging (Ambrose, 2001:1749-50). Their behavior likely was almost entirely genetically pre-programmed and chained to life routines, such as "obtaining food, finding or creating shelter, avoiding predators, mating, etc." Communication likely was restricted to simple gestures and vocalizations, perhaps some vocal mimicry, but nothing approaching culture (Richards, 1989:245, 51). Yet, the presence of larger social groups (60-70 individuals) than contemporary primates such as chimps (which form groups of about 50 individuals) suggests that early hominoids had well-developed social intelligence. Australopithecines probably could recall past experiences and perceive "ongoing social situations," but lacked sufficient neurological development in the frontal,

[47] Advances in neuroimaging and decoding will provide new insights in comparative neuroanatomy and cognitive functions. For example, see: Kay et al. 2008.

temporal, and parietal lobes, and the laterality in the brain, considered necessary for abstract reasoning, semantic memory, and language. Neocortical development was primarily localized in those parts of the brain responsible for sensory processing and possibly control of emotional expression (Massey, 2002:3-4).

Toward the end of the period, however, a dramatic mutation may have paved the way for future cognitive developments. Evidence summarized by Corballis (2004) suggests that a mutation in early humans occurred between 2.1 and 2.2 million years ago that inactivated the gene responsible for producing the enzyme CMP-N-acetylneuraminic acid (CMP-Neu5Ac) hydroxylase, resulting in a deficiency of N-glycolylneuraminic acid (Neu5Gc), which inhibits brain growth in primates. This mutation may have allowed hominoids' increasingly large brains to continue to develop after birth where environmental factors influenced their development much more than neural development in other primates.

Homo habilis: 2,000,000 years ago

Around 2,000,000 years ago, the morphological versatility of early hominoids, e.g., bipedalism and manual dexterity, together with a superior capacity for imitative leaning enabled a rapid expansion of the behavioral repertoire tied to life routines. Fossil evidence indicates that *Homo habilis* displayed brain asymmetry (enlarged frontal region), right handedness (Corballis, 1989), used stone tools (Richards, 1989), and possessed Broca's area, a neuroanatomical feature associated with fine motor control of the mouth and face and language (Ambrose, 2001). Their cognitive ability increased due to a 20 percent increase in cranial capacity over Australopithecines, presumably necessary to maintain cohesion among social groups, which increased in size by about 20 percent to 70-80 individuals. This larger group size exceeds the upper bound for individuals to "maintain dyadic bounds through mutual grooming, which causes the release of natural opiates in the brain, which in turn promote feelings of well-being and attraction and lead to social cohesion" (Massey, 2002:4). Thus, Massey concluded that *Homo habilis* must have possessed more complex mechanisms for emotional communication than those of Australopithecines.

Smillie proposed that *Homo habilis* possessed some sort of a "paleo-language," i.e., a primitive speech communication, which "played some significant role in increasing other dimensions of social coordination and in enhancing cooperative behavior strategies" (1996:147-48). Parker believed that early hominoids such as *Homo habilis* probably possessed cognitive abilities at least as impressive as contemporary great apes and may have used "gestural protolanguage" within kin groups to identify the nature and location of food. By the end of this period, the increased individual fitness conferred by social cooperation and the relative energy efficiency of vocalizations over gestures presumably provided a relative selective advantage to effective vocally communicating social groups.[48]

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[48] "Cooperative hunting and gathering and food transport and distribution would have favored an expansion of the lexicon of things (i.e., nouns) and states, processes, and actions (i.e., verbs) and their classification by basic characteristics (e.g., animate vs. inanimate, plural vs. singular things, and agent, patient, instrument). Their activities imply that hunter-gatherers must have classified animals into predators, prey, and competitors, plants into foods, medicines, and raw materials, and locations into geographic features such as

Richard argues that *Homo habilis* were most likely forager-scavengers and probably did not possess language ability beyond vocal mimicry and a somewhat more advanced sound-signaling system than other primates of their time. It is also unlikely that they possessed culture, and learning was almost certainly restricted to imitation with little in the way of innovation. By the end of this period, however, *Homo habilis'* utilization of mid-day niche (which corresponded to a decrease in body hair as an adaptation to activity during the warmest parts of the day) may have provided a sufficiently novel behavioral environment to initiate a transition from an "imitatively derived behavioural repertoire" to a stage in which life routines become increasingly tagged to behaviors that are "stored in the environment" (Richards, 1989:246, 51). The exploitation of this new niche also precipitated a dramatic increase in the number of behavioral options available for completing life routines, e.g., "obtaining food, grooming, finding or creating shelter, avoiding predators, mating, etc." relative to "hard-wired" behaviors (Richards, 1989:245). This resulted in an increasingly high cost in terms of neurological memory (storage), access, and energy. Since each learned behavior was bound to each relevant life routine, multiple neural copies (memory) of each behavior applicable for more than one routine would have been necessary. Richards postulates that a more efficient system for neurological memory storage energetics and access began evolving with late *Homo habilis* and culminated with emergence of *Homo erectus*, around 1.5 million years ago.

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rivers, forest, hills, and plains; they must have classified bodies into parts and animals and people by age and sex; they must have classified animals by states such as dead or alive, sick or healthy, safe or dangerous and recognized processes such as growing, dying, cooling, beating, raining" (Parker 1985).

This system reversed the linkage between memory of behaviors and life routines, and thereby began to reshape fundamentally the cognitive relationship between early hominoids and their environment.[49]

Behaviors like transporting food, carrying tools and materials, and carrying infants represent likely candidates for the kind of generalized behavior that extends to multiple life-routines. Objects in the environment used for carrying (large leaves, vines, gourds) become abstractly associated with behaviors for fulfilling life-routines that an individual might undertake in the future. Such a scenario infers that this transition also coincided with the emergence in hominoids of a consciousness of time: individuals become aware that objects in the environment not immediately useful in completing a life-routine within which an individual engages at the present will be of use in completing another life-routine later. Just such a transition appears to be a necessary immediate pre-condition for both the emergence of an objectified "self" and Habermas' "attitude of addressing the other."

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[49] "Instead of tagging imitatively derived schemata to life routines, it is simpler to reverse the process and tag life routines to schemata…. Instead of the environmental phenomena's being given meanings in terms of the organism's motivational states, the organism's motivational states are given meaning in terms of the environmental phenomena. 'Shelter means leaves' reverses to 'leaves mean shelter,' 'water carrying means gourds' [changes] to 'gourds mean water carrying," and so on. Once the number of schemata in the repertoire exceeds the number of life routines, such a reversal becomes the more efficient way of storage. The importance of this cannot be overstressed; it represents a radical reversal of the way in which all animals have hitherto related to their worlds but one which has arisen purely in the course of simplifying information storage and, neurologically speaking, may be relatively simply achieved in the course of optimizing cortical energy resources" (Richards 1989).

Emergence of Homo erectus: 500,000 years ago

The large cutting tools manufactured by *Homo erectus* exhibited preconceived designs, standardization, and bilateral symmetry, implying greater conceptual and cognitive abilities than *Homo habilis.* In addition, burned bones found in South Africa suggest the systematic use of fire between one and 1.5 million years ago (Ambrose, 2001). Taken together, a variety of archeological evidence suggests radical social and communicative changes from *Homo habilis* to *Homo erectus*:

- A dramatic increase in brain size from about 550 cc to 1000-1100 cc, further expansion of the frontal, temporal, and parietal lobes, and evidence of laterality of the brain, collectively associated with communicative abilities;
- Development of sophisticated tools, evidence of manual dexterity and handedness;
- Decreased sexual dimorphism and, because of neurological development continuing throughout adolescences, the need for prolonged parenting.

These adaptations provided for greatly increased emotional expressiveness as “the cognitive bases for primary emotions such as fear, anger, disgust, happiness, and sadness were rewired and interconnected via the cortex to produce new sets of emotions, conducive to social cohesion and solidarity, such as shame, guilt, anticipation, and hope” (Massey, 2002:7). According to Richards, however, based on archeological evidence it was still unlikely that *Homo erectus* possessed language more highly evolved than vocal signaling, culture, or a reflexive self-awareness (i.e., they were similar to contemporary primates).

While the cognitive capacity for emulative learning and the ontogenetic ritualization of behavior are common among primates, between 2 million and 300,000 years ago human ancestors evolved an additional capacity for imitative cultural learning, which involves an understanding of intention separate from the actions and means used to achieve a goal (Tomasello, 1999).[50] It is through imitative learning that the capacity referred to by Habermas as the "attitude of addressing the other" first emerged. Unlike emulative learning, imitative learning requires an ability to understand the intention of an actor and act, which is predicated on the ability for social cognition: specially adapted skills and a social awareness that recognizes others, and for the learner to treated by others as an intentional agent. Imitative learning provided the vehicle for cultural reproduction and transmission, enabling humans not only to harness the skills and inventions of their contemporaries, but also to reproduce faithfully, improve upon, and expand the historical practices, rituals, and inventions of previous generations of their social group.[51]

The process of imitative cultural learning plays an important role in cognitive symbolic representation and language acquisition. Linguistic symbols inherently evolve through and represent intersubjective understanding. This is in part due to the specific perspectives they intentionally convey and their ability to focus the attention of others on

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[50] "Imitative learning does not just mean mimicking the surface structure of a poorly understood behavior, the way a parrot mimics human speech, with no understanding of its communicative significance, it also means reproducing an instrumental act understood intentionally, that is reproducing not just the behavioral means but also the intentional end for which the behavioral means was formulated. This requires some specially adapted skills of social cognition." Tomasello 1999.
[51] "This process of cumulative cultural evolution works because of a kind of "ratchet effect": Individual and group inventions are mastered relatively faithfully by conspecifics, including youngsters, which enables them to remain in their new and improved form within the group until something better comes along" Ibid.:513.

relevant aspects of a situation, to raise the salience of some aspects of the lifeworld over others, to convey intention, resulting in a shared perspective. This distances symbols from sensory/motor-accessible objects that occupy a particular space and time, and places them within the repertoire of human capabilities to draw upon salient aspects of the lifeworld for the purpose of communicative action. Imitative learning also made possible the necessary progression of increasing abstraction to move from gesture to symbolically-mediated communication by providing early humans with intellectual flexibility and the ability not only to influence each others' behavior, but also their perceptions.

Through imitative learning, children acquire symbols from adults. The developing child understands that the adult uses particular symbols to try to focus the child's attention on some aspects of a shared experience over others. The child learns to reverse these roles when it attempts to focus the action of others on some aspect of his or her reality. This learning process creates and initiates a child into a communicative convention.[52] The importance of imitative learning in cultural evolution and communicative action cannot be overstated:

> "It was not an everyday genetic event because it did not just change one relatively isolated characteristic, it changed the nature of primate social cognition, which changed the social-cultural transmission process characteristic of primates, which led to a series of cascading sociological and psychological events in historical time." (Tomasello, 1999:526)

[52] "It is in this sense and only in this sense that internalization involves a special form of social learning — cultural learning — in which the child internalizes the perspective of another person" (Ibid.).

Although *Homo erectus* likely had the cognitive ability for imitative learning, the capacity for gestural communication, and possibly used vocal signaling for warning and social relationships, the species was probably prelinguistic. Fitch (2000:263) postulates that evidence for lowering of the larynx in *Homo erectus* may have had little to do with language, rather, it conferred a selective advance because animals with “a lowered larynx can duplicate the vocalizations of a larger animal that lacks this feature, thus exaggerating the impression of size conveyed by its vocalizations.” Similarly, as socialization became increasingly important for survival, the emergence of vocal learning, critical for an extensive vocabulary, may have arisen primarily as an adaptive advantage by improving the ability to establish and communicate individual and/or group identity. Thus, although a lowered larynx also enabled a greater vocal range and vocal learning enabled the repetition of increasingly elaborate vocalizations, Fitch (as Arbib) argued that these likely were socialization adaptations, pre-adaptations for language, but that the emergence of language was not the primary selective pressure.

Parker (1985) inferred that *Homo erectus* had teleological awareness, which also is integrally related to and a prerequisite for ontogenetic language development and prepositional aspects of language, both of which are themselves adaptations for making rudimentary regulatory (social) rules.[53] Parker argued that the shift from primarily gesture-mediated to vocal language probably occurred during the time of *Homo erectus*,

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[53] Parker’s evidence to support this view was that a child’s earliest “…gestures and the one-word utterances that accompany or succeed them in development correlate with and probably depend upon the emergence of the understanding of causality and simple means-ends relationships (e.g., tool use)…” (Parker:620).

which she maintained possessed language with semantic systems and syntactic constructions. The adaptive advantages conferred by these evolutionary developments would have enabled survival in a wider range of habitats, as evidenced by the expansion of *Homo erectus* out of Africa to Asia and Europe about one million years ago.

The Lower Paleolithic: 500,000-250,000 years ago
(Corresponding to the decline of *Homo erectus* and the emergence of Neanderthal and early *Homo sapiens*; the oldest part of the Paleolithic Age, the emergence of the hand ax, ending about 120,000 years ago)

By the Paleolithic Age, early humans may have developed the ability to create mental maps of their surroundings, “probably greatly aided by language labeling of landmarks and ability to integrate time and distance information” (Hewes, 1978:8). These cognitive abilities are also likely pre-adaptations for language because, while human languages strongly rely on spatial metaphors, the ability to construct mental spatial maps is also found in many animals (Marcus, 2004). Increased behavioral diversity was likely a double edged sword for late *Homo erectus* and later, Neanderthal, increasing within a population the probability of the availability of adaptive behaviors for idiosyncratic problems, while simultaneously creating a challenge to group cohesiveness and age/sex hierarchical structure. Richards speculated that culture and language evolved to fulfill the need to maintain group identity and solidarity, through “some prototypic differentiation between nature and culture of the kind familiar to anthropologists,” enabling individuals to find identify in group membership and to apply and subordinate their skills and abilities to the group (Richards, 1989:248-49).[54]

At the point of the emergence of human culture, humans likely crossed an evolutionary Rubicon, changing “the very locus of natural selection.” An individual’s survival depended not only on proficiency at a set of species-specific behaviors, but also on acquiring an aptitude for a set of socially valuable behaviors (Richards, 1989:249).[55] From this point on, both environmental and societal selective pressures operated to shape the course of human evolution, resulting in a complex value system that was cognitively organized, represented, and reproduced through linguistic symbols, and ever balancing between, while always representing both, the individual and its social group.

The Middle Paleolithic: ending about 40,000 years ago

(Period of Neanderthal man with the emergence of *Homo sapiens sapiens)*

Neanderthals emerged around 300,000 years ago and were equipped with a brain that had expanded to about 1400 cc, almost the size of modern *Homo sapiens.* Neanderthal group-size reached 120-160 individuals, far exceeding the maximum number of individuals who could maintain cohesion through mutual grooming behavior alone. From archeological evidence, Massey concluded that the Neanderthal possessed a

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[54] “It is tentatively proposed that the advent of culture lies in this need to maintain group coherence in the face of an expanding behavioural repertoire. Species identity alone no longer suffices. An obvious step here will be some prototypic differentiation between nature and culture of the kind familiar to anthropologists. The individual’s identity lies not in his or her idiosyncratic behavioural repertoire or species-specific morphology but in group membership, and it is to the group interest that his or her particular skills, etc., must be subordinated.” Richards:248-49

[55] Placement of the emergence of human culture during this period also seems consistent with Fabrega’s critique of Arib’s mirror systems hypothesis. See: Fabrega 2005

"material culture" that included composite stone, flint, and wood tools, and permanent structures, evidenced by stone hearths and postholes: "culture, therefore, must by then have been the central mechanism maintaining social cohesion" (Massey, 2002:7). These adaptations enabled further expansion of the Neanderthal's range into northern Europe. Evidence suggesting heavy reliance on hunting indicates that social structure "probably began to move beyond small bands differentiated by age and sex to form large collectives such as kin-based clans" (Massey, 2002:7).

Although fossil and archeological evidence strongly suggest that the classic Neanderthal lacked the anatomical specializations (e.g., a bent supralaryngeal vocal tract) and cognitive ability necessary for human language (Lieberman, 1973), later regional and technological tool variations indicate the existence of cultural traditions, and conjunctive technologies required hierarchical cognitive abilities analogous to those required for grammatical language.[56] Adjacent areas of the inferior frontal lobe are responsible for the non-repetitive fine motor control necessary for both speech and construction of composite tools. Like language, collecting materials, modifying them into components, and constructing composite tools involved temporally planned sequences of actions performed at different places, "such as flaking a stone point, cutting and shaping a wooden shaft, and collecting and processing binding materials. The complex problem

[56] "Speech and composite tool manufacture involve sequences of nonrepetitive fine motor control and both are controlled by adjacent areas of the inferior left frontal lobe. A composite tool may be analogous to a sentence, but explaining how to make one is the equivalent of a recipe or short story. If composite tool manufacture and grammatical language coevolved ~ 300 [thousand years ago], then Neanderthals and modern humans could speak.…" Ambrose 2001:1751-52

solving and planning demanded by composite tool manufacture may have influenced the evolution of the frontal lobe" (Ambrose, 2001:1751-52).

Within 50,000 years of *Homo sapiens'* appearance on Earth around 150,000 years ago, the species had migrated out of Africa to occupy the entire planet. This is itself a remarkable feat, given that, "…Australopithecines and *H. habilines* had remained in Africa for five million years without moving, and *Homo erectus* and the Neanderthals had not expanded beyond southern Europe and Asia in over one million years…" (Massey, 2002:8). Early *Homo sapiens*' brain reached its current size and physiological development. By 71,000 years ago, modern humans made sophisticated composite stone, bone, and wood tools, and weapons and engraved ornaments (Jacobs et al., 2008). Corballis (1989:499-502) speculated that composite tool-making indicates that (and perhaps beginning as early as *Homo habilis*) *Homo sapiens* evolved the capacity for generative operations, i.e., the capacity to "describe, represent, or construct an enormous variety of composites, given only a relatively small number of building blocks and rules of construction," mediated by the left cerebral hemisphere. At a minimum, it appears that these abilities were necessary pre-adaptation for the evolution of symbolic units, and eventually, for grammatical speech.

It was not until about 50,000 years ago, however, that significant cultural change and differentiation was observed without any corresponding physical changes: "Human cognitive capacity had apparently reached a state of dynamism and flexibility where it could innovate adaptations ad infinitum" (Massey, 2002:8). Smille suggested that evolving paleo-language and a process of lineal fissioning, similar to what Chagnon observed among contemporary Yanomono, could have played a significant role in the rapid human expansion out of Africa, evolutionary change, and expansion and cultural diversity (Smillie, 1996). Atkinson et al. (2008) provided evidence that language evolved in "punctuational bursts," which account for 10 to 33 percent of variation in the vocabulary in the world's three major language families. They concluded that language both mirrors and promotes social cohesion and group identify, and changes rapidly during the formation of new or rival groups.

Thus, propelled by and propelling the further development of language, material culture began to include sophisticated tools, weapons, fabric and clothing, jewelry, permanent shelters, hearths, kilns, and lamps, and by the Neolithic, bronze began replacing stone. Although Massey did not specify when he believed language developed, other than "perhaps not immediately" after the appearance of *Homo sapiens* (Massey, 2002:8), he strongly implied that language was the adaptive feature that enabled the explosive migration out of Africa and subsequent rapid cultural development.

The Upper Paleolithic: from about 40,000 to 10,000 years ago
(The time-period during which it was believed only modern *Homo sapiens* existed)

By the Upper Paleolithic, increasingly sophisticated technology, social specialization, and the need to predict temporal and spatial distribution of resources provided selective advantage to increasingly complex and effective verbal communication. Early *Homo sapiens'* technology showed a marked increase in the number of usable edges; functional and stylistic diversity; complexity; and materials, including “ground, polished, drilled, and perforated bone, ivory, antler, shell, and stone, shaped into projectiles, harpoons, buttons, awls, needles, and ornaments” (Ambrose, 2001:1572). Corballis (2004) argued that this “human revolution” was precipitated by the development of language. Massey understood the evolution of language as a response to the selection of traits that enhance “social intelligence to enable [early *Homo sapiens*] to get along in large groups” (Massey, 2002:9). The success of language as an adaptation was due to its almost three-fold greater efficiency over grooming for maintaining group cohesion, based on a comparison of cranial capacity and expected group sizes between chimps and contemporary hunter-gatherers. In addition, while about 20 percent of chimps’ time is spent in one-on-one grooming, humans spend about the same amount of time in conversation, but human conversations cross cultures and typically consist of one speaker and three listeners.

Homo sapiens’ capacity for language was made possible by the evolution of specialized and interconnected areas of the brain, including: Broca’s area, associated with making and controlling of sound; Wernicke’s area, associated with hearing and differentiating sounds; and parietal and frontal lobe expansion, associated with conceptualization, i.e., “the ability to use and manipulate arbitrary sound symbols in meaningful ways—to *think* of words before uttering them and to organize them into large units of meaning” (Massey, 2002:8, italics in original). However, the development of language likely also coincided with a change in neural information storage and processing. Hominoids, beginning around 500,000-250,000 years ago with the end of *Homo erectus* and being fully realized in Neanderthal, increasingly decoupled imitatively learned behavior from life-routines, resulting in a further differentiated world. Human behavior evolved the capacity for “general problem-solving strategy independent of any particular life-routine” (Richards, 1989:248). The ability to acquire “knowledge” emerges because all behavioral schemata and outcomes increasingly were recognized as potentially useful. This new capacity provided for an even larger behavioral repertoire based on an expanding perception and appreciation of environment phenomena. This expansion, however, resulted in a tremendous strain on cognitive capacity — an information overload. To relieve the increasing strain on neural memory storage and access, Richards proposes the evolution of lexical encoding and syntax to have happened no earlier than around 40,000 years ago with the appearance of *Homo sapiens.*[57] Of relevance to social theory, this further abstraction of the world marks the transition from knowledge stored in the natural environment to knowledge stored in the cultural environment, fist observed as a demarcation between the natural environment and hominoid groups, and possibly a differentiation between hominoid groups.

As tool-making and use, carrying, communication, cultural reproduction, and language became increasingly co-dependent and critical for survival, there was

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[57] Note that Hewes, Pfeiffer, Parker, and Tomasello place the evolution of language as early as *H. hobilis* and *H. erectus* (400,000 years ago), much earlier in than Richards’ placement of lexiconic language at only 40,000 years ago (Hewes 1978;Parker ;Pfeiffer 1978;Tomasello). The main difference between Richards and earlier authors is his interpretation of the necessity of language to support archeological and paleontological findings associated with early hominoids, e.g., technological development. Apart from the actual timing, however, his chronology for cognitive development is very similar. As Richards was aware of these earlier works (he specifically acknowledges Parker’s contribution), reflecting a thorough consideration of recent archeological and paleontological findings that may not have been all available to the earlier authors, I consider his model more authoritative.

undoubtedly significant evolutionary pressure to free the hands from the additional burden of communication. Corballis (2004) argued convincingly that the "human revolution" observed in the Upper Paleolithic was not the result only of the development of language or speech; rather, "that it derives from the eventual accomplishment of fully autonomous speech," which may have partially resulted from a series of mutations to the FOXP2 gene that culminated in its present form as recently as 50,000 years ago. The series of mutations "honed vocal articulation to the point that speech could become fully autonomous, or nearly so, finally reducing manual and facial gesture to an embellishment rather than a necessary component" (Corballis, 2004:548).

Parker speculated that "prepositional aspects of language were selected among *Homo sapiens* as an adaptation for making constitutive rules, inferences, and predictions" (Parker, 1985:625). By providing vocabulary, syntax, and grammar, language enabled humans to perceptually differentiate and categorize time, objects, and events, which consequently led to conceptual models of causality: cultures based on myth. The appearance of calendars, musical instruments, symbols, art, ritual burying with jewelry, food, and utensils indicates the increasing importance of myth in early human culture from 50,000 to 10,000 years ago. As Massey points out, mythic culture, for the first time in history, allowed humans to synthesize discrete, time-bound events and circumstances and to connect them into a single coherent narrative, a world myth that provides a common meaning to life events, circumstances, and activities. Myth "explains how people are supposed to behave, why cultural rules must be obeyed, and how they are to be enforced… reflect a society's idea of causality: where life comes from, what happens to people after death, and what controls events in the world" (Massey, 2002:9).

Homo communicarus[58]

The interdependent phenomena of human language and culture became increasingly important for "establishing a symbolic system for social coherence and coordination rather than [only] as a means of transmitting knowledge from generation to generation analogous to genetic transmission systems" (Smillie, 1996:151). Human consciousness, language, and culture are the inseverable products of more than 2 million years of biological, cognitive, and social co-evolution (Table 10).

This inter-connectiveness between biology, consciousness, and society has important implications for the definition of human rationality and for the theoretical and methodological choices for social theory and policy analysis. The contemporary anthropological perspective lends further empirical support for Habermas' premise that successful communication aimed at achieving understanding requires that the speaking "self" and hearing "other" achieve an *intersubjective* understanding consistent with the communicative intent of the speaker. The theoretical importance of feedback and reinforcement in the development of language is also supported by artificial intelligence research that suggests emotional responses are actually necessary for the generation and processing of information to make decisions (Lawless, 2001).

[58] From the Latin word "Communicare:" to communicate, share, impart, participate.

Table 10. Human cognitive, behavioral, and social co-evolution

Years Ago	Hominoid Species	Knowledge Loci and Leaning Mode	Behavior	Communication	Cultural Development
>2,000,000	Pre-hominoid; Australopithecus	Genetic-Emulative learning Ontogenetic ritualization	Chained to life routines	Gestures, vocalizations	Species identification
2,000,000	*H. habalis*	Cortical-Imitative learning	Expansion of repertoire for completing life routine	——	——
1,500,000	*H. eretcus*	Environment	Life routines become linked to behaviors	Vocal signaling	——
500,000-250,000	*H. erectus* to Neanderthal, early *H. sapiens*	Environment Culture	Decoupling from life-routines	Ritualized gestures and vocalizations	Demarcation between nature and hominoid groups
40,000	*H. sapiens*	Culture linguistic	Symbolic	Lexicon and syntax	Differentiation among and between groups

Implications for the Social Sciences

The evolution of language, consciousness, and behavior cannot be considered in isolation of one another. The capacity for human culture and society has its roots in the natural environment: a product of natural section. This capacity is a phenotype, selected because it increased cooperative action among individuals in a social group, enabling social differentiation and individual specialization, and thereby increasing group fitness. Human cognition, language, and culture are mutually entwined, inseparable phenomena rooted in the selection of adaptations that improve cooperation among socializing individuals. Human consciousness, language, culture, and rationality are severable only artificially by overly simplistic analytical instruments, which are capable of viewing and interpreting results only though the distortion of a particular discipline.

This concept has important implication for the justification, design, and interpretation of social science research, including economics, and for its normative assertions. Social cooperation, language, human cognition and behavior are a singular, complex, and multidimensional phenotypic attribute (a cognitive-lingual-socio-cultural complex). Social cooperation is not a special case, secondary consideration, or simply a strategy for maximizing individual fitness, as frequently conceived in economics. Cooperation is a principal phenotypic expression that has evolved to maximize individual fitness, which is inseverable from the fitness of the individual's social group.

I propose, therefore, to consider rationality with respect to human lingual-cognitive-cultural co-evolution. Language is the way in which we organize and share our thoughts, symbolically represent objects and concepts, and coordinate action with others. It is our common software, without which we cannot operate normally. As Habermas argues, understanding is arrived though language, "as the medium for coordinating action" (1984:274). It is through language that society and culture evolve and reproduce. Consequently, rationality must be defined and individual actions assessed from the perspective of the individual actor in the specific social context within which the actions (are to) transpire, rather than operationally predetermining — through the selection and application of a particular methodology — an artificial context within which the actor is to operate and action is to occur. Any constructed research scenario must have theoretical continuity with empirical data and theory of human evolution —neurological, cognitive/consciousness, linguistic, cultural, and societal. Research methodologies used to develop and/or justify environmental policy, such as economics and benefit-cost analyses, need methodological and theoretical continuity with a social theory, grounded in the relevance of the underlying theoretical assumptions to the actor's actual (social) decision-making context. An experiment that places an expectation for an isolated actor to respond to constructed hypothetical alternatives and consequences, rather than placing the actor, actions, consequences, and decision within his or her socio-cultural milieu, likely will bias and distort any result. Instead of reflecting the values and likely actions of the actor, responses will conform to the theoretical ideology, conceptions of rationality, and value systems that spawned the methodology.

5. THE DEVELOPMENT OF IDENTITY, NORMS, AND CULTURE

The preceding discussion illuminates the origins and social aspects of consciousness and communication. The importance of these processes becomes more evident as I now discuss in greater depth language's role in the development, maintenance, and reproduction of social norms and culture.

For communicative efforts to be effective in coordinating behavior, it is also important that in determining "other's" (hearer's) response to "self's" (speaker's) communicative effort, assuming that "other" understands "self's" communicative intent, "other" must also judge the implicit validity of "self's" communicative effort within both the physical and social context, and determine whether to accept or reject "self's" validity claim. Whatever response is made by "other" to "self's" communicate effort, "self" must also judge the appropriateness of "other's" response within the context of "self's" original communicative intent and the physical and social environment. These two co-occurring social-cognitive mechanisms, i.e., achieving intersubjective agreement on meaning and critical evaluation of validity claims, lead to the evolution (and ontogenic development) of competent communicating participants, rules, and conventions.

As in Richards' Stages 4 and 5, objectively regulated patterns of behavior gradually are internalized and replace instinctual regulation with a cultural tradition communicated in language. In this way, gesture-mediated communication is replaced with symbolically mediated interaction and rule-governed behavior orientated to meaning conventions (Habermas, 1985). The process by which this occurs is an accretion to the learning process for agreement on the meaning of symbols.[59] At this point in both individual development and human evolution, the concept of socially mediated behavior begins to emerge. Coordination of action through communicative efforts is first maintained by the anticipation of sanctions by the social group against non-conformal behavior and by the potential for the "reciprocal satisfaction of interests" (Habermas, 1985:37). For socially sanctioned behavior to become binding norms, i.e., having the power to illicit behavioral self-restraint, individual members of a social group (children) must anticipate the consequences of misbehaving (punishment) and thus internalize the behavioral norm while simultaneously generalizing and abstracting the sanctioning authority of social groups (parents).[60]

This concept of a "generalized other" represents a significant shift from the role of symbols in expressing "gestures that stimulate behavior" to a new role of steering

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[59] "The transition from gesture to symbolically mediated communication to normatively regulated action requires that both speaker and hearer are capable of taking a third perspective. A manifestation of taking the "attitude of addressing the other" is that the conscious mind observes and differentiates between the social roles of speaker and hearers from a third-person perspective, objectifying oneself and others as participants in a social activity and enabling the critical evaluation of one's behavior against the normative validity of the observed social roles. By taking this third-person perspective, communicating individuals generalize roles from individuals to groups. They develop "the concept of a pattern of behavior that is socially generalized to every member of the group, and in which the places are not reserved for ego and alter but can in principle be taken by any member of their social group" (Habermas 1985).

[60] "The mechanism of taking the attitude of the other again operates here on the moral level. This time, however, it fixes on the sanction power of the group as a norm-giving entity, and not on that of individual persons, or even all of them… The authority of the group consists simply in the fact that it can threaten to carry out sanction in case interests are violated. This imperativistic authority is transformed into normative authority through internalization. It is only then that there arises a "generalized other" that grounds the validity of norms" (Ibid.).

behavior according to “normatively regulated action” (Habermas, 1985:43). It also provides the basis for developing individual self-identity through the interaction of the conscious self with the objectified generalized social groups to which self identifies. The perception of and identification with institutions similarly arises because of this ability by members of a communicating social group to generalize a common response to a particular situation.

Habermas points out that the consequences of failing to perform a social norm differ from failure at an instrumental action. Through the process of ego and superego development, the conscious self incorporates validated norms as binding behavioral controls. Violation of such self-binding norms results in an automatic acknowledgement of failure, an immediate internal consequence (guilt, shame).[61] The transition from symbolically mediated communication to grammatical language has profound implications for human identify, behavior, motivation, and institutions:

> “… the instruments for reaching understanding were transformed into signals, into signs with conventionally fixed meanings; at the stage of normatively guided action, however, the symbolism penetrates even into the motivation of the behavioral repertoire. It creates both subjective orientations and suprasubjective orientation systems, socialized individuals, and social institutions. In this process language functions as a medium not only of reaching understanding and transmitting cultural knowledge, but of socialization and of social integration as well.” (Habermas, 1985:24)

[61] “The violation of a valid technical rule leads to consequences that are internally connected with the action in a certain way: the intervention fails. The goal striven for is not realized, and the failure comes about automatically; there is an empirical, a lawlike relation between the rules governing action and the consequences of action… For this to happen, the individual must be able to remain for the development of obligatory social norms” (Ibid.).

The postulate that every communicative effort involves a series of validity claims and judgments between participants is a core tenant of Habermas' Theory of Communicative Action. Reaching intersubjective understanding between speaker and hearer involves the anticipation, recognition, and critique of a validity claim. Each communicative effort requires a determination of rationality of the communication and response within the physical and social environment. In every communicative effort, a speaker and hearer critique at least one of three validity claims with regard to truthfulness, sincerity, or legitimacy, depending on whether the speaker is attempting to communicate, for example, a fact, a feeling, or a command, to which a hearer is anticipated to respond. Of paramount importance to social theory is that intersubjective understanding and validation of normative and expressive communicative efforts is constitutive of language's role in coordinating actions:

> "With the validity claims of subjective truthfulness and normative rightness, which are analogous to the truth claim, the binding/bonding effect of speech acts is expanded beyond the range of convictions with descriptive content that is marked out by utterances admitting of truth. When participants in communication utter or understand experiential sentences or normative sentences, they have to be able to relate to something in a subjective world or in their common social world in a way similar to that in which they relate to something in the objective world with their constative speech acts. Only when these worlds have been constituted, or at least have begun to be differentiated, does language function as a mechanism for coordination." (Habermas, 1985:19)

The Differentiation of Society

Language enabled humans to effectively coordinate actions in ever larger social groups: “normed expectations and grammatical speech… yield the structure of linguistically mediated, normatively guided interaction, which is the starting point for socio-cultural development” (Habermas, 1985:46). While language provided a necessary tool, a pivotal question remained as to how cooperation and coordination was developed and maintained within groups and, ultimately, increased across generations of ever larger and more complex societies.

Changes in early humans’ physical environment likely resulted in evolutionary pressures that favored increasingly larger cooperating social groups. With increased size, specialization of roles became possible through coordination of action within the group. A social group could become more efficient at acquiring food and defending itself from predators and rival social groups, thereby enhancing individual and group survival. The initial differentiation of labor was made possible by the development of mutual expectations, an “intersubjective recognition of normed expectations of behavior,” for individuals performing a particular social role. This formed the basis for “a moralization of motives for action” based on status considerations other than physical power and intimidation (Habermas, 1979a:118). For example, the evolution of pair bonding further differentiated gender roles and also facilitated cooperation among hunting males who no longer needed to strongly compete for mates (Morris, 1967). Eventually, as the size of cooperating social groups increased from loosely coordinated kin groups to tribes and states, differentiation of labor occurred within and then between kin groups, based on individual, family, or clan status or prestige. Role specialization led to and reinforced social classes, resulting in sub-cultures, and behavioral adaptation to environmental pressures was certainly responsible for at least some cultural attributes (Linton, 1972).

Maintenance of cooperation within such role-differentiated social groups requires communication that effectively achieves mutual understanding about group identity, norms, roles, and actions across time and space, i.e., culture. With increasing group size, however, communication necessary for coordination and cultural transmission becomes increasingly problematic. Therefore, as the size of socially coordinated groups increased, selection favored those groups with communication mechanisms that were effective for transmitting culture.

Richerson, et al. (2002) make a compelling argument that selective evolutionary pressure during the Pleistocene, including pressures resulting from living in social groups and culturally influenced institutions, endowed humans with genetic traits that further enabled social cooperation and linguistic development. These traits included an elaborate ability for faithful imitation, docile temperament, and an uncommon sensitivity to praise and reproach by parents and others. According to Richerson and his colleagues, genetic and cultural co-evolution continued until about 10,000 years ago, when genetic evolution of social instincts became insignificant, a consequence of the reduction of selective pressure resulting from the development of subsistence agriculture. From then on, the cooperation necessary for humans to live in increasing large and complex societies was possible only though the cultural evolution of social norms and institutions that, sometimes with only marginal effectiveness, suppress selfish and nepotistic instincts that are undeniably part of our genetically transmitted psychology.

Boyd and his colleagues (2003) provide evidence for the importance of group selection in the cultural evolution of cooperative behavior and moralistic punishment. Using evolution simulation modeling, they demonstrated that the feasibility of maintaining cooperative behavior, in social groups similar in size with ethno-linguistic units in non-agricultural societies (about 600 individuals), depends on altruistic punishment. Boyd and his colleagues also suggested that ordinary natural selection may have led to the genetic evolution of moral emotions as a consequence of living in a social environment shaped by cultural group selection.

Richerson and his colleagues concluded that evolution provided humans with:

> "innate principles [that] furnish people with the basic predispositions, emotional capacities, and social dispositions that are implemented in practice through highly variable cultural institutions, the parameters. People are innately prepared to act as members of tribes; but culture tells us how to recognize who belongs to our tribes, what schedules of aid, praise and punishment are due to tribal fellows; and how the tribe is to deal with other tribes – allies, enemies, and clients." (Richerson, et al., 2002)

Once these "anthropologically deep-seated general structures" were solidified within early communicatively-integrated human social systems, further differentiation and development of social subsystems depended on specific historical circumstances and was likely frequently non-linear. Habermas comments that from the perspective of historical materialism, social evolution often is described in terms of material production (stone, bronze, iron, synthetic) and energy sources (fire, water, wind, atomic, renewable).

It also may be characterized by development of the market (household, town and national, world economy), social division of labor (hunting and gathering, cultivating and breeding, city crafts, agriculture, industry), and forms of cooperation (household industries, cottage industry, factories, national enterprises, multinationals). Finally, changes in the complexity of societies are described best in terms of modes of production (Habermas, 1979a):

> **Primitive Societies**: Kinship determined distribution, and labor and production were primitive communal, with no private ownership.
>
> **Early Civilizations** (Mesopotamia, Egypt, Ancient China, Ancient India, pre-Columbian America): Priesthoods, military, and bureaucracies owned and administered land.
>
> **Mediterranean Societies** (Greece, Rome, others): Private ownership of land and slaves, mastery of day laborers in household economy framework within city-states.
>
> **Feudalism** (Medieval Europe): Feudal lords allocated private estates to individual landowners with whom they had various economic and political relations.
>
> **Capitalism**: Labor is a commodity secured by owners of the means of production through contacts and labor markets.

In contrast to the perspectives of historical materialism, Habermas proposes social development be described in terms of the principles of social organization, which considered “(a) general structures of actions, (b) structures of world views insofar as they are determinant for morality and law, and (c) structures of institutionalized law and of binding moral representations” (Habermas, 1979a:134). As society becomes more complex, the social lifeworld that is maintained and reproduced though communicative action and legitimized through intersubjective understanding is increasingly differentiated and distanced from purposeful-rational social systems, such as economic and administrative/bureaucratic spheres.

> "…system and lifeworld are differentiated in the sense that the complexity of the one and the rationality of the other grow. But it is not only the qua system and qua lifeworld that they are differentiated; they get differentiated from one another at the same time. It has become conventional for sociologists to distinguish the stages of evolution as tribal societies, traditional societies, or societies organized around a state, and modern societies (where the economic system has been differentiated out). From the system perspective, these stages are marked by the appearance of new systemic mechanisms and corresponding levels of complexity. On this plan of analysis, the uncoupling of system and lifeworld is depicted in such a way that the lifeworld, which is at first coextensive with a scarcely differentiated social system, get cut down more and more into one subsystem among others. In the process, system mechanisms get further and further detached from the social structures through which social integration takes place…. [M]odern societies attain a level of system differentiation at which increasingly autonomous organizations are connected with one another via delinguistified media of communication: these systemic mechanisms — for example, money — steer a social intercourse that has been largely disconnected from norms and values, above all in those subsystems of purposive rational economic and administrative action, that … have become independent of their moral-political foundations." (Habermas, 1979b:188-89, Habermas, 1985:153-54)

Unlike the social lifeworld, these systems are regulated by non-symbolic steering exchange media like money and power. They are largely norm-free. While the social lifeworld remains the broader subsystem into which all others must be integrated, "…in modern societies, economic and bureaucratic spheres emerge in which social relations are regulated only via money and power (Table 11). Norm-conformative attitudes and identify-forming social memberships are neither necessary nor possible in these spheres; they are made peripheral instead" (Habermas, 1979b:189, Habermas, 1985:154).

Table 11. Habermas' levels of social integration

Level of Social Integration	Structure of Action	World view	Law and Moral Representation
Neolithic societies	Conventional: Symbolic reality enmeshed with action system	Mythological: enmeshed with action system	Pre-conventional: assessment of action consequences, retaliation, restitution, restoration
Early civilizations	Conventional	Mythological: distinct from action system, legitimizes authority position.	Conventional morality, administered by ruler, assessment of action intentions, transition toward punishment, toward individual liability
Developed civilizations	Conventional	Rationalized, split from mythological	Systemized law separated from ruler, justice
Modern age	Post-conventional, differentiated domains (law, economy, political)	Universalist doctrines of legitimization (rational natural law)	Strict separation of legality and morality, rationalized law, principled private morality

(Adapted from Habermas, 1979a:134)

Critical Theory on Science, Values, and Policy

Habermas argues that there are no logical reasons why even inherently subjective individual and societal values and goals should not be subject to rational analysis. It is the very nature of rationality, however, that subtly and stubbornly lies at the core of this problematic. I will present how Habermas views the problem of the social acceptability of technology through three models for the relationship between science and political decision-making, and then discuss rationality within the context of societal assessment and acceptance of environmental risk.

Habermas observes that technologies effectively are thrust upon society with inadequate planning or reflection. The rapidity of technological innovation generates its own inertia that catches society ill equipped and unprepared for the resultant material and social changes. In fact, technology not only provides a means to achieve social ends, but also results in new sets of social problems and goals that science or technology alone cannot solve. The evolution of discursive social institutions that facilitate meaningful interaction between the public, political decision-makers, and the technological elite is needed to address the problems resulting from technological self-inertia.[62]

Both the historical and normative nature of the relationship between scientific rationality and democratic decision-making continues to be an issue of considerable debate. Like Max Weber (1949), Habermas observes that modern analytical techniques cannot answer fundamental questions about societal norms and values. Habermas explores three models of this relationship: Decisionistic, Technocratic, Pragmatistic.

According to Habermas, the trend in the relationships among science, values, and politics in contemporary society is generally toward a decisionistic model, as evidenced by "the scope of research under government contract and the extent of scientific

[62] "Through the unplanned socio-cultural consequences of technological progress, the human species has challenged itself to learn not merely to affect its social destiny, but to control it. This challenge of technology cannot be met with technology alone. It is rather a question of setting into motion a politically effective discussion that rationally brings the social potential constituted by technical knowledge and ability into a defined and controlled relation to our practical knowledge and will" (1970).

consultations to public services" (Habermas, 1970:62). Under the decisionistic model, value-laden decisions are not amenable to rational empirical analysis, while the "means" of political practice are subject to rational analysis and scientific control. In other words, politicians and political appointees set policy goals, while practitioners of rational analysis, e.g., scientists and economists, are restricted to considering only how best to achieve policy ends. When viewed from this perspective — a perspective of instrumental-teleological rationality — social value, goals, and needs are themselves the products of irrationality.[63]

Under a decisionistic model, the politically-directed selection and utilization of analysts and techniques, such as systems analysis and decision-theory, operationally predefine those societal values and norms considered rational, as rationality itself is defined by and a manifestation of methodology. In the technocratic model, the roles of the politician and specialist are reversed. The politician cedes legitimate authority and becomes the agent of the specialist, who efficiently uses objective techniques. The political apparatus effectively abdicates decision-making power to rational administration.[64] The underlying argument for the rationality of the technocratic model

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[63] "A decision is made between competing values, orders and convictions, which escape compelling arguments and remain inaccessible to cogent discussion. As much as the objective knowledge of the expert may determine the techniques of rational administration and military security and thereby subject the means of political practice to scientific rules, practical decisions in concrete situations cannot be sufficiently legitimated through reason. Rationality in the choice means accompanies avowed irrationality [sic] in orientation to values, goals, and needs" (Ibid.).

[64] "… in concrete circumstances, elaborates the objective implications and requirements of available techniques and resources as well as of optimal strategies and rules of control…. [T]he politician in the technical state is left with nothing but a fictitious decision-making power… at best something like a

lies with the assumption of limitless technical progress, uncertainty associated with "practical issues" being continuously reduced through scientific analysis. The model is flawed, however, because it is based on the erroneous assumption that there is a "continuum of rationality in the treatment of technical and practical problems." Even as scientific research improves "our technological power of control, we can make no cogent statement about value systems, that is, about social needs and objective states of consciousness, about the direction of emancipation and regression." While "calculation by decision procedures, when carried to extremes, reduces the decision itself to its pure form, purging it of every element that could be made accessible in any way to cogent analysis," there remains that aspect of any political decision that remains inaccessible to further positivist analysis (Habermas, 1970:64). Technological progress cannot eliminate the uncertainty associated with subjective social values and goals. Of the technocratic model, Habermas concludes that ceding political power to rational administration can happen only "at the expense of democracy itself."[65]

Despite their appeal as representing realizable and desirable relationships between science and politics, Habermas sees both the decisionistic and the technocratic models as

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stopgap in a still imperfect rationalization of power, in which the initiative has in any case passed to scientific analysis and technical planning. The state seems forced to abandon the substance of power in favor of an efficient way of applying available techniques in the framework of strategies that are objectively called for. It appears to be no longer an apparatus for the forcible realization of interests that have no foundation in principle and can only be answered for decisionistically. It becomes instead the organ of thoroughly rational administration" (Ibid.).

[65]"If politicians were strictly subjected to objective necessity, a politically functioning public could at best legitimate the administrative personnel and judge the professional qualifications of salaried officials. But if the latter were of comparable qualifications it would in principle be a matter of indifference which competing elite group obtained power. A technocratic administration of industrial society would deprive any democratic decision-making process of its object" (Ibid.).

inconsistent with democracy because they effectively eliminate public participation in policy decisions and serve to reinforce the ruling group's legitimacy.[66] Both the decisionistic and technocratic models are based on a flawed philosophy that ignores the verity that scientific and technological progress both lead to the creation of new values, as they also are necessary for the fulfillment of values. Value-oriented needs and interests and the technologies developed to address those needs are interdependent. If the connection between values and the technologies to satisfy them are broken, they both become obsolete and fade away. In addition, new technologies can change interests. The main objection to these models, however, is that neither provides for public accountability on the part of experts, who cannot rightfully delegate to themselves the responsibility for reflecting and ratifying public needs.[67] Like Habermas, Dewey also criticizes "rule by those intellectually qualified, by expert intellectuals" (Dewey,

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[66] "The election and confirmation of governing individuals, or those capable of governing, are as a rule plebiscitary acts. The reason that democratic choice takes the form of acclamation rather than public discussion is that choice applies only to those who occupy positions with decision-making power and not to the guidelines of future decisions themselves. At best these decision-makers legitimate themselves before the public. Decisions themselves, according to the decisionistic view, must remain basically beyond public discussion…. The scientization of politics… unquestioned by modern political sociology, [is] a theory that in the last analysis reduces the process of democratic decision-making to a regulated acclamation procedure for elites alternately appointed to exercise power. In this way power, untouched in its irrational substance, can be legitimated but not rationalized.… The claim to rationalization, in contrast, is upheld by the technocratic model of scientized politics. Of course, the reduction of political power to rational administration can be conceived here only at the expense of democracy itself" (Ibid.).

[67] "…the articulation of needs in accordance with technical knowledge can be ratified exclusively in the consciousness of the political actors themselves [sic]. Experts cannot delegate to themselves this act of confirmation from those who have to account with their life histories for new interpretations of social needs and for accepted means of mastering problematic situations" (Ibid.).

1954:205) because it leads to public alienation and the entrenchment of the status quo and power elite.[68]

Dewey and Habermas independently argue that a more ideal relationship between science, policy, and democracy would be a model in which the public, experts, and policy-makers interact through reciprocal communication: social values and their interaction with science and technology are themselves understood as the product of public discourse.[69] Of the three models, Habermas concludes, “only the pragmatistic model is necessarily related to democracy.” Neither the decisionistic or technocratic models can be considered democratic because the separation between science, technology, and decision-making in the former and the colonizing of decision-making by instrumental rationality in the latter leave societal values themselves vulnerable to unreflected manipulation.

Pragmatism achieves the rational analysis of subjective societal values by broadening the scope of rationality beyond the instrumental rationality that inherently limits both the decisionistic and technocratic models. Under the pragmatistic model,

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[68] “It is true that all valuable as well as new ideas begin with minorities, perhaps a minority of one. The important consideration is that opportunity be given that idea to spread and to become the possession of the multitude. No government of experts in which the masses do not have the chance to inform the experts as to their needs can be anything but an oligarchy managed in the interest of the few” (Dewey, 1954:208).

[69] “The essential need, in other words, is the improvement of methods and conditions of debate, discussion and persuasion. That is the problem of the public. We have asserted that this improvement depends essentially upon freeing and perfecting the process of inquiry and of dissemination of their conclusions. Inquiry, indeed, is a work which devolves upon experts. But their expertness is not shown in framing and executing policies, but in discovering and making the facts upon which the former depend. They are technical experts in the sense that scientific investigators and artists manifest expertise. It is not necessary that the many should have the knowledge and skill to carry on the needed investigation; what is required is that they have the ability to judge on the bearing of the knowledge supplied by others upon common concerns” (Dewey 1954:208).

experts and politicians engage in critical interactions rather than functioning separately. Experts provide advice to decision-makers and politicians consult scientists. This reciprocal interaction opens scientific analysis to the validity of the decision-making process itself, rather than ascribing it false legitimacy.[70]

Habermas and Dewey recognized that the process of establishing the rationality and validity of both the means and ends of public decision-making, the discursive rationality that emerges through ideal communication about empirical and value-laden information, depends on the public coalescing as a political institution. It is only through this discursive process, however, that society can reflect and make informed decisions about the applications of science and technology. Social values, as well as their interaction with science and technology, are themselves the product of public discourse and reflect public opinion. The discursive process provides a mechanism, a "feedback monitored communication," for what Dewey called "value beliefs." The process ensures that society is conscious of value-laden issues that emanate from science and technology and interact with culture, directing science and technology by reflectively analyzing practical social needs and maximizing gratification by the technology.

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[70] "…the strict separation between the function of the expert and the politician [as under the deterministic model] is replaced by a critical interaction… through which the scientific experts advise the decision-makers and politicians consult scientists in accordance with practical needs… This interaction not only strips the ideologically supported exercise of power of an unreliable basis of legitimation, but makes it accessible as a whole to scientifically informed discussion, thereby substantially changing it… Social values themselves are subject to regulation… by being tested with regard to the technical possibilities and strategic means for their gratification" (Habermas:66-67)

The “scientization of politics” requires an enlightened political will, which can be assured only if ideal conditions of general (non- or pre-scientific) communication already extend to the entire public, free from coercion or domination, and can be institutionalized.[71] Such an environment does not currently exist because of

- The exercising and structuring of power by bureaucracies;
- A public consumed with sensationalism; and
- Military secrecy.

The decoupling of scientists from the public and each other due to the differentiation of research and the proliferation of technical and professional journals result in difficulty communicating information across specialized disciplines and the necessity of translating and transmitting scientific information to students and the public. Even if these barriers did not exist, Habermas suggests that it would still require scientists to take the initiative to inform public discourse on the “practical consequences of scientific results,” and to act as both scientists and citizens, going beyond technical recommendations and reflecting upon their practical consequences.

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[71] “Communication between experts and the agencies of political decision determines the direction of technical progress on the basis of the traditions-bound self-understanding of practical needs. Inversely, it measures and criticizes this self-understanding in the light of possibilities for gratification created by technology. Such communication must therefore necessarily be rooted in social interests and in the value-orientation of a given social lifeworld. In both directions the feedback-monitored communications process is grounded in what Dewey called “value beliefs.” That is, it is based on a historically determined preunderstanding, governed by social norms, of what is practically necessary in a concrete situation. This preunderstanding is a consciousness that can only be enlightened hermeneutically, through articulation in the discourse of citizens in a community. Therefore, the communication provided for in the Pragmatistic model, which I supposed to render political practice scientific, cannot occur independently of the communication that is always already present in process on prescientific level. The latter type of communication, however, can be institutionalized in the democratic form of public discussions among the citizen body. The relation of the sciences to public opinion is constitutive for the scientization of politics” (Ibid.:68-69).

As I stated, one difficulty in implementing the pragmatistic model is associated with the difficulty of translating scientific information among sciences and to the public. In fact, Habermas observes that anyone advocating consideration of science in terms of "political relevance" to inform public opinion is "suspect to wanting to put scientific discussion on a mass basis and thus to misuse it ideologically." The repeated criticism that this challenge "makes science impervious to self-reflection," confuses the difficulty of communication with a "violation of logical or methodological rules." Habermas observes that communication has evolved in the area of directing research and technical progress to focus on social interests with the objective of "interdisciplinary, future-oriented research" to reflect upon social values in light of expected scientific and technological progress. To accomplish this, Habermas advocates the use of social sciences to understand social interests better and to identify techniques and strategies.

The extent to which any of these three models dominate the contemporary relationship between science, technology, and society is arguable. It seems clear, however, that the application and encroachment of economic rationalism on environmental issues seriously threatens a pragmatistic relationship. The economic subsystem, grounded in teleological instrumental rationality with money as its steering medium, by itself cannot rationally determine social values. Money is an inappropriate medium for informing social norms related to the environment because it is distinguished by its intrinsic sterility with regard to social norms; money is not bound by any social norms nor does it convey any moral imperative. Thus, economics, like other science and technological information, must be considered within a broader decision-making process anchored and steered by the medium of language and discourse.

The difficulty here is that the economic subsystem's internal pressure for continuous growth, driven by the need to reproduce the material social world, presses upon those spheres of society that are traditionally bound together by communicative processes aimed at intersubjective understanding toward achieving discursively validated social norms. Under this economic pressure, these social institutions and techniques are colonized, transmuted into forms and processes that facilitate rather than direct the trajectory of economic and technological expansions.[72] Consequently "the capitalist enterprise and the modern administration are systemically independent units within norm-free subsystems" (Habermas, 1985:172).

There is ample evidence for this battle of dominance between the economic subsystem and communicatively steered social institutions. Nevertheless, a compelling argument can be made that environmental public policy in the United States has evolved, albeit inconsistently, in the direction of democratic pragmatism.[73] Policy decisions and the institutions responsible for them are increasingly open to, scrutinized by, and face

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[72] Habermas's Theory of Communicative Action elegantly describes the processes and consequences of the reification of the lifeworld into subsystems corresponding to different validity spheres. See: Habermas (1984;1985).

[73] Like Habermas, Dryzek focused on practical, real world problem solving. Habermas' pragmatistic model and Dryzek's characterization of democratic pragmatism diverge in the degree of democratic participation necessary to legitimize rationality in social problem solving. Habermas' pragmatistic model requires full and consistent self-reflection by a "scientized society," while democratic pragmatism requires only a "plurality of perspectives... as long as this plurality is achieved, there is no need for more widespread public participation in problem solving" (Dryzek 1997:85).

legal challenges from ever more sophisticated, well-organized, and better-funded interests groups representing diverse and often competing values. For example, O'Leary, Durrant et al. (1999) observed that legal requirements and practicality have increased public involvement in environmental decision-making. Community-based environmental protection and other innovative approaches also have increased public involvement in decisions (Crosby, 1999, Finnegan and Sexton, 1999, John and Mlay, 1999, Murdock and Sexton, 1999., Sexton and Zimmerman, 1999). Bosso (2000) made a compelling argument that the historical dynamics of public opinion and the influence of environmental advocacy groups have had a significant impact on the U.S. environmental policy.

Fiorino (1995) describes administrative policy-making in the United States as occurring in an "open system," facilitated by effective lobbying, scientific credibility, and legal avenues to challenge administrative proceedings and policies, and he stresses the need for mechanisms to promote effective citizen participation in early policy deliberations. Accordingly, government institutions have a responsibility to engage the public proactively in policy-making. Fiorino argued that:

> "Policy-making will be more rational not only when social benefits are greater than social costs but when good information about the effects of decisions leads to reasoned debate over the choices that are being made.… Rationality requires that technical experts and administrators accept that the intuitive evaluations of the lay public are as valid as their formal risk and cost-benefits analyses." (Fiorino, 1995:92-97, 224–25)

6. VALUES IN POLITICAL PHILOSOPHY AND ENVIRONMENTAL POLICY ANALYSIS

> "The art of decision-making is to … help decision-makers and policy-makers better understand how preferences are formed in particular problem contexts and how framing and changes in experience and information used to evaluate these problems affect decision outcome…. Framing of problems, information available to the decision-maker, and the general social ethic or sense of moral obligation associated with particular problems can all be important components of how decision-makers view the requirements of legitimization. The anticipation of these requirements can, in turn, have a fundamental impact on decision processes and outcomes." (Kleindorfer, 1999:44, 53)

The debate over biotechnology, where "the complexity of the scientific evidence and the perception of expert untrustworthiness combine with an extremely muddled popular understanding of risk," (Agar, 2003:601) serves as an excellent example of the problem of integrating "objective" science, public opinion, and societal values into public policy. No policy decisions are objective from the perspective of originating from an unbiased viewpoint that is independent of social value and culture. Policy decisions are made within a cultural, social, institutional, economic, and experiential context, all of which influence the initial way policy issues are assessed (Dayton, 2001). The analysis of individual and cultural values associated with environmental issues is therefore fundamental to understanding government decision-making. Values both shape and legitimize public policy in modern democracies. The integration of positive science and social values in public policy and the influence of individual and cultural values in science and administrative decision-making are central themes of political theory, philosophy, economics, and sociology.[74]

A core goal of public policy is to resolve often-competing responses to what Pippin calls “first-order questions about normative truth” (Pippin, 2009:37-38). Pippin’s main point is that the sciences are poorly equipped to answer an individual’s questions about “what ought to be believed and/or done.” Science can at best provide useful information only on “second-order questions” that “explain why people do this or that, believe this or that.” While these two types of questions are fundamentally different, our individual beliefs about why people act in certain ways contribute to and derive from our cultural mosaic.[75] Another aspect to this problem is that, according to Joss (2005:171), contemporary democratic governance is challenged both vertically through overlapping levels of decision-making by local, state, national, and multi-national governments and horizontally (or thematically) in increasingly complex issues, “contested expert knowledge, different socio-cultural practices, and competing normative preferences.” This situation lengthens the communicative distances between technocratic and policy discourses and the discourses of the broader public.

Dietz (1994:301-02) asserts that the process of integrating science and values into public policy can be made more rational through “systematic scientific thinking.” According to Dietz, two types of information are necessary for “rational decisions about

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[74] For a comprehensive overview of public policy analysis and delivery theories, see: Parsons 1995.
[75] For a brief overview of the neuroscience work on morality that elicits Pippin’s concerns, see: Miller 2008. Also see: Hsu et al. 2008.

public policy." The first type of information addresses the consequences of a policy and requires "positive, or descriptive, knowledge of the human ecological systems that will be affected." For example, by characterizing the magnitude and extent of environmental problems, developing preventive and remedial approaches, and assessing the relative costs and benefits of alternative policies and strategies, positivist science plays an important role in transforming collective environmental social values into individual behavioral norms and promoting compliant behavior.

The second type of information involves assigning values to the various policy options. In democracies, environmental statutes, regulations, and public institutions theoretically reflect social values related to the environment. Although environmental phenomena are arguably objective realities in the physical, chemical, and biological world, environmental issues themselves, i.e., aspects about the environment for which individuals and institutions express interest and/or concern, are constructs that reflect individual and/or societal values. That is, the existence and salience of environmental issues are based on individual and collective social values and perceptions about the responsibility of individuals and human society for such enterprises as protecting biodiversity, ecological systems and wilderness; minimizing adverse impacts on health; and sustaining resources (Pachlke, 2000). Although this second type of information is subjective and normative, policy-making frequently conceptualizes these as the empirical positivist outputs of scientific political, economic, and policy analyses.

Science itself, however, is not a homogeneous culture; rather, scientists comprise many different cultures often reflecting training and disciplines with different acceptable practices, biases, and traditions. For example, Collins (1992:42, 17-18) observed that social scientists generally consider the probability of an observation being due to chance less than five times out of one hundred to be significant. Other sciences require higher statistical confidence, and some physicists feel that experimental results should not need to rely on statistical analyses. Collins suggests that perception is based on “multiple entrenchment of concepts,” or “networks of social institutions that comprise forms of life.” Social conventions influence scientists’ perceptions of problems, conduct of experiments, analyses, interpretation of results, and consensus on the significance of findings. Accordingly, “like any other cultural activity, [science] rests on a foundation of taken-for-granted reality. Usually, scientists spend their time looking at things through the frame of reference that they were given when they were trained.”

Characterizing Public Values

News media reports, public opinion polls, interviews and focus groups, government reports, and scientific assessments often provide a confusing, sometimes contradictory, and generally incomplete picture of how individuals and societies frame environmental issues. Media reports tend to emphasize (or perhaps distort) the magnitude of disagreement, but usually provide little to substantiate facts or discredit fictions. For example, a recent front-page article in the Washington Post describes the growing agricultural biotechnology trade dispute between the United States and Europe, but provides little detail about underlying reasons and scientific uncertainty underlying the dispute (Sipress and Kaufman, 2001).

Surveys and polls provide little insight into the underlying values and value structures operating within and among society's complex organizations and cultures.[76] For example, Downs (1972) postulated an "issue-attention cycle" that "equated public attention with public support for the environment and assumed that, as the costs of environmental protection became apparent, support for implementation would decline." Lake (1983) found continued strong California public support for environmental issues in the 1970s by comparing the results of opinion polls, willingness-to-pay for bond issues and public spending measures, despite a lack of national policy salience and a national political effort to roll back environmental regulation. Lake attributed the "underrepresentation of the general public's policy preferences," to the rise of political interest groups, and to federal laws prohibiting nonprofit tax-exempt public interest groups from lobbying and endorsing candidates.

Focus groups and interviews can provide good information about individuals' value structures and how individuals frame a particular issue, but results from these approaches are difficult to objectively analyze, extrapolate, and compare. Government reports may be biased by special interests rather than public welfare concerns. Even scientific assessments may be far from objective, reflecting the interests of sponsoring organizations and the biases and perceptions of individual scientists.

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[76] For example, the "National Report Card on Environmental Attitudes, Knowledge, and Behaviors" indicated broad support for but limited knowledge about environmental issues among respondents (only 11 percent have broad environmental knowledge) (National Environmental Education and Training Foundation/Roper 2001, Personal communiction, Coyle 2001).

Risk Assessment

Information on current or projected environmental and health conditions and costs of alternative strategies to optimize them typically feed into an analytical context that allows comparisons of the cost-effectiveness of policy options. Risk assessment and benefit-cost analysis are widely used tools for this purpose (Dietz et al., 2000, Easter et al., 1999, Freeman, 2000). However, "neither risk assessment nor cost-benefit analysis are 'pure' or 'certain' – the former often requires highly uncertain estimates, the later requires value assumptions... Science cannot decide whether we wish to err on the side of prudence or on the side of cost-effectiveness" (Pachlke, 2000:82).

As defined in by the National research Council risk assessment is "the qualitative or quantitative characterization of the potential health effects of particular substances on individual or population" (National Research Council, 1983:38). Risk assessment involves the identification and estimation of the likelihood of adverse effects resulting from exposure to some environmental stressor(s) or toxin(s).

> "Risk is defined as the possibility of suffering harm from a hazard. A hazard is a source of risk and refers to a substance or action that can cause harm. Risk assessment refers to the technical assessment of the nature and magnitude of risk." (Cohrssen and Covello, 1989)

A great deal of scientific analysis is involved in risk assessment. It is a multidisciplinary exercise and frequently utilizes the skills and expertise of a range of social, physical, and biological scientists, engineers, statisticians, and communication experts. Risk assessment is considered conceptually distinct from "risk management," which is “the process of evaluating alternative regulatory actions and selecting among them… [in] consideration of political, social, economic, and engineering information with risk-related information …” (National Research Council, 1983:18, 38).

The potential political, economic, policy issues and other risk management considerations to inappropriately influence scientific risk assessment, however, has been known and acknowledged for some time. To address concerns that regulators, “may skew their assessments of risks associated with a particular substance to support a preference to regular or not to regulate the substance” in 1983 the National Research Council published landmark recommendations for risk assessments performed by federal agencies (National Research Council, 1983). Among these was that regulatory agencies should:

- Establish and maintain a clear conceptual distinction between assessment of risk and the consideration of risk management alternatives;
- Clearly distinguish between the scientific basis and the policy basis for the agency’s conclusions;
- Have risk assessments reviewed by an independent science advisory panel before any major regulatory action or decision not to regulate (National Research Council, 1983:151-56).

Roger and Gene Kasperson commented, however, that “assessment procedures derived from the public health, toxicity, and engineering studies that have dominated the management programs of governments and corporations illuminate one portion of the risk complex while concealing others” (Kasperson and Kasperson, 1996:96). Risk assessment “in practice is permeated by judgments that cannot be reduced to science” (Andrews, 2000:215). and virtually every step in a risk assessment is associated with a high degree of uncertainty that necessitates scientific judgments (Dietz, et al., 2000, Hornstein., 1992, Stern and Fineberg, 1996), including:

- Choice of substances of concern;
- Selection of health effects and ecological endpoints for study;
- Project staffing and budgets;
- The importance of individual studies and results; and
- The characterization of risk and uncertainty.

Risk assessment-related decisions based primarily on subjective value judgments often are referred to collectively as “risk assessment policy” or “science policy judgments.” Cultures and the values of those conducting risk assessments therefore greatly influence the scope, procedures, and interpretation of the assessments. In practice, both positive/descriptive and valuation types of information involve an implicit assessment of values. The U.S. EPA emphasizes the need to “discuss science policy judgments or default assumptions used to bridge information gaps and the basis for these assumptions” (USEPA, 1998:120). Thus, while risk assessments are intended to provide an “objective” analysis that leads to a determination of what is safe, as Lowrance (1976:8) wrote:

> “a thing is safe if its risks are judged to be acceptable … Notice that this definition emphasizes the relativity and judgmental nature of the concept of risk. It also implies that two very different activities are required for determining how safe things are: *measuring risk*, an objective but probabilistic pursuit; and *judging the acceptability of that risk (judging safety)*, a matter of personal and social value judgment.” [italics in original]

The Economic Perspective

> "Far from being neutral, modern consumer theory can be seen as having a basis in a philosophy of preference utilitarianism and a restricted model of social psychology based upon individual values." (Spash, 2000:1435)

Mainstream economics asserts that economic theory provides a rational basis for how people ought to behave. Many economists argue that the legitimacy of economic theory resides in human behavior; they claim that humans with freedom of choice would behave as "homo-economis," i.e., utility maximizing individuals. Recent studies, however, provide evidence that utilitarian decisions in moral decision experiments are not automatic. Rather, they are influenced by cognitive load and tied to intention and whether personal physical force is envisioned as necessary to the utilitarian (as opposed to deontological) moral judgments (Greene et al., 2009, Greene et al., 2008). Further, Greene and colleagues (Greene, et al., 2004) provide evidence that moral decisions involving personal violations (which would have been familiar to our primate ancestors) "are driven by social-emotional response," while other judgments involving more impersonal violations are more cognitive. Practically, people frequently are uncertain about the reasons for their decisions and actions, especially when they must weigh desires or needs that are incommensurate, having no common scale (Hodgson, 2007, Huigens, 2001).

Bowles (2008) points out, however, that the "conventional economic approach to policy design" not only inappropriately dismisses the possibility that economic incentives could undermine the "salience of ethical, altruistic, and other social preferences," but incorrectly assumes that any such interactions would be "additive" (p. 1605).[77] Bowles argues that the invalidity of these assumptions is likely due to the economic incentives themselves through the following four processes:

> **Framing**: framing the decision process as appropriately one of self-interest. For example, use of market terminology (e.g., "exchange") or experiments that isolate an individual in market-like competition. Experiments show increased group participation and communication in a commons pool experiment increased socially optimal behavior over self-interest.
>
> **Endogenous preferences**: influencing the long-term development of preferences. Experiments show residual incentive-induced self-interested behavior after removal of the incentives. Research in multiple disciplines show economic structures influence child rearing values, which influence preference development.
>
> **Over-determination**: undermining an individual's sense of agency or self-determination/autonomy. Experiments show agents voluntarily elect to produce more when others do not impose minimum production levels.
>
> **Information content of incentives**: providing information that affects behavior. Incentives themselves reveal assumptions about a principal's preferences (whether exploitive or equitable), their views of the task (level of difficulty, required skill or effort), and their beliefs about the agent (ambitiousness, competency, trustworthiness). Experiments show that actions designed to convey trust increase payoffs and contributors respond positively to peer-imposed group punishment (presumable, due to a sense of shame or guilt by low contributors or anger by high contributors).

Perhaps no greater challenge to the future utility of risk-benefit-cost analysis resides in the debates over the valuation of environmental goods and services, especially those considered passive-use or nonmarket amenities, inter- and intra-generational equity issues such as discounting; and the fungibility of ecological resources are fungible (Dietz,

[77] Bowles calls this the "assumption of separability" and reviews 41 studies that provide evidence the assumption frequently is invalid (Bowles 2008).

et al., 2000, Fiorino, 1995). Successful resolution of these issues does not appear imminent. Leading environmental economists still seem to treat these issues as minor annoyances, rather than core problems, and the methodological solutions proposed by many economists do not address the theoretical issues raised by critics. An example of the controversy is the use of discount rates for environmental goods and services. For example,

> the "justification of discounting is based on observed human behavior for both consumers and producers. Both prefer their income or profits today rather than some time in the future… the best solution [to the debate over discount rates] is to use sensitivity analysis and test the decision under a range of discount rates." (Easter, et al., 1999:166, 72)

By far the most controversial aspect of risk-benefit-cost analysis involves the assessment of values for nonmarket goods and services associated with the environment, such as recreational, spiritual, and aesthetic values (Fiorino, 1995). For nonmarket environmental amenities, it is difficult to understand how economists ever "observe" consumers and producers, nor does this solution address the dispute over the application of the same economics principles to market and nonmarket amenities, a practice criticized by many non-economists.

Contingent valuation is a frequently used approach that relies on surveys for placing a monetary value on nonmarket environmental goods and services. The approach has been applied for over 35 years in more than 50 countries to estimate a variety of benefits. Carson (2000:1413) discusses several examples of benefits estimates, including:

- Increasing air and water quality;
- Reduced risk from drinking water and groundwater contaminants;
- Outdoor recreation;
- Protecting wetlands, wilderness areas, endangered species, and cultural heritage sites;
- Improvements in public education and public utility reliability;
- Reduction of food and transportation risks and health care queues;
- Provision of basic environmental services such as drinking water a garbage pickup in developing countries; and
- Natural resource damage assessments.

Contingent valuation is considered by many to be the only "comprehensive" and the most "flexible" nonmarket valuation method widely available. Advocates of contingent valuation assert that the method can measure both "use values" as well as "nonuse" or "passive use values" associated with environmental amenities (Bishop and Welsh, 1999:178-79).[78]

Critics and advocates of contingent valuation studies cite a large number of contentious and interrelated methodological and/or philosophical issues (Bishop and Welsh, 1999, Clark et al., 2000, Dietz, et al., 2000, Fischhoff, 2000) including:

- Sensitivity to task and context, also referred to as sensitivity scope or embedding;
- The meaning of non-compliance, refusals, and protest bids;
- The significance of differences between willingness-to-pay and willingness-to-accept;
- Participants responding as consumers or citizens with regard to nonmarket environmental goods and services;

[78] Bishop defined use values "as those associated with enjoying a fish dinner from an uncontaminated marine environment or breathing clean air in one's own neighborhood." Nonuse values "are related to the desire to leave environmental bequests to one's heirs or future generations more generally, the desire simply to know that pristine environments continue to exist, or other such motives" (Bishop and Welsh 1999)

- Measurement of economic value or something else (e.g., “moral satisfaction”);
- Whether study results are artifacts of the “elicitation question,” or pre-existing, well-formed preferences;
- The role of “benefit estimation” in public policy decision-making;
- Participants responding strategically; and
- Compatibility between the research and respondent’s perception of the study’s intent[79]

Participants’ difficulty monetizing “feelings” about environmental goods and service, thereby providing “general expressions of concern, little related to an economic interpretation. They may not be able place their values on a single metric.

- Participants may not have full knowledge of the issues or may not fully appreciate the long-term consequences of their decisions or responses.
- Participants may be unable to consider future generations’ “rights” above contemporary self-interests.
- Changes in view over time.

Randall (1997) argued that any of the various tests to evaluate the reliability of contingent valuation results have significant theoretical and/or practical limitations. Randall discussed a number of approaches for validating the results of contingent valuation studies, including crucial experiments based on Popper’s heroic model of science, tests against real values, tests against the requirements of economic theory, tests

[79] Fischhoff distinguishes between “gist” and “contract” studies. Gist studies are designed and interpreted to represent general attitudes while participating in contract study assumes that a respondent will “promote those policies that fit the investigator’s interpretation of their responses. Misinterpretation occurs when an investigator and respondent understand the intent of the study differently. Fishhoff discusses the need for respondents in contingent valuation studies to “abide by the commitment implied by any proposal that one accepts or rejects in it,” and recommends, “investigators must secure the *informed consent* [sic] of participants” (Fischhoff 2000:1439).

of regularity in the data, test-retest validity, tests against alternative valuation methods, and calibration. According to Randall — even in the case of revealed preferences — choice mistakes, choice constraints, and the inability to observe prices for nonmarket goods and services introduce uncertainty. For expressed preferences, inherent incentives also distort results (positively to both impress, and the absence of incentives to promote care in answering questions) and strategic behavior. Spash (2000:1435) provided evidence that contingent valuation surveys inappropriately account for significant percentages of respondents who have discontinuous lexicographic preferences (such as rights-based).

Sagoff (2000) made a case that the theoretical and practical assumptions underlying environmental economics are invalid. First, he dismissed economics' normative proposal that utilitarian principles should guide social decisions, pointing out that no U.S. environmental law articulates a policy goal of maximizing individual welfare. Based on moral and cultural values, people support environmental causes that even may be contrary to policies that maximize economic efficiency. Second, Sagoff argued that contingent valuation "is fallacious" because it "misconstrues as a sort of nonconsumption consumption, nonuse use, or nonwelfare welfare what are in fact views and opinions about the goals of public policy directly opposed to its own assumptions." By definition, individuals do not directly or indirectly benefit from policies that protect the nonuse (existence or intrinsic) value of environmental assets, so it is a logical fallacy to assert that willingness to pay reflects respondents' expected benefits. Rather, such studies reveal "what people think society ought to do, not what they believe will benefit them" (Sagoff, 2000:1427).

Huigens (2001:547, 54, 57) postulated a "tragic dimension of value [that is] invisible to revealed preference analysis because lost and unrealized value is never revealed in choice made." As a result, valuation has cognitive dimensions, is content-dependent, incommensurable, and often intransitive. Huigens contends that this "renders economic analysis impossible because the theory of utility maximization depends entirely on the notion that preferences are transitive." He criticizes the "skeleton of value thesis" — the "notion that the assumption of utility maximization captures the essentials of sound practical reasoning and creates a uniquely reliable set of economic implications, even if the value thesis fails to capture all human practical reasoning." Huigens contended that "many valuations do not call for maximization as a rational response; they call instead for expression, or fidelity, or nurturing" which are "neither irrational nor reducible to "real" value." Using similar reasoning, Berkowitz (2000) also criticized the application of economic analysis and game theory to law and politics.

An empirical example of incommensurable values may be found in the results of Clark et al. (2000). They found that respondents questioned the validity of willingness-to-pay figures and expressed difficulty framing a meaningful reply to the survey. Problems that the study's participants encountered included difficulties "contextualising" the study scenario, deciding on its monitory and non-monitory worth, and valuing the scheme in isolation.

7. HYPOTHESES OF VALUE STRUCTURES WITHIN BUREAUCRACIES

> "Understanding the character and role of institutions is pivotal to understanding human-environment interactions and to assessing the potential consequences of the many institutions emerging at multiple scales to deal with environmental change." (National Research Council, 2001:43)

The dynamics of bureaucratic behavior long have been a focus of political scientists and economists. In this section, I present the public choice approach based on conventional economics theory and the critical theory perspective based on theory of communicative action.

Public Choice Economics

Downs (1965:445) theorized that bureaucratic officials are motivated by their own self-interests, that the internal structure of a bureaucracy is closely related to its external environment, and that "bureaus use selective recruitment, indoctrination, and ideologies to increase the degree of goal-homogeneity among their members." Clark (1988) found evidence of rent-seeking behavior by bureaucrats in a state environmental department. Laffont and Tirole (1991) developed an economic model that describes agency capture and predicts that regulatory agencies' discretion is reduced when the regulated stakeholders become better organized. The model predicts that multiple interest groups can compound regulatory inefficiencies. Consequently, regulatory agencies will try to reduce interest groups' stakes in regulation unless those groups contribute information about the agency's activities. In addition, the model predicts that an environmental interest group's influence on policy is greatest when its interest is to promote an "informational asymmetry between the regulated industry and Congress" (Laffont and Tirole, 1991:1117) and when shutting down the industry is a viable policy option (i.e., when the industry's output is unessential).

Building on Downs' theory and Laffont and Tirole's model, several hypotheses can be developed on which to base a research agenda.[80]

> Hypothesis 1: A regulatory agency's incentives to share information with Congress and to regulate efficiently will decrease as a regulated industry becomes better organized (i.e., increases the number of Congressional mandates and legal decisions).

Based Downs' theory and Laffont and Tirole's model, both the number and interest positions of external stakeholders (e.g., Congress, industry, and environmental groups) should influence the nature of regulation and the incentive structures operating within government agencies. Accordingly, regulatory discretion and internal incentive structures among regulatory agencies should be predictable based on the organization, funding, and goals of the industry, e.g., agricultural biotechnology and environmental groups. Thus:

> Hypothesis 2: The distribution of cultures (i.e., subcultures) within a regulatory agency will reflect the distribution and number of cultures among the agency's stakeholders. The greater the number of stakeholders, the greater the number of subcultures can be characterized within the regulatory agency staff.

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[80] These hypothesis are presented as part of the conceptual framework a broader research agenda than addressed by my empirical research in this dissertation.

Differences in regulatory approaches between the United States and Europe may also reflect differences in industry interest group organization and influence, the number and organizational strength of environmental groups and other stakeholders and their missions, and the level of expertise and mission-orientation of European bureaucracies. The complexity of regulations issued by a given agency may reflect the nature, number, and historical influence of external stakeholders. The Laffont and Tirole model predicts that regulatory agencies have an incentive to engage external stakeholders when they can contribute to regulatory development and not just agency capture. Both the agricultural biotechnology industry and environmental groups can provide information to make regulations more efficient, for example, through research, technology transfer, and public information. According to Laffont and Tirole, however, industry and environmental groups have an interest in regulatory inefficiency by keeping information from Congress. While industry's goal is to "enjoy a rent," environmental groups will theoretically seek to reduce industry output beyond the economic (social welfare) optimum. Therefore:

> Hypothesis 3: The complexity of an agency's regulatory framework will increase (i.e., the efficiency will decrease) as the (a) number and (b) available funding of stakeholders increases.
>
> Hypothesis 4: The (a) number, (b) frequency, and/or (c) quality of a regulatory agency's stakeholder outreach activities will be reduced as the number of well-organized stakeholders increases.
>
> Hypothesis 5: The degree of satisfaction with the regulatory/stakeholder involvement process that is expressed by stakeholders will decrease as the number of active stakeholders increases.
>
> Hypotheses 6: As the number of stakeholders increases, individual stakeholders will seek to reduce an agency's discretion by developing and sharing information on the agency's inefficiencies in achieving the stakeholders' goals (e.g., monitor

food supply and product lines, and showcase development of resistant insect populations to highlight regulatory system failures).

Hypothesis 7: The most influential non-industry stakeholders will develop and publicize “scientific” information related to the efficiency/effectiveness of a regulatory agency relative to the stakeholders’ opposition to the production of the regulated product (i.e., oppose genetically modified organisms).

Inclusiveness in the regulatory process, especially in areas of great scientific and policy uncertainty, would tend to result in significant regulatory inefficiencies, as government institutions must confront and accommodate into their policy decisions the different value systems represented by various stakeholders. For example, the EPA, with the mission to “protect human health and the environment,” (USEPA, 2010) is arguably less beholden to agricultural interests than are other federal bureaucracies. The EPA has extremely complex rules and analytical requirements for the commercialization of genetically modified plants and microbes. Unlike the UDA or the FDA, the EPA has a large number of diverse, well-organized, and well-funded non-industry interest groups that voraciously monitor the agency’s activities. The EPA’s regulatory process for genetically modified organisms is extremely resource intensive both for the agency and industry, i.e., as Laffont and Tirole’s model predicts, the regulatory process is relatively inefficient.[81]

[81] I stress “relative inefficiency” from the industry perspective, when considering only the time and cost for industry to evaluate their products for compliance with federal standards and procedures, for submitting necessary documentation and evidence, and for initial agency review and approval. In fact, once received, the EPA is extremely efficient in evaluating permit applications, completing almost all each year (98-99 percent) within the statutory limit (USEPA 2012:886). Under FIFRA section 33(f)(4)(B), “Initial Content and Preliminary Technical Screenings,” the EPA must conduct an initial screening of the contents of an application no later than 21 days after receiving an application. If the application fails the screen and cannot

In contrast, the USDA, a strong proponent of U.S. agricultural interests, has a relatively simpler notification and permit procedure. The USDA's mission includes "… supporting production agriculture;… expanding global markets for agricultural and forest products and services; and working to reduce hunger in America and throughout the world," and its first strategic goal is to "Expand economic and trade opportunities for U.S. agricultural producers" (USDA, 2000:11). The USDA's position with regard to biotechnology is that it "can help the world meet the challenge of global food security, holding the promise of foods that promote health and combat disease," and it employs a streamlined notification procedure for authorizing genetically modified organisms (USDA, 2000:6).

The FDA's statutory mission includes protecting public health "by ensuring that foods are safe, wholesome, sanitary, and properly labeled" (USFDA, 1998, USFDA, 2000, USFDA, 2001a). Congress codified the FDA's mission in 1997 (Public Law 105-115). The FDA specifically addressed biotechnology in its FY 2001 Annual Performance Plan: "Ensure the safety of food and feed… that are derived from biotechnology"(USFDA, 2000). Over several years, however, the FDA's mission statements subtly evolved to put more emphasis on the promotion of food biotechnology. For example, from 2002 through 2007, the FDA's Annual Performance Plans included

be corrected by the applicant within the 21-day period, the EPA will reject the application no later than 10 days after making the determination.

the following or similar statements (USFDA, 2001b, USFDA, 2002, USFDA, 2003, USFDA, 2005, USFDA, 2006, USFDA, 2007):[82]

> "As we enter the 21st Century, trends in the food industry promise better nutrition, greater economies and wider choices for the U.S. consumer than ever before. To illustrate: The biotechnology explosion has opened new frontiers in product development, thus providing us the ability to genetically alter foods to make produce more resistant to disease, add desirable consumption characteristics to the foods, and to prolong shelf life…. The Agency's job is to give consumers the confidence to enjoy the benefits of these expanded food choices."

This positive, if not advocative, description of biotechnology appears at odds with a precautionary approach to protecting the food supply. In this statement, the FDA seemed to be saying that at least part of its role (give consumers confidence to enjoy the benefits) was one of persuasion.

The FDA is an agency that has not traditionally engaged with agriculture or environmental groups. Its responsibility for ensuring that the national food supply is not adulterated promotes routine interaction and cooperation with the food and beverage industry. For example, in 2004 Congress inquired about the disposition of a regulation that the FDA proposed in 2001. This regulation would have required "food developers to notify the FDA at least 120 days in advance of their intent to market a food or animal feed developed through biotechnology and to provide information to demonstrate that the product is as safe as its conventional counterpart." The FDA responded that it:

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[82] I could not locate similar references in FDA budget documents after 1997, when references to agricultural technology almost disappeared.

> "… utilizes a process under which any firm that intends to market a food developed through biotechnology is encouraged to consult with FDA and to submit to the Agency a summary of the firm's safety and nutritional assessment. This process is working well; companies have continued to appropriately consult with the Agency. In addition, FDA has provided advice to developers and marketers on labeling foods and food ingredients as being made with or without bioengineered products. FDA believes that these practices fully protect the public health. In view of these existing protections, we are focusing our limited resources on those other high priority areas where protections need to be enhanced. We are continuing to monitor the success of these actions, and will consider additional action if it becomes necessary." (USFDA, 2006:125)

With regard to biotechnology, the FDA also faces a relatively small number of interest groups and a well-organized, well-financed industry (i.e., the food and beverage industry). In conformance with the economic theories discussed above, the FDA's regulatory process is streamlined, requiring only consultation with food producers for food containing genetically modified ingredients. A successful consultation results in the food being "generally recognized as safe" (GRAS), which allows it to then be placed directly on the market.[83]

An interesting question is, if the economic models of bureaucracy are accurate, do external stakeholders and interest groups affect the internal culture of an agency? The agency's culture and value systems should therefore be manifestations of the incentive structure of an agency. Building on Downs' theory and Laffont and Tirole's model, the incentive structure within a bureaucracy should be a result of the interaction of external influences and the rational self-interested behavior of the individuals within the

[83] Although FDA can require more than consultations, it has yet to go beyond this procedure for any genetically modified food or ingredient.

organization. The cultural dynamics of regulatory agencies could reflect the qualitative and quantitative composition of external stakeholders on any particular issue. Environmental and industry groups generally are expected to be somewhat monolithic in terms of their internal cultures, although great variability could be expected when looking across groups.

On the issue of agricultural biotechnology, when compared to the cultures of agencies like the USDA and the FDA, economic theory would predict that the EPA will have a relatively diverse culture that mirrors the diversity in industry and environmental groups with stakes in agency decisions. It is important to note that this hypothesis may not be valid for politically appointed staff in the most senior levels of a bureaucracy, who may be more likely to be monolithic and reflect the value structure of the President and administration. Most career bureaucrats in senior professional positions have experienced several different administrations during their government careers. They therefore are more likely to possess values that are the product of the institutional incentive structure than would politically appointed staff with much shorter tenures within the bureaucracy.

Critical Theory Perspective

The previous discussion predicted that incentives operating on regulatory decision-makers and the influence of external organizations on regulatory agencies influence their internal structures and functions. According to Dietz and Burns (1992:190-93) culture is dynamic, defined by the number of people that hold a rule within a group. Cultural change within a group occurs through a change in the frequency distribution of rules held by its members, a process mediated through “cultural learning” and the distribution and use of power. Their degree of “agency” determines the extent to which individuals, groups, or subcultures can produce a change in culture. Dietz and Burns describe agency as a function of influence on the use and distribution of rules within a culture, which is limited by power, intention/volition, the availability of alternatives in decision-making, and reflexivity (the ability to monitor consciously the effects of actions and to use this feedback to modify a rule system).

Within institutions such as regulatory agencies, one expects the existence of many cultures, subcultures, and epistemic communities based on a complex interaction of personal values, beliefs, and motives, as well as explicit and implicit incentive structure. These may derive, in part, from professional training and experience, position within the bureaucratic hierarchy, organizational affiliation, and association with epistemic communities within and outside of the organization. In fact, the ability of epistemic communities to exert agency has been show to sometimes be critical to the development of environmental policy. For example, Haas (1989) discusses how international agreement on the Mediterranean Action Plan, a marine pollution control regime in the Mediterranean Sea, was possible because of the influence (i.e., agency) of the epistemic communities of ecologists in a number of countries.

In contrast to economic public choice theory, critical theory argues that the colonization by purposive (teleological) rationalism of social institutions — which were previously bound and legitimized through communicative action — may be more important in influencing internal organizational cultures than pressure from outside stakeholders. We can see this colonization process across many public institutions. For example, higher educational systems generally place a greater emphasis on purposive-rational disciplinary curriculum and positions (math, engineering, natural sciences, economics, and business) than on the arts, humanities, or social sciences. *Prima fascia* evidence to support this assertion of colonization in the observation of limited, if any, requirements, for philosophy courses in primary or secondary education, or undergraduate or graduate natural science curricula, [84] and the disproportionally higher U.S. government funding of science and engineering research programs relative to the humanities and the arts. [85]

Habermas argues that the legal basis of bureaucracies, established to achieve purposive means, provides their social legitimacy and the basis for their interior organization.

> "The idealized background assumptions of the classical model of bureaucracy have rightly been criticized on the grounds that the organizational structure expressed in programs and positions certainly does not get translated automatically and without distortion into organizational activity that is calculated, impersonal, open to objective check, and independent of situation. Even within formally organized domains of action, interactions are still connected via the mechanisms of mutual understanding. If all processes of genuinely reaching understanding were banished from the interior or organizations, formally regulated social relations could not be sustained, nor could organizational goals be realized. Nevertheless, the classical model of bureaucracy is right in one respect: action within organization falls under the premises of formally regulated domains

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[84] When asked, few of my colleagues with a Ph.D. in the sciences reported ever taking a philosophy course, not even philosophy of science.

[85] For example, compare the President's FY 2013 budget request for the National Endowment for the Arts ($154 million) and National Endowment for the Humanities ($154 million) with the National Science Foundation ($7.373 billion), and the Department of Education Science's Technology, Engineering, and Mathematics program ($149.7 million). National Endowment for the Arts 2012;National Endowment for the Humanities 2012;National Science Foundation 212;U.S. Department of Education 2012.

> of action. Because the latter are ethically neutralized by their legal form of organization, communicative actions forfeits its validity basis in the interior of organization." (Habermas, 1985:310)

Within the legalized purposive organizational structure of bureaucracies, operating staff reach mutual understanding within the framework of formal regulations and relationships, not solely through communicative action to achieve consensus within the context of the lifeworld. Even within the formal organization framework, however, communicative action still holds an essential role:

> "Of course, the externalization of lifeworld contexts cannot be carried through without remainder, as the informal organization upon which all formal organization relies amply demonstrates. Informal organization covers those legitimately regulated, inner organizational relations that, notwithstanding the juridification of the framework, may be moralized. The lifeworlds of members, never completely husked away, penetrate here into the reality of organizations." (Habermas, 1985:311)

According to Habermas, the extent to which formal organization imposes purposive-rationality or rather is influenced by social values and norms are empirical questions:

> "To what extent the scope of disposition cleared by a formal organization is utilized in a purposive-rational manner, instructions are carried out in a purposive-rational way, and internal conflicts are dealt with in a purposive-rational fashion, to what extent the imperatives of profitableness in business, which capitalist enterprises must (more or less) follow, leave their mark on the action orientation of the operating staff – these are questions that, as empirical studies have shown, can by no means be answered deductively…. There is no doubt that the coordinating mechanism of mutual understanding is put partially out of play within formally organized domains, but the relative weight of social versus system integration is a different question, and one that can be answered only empirically." (Habermas, 1985:310, 12)

Critical theory views the colonization of the lifeworld by purposive-rational steering media as a more pervasive influence on the values and belief systems than only though external pressures placed on bureaucracies and their incentive structures. Even within the formally regulated and legalistic organizational structures of bureaucracies, social integration though communicative action remains.

Ringquist (1995:340, 55) predicted that the U.S. EPA, "with high levels of expertise, a strong sense of mission, high levels of external support, and a view of responsiveness more compatible with broader notions of the public good than direction…" should be relatively resistant to political control. He found indirect evidence that while external political control affected agency activities, it "did not affect the values of EPA bureaucrats." If members of the organization share a common set of values based on disciplinary training or other communicatively integrated and normatively bound social institutions, I expect that:

> Hypothesis 1: The cultures present within a regulatory agency with broad public support for its mission will be less reflective of industry's values than those regulatory agencies with limited public (or more concentrated) support.
>
> Hypothesis 2: Individuals values, beliefs and norms will be relatively constant over time, resistant to the influence of external stakeholders.
>
> Hypothesis 3: The cultures present within a regulatory agency with a high percentage of technical experts (e.g., advanced degrees) will be less reflective of industry's values than those with a low percentage of technical experts.
>
> Hypothesis 4: Individuals with similar disciplinary training and/or similar experiential backgrounds will share common values, beliefs and norms, regardless of organizational affiliation.

To assess how values are formed and maintained within bureaucracies, I used a combination of Q methodology, semi-structured interviews, and a survey, as described in the following sections.

8. Q METHODOLOGY IN ENVIRONMENTAL POLICY RESEARCH

Overview of Q Methodology

Q methodology is a social science technique invented in 1935 by William Stephenson, a British physicist-psychologist (Stephenson, 1935a, 1935b). "Q methodology was developed "…expressly to explore the subjective dimension of any issue towards which different points-of-view can be expressed" (Stenner et al., 2008:215) by quantitatively analyzing subjectivity, i.e., "subjective structures, attitudes, and perspectives from the standpoint of the person or persons being observed" (Brown, 1996). It provides a quantitative basis for determining how people subjectively frame an issue and identifies those statements most important to each discourse. Subjectivity, like Habermas' concept of the lifeworld, "is conceived as the internal reference frame that a person calls upon to understand the world" (Vugteveen et al., 2010:808). The self-referential aspect of Q methodology places the researcher and participant at the same linguistic and (therefore) cognitive level, a necessary condition for intersubjective understanding and normatively bound communicative action. As such, Q methodology embodies many characteristics consistent with critical theory and also provides a practical approach to policy analysis that addresses many of the limitations of logical positivism (Durning, 1999). Q methodology should not be labeled an exclusively post-positivists methodology, at least not in the sense of Lynn's (Lynn, 1999) polemic characterization of post-positivism and critical theory. Rather, Q methodology is a pragmatic approach to elucidate the self-referential subjectivity of participants, to understand the structure of values in a way that seeks to minimize methodologically induced bias. Q methodology also can be a powerful and relatively cost-effective tool for developing and conducting reliable contingent valuation studies, supplementing or replacing the interviews and focus groups advocated by Carson (2000) and Fishhoff (2000).[86]

In Q methodology, participants map their individual subjective preferences by rank ordering a set of statements (or other stimuli, like pictures) from agree to disagree, either by sorting statements printed on cards, using a traditional survey instrument and numerical scale, or more recently, using computer software over the internet. When participants are asked to sort statements in the traditional approach to Q methodology (as opposed to using a survey instrument and Likert scales), the sorting is often carried out according to a predetermined "quasi" normal distribution (i.e., the number of allowable responses for each value in the scale is predetermined, with fewer responses allowed at either end and the greatest number of responses in the middle of the scale). The individual sorts form a kind of cognitive map or mental model of a person's subjective preferences with regard to a particular issue. Ordering effects do not occur because the statements are interpreted within the context of each other (Webler et al., 2009). In

[86] The time and costs necessary to do a competent Q study are not trivial. I therefore agree with David Weimer that policy analysts and researchers should consider carefully the cost and value-added of Q methodology relative to other quantitative and qualitative approaches (Weimer 1999).

addition, through the statement selection process and the self-referential ordering of preferences, Q methodology avoids a criticism of psychometric approaches, where "imposed characteristics may not reflect the most important or salient characteristics for the general public, and hence, that any resulting model of perceptions might be constrained to the extent that it does not reflect the natural way in which people think about food risks" (Fife-Schaw and Rowe, 1996:491).[87]

Following the sorting, researchers frequently ask participants to reflect on their responses. Participants' individual Q sorts, which represent their preferences, are correlated with each other and factor analyzed. Researchers usually rotate factors either judgmentally, based on theoretical considerations, or frequently by using Varimax rotation. The factor outputs represent the degree to which the study participants are similar in their pattern of responses, as indicated by individual loadings on each factor. Factor scores represent the degree to which each statement characterizes the factor. The factors and patterns they identify represent "inter-subjective orderings of beliefs that are shared among people" who participated in the study (Webler, et al., 2009:7). The factors obtained through Q methodology identify "distinct Clusters of opinion" (McKeown and Thomas, 1988:14), each of which can be viewed as "idealized forms of discourses latent within the data provided by the individuals in the study" (Barry and Proops, 2000:21), or cultural models within the population.

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[87] Fife-Shaw and Rowe used "relatively-unconstrained discussions of a number of focus groups" to identify the key themes used for developing the risk characteristics for their study.

With this technique, it is therefore possible to analyze composition and value structures of discourses with regard to agricultural biotechnology within individual populations associated with the regulatory system. Surveys by themselves are inadequate for this purpose because their resolution is too limited:

> "… surveys are useful as general indicators of the contours of public perceptions, particularly when comparative and time series data are available. Surveys provide low-resolution portraits of the broad panorama. But they are clearly not ideal when it comes to the very fine detail – the shades of light and colour revealed only through close inspection. For this, other types of social research can provide the complementary perspective" (Gaskell, et al., 2006:9)

Case Example: Forest Management – Steelman and Maguire

Two Q studies conducted by Steelman and Maguire (Steelman, 2001, Steelman and Maguire, 1999), described here in some detail, provide illustrative examples of Q methodology and its application in environmental policy research. Like others, Steelman and Maguire argue that value-free policy analysis does not exist and that methods for systematically analyzing participant perspectives as part of the public involvement process are largely inadequate because:

- Surveys and contingent valuation studies are difficult to design, administer, and interpret;
- Focus groups are small and unrepresentative, and there are no specific guidelines "to elicit a systematic understanding of value-relevant information;"
- Multi-attribute utility analysis is difficult to understand.

Steelman and Maguire use two case studies of the perspectives of participants in forest management planning processes under the U.S. National Forest Management Act (1976) to illustrate the utility of Q methodology as "an inductive, systematic approach for providing information on public viewpoints, values, and positions" (p.362). Specifically, Steelman and Maguire illustrate the use of Q methodology to:

- Identify constituencies;
- Define participant viewpoints and perceptions;
- Provide insight into participant-preferred management directions;
- Identify criteria that are important to participants;
- Explicitly outline areas of consensus and conflict; and
- Develop a common view toward the policy.

The case studies illustrate the use of Q Method in the intelligence function of the policy cycle,[88] where public involvement was "consultative." The findings contribute to policy development by facilitating a methodical conversation over values, and thereby "contribute to the stabilization of expectations needed to achieve prescription outcomes" (p.365). Steelman and Maguire's first case study used Q Method to understand residents' beliefs about ecosystem management in the Chattooga Watershed in the southern Appalachians. In this study, 55 Q sample statements about ecosystems and their management were drawn from 143 interviews and written responses of Chattooga watershed residents between November 1993 and July 1995. The Q sample was semi-natural and unstructured, but balanced between pro and con views.[89] Statements were

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[88] Steelman and Maguire view policy as consisting of the following functions: intelligence, promotion, prescription, invocation, application, termination, and appraisal, citing Lasswell 1971.

[89] Unstructured Q samples provide a survey of perspectives, but can suffer from bias. A structured Q sample purposefully covers a range of topics and seeks to avoid biases. "Naturalistic" Q samples are drawn from interviews of respondents participating in the Q sort, while "ready made" samples are taken from sources other than respondents participating in the Q sort. In the Chattooga study, the sample was semi-

categorized into five issue areas: forests, wildlife, roads, water, and recreation. The statements were selected to represent the full range of residents' views within each topic and were edited for clarity and to eliminate repetitious statements.

A survey was sent to all interviewees and to participants in a prior survey and a public meeting. A snowball technique was used to ensure adequate respondents. In all, 143 surveys were mailed, each with a $1 incentive enclosed. Reminder postcards were sent every two to four weeks. Eighty-seven surveys were returned; a response rate of approximately 61 percent. Nineteen surveys were unusable due to omissions or incorrect markings, leaving 68 surveys or about 47 percent usable responses.

Three factors emerged from these Q sorts that expressed Chattooga residents' beliefs in the importance of water, hardwoods, and mixed forest tree species for wildlife and recreation. The three factors identified importance differences, however, in resident's subjective definition of these goals and their acceptance of various management techniques to achieve them. The first factor emphasized water quality, ecological protection, and minimizing human impacts. The second factor emphasized the importance of human uses and forest management. The third factor, while agreeing with factor two in the importance of human use and forest management, disagreed on the management techniques and goals. Like the first, the second factor identified water quality as important, but disagreed about the causes of degradation.

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natural because although the statements were drawn from respondent interviews, participants who were not interviewed also performed Q sorts (McKeown and Thomas 1988).

In a second study, Steelmen and Maguire (1999) used a focus group setting to understand the U.S. Forest Service (USFS) staff's perceptions of the role of public involvement in national forest planning for the Monongahela National Forest in West Virginia. A focus group of 15 pre-screened participants (eight women and seven men selected for their diversified backgrounds and their interest in participation in the two-day workshop) discussed five questions developed by Steelmen, Maguire, a forest planner, and "planning participants." A "Q sample of statements" was derived from focus group discussions, with the number of statements addressing each question as follows:

"What are the most and least useful aspects of the planning process?" – 11 statements

1. "What aspects of the plan work or do not work?" – 29 statements;
2. "What does the public feel the plan does or does not address?" – 26 statements;
3. "What is most or least useful with respect to public involvement?" – 18 statements;
4. "How should the public be involved?" – 21 statements.

Q sorts were conducted independently on each of the five sets of statements using a forced normal distribution. The results of the Q analysis illustrate that despite working within the same organization, staff have very different perceptions of the planning.

Four factors were identified with regard to the planning process (question 1). These factors reflected differences in participants' expressed beliefs regarding the importance of compromise and negotiation, communicating with the public, the need for information, and a dynamic process. There was a consensus on the belief that job security was related to effective planning, and the unimportance of an appropriated planning budget or "realistic workload to accomplishing their planning tasks." Two factors were identified from the Q sort related to the usefulness of the plan (question 2). These two factors reflected differences in participants' satisfaction with the ability to change the plan if a problem emerged, selection of delineated management areas, the plan's success in balancing technology and social concerns, and the need to write the plan in "understandable language."

The Q sort of statements related to USFS staff's perception of public expectations for the plan (question 3) revealed four factors. These differed with regard to staff's perception of the importance to the public of addressing in the plan ecological issues, human use issues (e.g., hunting, motorized vehicle use, fire-wood collection) and the responsiveness of the plan to new conditions and information. Three factors were identified on the utility of public involvement (question 4) that differed with respect to the conditions under which the public is most helpful (e.g., flexibility, engaging, providing new information, providing site-specific information, personal attacks, positive versus negative feedback). Participants agreed that public was most useful when it "could articulate the desired future conditions it wanted to see" and when it offered solutions. Finally, two factors emerged with regard to how the public should be involved (question 5). These factors differed on the usefulness of small group and individual communication versus larger audiences, public meetings, and written comments. Both factors reflected participants' agreement that many approaches to public involvement were not useful.

Methodologically, Steelman and Maguire's two case studies demonstrate how Q methodology can be used to:

- Identify constituencies;
- Define participant viewpoints and perceptions;
- Provide insight into participant-preferred management directions;
- Identify criteria that are important to participants;

- Explicitly outline areas of consensus and conflict;
- Develop a common view toward the policy.

Substantively, these case studies illustrate and characterize different external and internal (agency staff) perceptions and belief systems related to forest management and planning. As Steelman and Maguire concluded, “constituencies within the agency could be as complex as the public external to the agency” (Steelman and Maguire, 1999:380). Failure to characterize different value systems systematically can create several problems in environmental planning and management. First, it could lead to the incorrect assumption that all participants in a public policy domain have a common system of values, as might underlie economic studies (i.e., rational actor/utilitarian model) or that important distinctions and patterns of agreement and disagreement might be blurred, as could occur in public opinion studies.

With regard to public participation, failure to correctly characterize and identify individuals representing the range of value systems extant in the public can result in biased representation in public involvement and inappropriate understanding of public values and beliefs. These could have important implications for the agency and external public acceptability of management strategies, plans, and legitimacy of planning and management processes, which in turn have implications on management efficacy (e.g., internal agency support, policy consistency and continuity, political support, funding and inter-governmental cooperation, and compliance.). By explicitly characterizing areas of consensus and disagreement, environmental managers can better set priorities by identifying areas of pre-existing consensus that will not necessitate a great deal of additional attention (other than, perhaps, verifying the consensus), and thereby enabling the focus of attention on understanding and resolving areas of disagreement. In addition, Q methodology can be very useful for identifying individuals and organizations that represent diverse perspectives, and should be involved in a decision-making process, and in developing decision-making processes (and subsequent decisions) that are legitimate in the view of participants.

Additional Examples of Q Studies

The remainder of this section discusses additional examples of the use of Q methodology in environmental policy, values, and beliefs research. Though not an exhaustive review, these studies highlight the range of environment-related topics and procedural innovations employed with Q methodology.[90]

Attitudes Toward Land Use — Brown and Coke

Brown and Coke (Brown and Coke, 1977, Coke and Brown, 1976) conducted one of the earliest Q methodology studies related to environmental issues. They studied Americans' attitudes to property to determine if an ideology that emphasized human values (environmentalist) was replacing the prevailing ideology of economic growth and expansion (developmentalist). Brown and Coke identified several hundred statements from government reports, prior research, the media, and other publications. To select a

[90] For an introduction to Q methodology and case studies of environmental policy research using Q methodology (and the source for many of the studies discussed in this section), see Addams and Proops 2001

subset of statements for Q analysis, they characterized each statement according to its definiteness and theoretical completeness,[91] and used a three by three matrix to select a representative set of 55 statements. A total 247 individuals participated in the Q study, including 110 participants from Ohio, 89 from six communities in a national study, and an additional 48 participants who were members of the Colorado Farm Bureau. All participants sorted the 55 statements, which were printed on individual cards, from most agree (+5) to most disagree (-5).

The Ohio results indicated only two factors. One factor expressed environmental interests, comprised many participants affiliated with environmental groups, and was favored by approximately 80 percent of the women participants. The second factor expressed developmental interests, was favored by males, generally older participants than those associated with the environmental factor, and by participants who were managers, local government officials, and businessmen. The national study also resulted in only two factors, both very similar to the factors from the Ohio study. The Farm Bureau study produced only one factor reflecting a homogeneous developmentalist attitude. Because the studies had highly correlated results, Brown and Coke merged the Q sorts of individuals who significantly loaded on any factor from any of the three studies'

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[91] Definiteness was based on whether a statement expressed a bias (preference for a way to interpret facts), a wish (desire for a particular outcome or action), or a policy (a means to achieving a policy outcome). Theoretical completeness referred to the particular ideology expressed in the statement: developmentalist, environmentalist, or cooperative (midway).

results and described two national attitudes concerning land use: environmentalist and localist.

The results supported the emergence of a new environmentalist attitude toward land use, but surprisingly not in the way the authors anticipated. The major difference between the two discourses lay not in disagreement over a laissez faire attitude toward development; neither discourse expressed support for that. Rather, the major differences reflected alternative perspectives on the need to consider and have control over the broader widespread impacts of development, or to maintain local independent control over development decisions.

Landscape Perceptions – Fairweather and Swaffield

Fairweather and Swaffield (2001) discussed three Q methodology studies in landscape perception research that used photographic images of the natural environments. The first study focused on alternative land uses in the Mackenzie high country of the South Island in New Zealand, as part of an effort to develop improved land use planning methods (also see Swaffield and Fairweather, 1996). Seventy-seven participants Q-sorted computer-generated photographic images representing forestry, agriculture, and conservation land uses. The Q methodology resulted in three factors, which were stable after two years.[92] These factors were used to develop five land use scenarios that

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[92] Fairweather and Swaffield reported that the second Q sorts conducted two years after the first were very similar for 19 of 22 participants.

modeled forestry regimes, areas for planting, and tree species and predicted changes in population, incomes, and employment.

In a tourism study described by Fairweather and Swaffield, 66 participants Q-sorted two sets of photographs of landscapes, cultural features, attractions, and activities. The two sets of photographs were from Kaikoura, located on the East Coast of the South Island, and Rotorua, a tourist attraction located on the central North Island of New Zealand. Both of the sorts resulted in five distinct factors; three of the factors were similar for both locations.

Fairweather and Swaffield described a third study aimed at gaining a better understanding of how a range of stakeholders perceives “natural character,” a poorly defined phrase found in one of New Zealand’s environmental laws, with important legal implications. In the study, 88 participants representing planning, conservation, forestry, and mining performed three separate Q sorts of photographs of Coromandel, a peninsula on the East coast of New Zealand’s North Island with diverse land uses, landforms, and coastal features. The photographs included a wide range of landforms (“hills, foothills, estuarine, beach and headland”) and features (“water, land use, vegetation type, landscape pattern, artifacts and cues for care”) (Fairweather and Swaffield, 2001:143).

One Q sort used 26 images showing a full range of landscape features, sorted from ‘most like’ to ‘least like.’ A second Q sort of a set of 26 images that focused on more subtle differences in landscape change were sorted from ‘most natural’ to ‘least natural.’ Six images were common to both sorts. After each of these sorts, participants also were asked to explain what aspects of each photograph they considered natural and unnatural. Following factor analysis of each set of sorts, both of which resulted in two significant factors, the responses of each participant who significantly loaded on a factor were “collated” to characterize participants’ definition of natural and unnatural. The two factors from the full range of landscapes were highly correlated (0.82), with features such as unmodified bush, headland, dune, and estuary characterizing natural. The main distinguishing photographs were of non-native pine species. The factors emerging from the focused sorts were more dissimilar (correlation coefficient = 0.46). Non-native pines again distinguished between the two factors, but also the presence of built structures and evidence of human management were considered more unnatural in one factor than the other was.

Vegetation Landscape Preferences in Israel – Misgav

In another landscape study, Misgav (2000) used a combination of questionnaire and Q analysis to relate visual landscape preferences with vegetation characteristics. Misgav selected 150 households that proportionately represented the number of rural, urban, and communal households in the area of study. In the Q analysis, participants graded 44 pictures of various landscapes on a 1 through 7 scale. Participants also rank-ordered their preferences to a variety of physical-visual vegetation elements like height, color, foliage, density. The results indicated clear preferences for some landscapes relative to others and provided support for an analytical approach for using visual factors to predict landscape preferences.

Airport Expansion – Van Eeten

As part of a public engagement exercise, Van Eeten (2001) used Q methodology to conduct an in-depth study of stakeholder arguments related to a controversial proposed expansion of Schiphol Airport, Amsterdam, The Netherlands. Thirty-eight participants representing airlines, airport management, government, environmental organizations, local citizens, and economic interests preformed Q sorts of 80 statements covering the range of the controversy. The Q analysis extracted four factors. One factor was bipolar and described the prevalent divisive policy debate, but the other three factors (discourses) were discrete, and "submerged and collapsed" into the prevailing polarization arguments for/against growth. The Q analysis enabled a decoupling and recasting of policy issues in a way that was both surprising and welcomed by stakeholders, thereby increasing the possibility of a successful policy deliberation.

Environmentalism and Alternative Economies – Barry and Proops

Local Exchange Trading Systems (LETS) are non-profit, voluntary organizations, associations, or networks that provide alternative systems for their members that use their own “nominal currencies” in lieu of formal state-issued money for exchanging goods and services. LETS have become popular in the United Kingdom, with as many as 400 reportedly in existence in the year 2000. Because LETS are a social phenomenon associated with green political economy and green political theory, Barry and Proops (1999, 2000) conducted a Q study to explore the attitudes of members from several LETS groups toward the LETS themselves, citizenship, and the environment. Twenty-five participants with diverse demographics were selected from various LETS across the United Kingdom. Each participant conducted three separate Q sorts, one each on (1) LETS themselves, (2) citizenship and community, and (3) environmental concern, awareness, and sustainability. Each Q sort involved 36 different statements selected from interviews and the literature.[93] Participants sorted statements within a pyramidal forced distribution, from ‘disagree most strongly’ (-4) to ‘agree with most strongly’ (+4). Factors were extracted using the centroid procedure with verimax rotation. Factors with eigenvalues greater than 1.0 were significant.

Five significant factors emerged from the Q sort on LETS, one of which was bipolar. Collectively, these factors accounted for 55 percent of the variance among the individual sorts. Two factors were highly correlated (r=0.63). Notably, most discourses shared common elements, including that LETS create something new in society and provide an opportunity to everyone; that local government could be helpful; and general agreement that LETS are part of a greening of society. Three factors were extracted from the Q sort on citizenship and community, which accounted for 55 percent of the variance. The factors were highly correlated and there were ten consensus statements (differences in ranking were no greater than one unit). The factors expressed a range of discontentment and alienation from the political system. Yet, they also expressed

[93] Barry and Proops initially identified hundreds of statements and used a 4 x 4, 16-cell concourse matrix to arrive at a manageable number. Each statement was characterized according to discourse element (ontology, agency, motivation, natural/unnatural relationship) and by type of claim (definitive, designative, evaluative, advocative).

opposition to the use of force to change the political system and supported tolerance for others. Four significant factors were identified from the Q sorts on LETS and environmental sustainability, also accounting for 55 percent of the variance. Two pairs of factor were correlated and there were six consensus items. All factors expressed concerns over the threat of multinationals to the environment, global environmental issues, the consumption-driven society, and the need for government to do more.

Global Climate Change – Dayton

Dayton (2001) selected 60 statements on environmental beliefs and attitudes and global climate change from a variety of published sources and personal communications. He then conducted a Q analysis with 30 participants actively involved in global climate change issues. The participants included representatives from government and non-governmental organizations, and from the business, industry, finance, and labor sectors. The analysis identified “at least three distinct and discordant policy frames, that are representative of the viewpoints of a cross-section of climate stakeholders” (p.95) and ideal types, which Dayton labeled “transcendentalists,” “policy activists,” and “cautious incrementalists.” The results suggest that the intractable policy conflicts over global climate change are due, in part, to the absence of intersubjective understanding among various stakeholders, which can improve though repeated interaction and discourse.

Water Quality Management – Focht and Lawler

Focht and Lawler (2001) suggest the use of Q methodology to facilitate policy dialogue, such as environmental dispute resolution and alternative dispute resolution.

They argue that because Q methodology provides an operant view of stakeholder perception, it can distinguish between veridical conflicts (bipolar factors) and non-veridical conflicts (orthogonal factors); therefore it is well suited to characterize conflicts and inform policy dialogue. Focht and Lawler conducted a Q Method study on the potential siting or remediation of hazardous waste management facilities in Oklahoma, using both a composite first order and second-order analysis of 112 Q sorts from participants in seven communities. Each factor analysis resulted in three perspectives that differed primarily in their level of trust in government and technology, belief in the role of government and the nature of public involvement, degree of risk aversion, and acceptance of risk and economic analyses. At one extreme was a technocratic discourse, held mostly by government and industry employees, which reflected support for technical and economic criteria and only limited and conditional public involvement in decision-making. At the other extreme were what Focht and Lawler labeled “Disafffected Opponents,” who distrusted technocratic supporters and decried technical rationality and optimization in favor of local community control (“sceptical communitarian parochialism”). In between these two extremes, Focht and Lawler identified a pragmatic discourse (“pragmatic guardians”), which valued information access and power sharing opportunities, conditional trust in government (with oversight), and a desire for technological progress and economic growth. They also recognized, however, that “quality of life is not limited to technically rational, utilitarian objectives” (p.114); they believed there is a need for government regulation of industry, protection from threats, and direct public involvement in decision making.

Focht (2002) also used Q methodology to study stakeholder perspectives on concerns over impacts and impact management preferences for the Illinois River watershed in Oklahoma. He derived five factors from 99 respondent Q sorts of 47 items expressing various concerns related to water quality, including water quality, hazardous chemicals, industrial pollution, trash, logging, erosion, floods, ranching, poultry farming, agriculture, commercialization, tourism, boating, private land rights, public property, and cultural and spiritual resources. Participants included federal, state, and tribal government environmental officials and self-identified environmentalists. The resulting factors expressed discourses reflecting ecocentricism ("preservationists"), responsible use ("stewardship"), libertarianism ("traditionalist"[94]), trepidation ("pessimistic"), and resource stewardship ("conservationist"). Focht highlighted that four of the five discourses expressed concern over water quality and support for regulation, differing mostly in who was responsible for problems. The exception, traditionalists, denied the existence of water quality problems. Despite their differences, no discourses were juxtaposed diametrically, as would have been indicated by a bipolar factor, suggesting at least the possibility of a consensus strategy to manage water quality impacts.

In a second part of the study, Focht conducted a Q analysis with 99 stakeholders on various approaches and issues associated with developing a water quality management strategy. The 58 Q statements used in the study reflected trust in/role of various levels of government, consensus building, natural resource use, public involvement/influence, red

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[94] Significant loading on this factor were all from ranchers and poultry farmers.

tape, corporate and individual roles and responsibility, law enforcement, and economic issues. Focht analyzed four factors, but more than half of the participants loaded onto one. This majority of participants favored a cooperative and enforceable approach that would hold accountable those responsible for pollution (“rational management”). A second discourse reflected a conservative viewpoint (“skeptical”) that distrusted government and scientific evidence of impacts, and generally opposed rapid change to the status quo. The third discourse favored immediate action to protect the river, including land use restrictions, and supported a willingness to sacrifice jobs to protect the river (“precautionary”). The final discourse (“local control”) supported the need for an impact management plan, but also reflected a belief that management control of the river should rest with local officials and stakeholders. The four discourses differed most in the role of outsiders (government agencies and experts), the need for a management plan, land use restrictions and other regulations, special protection of recreation and tourism, adequacy of scientific evidence, and the most appropriate decision-making process. Despite these areas of disagreement, all discourses supported the goal of sustainable use of the river, believed in the responsibility of those adversely affecting the river to share in the burden of its restoration, and believed that all stakeholders must have a meaningful impact on the policy output. Based on these results, Focht suggested concrete policy options to capitalize on areas of agreement and nuances revealed in the Q analysis.

Watershed Management – Webler and Tuler

Webler and Tuler (2001) used Q methodology to characterize how “active and experienced people in watershed planning think about the public’s role in producing a watershed management action plan.” Their analysis identified four perspectives that “highlight different principles important in public participation processes” (Webler and Tuler, 2001:29) and illustrated that even experienced and knowledgeable people (in this case, people involved in watershed planning) differ in their expectations for public participation processes and results. They suggested that these different perspectives reflected genuinely held values and motives, such as a need to obtain legitimacy for policy implementation and a moral right for affected individuals.

Stakeholder Values in Water Management – Vugteveen et al.

To bring together facts and values in developing integrated water management strategies in The Netherlands, Vugteveen et al. (2010) conducted a Q study involving 56 individuals affiliated with stakeholder organizations active in the management of national water bodies. They included representatives from national, regional, and local government; universities and research institutes; interest groups; utility companies; and industry. The Q sample consisted of 36 statements selected from conference proceedings, scientific and policy professional literature, government documents, and advisory reports that expressed human values and preferences toward water systems. To ensure the Q sample represented a broad range of values, the selection of statements was facilitated with a 3 x 3 theoretical matrix that characterized each statement as either an ethical, affective, or cognitive expression, and whether it expressed an individual, social, or object-oriented perspective.

The participants sorted the statements according to the extent to which each statement represented their aims and values related to integrated water management, from most (+5) to least (-5) in accordance with their viewpoint. Participants were encouraged to use a quasi-normal distribution, but "were allowed to deviate from it if adhering to the distribution would misrepresent their perspective" (Vugteveen, et al., 2010:810). In addition to the Q sorts, participants provided demographic information, formulated keywords that they associated with integrated water management, and identified what they thought were the most important societal values of water systems. The Q analysis resulted in five significant factors, which Vugteveen and colleagues labeled as follows:

- "Holists" expressed mostly cognitive statements reflecting a systems approach that values the eco-social entity, with significant loading by participants from research and consulting organizations.

- "Technocrats" favored by representatives from consulting, economic, and recreational use organizations, expressed trust in technology to address water problems and rejected emotional arguments, placing a high emphasis on human use.

- "Producers" articulated by representatives from government agencies and agriculture, drinking water, and fisheries industries, reflected an appreciation of the multifuntionality of water systems, with water seen as a commodity, nature as a monitory value, and responsibility for environmentalism residing with individuals.

- "Accountable Managers" conveyed ethical and cognitive values, expressed by government representatives from water management organizations.

- "Environmentalists" advocated ethical values toward nature, expressed mainly by representatives of environmental non-government organizations and government.

Impacts of Participatory Planning on Viewpoints – Pelletier et al.

Pelletier and colleagues (1999) used Q methodology to assess the impacts of a deliberative policy forum on participants' viewpoints about local food system policies in rural upstate (northern) New York. In their study, participants conducted Q sorts before (171 participants) and after (141 participants) two-and-a-half-day deliberative "search conferences"[95] on community food security held in six New York counties. The authors selected 48 statements from literature that dealt with social justice, environmental sustainability, economic viability, and healthfulness. Participants sorted the statements according to a 7-point scale, from -3 (strongly disagree) to +3 (strongly agree) using a forced distribution. The centroid method with verimax rotation was used to extract factors separately for the pre- and post-conference sorts, both of which resulted in three distinct and coherent factors. Pre-conference factors were labeled "social justice advocates" (sympathetic with the poor and hungry), "pragmatists" (support agriculture and current food system) and "visionaries" (support agriculture, but environmentally conscious, and views food systems as inequitable and unsustainable).

To assess changes in participants' viewpoints, Pelletier and colleagues compared the pre- and post-conference factors by comparing the top ten most agreed and disagreed statements, changes in factor membership, and changes in loadings. They found little

[95] Search conferences that were part of this study consisted of "two-and-a-half-day participatory learning and planning process typically involving 30-50 individuals who work in small groups (4-6 members) and in plenary sessions at various points in the process" (Pelletier et al. 1999:106).

difference between the pre- and post-conference factors content, but rather, a reinforcement of the main distinctions between factors. In addition, the magnitude of difference between the pre- and post-conference factors is similar, evidence of minimal impact of the conference on the structure of the discourses. On the other hand, factor membership changed significantly, with a net increase of 88 percent in the number of participants loading onto the pragmatist factor, a decrease of 14 percent for the social justice factor, and a decrease of 19 percent for the visionary factor.

Overall, the results seem to indicate that 40 percent of the participants changed their viewpoints. Since attitudes and beliefs are generally considered to be stable, however, Pelletier and colleagues suggest that the conference may have affected participants in other ways. First, they observed that the increase in the number of post-conference participants loading significantly on the pragmatist factor was stronger in some counties than others, perhaps due to the strong persuasiveness of individual participants. They also suggested that participation in the conference might have changed the way in which participants interpreted and related to particular statements in the Q statement sample, toward a “deeper reflection after the conference.” Another possibility is that the conference facilitated participants’ recognition and resolution of discrepancies in their internal belief systems. Regardless of the underlying cognitive reasons, results indicated that a reflective, discursive process can promote normatively binding communicative action as evidenced by the increase in the support of the pragmatist discourse. What remains undetermined is the extent to which the conferences were free of coercion and the disproportionate persuasive influence of some participants, or whether the results reflect a genuine movement toward a normative consensus.

Environmental Protests – Capdevila and Rogers

A Q study was conducted by Capdevila and Rogers (2001) to elucidate perspectives associated with protests over a proposed bypass road around Newbury, England. From literature, cultural analysis, and interviews with people who had read a short article about protests over the Newbury Bypass, Capdevila and Rogers selected and pilot-tested a set of 74 statements about environmentalism, protest and protesters, gender, age, lawfulness, motivation, and the short article itself. Thirty-six participants conducted Q sorts (most agree to most disagree). Principal component factor analysis with verimax rotation was used identify seven factors that represented different positions about the short article on the protests. Capdevila and Rogers labeled the factors as the “Law Abiding” (opposed protesters), “Liberal Humanist” (supported protestors), “Activist” (identified with protestors and activism), “Radical” (anti-establishment, revolutionary), “Sceptical” (supportive of cause, but doubted effectiveness of protests), “Cynical” (supported issues but questioned protesters’ motivation), “and Superficial Motives” (dismissed issue and protestors) narratives. The narratives differed according to whether the underlying issues should be addressed through protests or other means, the politically legitimacy of the protests, and the discourse’s attention to gender and age.

Scientists' Perspectives on Genetically Modified Crops – Kvakkestad et al.

Kvakkestad et al. (2007) used Q methodology and logistic regression to characterize the perspectives of Scandinavian scientists[96] from universities and industry on the release of genetically modified crops into the environment. The authors postulated four dimensions of the scientists' debate and evaluation of genetically modified organisms:

- Consequences of releasing genetically modified crops;[97]
- Predictability of consequences;
- Differences from convention crops;
- Moral status of nature, e.g., anthropocentric or ecocentric worldviews.

The authors also speculated that scientists' beliefs about the consequences of the release of genetically modified crops and how they valued those consequences would relate to their disciplines, places of employment, types of research, and funding sources. They expected ecologists to believe that the effects of the release of genetically modified crops would be either unpredictable, given the complexity of ecosystems, or would destabilize ecosystems. Molecular biologists were expected to believe in the ability to predict and control genetically engineered crops for human and ecological benefits. Conventional plant breeders were thought have a very different perspective from molecular biologists on whether genetically engineered crops fundamentally are the same as conventional crops. Kvakkestad et al. also predicted that scientists from the

[96] The scientists included molecular biologists, ecologists, plant breeders, and related disciplines.
[97] "This involves both factual beliefs about nature and society (what will happen) and value commitments (how consequences are evaluated)" (Kvakkestad et al. 2007:82).

biotechnology industry and universities, where research increasingly has become more market-oriented, would be inclined to diminish the importance of issues that are external to the market and do not add value to products. This would be especially likely for university scientists who receive research funds from the biotechnology industry. Publicly funded scientists were expected to be heterogeneous with respect to their beliefs about genetically modified organisms.

To conduct the Q analysis, Kvakkestad et al. selected 36 diverse statements (from a total pool of 245 statements) obtained from interviews with scientists, the literature, and web sites. Q sorts were conducted by 62 scientists[98] using an 11-point scale, from strongly disagree (-5) to strongly agree (+5) on a forced distribution. Individual Q sorts were followed by interview questions, and participants completed a brief survey with questions on their demographics, research funding sources, nature of their research (basic or applied), and general attitude toward genetically engineered crops. The authors used three criteria to identify significant factors representing distinct, coherent views: eigenvalues greater than 1.0, the leveling off point on a scree plot of eigenvalues, and theoretical importance.

Eleven factors had eigenvalues greater than 1, but only three factors were retained based on the scree plot results. The three factors accounted for 55 percent of the variance, with 32 participants loading significantly on one factor, 25 on a second factor, and one

[98] The authors reported they contacted nearly 70 scientists, but several did not respond or otherwise participate.

participant loaded on a third factor (which ultimately was rejected because if had only one significant loading). The two factors emphasized different aspects of the debate, rather than opposing viewpoints, and results of the logistic regressions generally supported the authors' hypotheses.

Agrobiologists, plant physiologists, evolutionary geneticists, bioethicists, and all publicly funded scientists held a perspective that emphasized the unpredictability of the consequences of releasing genetically modified crops into the environment and the potential for negative consequences. Scientists from the genetic engineering industry all held the same perspective, emphasizing that genetically modified crops hold potential benefits and are not fundamentally different from conventional crops. No ecologist, scientist from a non-profit research foundation, or scientist from conventional breeding companies loaded significantly on this factor. Molecular biologists whose research was funded by the biotechnology industry also favored this perspective. These latter two findings may have significant implications for government agencies reviewing genetically modified crop research, as the source of research funding may introduce bias by influencing scientists' perspectives (through the promise of additional funding for supportive research) and through differential funding of researchers known to support industry perspectives.

Attitudes Toward Animals – Kalof

Kalof (2001) used Q methodology to gain a better understanding of American's complex attitudes toward animals. Kalof first conducted a survey of American undergraduates, which included questions on demographics, sexual orientation, political ideology, participants' animal-related activities, environmental group membership, and exposure to farm animals. Based on the results of the survey, Kalof selected 40 students to participate in a Q analysis that used 43 statements about animals, which were collected from literature. Participants scored statements, which addressed a wide variety of animal issues, using a 5-point Likert scale. Participants also indicated the importance of certain values that measure altruism (or self-transcendence) as "guiding life principles" using a 5-point scale. The ratings of the 43 statements about animals were transposed and analyzed using principal component factor analysis with verimax rotation and Kaiser normalization,[99] so that the respondents themselves were treated as variables (as opposed to the statements). From this, six factors (discourses) emerged, which Kalof described but did not label.[100] The results indicated a complex set of human concerns and associated demographics, but altruism was the most defining characteristic. For example, one discourse, which reflected an "appreciation of all in the community of life, a concern for justice and love for animals," was significant mostly for young, politically liberal to moderate, and altruistic Hispanic and white women. Another discourse supported killing animals for human use or pleasure and was mostly associated with white males with

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[99] To correct for weighting variables equally without regard to their communalities, before rotation each loading is divided by the square root of its communality, and then each loading is multiplied by the square root of the communality following verimax rotation. See Harris 2001;Kaiser 1958.
[100] Some researchers believe that labeling discourses introduces an unnecessary degree of investigator interpretation, which they believe detracts from the self-referential meaning of a discourse, from the "respondents' construction of reality" (Kalof 2001:186).

relatively low levels of altruism. However, these same individuals valued animal welfare and did not express dominionistic attitudes toward captive animals.

Ideological Shifts in the Third World – Peritore and Galve-Peritore

Q methodology was used by Peritore and Galve-Peritore (2001) to assess whether Third World countries had shifted from the modernist ‘left-right’ ideological spectrum to a “post-modern” value orientation. Q sorts of 36 statements selected from international literature and interviews were conducted by 241 “elites” (top business executives, leaders of non-governmental organizations, and high-level government or political officials) from seven developing countries.[101] Participants were selected though “respondent pyramiding,” based on the recommendation of at least two other elites. Peritore and Galve-Peritore masked participants’ identity and specific positions to protect them from possible retribution. The 36 statements covered a range of environmental issues, including biocentrism, anthropocentrism, sustainable development, developmentalism, policymaking, international treaties, energy, biotechnology, global warming, and population. Q sorting was conducted using statements printed on cards and an 11- point scale, from -5 (disagree) to +5 (agree), with 0 as neutral. Seven factors representing different attitudinal types resulted from the factor analysis and verimax rotation. Peritore and Galve-Peritore labeled the seven factors:

[101] The countries included in the Q study were Brazil, India, Iran, Korea, Mexico, Puerto Rico, and Romania.

1. “Green” – desired a green economy, values life and biodiversity;

2. “Sustainable development” – believed both incentives and regulations necessary for conservation;

3. “Postmodern managers” – supported a variety of approaches to develop environmentally sound economies and technologies;

4. “Political greens” – was environmentally aware, but lacked conviction or ability to implement green programs;

5. “Developmentalists” – believed in economic rationalism and self-regulating power of the capitalist market, but was increasingly concerned;

6. “Bureaucratic nationalists” – was critical of government’s ability to regulate, saw necessity of national solutions and systemic change to achieve environmental and economic goals, and believed in the collapse of the West;

7. “Cultural traditionalists” – was strongly critical of Western modern culture and institutions.

While the results showed a range of ideologies among Third World elite, the study indicated a broad consensus among elites in business, government, and non-governmental organizations on the importance of environmental protection, and a cultural shift away from left-right politics toward a post-modern value orientation.

9. METHODOLOGICAL APPROACH

My research builds on the body of work devoted to understanding how people frame environmental issues by characterizing and comparing the attitudes and values of staff within organizations involved in the regulation of agricultural biotechnology. While there has been much research on public attitudes related to biotechnology, little has focused on those individuals most knowledgeable about environmental issues and the risk, benefits, and regulation of GMOs. My empirical research, therefore, focused on individuals within the U.S. federal government — EPA, FDA, and the USDA — who are most directly involved with the regulatory risk analyses of genetically modified organisms. In addition to characterizing value and belief systems within these populations, using the research enables initial comparisons among institutions with different missions to understand differences in their organizational culture as characterized by the discourses related to genetically modified organisms.

I also structured the research to understand the relationship between explanatory variables identified in the literature (e.g., age, gender, ethnicity, income, education, profession, general environmental attitudes, etc.) with GMO-related discourses within the regulatory system (regulatory agencies, agriculture biotechnology firms, Congress, non-governmental organizations, farmers) and the educated public (e.g., students), as characterized through Q methodology. I used methodological triangulation that incorporates Q methodology, semi-structured interviews, and a traditional survey instrument (Fielding and Schreier, 2001, Morse and Chung, 2003). There are a relatively small number of staff in each regulatory agency who work directly on the regulation of GMOs or genetically modified ingredients in food. Q methodology is well suited for this relatively small number of potential participants and for critical social analyses: its validity lies in the self-referential aspects of the methodology itself, and not on representative sampling.[102]

Q Statement Sample

I followed the methodological principles of Stephenson (1953) and Brown (1980), and used an approach similar to that of Dayton (2001) to select a balanced and structured set of natural statements for the Q sample that represents the range of perspectives and issues related to agricultural and food genetic engineering. First, I collected a sample of 524 statements from published literature; government documents; news media; industry and non-governmental organization position papers and internet sites; and published interviews about genetically modified organisms, agricultural biotechnology, and related topics.

To ensure that the final set of statements would be relatively clear and unambiguous across a range of people, I asked four colleagues at the EPA to review the

[102] "Q methodology is a typically qualitative and a very *critical* method. The surprise, perhaps, is that it achieves its critical stance through the embrace (rather than the rejection) of many natural scientific assumptions" (Watts and Stenner 2005:91). "Most Q technique studies involve administration of the Q sort to several respondents, but to far fewer than is the case, say, in survey research: even in studies of public opinion, samples of persons (P sets) rarely exceed 50…" Brown 1993:104.

entire sample of 524 statements. The group included two men and two women, including one minority. The individuals represented a range of educational levels (bachelor, master, law, and doctoral degrees), disciplines (geology, biology, public and environmental policy, political science), and organizational responsibilities (professional staff and management). These reviewers provided a good surrogate for the principal target participants in this research, i.e., individuals involved with the regulation of genetically modified organisms. I presented each reviewer with a table containing all 524 statements and a column with written instructions requesting that they identify those statements that "present[s] the opinion or issue in a manner that is clear and concise, from the perspective of an educated layperson." I compiled the results and retained the 166 statements that all four of the reviewers identified as "clear."

To ensure that I achieved a parsimonious set of statements that represent the full range of issues associated with agriculture biotechnology, following Fisher's principles for experimental design (Brown, 1980), I coded each of the remaining 166 statements by topic and sub-topic, by its implicit validity claim (Habermas, 1984), and according to its frame of reference, theme, and the type of actor who made the statement (modified from Bauer, et al., 2001) (Table 12). I eliminated any redundant statements and ensured I had an equal number of statements express positive perspective (Pro) and negative (Anti) sentiment on GMOs. I ultimately selected 66 statements for the Q statement set (see APPENDIX A: COMPLETE Q STATEMENTS AND TOPOLOGY). These statements cover the range of sentiments expressed within the concourse and ensure that I have sufficiently more statements than participants.[103]

Table 12. Q statement coding matrix

<table>
<tr><th>Validity Claim / Frame</th><th>Purposive-Rational (Cognitive-Instrumental)</th><th colspan="2">Normative (Moral-Practical)</th><th>Esthetic-Expressive</th></tr>
<tr><td>Progress</td><td colspan="2">Theme</td><td colspan="2">Actors</td></tr>
<tr><td>Economic prospect</td><td colspan="2">Biomedical (‘red’)</td><td colspan="2">Independent Science</td></tr>
<tr><td>Ethical</td><td colspan="2">Agrifood (‘green’)</td><td colspan="2">Interest groups/NGOs</td></tr>
<tr><td>Pandora’s Box</td><td colspan="2">Generic research</td><td colspan="2">Media/Public Opinion</td></tr>
<tr><td>Nature/nurture</td><td colspan="2">Economics</td><td colspan="2">Government/Politics</td></tr>
<tr><td>Public accountability</td><td colspan="2">Moral issues</td><td colspan="2">Biotechnology Industry</td></tr>
<tr><td>Globalization</td><td colspan="2">Public opinion/policy</td><td colspan="2">International</td></tr>
<tr><td>Runaway</td><td colspan="2">Regulation</td><td colspan="2"></td></tr>
</table>

Individual statements do not always fall neatly under only one discrete category. For example, a statement about the legal right of the public to know if food contains genetically engineered ingredients implicitly contains a normative preposition (the public’s right) and a purposive-rational (economic) validity claim, an ethical (rights) and a public accountability (agrifood business and government) frame, and an economic (market information), moral (rights), public opinion/policy, and regulation theme.

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[103] While the number of participants was often approximately the same or significantly exceeded the number of statements in many Q studies (several of which I described previously), according to Webler and colleagues, a 3:1 ratio between statements and participants is preferred, with a minimum of a 2:1 ratio (Webler and Tuler 2001). I anticipated no more than 10-15 participants from each federal agency who are directly involved in regulating genetically engineered plant and or food ingredients, and the participation of relatively few individuals from industry and/or advocacy organizations. Actual participation was as expected; therefore, there was no need to run the factor analyses of Q sorts for each organization individually or to sample sorts.

Nonetheless, the classification helped ensure a balanced, comprehensive set of statements, and facilitated interpreting the Q analysis. For the actual sorting by participants, I printed the selected statements on business cards, one statement per card.

Participant Selection

I conducted the research in two stages. In the first, pilot stage, I used a convenience sample of undergraduate and graduate students from a U.S. university population. In April 2012, I sent an initial email and up to two follow-up emails requesting volunteers for my study to 94 undergraduate and graduate students in three environmental science and policy courses. Ten students volunteered and performed Q sorts from April to June 2012. This pilot stage enabled me to refine my administration of the Q sorts, interview, and statistical treatments. Based on the robustness of a trial factor analysis, I determined *post hoc* that the result of the pilot stage were reliable and included those results as part of the study, providing me a baseline sample of public values and attitudes about agricultural biotechnology against which I could compare the target population.

The second stage (January - March 2013) involved administering the Q sort and survey to staff and management from the U.S. EPA, concentrating on a target population of individuals involved with regulatory risk analysis of GMOs. In addition, using a snowball approach and internet searches, I sought participants from USDA and FDA, and non-governmental consumer advocacy organizations (NGOs). I telephoned and/or sent an initial and up to two follow-up emails to each potential participant. Within one day of participants' completing the Q sort, I sent each participant an email with instructions for completing and returning the survey. Until the end of the study (in March 2013), I followed up with reminder emails every one to two weeks to participants from whom I had not received survey responses. Samples of this correspondence are found in APPENDIX B: RECRUITMENT AND FOLLOW-UP CORRESPONDENCE.

Q Sorts

I arranged to meet each participant at a time and place of his or her convenience. I met most of the pilot study participants in a conference room at George Mason University, Fairfax, VA. One participant met me at a conference room at the U.S. EPA, and another met me in her office. Most participants for the main study preferred to meet in conference rooms near their offices; however, I met with one participant at a restaurant and another at her home. Prior to beginning the Q sort, I provided each participant a copy of the informed consent document for his or her oral approval (see APPENDIX C: INFORMED CONSENT). I also told participants that the survey included another informed consent statement on which they would need to indicate their approval before they could complete the survey.

For each Q sort, I placed on the table a 4 foot x 3 foot paper presenting a matrix with cells the size of the business cards containing each statement. Within the matrix, I indicated with bold lines a quasi normal distribution for the distribution of 66 cards.[104] The matrix also included additional spaces should a participant wish to deviate from the

[104] The distribution closely resembles the sample distribution provided by Watts and Stenner for 60 statement cards. (Stenner et al. 2008;Watts and Stenner 2005).

recommended distribution. I asked participants to “sort” each card into different columns based on the extent to which they agreed or disagree with the statement, from -6 (least how I think) to +6 (most how I think) (Webler, et al., 2009).

I provided the distribution to encourage participants to make meaningful distinctions between statements. According to some researchers, however, the specific distribution used is somewhat arbitrary, has no statistical importance, and has no effect on the final analysis. Perfectly acceptable results are obtained using a free-distribution format. To investigate the necessity of “forcing” participants in a Q sort to respond according to a predetermined ranking distribution, Brown (1971) studied the effect of various distributions of Q sorts and statistical tests of correlation on the resulting factor loading. The result of Brown’s study indicates that the shape of the Q-sort distribution has no significant effect on the results, and that Person’s *r* is the most appropriate statistical test for the rank ordering information developed using Q methodology.[105]

Cottle and McKeown (1980) simulated Q sorts with distributions where some categories were unused. Their results support the conclusion that “unstructured free-choice distributions are just as valid for factor analysis as are forced-choice quasi-normal distributions.” In addition, Brown (1985) compared unstructured, free choice Q sorts of

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[105]Brown evaluated Kendall’s τ, Pearson’s *r*, Spearman’s *r* uncorrected for ties, and Spearman’s *r* corrected for ties. He used 11 untied distributions, each containing 45 items. One distribution represented a complete ranking (range=45, the remainder were ranked from –4 to +4 (range=9). The same item ordering was used for ten of the distributions; the other distribution contained a random order of items. All but the random-ordered distributions loaded onto one factor, accounting for approximately 84.4-87.1 percent of the variance. The random-ordered distribution represented an independent factor that accounted for approximately 9.1 percent of the variance. Brown 1971.

45 statements by 30 respondents. The results indicated that even without a forced distribution, Q sorts roughly approximate a normal distribution.[106] Although these findings support the validity of questionnaire formats to facilitate Q sort data gathering, Cottle and McKeown (1980:62) cautioned that Q methodology "is more than just a technique," and "the technical components… should not overshadow the validity of the total methodology." This is because sorting has the advantage of allowing a greater degree of reflexivity than a survey instrument, and a forced distribution (or, as in the case of my research, an encouraged distribution) promotes making fine, but real, preference distinctions that would not be manifest in a survey or free distribution. Consequently, as a compromise between the forced and unstructured free choice distributions, I encouraged participants in this study to adhere to the suggested distribution as closely as possible, but I also informed them that they could deviate from the distribution if necessary to model their subjective preferences most accurately.

I read each participant a set of instructions (see APPENDIX D: INSTRUCTIONS TO PARTICIPANTS), following the advice of Webler and colleagues (Webler, et al., 2009). I also followed Webler and colleagues' practice of asking participants "if they

[106] Brown was replying to critics who argued that a forced distribution does not allow subjects to display individual differences in distributing statements. According to Brown, "none of the means differs significantly from the zero mean of the Q sort distribution which was employed, and neither did the highest and lowest variance differ, that is, there is comparability of means and homoscedasticity. Hence a model picturing a mean of zero and a common variance, while not completely homologous with reality is not that farfetched either." Brown also argued that the Q methodology is designed to elicit an operant response and that the statistical techniques employed cannot be considered independently of the overall methodology and theory. 1985.

discern a meaningful difference among the categories.” If not, I asked them to “re-examine each statement” to “assure that they all have equal salience” (p.19).

Semi-structured Interviews

Following the approach of Brown (1993),[107] to ascertain that the participants understood what I asked them to do and to provide an opportunity to reflexively self-interpret the meaning of their Q sorts, I asked the following questions after they completed their sorts:

1. Did you understand the instruction? If not, what was unclear? How could they be improved?

2. Where there any particular statements that you did not understand or that were problematic? If so, which statements? In the end, how did you resolve the problems and why did you sort those statement(s) in the way you did?

3. Looking at only those statements that most reflect how you think, is there anything about them you feel is important in explaining why you sorted them the way you did?

4. Looking at only those statements that least reflect how you think, is there anything about them that you feel is important in explaining why you sorted them the way you did?

5. Looking only at those statements in the middle of the distribution (neutral), is there anything about that them you feel is important in why you sorted them the way you did?

[107] According to Brown :106“… a completed Q sort should be followed where possible with an interview so that the Q sorter can elaborate his or her point of view. The Q sort provides focus to the interview by indicating which of various topics in the Q sample are most worth talking about: obviously those statements scored [most like or unlike how the participant thinks] should be addressed first since they are demonstrably the most salient, but those scored 0 can be revelatory by virtue of their lack of salience.”

6. Looking across all the statements, are there any perspectives or sentiments you think are not represented at all, or are over- or under-represented? Are there any statements you think should be added?

7. Have your opinions about genetically modified organisms changed over time? How? What do you think were the most important factors in changing your opinions?

8. Is there anything else you would like to add, either about the survey, the statement sorting, or about genetically modified organisms?

Using a laptop computer I typed summaries of participants' responses, as close to the participant's actual words as possible, into a response sheet. I read back to participants any substantial paraphrases of their responses to verify that that I correctly understood their intended meaning and thereby more closely approached an inter-subjective understanding. Throughout the interview, I allowed and encouraged participants to "fine-tune" their Q sorts based on any additional insights.

Upon completion of the interviews, I asked each participant to read the cards again to ensure that he or she was satisfied with their placement. I then asked participants to flip each card over, one at a time, and read me the statement number as I recorded each in a response sheet illustrating the sorting distribution (see APPENDIX E: SAMPLE Q SORT AND FOLLOW-UP QUESTIONS RESPONSE RECORDING SHEET). Once I had recorded all the statements, I took a digital photograph of the sort for quality assurance (Figure 10). At the conclusion of the session, as time allowed, I offered each participant a short explanation of Q Method and its use in the research project.

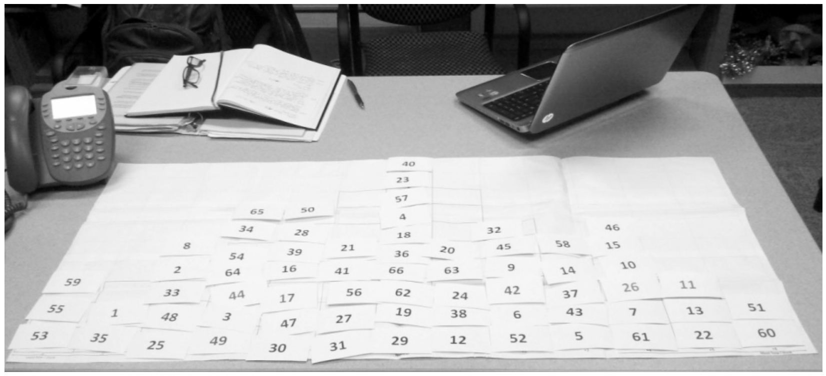

Figure 10. Photograph of completed Q sort

I entered each individual Q sort into a free, widely used statistical program specifically designed for Q Method: PQ Method version 2.33 (Schmolck, 2012). Data input into PQ Method is extremely easy, and the program automatically verifies the input. I used PQ Method to:

1. Correlate each individual Q sort against the others;
2. Conduct factor analysis using the principal component method and verimax rotation;
3. Compute factor scores for each factor.

Factor analysis is a data reduction method used in Q studies to help determine the number and nature of relatively distinct discourses (or narratives) on the particular topics that exist among the subjects studied.

> "Factor analysis examines a correlation matrix … and, in the case of Q methodology, determines how many basically different Q sorts are in evidence: Q sorts which are highly correlated with one another may be considered to have a family resemblance, those belong to one family being highly correlated with one another but uncorrelated with members of other families. Factor analysis tells us .how many families (factors) there are." (Brown, 1993:111)

The relative orientation of the factors (rotation) can be determined statistically using a variety of automated techniques; however, as any coordinate system is arbitrary, it is also possible to judgmentally “rotate” each factor to discover previously unknown associations among individuals, or to test *a priori* hypotheses. I used an automated technique, verimax rotation, in this study to maximize explained variance while minimizing the influence of investigator subjectivity.

PQ Method automatically weights the statement rankings of those sorts that statistically defined a factor (i.e., individuals who significantly loaded on one and only one factor), based on their individual statistical proximity (loading value) to each factor (Equation 1).

Equation 1. Factor weights

$W = f/(1 - f^2)$

Where W is the weight and f is the factor loading

The PQ Method software then aggregates the weighted scores to yield a composite score for each statement. It arranges the composite scores according to the original Q sort distribution to yield a representative or “ideal” Q sort for each factor.

Following the general approach of Stenner et al. (2008), with the aid of the interview results of those participants statistically associated with (i.e., loaded onto) each factor, I described and interpreted the idealized Q sorts as a discourse for each factor. In this regard, each discourse represents a cultural model of the issue, an approximation of the system of beliefs held in common by those participants who define the factor.

Demographic and Attitude Survey

To complement the Q Sort, I administered a survey that characterizes respondents' demographics, values, overall environmental beliefs and specific knowledge and opinions about modern biotechnology (APPENDIX F: SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING). Within one day of their completing the Q sort and interview, I sent participants an email that included instructions for completing the survey and returning the results.

The survey included the widely used New Environmental Paradigm (NEP) (Dunlap and Liere, 2008, originally published 1978) Likert questions (survey items 1-15) as modified by Dunlap et al. (2000) and used by Kotchen and Reiling (2000).[108] The responses to the NEP provide a basis to relate the discourses within regulatory agencies to more general underlying belief systems and worldviews, and to orient those discourses with the expansive research on the environmental attitudes. The NEP focuses on core, underlying beliefs "about the nature of the earth and humanity's relationship with it," including "humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature" (Dunlap,

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[108] The authors successfully used a multivariate survey instrument that consisted of 15 statements to evaluate the relationship between the New Environmental Paradigm and environmental attitudes, motivations, and contingent valuation of endangered species (Kotchen and Reiling 2000).

et al., 2000:427). It "measures awareness of very general adverse consequences of environmental conditions" (Stern, et al., 1999:85). In contrast to the dominant social paradigm that is grounded in economic rationality and which views "economic growth as the engine of economic and social progress," the NEP "emphasizes qualitative values that are not easily accommodated by economic cost-benefit models" (Dalton et al., 1999:200). Using the NEP, Kotchen and Reiling (2000) provided evidence that underlying environmental attitudes as measured by the NEP describe underlying motivations , especially ethical motives, that result in increased participation in and willingness to pay in contingent valuation studies.

Survey item 16 was selected from Eurobarometer 73.1 (TNS Opinion & Social, 2010b) and items 17-18 from Brossard and Nisbet (2006) to characterize the degree of respect for science and unrestricted research. To characterize underlying values, I included a number of statements (survey items 19-50) from Schwartz's norm activation theory (Schwartz, 1992, Schwartz and Bilsky, 1990, Schwartz and Boehnke, 2004), as modified by Stern et al. (1999) and used by Slimak and Deitz (2006). According to the norm activation theory, a relationship:

> "…between people's norms and their behavior can be expected only when pertinent norms are activated in the choice situation, and that activation depends upon how consequences and responsibility for social behavior are perceived…. It is only when there is both awareness of interpersonal consequences and acceptance of responsibility for them that norms governing these consequences are likely to be experienced as applicable and to influence behavior…" (Schwartz, 1968:234, 34)

The norm activation theory is consistent with Habermas' Theory of Communicative Action, that the act of achieving interpersonal understanding through speech acts draws on salient aspects of the lifeworld to influence and coordinate behavior. As human society and social organization evolved

> "At first action, motives (or behavioral expectations), and acting subjects are perceived on a single plan of reality. At the next stage action and norms separate; norms draw together with actors and their motives on a plan that lies behind, so to speak, the reality plan of actions. At the last stage, principles with which norms of action can be generated are distinguished from these norms themselves; the principles, together with actors and their motives, are placed behind even the line of norms, that is, the existing system of action." (Habermas, 1979a:132)

Stern and colleagues (Stern, et al., 1999, Stern et al., 1995a, Stern et al., 1998, 1995b) found a very strong relationship between the NEP and a subset of Schwartz's scale of personal values – altruism, self-interest, openness-to-change, and traditional (conservation) – and provided empirical evidence for a value-belief-norm system, similar to that deduced by Habermas. Value systems and general beliefs, particularly self-transcendent or biospheric-altruistic values, shape how people frame and interpret information, influence more specific attitudes and beliefs toward environmental issues, and appear to have some bearing on pro environmental behavior:

> "… norm-based actions flow from three factors: acceptance of particular personal values, beliefs that things important to those values are under threat, and beliefs that actions initiated by the individual can help alleviate the threat and restore the values." (Stern, et al., 1999:83)

Slimak and Dietz (2006) used the same subset of Schwartz's value statements and an abbreviated set of NEP scale statements to study the relationship between the values, norms, and the perception of ecological risk by four groups: (1) professional risk assessors and risk managers at the U.S. EPA; the experienced public; and the lay public. They found that the NEP and Schwartz's altruism scales positively related to perceptions of risk. Schwartz's other value scales were not significantly related to risk rankings. Interestingly, all four groups ranked low the ecological risks from genetically modified organisms (23 out of 24 issues), although slightly more concern was expressed by the lay public than the three other groups.

I included number of items from Gaskell et al. (2010) on confidence in institutions (items 51-60), and on beliefs about the impact of modern technologies (items 61-70), and a number of questions on modern biotechnology/genetic engineering, GMOs, and GM food (items 71-82). From Brossard and Nisbet (2006) I also included questions about beliefs on the costs and benefits of biotechnology in food and agriculture (items 83-87), factual knowledge about genetics and genetic engineering (items 88-93), and sources of information about GMOs (items 94-106). Items 107-121 asked for demographic information: organizational affiliation, age, education, income, profession, work experience, background, politics, religion and religiousness/spirituality, race, and gender. (many of these items were adapted from Slimak, 2003, Slimak and Dietz, 2006) The survey concluded with a few direct questions on expertise with modern biotechnology (items 122-124) and an open question for additional comments.

10. RESULTS AND DISCUSSION

Participants

The number of invitees and the number and percent of invitees who participated in the study are shown in Table 13. The estimates of the target populations within EPA, FDA, and USDA were derived from the interviews with participants from each organization. To be conservative, I used the highest estimates obtained.

Table 13. Summary of Q sort participants by organization/type

Target Organization	Estimated Population	Number of Invitees	Number of Participants	Percent Invitees	Percent Estimated Population
EPA	<40	37	12	32%	>30%
FDA	~12	12	3	25%	~25%
USDA	<40	11	4	36%	>10%
Agency Total	92	60	19	32%	21%
Students	N/A	94	10	11%	N/A
NGOs	N/A	4	2	50%	N/A
Grand Total	--	158	31	19.62%	--

It is important to note that the actual percentage of the target population that participated in the study is significant, and well within the typical range of participants in studies using Q methodology.[109] It also is important to note that in addition to other theoretical reasons, the small size of the population of experts whom I targeted in this study (fewer than 100 by all estimates) and an *a priori* anticipated low participation rate, argued against using a traditional survey approach based on a stratified random sample.

As I stated, one of the reasons I selected Q methodology for this study is that it does not depend on obtaining a representative sample from the participant population based on predetermined parameters; rather, sufficient participants to parsimoniously characterize the range of discourses within a population. As Coke and Brown explain:

> "… the frequent criticism that Q-technique studies employ too few respondents is misguided. Since interest focuses on the differences between factors… as attitude types, all that is really required are one or two respondents of each type.… Q studies are useful in determining the existence of basically different attitudes or thought processes.… Surveys, on the other hand, are useful in determining the percentages of attitudes in the general public and the demographic variables associated with each" (Coke and Brown, 1976:103).

Since Q methodology's focus is on the nature of discourses and "the extent to which they are similar or dissimilar, the issue of large numbers, so fundamental to most social research, is rendered relatively unimportant" (Brown, 1993).

An important consideration in designing this research was the anticipated difficulty of enlisting participants from the target population. First, staff and management in federal regulatory agencies are extremely busy. Second, given the ongoing controversy

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[109] Of the Q methodology studies reviewed previously in this dissertation, the median number of participants was 68. The minimum was 15 and the maximum was 247. The target population for most of these studies far exceeded that of the current study.

surrounding GMOs, I anticipated that many potential participants would be concerned that participation in external research studies such as mine could violate agency ethics rules. Finally, some potential participants could be concerned that the results of studies could be used to discredit their organizations, tarnish their profession reputations, or otherwise impugn their impartiality. To assuage such concerns, in addition to undergoing review and approval by George Mason University's Human Subject Review Board, the EPA's Human Subject Research Review Official also reviewed and approved my methodology. I also offered to meet with potential participants at "a time and place of their convenience" outside of work.

I believe that these steps were crucial, but they were only partially effective in overcoming barriers to participation. One participant met me at a restaurant, another at the participant's home. At least three potential participants, however, informed me that they were too busy to participate in an hour-long exercise, and I suspect the significant time commitment deterred others who did not respond. Additional reasons for a lower than anticipated responses rate may be the limited number of contacts (3) that the George Mason University's Human Subject Review Board approved for my research protocol. Dillman (2000) recommends contacting potential participants 4-5 times for mail surveys and cited 20-30 contacts for telephone surveys.

My initial emails to EPA staff and management also raised a "bit of a ruckus." Since I contacted them through their federal email, staff were unsure if they were ethically allowed to participate in the study, even in their private capacity. Several contacted their programs' ethics official, who in turn contacted me and requested my protocol. After what was an extremely fast review (two days), I was delighted and very appreciative that the ethics official and the senior manager of the organization gave permission for staff to participate in the study during their work hours.[110] My emails received a similar reaction in another EPA organization, in which staff also contacted their ethics official. After a three-week-long exchange of emails, this ethics official also granted permission for staff to participate, as long as I provided assurance that I would ensure the anonymity of the participants.

I had very limited success in recruiting participants at FDA. One person I contacted referred me to the FDA's Office of Public Affairs. Despite the official's initial willingness to help, after a couple of convivial telephone conversations and email exchanges, I received no additional correspondence, despite several additional inquires over a two-month period.

At the USDA, I was informed in an email by one potential participant that, "Unfortunately, our administrators have determined that these types of surveys are not in the best interest of the Agency, and we are not allowed to take part in them. So, I cannot participate in your survey." Fortunately, one of my previous participants, a senior career

[110] The EPA ethics official's email to employees read: "It is fine for people to participate if they wish; they should not feel obliged to do so, nor should they feel obliged to do it on their own time. While Mr. Greenblott says he is asking them to participate in their private capacity, it is evident that they were selected because of their positions and experience as EPA regulators, and they were all contacted through their EPA email. However, we can also see that this exercise could be in the interest of the agency and science. Thus … employees may participate in their official capacity (assuming it does not interfere with normal workload management). They should base their answers on their experience. They should provide a disclaimer indicating that responses reflect their personal opinions and do not necessarily reflect policies of the EPA or the federal government."

official within USDA, offered to assist me in recruiting additional USDA participants. I subsequently learned from one participant that the official granted a special waiver from the organization's policy to staff who wished to volunteer for my study.

I want to underscore that I am extremely grateful for the support I received from the federal agencies' management and staff who participated in this study. The federal officials whom I contacted are incredibly busy, under enormous pressure, and entrusted with great responsibility. They are very conscientious about how they use their time as public servants and most appropriately and commendably guard their reputations as impartial government regulators to ensure their actions are above reproach.

Demographics

Demographic data on the participants are included in APPENDIX I: SURVEY SUMMARY STATISTICS AND FREQUENCY TABLES. The federal regulators who participated in this study were highly educated, experienced, and graded within the federal government. Of the 19 federal regulators, 18 earned more than $100, 000 per year and all were graded at a GS-13 or higher, including 6 participants who were GS-15 and 5 members of the senior executive service;[111] 11participants were male; only 1 was not Caucasian; 2 held master's degrees, 15 held doctorates, and 2 had law degrees. Of the 18 federal regulatory who returned the survey, 14 have more than 10 years experience

[111] The federal General Schedule (GS), which indicates the rank and salary scale for federal career professional, up to level 15. The senior executive service is the highest level of career federal executive managers.

working with modern biotechnology/genetic engineering and GMOs; 9 report that they are recognized experts; and 8 are very familiar with the area.[112]

I used Pearson's chi^2 to determine if there were significant differences among participants from different organizations. The demographic data indicate anticipated significant differences among participants generally, but not between participants from regulatory agencies in their gender, ethnicity, setting where they grew up, educational level, disciplinary training, professional discipline, federal grade level, annual income, years experience in working with biotechnology, or familiarity with biotechnology-genetic engineering. There also were no significant differences based on organization found among participant's political leanings or party affiliations, religious affiliation, religiousness, or spirituality.

Q Sorts

Meetings with participants were usually held in a quiet conference room or in an office. As stated, I met with one participant at a restaurant and another at a home. After I completed reading the instructions to each participant, I shuffled the cards (to ensure the order of the cards was not an artifact of the previous participant's sort) and handed them to the participant. Participants conducted their Q sorts in a number of different ways:

- 16 participants initially read each card and placed it in 3 to 5 discrete piles, after which they sorted each card into the matrix;

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[112] One of the student pilot participants and one EPA participant did not return completed survey results, and are therefore not included in most of the survey analysis. For the survey, N=29.

- 3 participants initially read the cards and sorted them into a “cloud,” roughly approximating the location of each card in the matrix before refining their sorts; and

- 11 participants read each card and sorted it directly into the matrix.

After completing their initial sorts into the matrix, almost all participants refined their sorts before beginning the interviews. Most participants continued to fine-tune their sorts during the interview and the final reading and recording of their sorts.

All participants told me that they understood my instructions, and none provided advice on how I could improve them. When I asked if there were particular statements that they did not understand or that were problematic, 28 of the participants identified one or more statements. In answering the question, however, it was evident that many participants mostly identified statements for which they 1) wanted to share their reasons for strongly agreeing or disagreeing, 2) disagreed with the wording or technical correctness of the statement, or 3) did not know enough about the topic to either agree or disagree. Participants did identify16 statements that they felt were either ambiguous or that were circumstance-dependent, but only 2 statements were identified by more than one participant. With regard to statement 64 (Organic farmers are very concerned, because these (GM) crops are a major threat to organic farming), 3 participants felt they had to decide which part of the statement was relevant. All agreed that organic famers <u>think</u> GMOs are a threat, but disagreed that GMOs really are a threat. About statement 65 (GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up), 3 participants stated that the extent to which GMOs spread depends on the crop type.

The observation that only a couple statements were problematic for more than one participant indicates that the statement set was generally robust and that most issues raised were the result of differences in framing specific statements. These results reinforce one of the underlying premises of Q methodology, that “participants are not passive subjects but *genuinely active participants* who operate on a set of items from an explicitly self-referential and semantic point of view (what I believe or understand from *my* perspective)” [*italics* in original] (Stenner, et al., 2008:218).

Participants also generally believed that the statement set was a good representation of the range of issues: 23 participants told me that the set of statements was comprehensive. Notwithstanding, participants did offer several substantive suggestions. A couple of participants offered that I could add statements about technical aspects of genetic engineering and new applications, such as stacked genes, pharmaceuticals, enzyme processing, mandatory labeling, and RNA-induced pesticide properties. Others believed that I could expand the set to include statements about international trade, hatred of corporations, feelings that genetically engineered food is unethical, or that genetically engineered foods present some religious issues related to Jewish Kosher and Islamic Halal laws. A few other participants felt that the statements were biased in some way, such as that “organic” came up only once; more should be said about ecology; there were too many statements about the spread of GMOs; or the set favored GMOs. After further discussion and reflection on the statement set, however, participants agreed that most of these suggestions reflected sentiments already expressed in the set of statements, albeit at a different level of specificity or emphasis.

When asked, all participants stated that the Q sorts and interviews were interesting and several indicated that the process was enjoyable. None expressed any misgivings about the Q sort, the statement, or the interview questions. The median time to complete the Q sort and interview was 56 minutes; the maximum time was 100 minutes; and the minimum was 30 minutes. The time required was very dependent on the amount of social discussion in which the participant and I engaged.

I provide the individual Q sorts for each participant in APPENDIX G: INDIVIDUAL Q SORTS. As can be readily seen, while some participants remained close to the suggested quasi-normal distribution, others disregarded it. Only one participant (E11) appeared to struggle with the sort, and expressed difficulty in doing the Q sort.

Q Factor Analysis

Using PQ Method software, I conducted a factor analyses of the complete set of 31 Q sorts. Rather than using only those Q sorts from the target population of regulatory experts, I included the student Q sorts from the pilot study to increase the number of data points for the subsequent analysis of the survey data and enable direct comparisons between the Q sorts of the environmental science and policy students (many of whom aspire to work in regulatory agencies), the NGOs, and the target population of experts from the federal regulatory agencies.

As several of the students loaded significantly onto the same factors as participants from the regulatory agencies, the revealed discourse of the target population will be somewhat “distorted” by the students loadings. To assess the significance of this distortion, I ran a second factor analysis using only the regulatory agency and NGO participant Q sorts (none of the NGO participants loaded significantly on any factors with the regulatory agency participants). Then, using Stata 11 statistical software (STATA Corporation, 2009), I calculated pairwise correlations of all participant loadings and all statement values across all retained corresponding factors.

The factor analysis without the students yielded 4 factors with eigenvalues greater than 1.0 and at least 2 significant loadings. The pairwise correlations revealed high compositional (Q sort loadings) and structural (Q statement values) consistency between the corresponding factors in each set. Correlation coefficients of loadings across the 4 corresponding factors were $r = 0.98, 0.97, 0.78, 0.88$ ($p < 0.01$). The correlation coefficients for statement values across the 4 corresponding factors was $r = 0.98, 0.98, 0.70$, and 0.93 ($p<0.01$). Given that each corresponding factor differs only slightly and statistically insignificantly in both structure and composition, analysis of the full set of Q sorts is an acceptable approximation of the target population's discourses. I base the remainder of my analysis and discussion on the full set of Q sorts.

The correlations matrix of the 31 Q sorts (Table 14) indicates that the Q sorts are acceptable, based on a "rule of thumb" that many correlation coefficients are greater than 0.30 with none exceeding 0.90 (Addams, 2001:24). Of the 450 separate correlations in the matrix, 285 were positively correlated and one negatively correlated at the 0.01 confidence level, as calculated by Equation 2.

Equation 2. Standard Error (SE) and significance of correlations

$SE=1/\sqrt{N}$	
N (statements) =	66
$\sqrt{N}$ =	8.12
SE =	0.12
Significance (p = 0.01)	
SE (2.58) = ±	31.76

Table 14. Q sort correlation matrix

SORT	E01	E02	E03	E04	E05	E06	E07	E08	E09	E10	E11	E12	F01	F02	F03	A01	A02	A03	A04	N01	N02	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10
E01	100	41	54	45	32	33	35	44	48	58	65	63	52	66	37	59	43	62	49	14	15	16	21	18	41	41	35	32	47	30	41
E02	41	100	52	54	41	28	39	63	43	67	54	47	45	37	58	66	42	58	38	-27	-7	10	16	-1	48	47	36	23	36	15	62
E03	54	52	100	70	42	40	50	59	52	68	60	59	41	57	49	62	50	59	46	-7	6	23	13	26	53	58	60	24	65	25	64
E04	45	54	70	100	47	36	51	52	60	63	58	52	44	47	51	70	54	64	37	-6	-6	15	23	27	46	52	52	14	63	12	61
E05	32	41	42	47	100	35	15	23	41	37	32	59	42	9	17	34	19	48	36	17	12	38	35	41	30	49	33	27	49	43	40
E06	33	28	40	36	35	100	37	34	35	32	13	44	31	35	36	26	57	44	47	10	1	21	-3	13	20	32	13	11	31	37	29
E07	35	39	50	51	15	37	100	57	39	38	44	38	23	55	51	47	45	49	33	-10	3	-2	1	26	38	42	33	18	41	17	47
E08	44	63	59	52	23	34	57	100	44	69	56	50	43	48	65	68	54	61	51	-24	4	0	12	5	49	41	39	20	30	10	50
E09	48	43	52	60	41	35	39	44	100	49	66	42	42	45	45	53	35	53	42	5	16	19	15	12	28	40	32	14	52	18	41
E10	58	67	68	63	37	32	38	69	49	100	64	61	47	59	58	73	53	68	46	-15	9	9	25	22	61	53	52	31	43	21	47
E11	65	54	60	58	32	13	44	56	66	64	100	51	42	60	52	70	43	66	53	-4	16	17	41	20	43	47	41	31	60	14	47
E12	63	47	59	52	59	44	38	50	42	61	51	100	52	44	40	51	41	58	40	11	18	25	31	35	46	62	36	34	43	39	38
F01	52	45	41	44	42	31	23	43	42	47	42	52	100	45	43	59	44	63	46	-21	2	10	27	14	31	54	35	21	37	13	32
F02	66	37	57	47	9	35	55	48	45	59	60	44	45	100	52	59	50	60	54	-9	14	5	14	9	33	36	42	10	46	20	36
F03	37	58	49	51	17	36	51	65	45	58	52	40	43	52	100	64	57	69	36	-40	-4	-13	11	-7	47	38	26	4	33	4	33
A01	59	66	62	70	34	26	47	68	53	73	70	51	59	59	64	100	64	70	56	-24	-10	10	13	9	45	43	41	25	46	4	51
A02	43	42	50	54	19	57	45	54	35	53	43	41	44	50	57	64	100	64	50	-24	-12	-13	7	19	46	40	25	21	47	23	47
A03	62	58	59	64	48	44	49	61	53	68	66	58	63	60	69	70	64	100	63	-28	2	8	30	16	57	51	49	19	58	28	50
A04	49	38	46	37	36	47	33	51	42	46	53	40	46	54	36	56	50	63	100	-1	26	18	33	11	27	34	29	30	41	14	42
N01	14	-27	-7	-6	17	10	-10	-24	5	-15	-4	11	-21	-9	-40	-24	-24	-28	-1	100	41	27	8	34	-26	5	-4	32	11	11	-2
N02	15	-7	6	-6	12	1	3	4	16	9	16	18	2	14	-4	-10	-12	2	26	41	100	13	21	16	-17	11	9	16	13	6	-5
S01	16	10	23	15	38	21	-2	0	19	9	17	25	10	5	-13	10	-13	8	18	27	13	100	25	27	-11	22	19	15	28	12	14
S02	21	16	13	23	35	-3	1	12	15	25	41	31	27	14	11	13	7	30	33	8	21	25	100	34	22	44	15	35	29	5	10
S03	18	-1	26	27	41	13	26	5	12	22	20	35	14	9	-7	9	19	16	11	34	16	27	34	100	33	41	33	62	52	42	25
S04	41	48	53	46	30	20	38	49	28	61	43	46	31	33	47	45	46	57	27	-26	-17	-11	22	33	100	50	53	42	44	33	45
S05	41	47	58	52	49	32	42	41	40	53	47	62	54	36	38	43	40	51	34	5	11	22	44	41	50	100	41	50	53	29	55
S06	35	36	60	52	33	13	33	39	32	52	41	36	35	42	26	41	25	49	29	-4	9	19	15	33	53	41	100	35	46	23	44
S07	32	23	24	14	27	11	18	20	14	31	31	34	21	10	4	25	21	19	30	32	16	15	35	62	42	50	35	100	34	21	32
S08	47	36	65	63	49	31	41	30	52	43	60	43	37	46	33	46	47	58	41	11	13	28	29	52	44	53	46	34	100	39	64
S09	30	15	25	12	43	37	17	10	18	21	14	39	13	20	4	4	23	28	14	11	6	12	5	42	33	29	23	21	39	100	33
S10	41	62	64	61	40	29	47	50	41	47	47	38	32	36	33	51	47	50	42	-2	-5	14	10	25	45	55	44	32	64	33	100

Equation 3. Correlation coefficient

$$\mathbf{r = \Sigma\ (A\text{-}B)^2/\Sigma A^2+\Sigma B^2}$$

As I discussed, factor analysis identifies individuals who are statistically similar in the way in which they sorted the statements. Factors may be thought of as:

> "…representing different discourses or points of view. Individuals who are significantly loaded on a factor are assumed to share a common perspective with one another, while those negatively on the same factor hold opposite views" (Addams, 2001:24).

Brown (1980:42-43, 220-23) demonstrated that the number of significant factors can be determined by a variety of criteria, including selection of factors with eigenvalues greater than 1.0 (most common), with at least two sorts with significant loading,[113] or when the product of the two highest loadings on a factor either exceeds or twice exceeds the standard error (Humphrey's rule). A minimum factor loading of 0.4 also has been used to determine significance (Stern, et al., 1995b). Brown argues, however, that the selection of factors ultimately depends on the investigator's judgment:

> "For the purposes of rotation… it is best to take out more factors than it is expected ahead of time will be significant. Experience has indicated that the "magic number 7" is generally suitable. This nonstatistical criterion will no doubt sound arbitrary, which it is, and will no doubt raise the ire of practitioners who value more objective procedures. But… insignificant factors frequently contain small amounts of systematic variance that can help in improving the loadings on a major factor… After rotation, insignificant residual factors can be discarded." (Brown, 1980:223)

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[113] The significance of loadings is a function of the standard error of the correlations. Loadings are significant at the 0.05 level if greater than 1.96(SE) and at the 0.01 level at 2.58(SE).

The factor analysis resulted in 6 factors with eigenvalues great than 1.0 (Table 15), which I retained for rotation and subsequent interpretation. The relative orientation of the factors (rotation) can be determined statistically using a variety of automated techniques; however, as any coordinate system is arbitrary, it is also possible to judgmentally “rotate” each factor to discover previously unknown associations among individuals, or to test *a priori* hypotheses. In this study I used an automated technique, verimax rotation, to minimize the influence of investigator subjectivity, maintain a common systematic approach to cross-group comparisons, and maximize explained variance.

PQ Method software automatically weighted the statement rankings of those individuals who statistically defined a factor (i.e., individuals who significantly loaded on one and only one factor) based on their individual statistical proximity to each factor (Equation 1). In one instance I added a participant to a factor because his/her loading on that factor exceeded 0.50, and it therefore explained more than half of the Q sort’s variance. PQ Method then aggregated the weighted scores to yield a composite score for each statement. It arranged the composite scores according to the original Q sort distribution to yield a representative or “ideal” Q sort for each factor. Each of the 6 factors after verimax rotation has at least two participants with significant (defining) loadings greater than 0.5 (Table 16).

Table 15. Unrotated factor matrix

No.	Sorts	Factors 1	2	3	4	5	6	7	8
1	E01	0.7129	0.0803	0.2692	0.0428	-0.1245	-0.1257	0.3131	-0.0057
2	E02	0.7041	-0.2472	-0.0777	-0.148	0.2253	0.1273	-0.0694	0.3466
3	E03	0.8127	0.0044	-0.0584	0.0808	-0.0781	0.2834	0.0707	0.0575
4	E04	0.7828	-0.0605	-0.0683	0.0171	0.0535	0.3455	-0.1152	-0.1202
5	E05	0.5574	0.4384	-0.0603	0.0623	0.5121	0.0501	0.0463	0.062
6	E06	0.4965	0.0295	0.0609	0.6757	0.1883	-0.2415	-0.2021	0.0789
7	E07	0.6114	-0.1604	-0.0904	0.2232	-0.3712	0.0775	-0.233	0.0217
8	E08	0.7293	-0.3288	0.0406	-0.0499	-0.0832	-0.0424	-0.1167	0.3319
9	E09	0.6616	0.0082	0.2928	0.0926	0.0242	0.2701	0.0118	-0.084
10	E10	0.8179	-0.1205	0.0053	-0.1619	-0.0298	-0.0298	0.1577	0.223
11	E11	0.7761	-0.0161	0.2576	-0.2633	-0.1498	0.1298	0.0472	-0.1498
12	E12	0.7355	0.2323	0.0574	0.052	0.1697	-0.1852	0.1799	0.2404
13	F01	0.645	-0.0734	0.1287	-0.1187	0.3291	-0.2342	0.0818	-0.1052
14	F02	0.688	-0.184	0.2953	0.123	-0.3158	-0.0523	0.2107	-0.1914
15	F03	0.6642	-0.4944	0.0449	-0.0237	0.0006	-0.112	-0.0765	0.0188
16	A01	0.8099	-0.303	0.0981	-0.1256	0.0353	0.0843	-0.0778	0.007
17	A02	0.6827	-0.2781	-0.1319	0.2615	-0.0678	-0.2808	-0.2357	-0.186
18	A03	0.8531	-0.1773	0.0471	-0.0055	0.1286	-0.1452	0.0866	-0.1812
19	A04	0.6502	0.016	0.3802	0.069	0.0029	-0.2406	-0.2065	-0.0793
20	N01	-0.0938	0.7302	0.2714	0.2021	-0.2459	0.0808	-0.1095	0.2015
21	N02	0.0881	0.4297	0.5644	-0.0492	-0.2948	-0.1108	0.0812	0.2101
22	S01	0.1982	0.5087	0.2338	0.0468	0.372	0.3591	-0.0732	0.0163
23	S02	0.3319	0.385	0.1425	-0.551	0.1915	-0.2509	-0.1641	-0.276
24	S03	0.3501	0.6776	-0.3586	-0.0224	-0.2044	-0.0947	-0.108	-0.1684
25	S04	0.652	-0.0723	-0.5047	-0.1929	-0.1129	-0.1642	0.1798	0.0463
26	S05	0.7099	0.2725	-0.169	-0.1458	0.0945	-0.0919	-0.1481	0.0811
27	S06	0.5976	0.1299	-0.2064	-0.1679	-0.18	0.2528	0.2917	0.0375
28	S07	0.4063	0.5131	-0.2334	-0.2809	-0.2636	-0.2689	-0.2444	0.1882
29	S08	0.7166	0.3057	-0.1022	0.0949	-0.092	0.2357	-0.0369	-0.3817
30	S09	0.3504	0.374	-0.3263	0.4413	0.0648	-0.201	0.4132	-0.0426
31	S10	0.693	0.0504	-0.2566	0.1127	-0.0396	0.3111	-0.1787	0.0796
Eigenvalues		12.4496	3.1308	1.6976	1.5004	1.3028	1.2445	0.9259	0.9065
% Expl. Var.		40	10	5	5	4	4	3	3

Participants from each organization (organization type) are indicated as:

EPA: E01 - E12
FDA: F01 - F03
USDA: A01 - A04
NGOs: N01 - N02
Students: S01 - S10

Table 16. Factor matrix after verimax rotation

No	Q SORT	Factor Loadings: Box indicates a defining sort					
		1	2	3	4	5	6
1	E01	$\boxed{0.6355}$	0.1662	0.2931	0.2314	0.0576	0.2144
2	E02	$\boxed{0.6690}$	0.0847	-0.3251	0.0383	0.2096	0.2146
3	E03	$\boxed{0.7435}$	0.3036	-0.0322	0.1262	0.2962	-0.085
4	E04	$\boxed{0.7289}$	0.2237	-0.1453	0.0643	0.368	-0.0395
5	E05	0.1992	0.2877	-0.0625	0.3414	$\boxed{0.6342}$	0.3609
6	E06	0.3182	-0.0268	0.054	$\boxed{0.8237}$	0.1335	-0.0156
7	E07	$\boxed{0.6448}$	0.2504	0.0329	0.2009	-0.1072	-0.2644
8	E08	$\boxed{0.7736}$	0.074	-0.1153	0.1106	-0.0851	0.1267
9	E09	$\boxed{0.6612}$	-0.0005	0.1754	0.0984	0.3575	0.0153
10	E10	$\boxed{0.7574}$	0.2486	-0.0722	0.0747	0.0526	0.25
11	E11	$\boxed{0.7875}$	0.1858	0.192	-0.1319	0.1433	0.2196
12	E12	$\boxed{0.4838}$	0.295	0.0904	0.3764	0.2404	0.3677
13	F01	0.5086	0.0246	-0.1027	0.2415	0.1332	$\boxed{0.5190}$
14	F02	$\boxed{0.7696}$	0.0335	0.2672	0.1799	-0.1217	-0.0058
15	F03	$\boxed{0.7541}$	-0.075	-0.2266	0.1507	-0.1678	0.1557
16	A01	$\boxed{0.8462}$	0.0439	-0.1367	0.0374	0.0896	0.1882
17	A02	$\boxed{0.6210}$	0.1492	-0.1644	0.4829	-0.2029	0.0583
18	A03	$\boxed{0.7606}$	0.1263	-0.1199	0.2917	0.0694	0.3168
19	A04	$\boxed{0.5837}$	-0.001	0.2931	0.3051	0.0299	0.3311
20	N01	-0.2582	0.2617	$\boxed{0.6977}$	0.0906	0.2783	-0.1261
21	N02	0.063	0.0477	$\boxed{0.7603}$	-0.04	0.0334	0.1595
22	S01	0.0048	0.0497	0.2244	0.0401	$\boxed{0.7433}$	0.1235
23	S02	0.1064	0.3065	0.1683	-0.1644	0.1565	$\boxed{0.7048}$
24	S03	-0.0138	$\boxed{0.8168}$	0.1902	0.1656	0.1637	0.0619
25	S04	0.4869	$\boxed{0.5830}$	-0.3583	0.0986	-0.1479	0.1584
26	S05	0.4395	$\boxed{0.5067}$	-0.0423	0.1732	0.2275	0.3346
27	S06	$\boxed{0.5054}$	0.4806	-0.0446	-0.1126	0.1959	-0.0414
28	S07	0.1175	$\boxed{0.7468}$	0.2087	0.0142	-0.0563	0.2916
29	S08	$\boxed{0.5279}$	0.4785	0.1055	0.1659	0.3752	-0.057
30	S09	0.0206	0.4479	-0.0108	$\boxed{0.6176}$	0.1561	-0.0384
31	S10	$\boxed{0.5782}$	0.3912	-0.1637	0.1385	0.3154	-0.1638
% Explained Variance		32	11	6	7	7	6

All 31 participants load onto one of the 6 retained factors, which collectively explain 69 percent of the variance among Q sorts. The 6 factors have high reliability coefficients (Table 17), and correlations between factors are insignificant at p<0.01 (Table 18). Table 19 shows the composite factor scores for each statement (after rotation and weighting).

Table 17. Factor characteristics

	Factors					
	1	**2**	**3**	**4**	**5**	**6**
No. of Defining Variables	19	4	2	2	2	2
Cumulative Explained Variance	32	43	49	56	63	69
Average Reliability Coefficient	0.8	0.8	0.8	0.8	0.8	0.8
Composite Reliability	0.987	0.941	0.889	0.889	0.889	0.889
S.E. of Factor Z-Scores	0.114	0.243	0.333	0.333	0.333	0.333

Table 18. Correlations between factor scores

Factor	2	3	4	5	6
1	0.4266	-0.0493	0.4419	0.296	0.4477
2		0.2181	0.2975	0.3616	0.4579
3			0.0757	0.245	0.1096
4				0.3565	0.1188
5					0.3903

Table 19. Factor Q-sort values

No.	Statement	Factor Array 1	2	3	4	5	6
1	Allergies are only minor inconveniences.	-5	-6	-6	-5	-2	2
2	GM foods could pose some potentially serious allergenic and toxic reactions among consumers.	0	0	3	1	0	3
3	Modern biotechnology can be used to reduce the allergenic risks associated with our current food supply.	2	0	-3	4	0	-1
4	The allergenic potential of newly introduced microbial proteins is uncertain, unpredictable, and untestable.	-3	2	2	-1	1	-3
5	The safety assessment of a recombinant DNA-modified organism should be based on the nature of the organism and the environment into which it will be introduced, not on the method by which it was modified.	5	0	2	1	3	2
6	Transgenic pest-protected plants should not only be compared to the use of chemicals, but also to alternative methods such as biological control.	1	2	1	0	1	6
7	Biotechnology can help farmers increase crop yields and feed even more people.	4	4	-3	3	-1	-1
8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	-1	6	-4	-6	6	5
9	Environmental biotechnology products make it possible to more efficiently clean up hazardous waste without the use of caustic chemicals.	2	1	-1	1	-1	3
10	Researchers are creating ways to boost the nutritional value of foods using biotechnology.	5	3	-1	4	5	1
11	Biotechnology can help farmers reduce their reliance on insecticides and herbicides.	5	2	-6	1	3	2
12	Agricultural biotechnology products, like modified pulp trees for use in paper production, will allow manufacturers to use less water and other natural resources, and to produce less waste from the production stream, while producing higher-quality materials.	1	3	0	1	2	1
13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	1	-4	-2	-6	-4	-4
14	We can be pleased with ourselves that, in the U.S., we've really been the leaders in developing the new technology and implementing it safely in this country.	1	0	-3	1	-2	0
15	Gene technology can expand our options to improve our health, create a safer, more secure food supply, generate prosperity and attain a more sustainable agriculture.	4	4	-1	1	2	-3
16	The American consumer probably cares more for cheap food … than about the ecology.	1	3	2	2	4	2
17	Consumers have a perfect right to chose and eat transgenic foods if they so wish.	3	1	4	0	3	2
18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical and emotional reasons.	6	0	5	5	5	3
19	Biotechnology has developed in a way that has forced government agencies to choose between democratic principles and the technological vision of an elite group of scientists and entrepreneurs.	-4	-3	-1	-2	-3	-5
20	All of our major universities are tied into all sorts of contractual relationships and consulting relationships with the life science companies.	0	-3	4	0	-2	-1
21	The problem is, the benefits are always here and now. The costs always come later.	-2	3	1	0	1	4
22	Developing countries should have access to any technologies that we have here.	2	-1	3	2	1	-1
23	Nearly everything that the human race will be eating will soon be produced from genetically engineered plants and animals.	-2	2	-2	-5	-6	4
24	Biotechnology has tremendous potential to help fight hunger.	3	5	-4	-1	0	1
25	There is no need for genetically engineered organisms for feeding the world or solving nutritional deficiency problems.	-4	-6	2	-1	-3	3
26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	2	6	5	5	6	4
27	Eventually, it could be possible to reduce gene flow from cultivated plants with various containment methods.	2	-3	0	0	0	-4
28	Concerns about genetically modified crops arise mainly when novel, beneficial traits have the potential to spread to wild populations and cause them to become more invasive and difficult to control.	0	3	1	-3	1	1
29	Existing laws are for the most part adequate for oversight of biotechnology products.	3	-3	-3	-4	-2	-1
30	Genetically engineered foods are thoroughly tested before they are allowed onto the market.	1	-2	-5	2	0	0
31	We can expect that in the future genetically engineered food will be developed and grown in many countries, many of them with no premarket safety reviews.	-1	1	1	1	-1	4
32	There's not really much monitoring of this technology once it's released into the environment or into the food supply.	0	0	4	4	0	-1
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	-5	-1	5	-3	2	-2

No.	Statement	Factor Array 1	2	3	4	5	6
34	The scientific education of genetic engineers and regulators has been inadequate even to understand the technical challenges of biosafety, let alone to take appropriate precautions and conduct science-based testing.	-4	-4	-2	0	2	-3
35	Genetically engineered foods are not being regulated and could enter the food supply without oversight.	-3	-1	0	0	4	-2
36	Because [GMOs} may present risks, they should be carefully regulated.	0	0	5	-1	4	1
37	It has proved impossible to develop government regulatory programs that are truly science-based and not compromised by political pressures.	-2	5	0	-2	-1	1
38	Ultimately, the credibility of the regulatory process depends on the public's ability to understand the process and the key scientific principles on which it is based.	3	1	1	0	0	0
39	Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	-2	-3	-2	4	-3	-4
40	The U.S.'s food safety regulatory system is head and shoulders above anybody else's in the world.	0	-1	-4	3	0	0
41	Some people in the agencies fear that they would be punished or even fired if they raised problems for biotech.	-3	-1	3	-4	1	-1
42	The threat of law suits will cause the biotech industry to try their best to market safe food.	-1	-4	-3	-2	-2	-4
43	Biotechnology is a high-pressure, competitive enterprise. There are always pressures to cut costs and move quickly to commercialization.	0	4	2	3	-1	0
44	Life science companies are turning seeds into intellectual property, so they have a virtual lock on the seeds upon which we all depend for our food and survival.	-1	-1	0	-3	-5	-1
45	Genes are a discovery, they should not be patented	-1	1	1	-1	-1	-5
46	It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	-1	-2	0	5	-1	-5
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	1	2	5	-1	5	5
48	To put a label on biotech foods, a mandatory label, would be an indication that something is wrong.	-2	-5	-1	-5	-5	-1
49	The industry is not forced to prove relative safety. Rather, the burden of proof is on people like us to show that there's some risk	-3	-1	0	-2	-6	-6
50	It could be difficult or impossible to isolate a problem and prove its GMO related cause in a court against highly paid defense attorneys.	-3	-1	3	-4	-3	0
51	Virtually all of our foods have been genetically modified.	0	4	0	5	-5	0
52	Genetically engineered organisms are not fundamentally different from nonmodified organisms.	2	-2	-4	-2	-4	1
53	It is not for a human being to modify the basic laws of nature.	-5	-2	-5	2	1	-6
54	It is not right to exploit a technology which may give rise to unexpected substances that may be damaging to health, before this risk has been carefully investigated.	-1	1	-2	4	1	-2
55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-6	-5	1	-3	-4	-3
56	If you made people aware and knowledgeable about genetic foods, they would tend to be more supportive.	1	0	-1	-3	-4	-3
57	Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	0	-2	-6	0	-1	2
58	These genetically engineered foods have never been subject to long-term testing, and yet there are millions of acres of them growing in the United States and pervading the food system here.	-4	0	1	-1	0	-3
59	We are being put in jeopardy. We are guinea pigs in this experiment.	-6	-5	-1	-4	2	-3
60	Conventional agricultural activity entails certain environmental and ecological risks.	6	1	0	3	4	5
61	We have looked very carefully at the use of recombinant DNA techniques, and we do not have any information that the simple use of the techniques creates a class of foods that is different in safety or quality from foods developed by other methods of plant breeding.	4	-4	-2	-1	-2	0
62	You can't prove that any new technology that we have in the world today is absolutely safe.	4	2	0	3	3	6
63	Risks - calculable risks - must be taken, otherwise technological progress becomes impossible.	3	-2	-2	2	2	2
64	Organic farmers are very concerned, because these (GM) crops are a major threat to organic farming.	0	0	2	-3	0	0
65	GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	-1	5	3	0	-3	1
66	Genetically modified products are alive. So at the get-go, they're inherently more unpredictable in terms of what they'll do once they're out into the environment.	-2	1	4	1	3	-2

Factor and Interview Interpretation

Unlike most other social research methodologies, which focus on an obtaining an objective, third person perspective, Q methodology "is concerned with the self-reference of the first-person perspective"(Stenner, et al., 2008:232). As Stenner et al. (2008:227) commented,

> "…in contrast to many other qualitative methods, [the subjective input of the participant group] is actually reflected in the objective structure of the relevant factor array. In a nutshell, the task is to reconstruct the subjective point of view expressed in the factor array and hence to 'breathe subjective life back into the purely numerical representation."

Factor interpretation is the process by which I extract and interpret the viewpoints expressed by each participant represented in each factor. To develop a narrative, or discourse, for each factor, I describe and interpret the idealized Q sorts with the aid of the interview results of those participants statistically associated with (i.e., loaded onto) the factor. In this regard, each discourse represents a cultural model of the issue, the system of beliefs held in common by those participants that define the factor.

As the relative salience of each statement in a factor is characterized by its weighted factor value, I pay particular attention to those statements with the extreme rankings (+/- 6, 5 and 4) and those that statistically distinguish each factor from the others. I present my interpretations as running commentaries representing holistic interpretations of each factor, interspersing the defining statements (columns are statement number, statement, and factor score) and paraphrased interview responses[114] interspersed. I provide a title for each factor as a convenience, again based on my interpretation of the main theme expressed in the factor. Like the interpretations themselves, the titles are subjective.

For each factor I also provide a table (Table 20 through Table 25), identifying the attributes of the most salient statements (those with factor scores greater than +3 and less than -3) according to the typology I used to originally code each statement (see Table 12, page 211). This includes each statement's implicit propositional validity claim (purposive-rational, normative, or esthetic-expressive) based on Habermas' Theory of Communicative Action, the position expressed by each statement (either pro- or anti-GMOs), and the statement's argumentative frame (economic prospect, ethical, globalization, Pandora's Box, progress, public accountability, and runaway) based on the media content analysis of Bauer et al. (2001) (see footnote 27, page 53).

Factor 1: Positivism

Factor 1 represents the dominant discourse among the participants and is defined by all of 4 the participants from USDA, 10 of the 12 EPA participants, 2 of the 3 FDA participants, and 3 of the 10 students from the pilot study. It explains the greatest amount of variance (39 percent). Statements reflecting a purposive-rational validity claim, a

[114] I indicate paraphrased interview responses with italics and single quotation marks, followed by identification number of each participant in parenthesis.

progress argumentative frame, and which are pro-GMO are the most positively salient. The most rejected statements are statements that express a normative validity claim and opposition to GMOs from a variety of argumentative frames (Table 20).

Table 20. Factor 1 - Statement typology salience

Factor Scores	Greater than +3	Less than -3
Preposition		
• Purposive-rational	7	1
• Normative	2	8
• Esthetic-Expressive		
Position		
• Pro-GMO	9	1
• Anti-GMO		8
Argumentative Frame		
• Economic prospect		
• Ethical		1
• Globalization		1
• Pandora's Box	1	
• Progress	8	2
• Public accountability		3
• Runaway		2

Factor 1 represents a strong positivist scientific perspective. The most salient statements reflect strong support for a scientific "factual" approach to assessing the risks from GMOs, recognition that public does not base its decisions on science alone, and frustration that the public debate is not based on science.

18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical, and emotional reasons.	+6
5	The safety assessment of a recombinant DNA-modified organism should be based on the nature of the organism and the environment into which it will be introduced, not on the method by which it was modified.	+5

'What we have over here are facts. It's not possible to prove anything is safe; I disagree with the precautionary principle. These statements are not debatable. Statements with

which I disagree are less strong in terms of facts, but others are just not true. Some are opinions, or they get into policy things more than fact' (A02).

'We don't have a reasoned debate about GMOs. That you can't prove any technology is safe, is a fundamental strategy in what groups opposing biotechnology bring up over and over again' (A03).

'Statements with which I agree are all things that I feel are pretty well-established from a scientific point of view; that I feel pretty strongly about. Some of the statements with which I don't agree are patently, unequivocally false. Nearly all are things I think don't hold water based on my training and experience: they are kind of offensive' (F02).

'The statements with which I disagree, they're factually wrong' (E01).

'*People have a right to know and education helps, but people have cultural and other reasons for eating food*' (E03).

'Statements with which I agree tend to be more fact based. The issues are also subjective, but there's a little more acknowledgement that there's a regulatory system in place and what's being brought to bear reflects the best available science. The statements I reject reflect a lot of belief-based assumption, and outright fallacies' (E07).

Most of the statements with which I disagree are political statements aimed at tarring biotechnology, creating fears about biotechnology and the modern industrial way of the world. Some are moral judgments. Some are just lies (e.g., people in agencies will be fired if they raise problems about biotech -- I know people say that, but it's just not true). Many of these statements are just factually incorrect' (F03).

'The statements have a factual basis to them: boost nutritional value of foods (golden rice), the U.S. food regulatory system is the best, GM pollen spreads. Lots of these statements with which I disagree are very subjective. They are just opinions' (E08).

'They are objective statements. They're not judgmental' (E11).

'I support the statements that are factual; things that I have personal experience with and that I can attest to being factual statements, and a few things that are my observations of what I believe to be the beliefs of others. If I can demonstrably show the statements are not true, or observe opinions of others and they are different than what's written, they are negative. Several of the statements with which I disagree are statements of beliefs of others with whom I have had interactions. A lot are the kinds of things you'd find in the popular press, stating opinion as fact, opinion statements that cannot be documented as the truth' (E12).

The notion that genetic engineering is unethical or a violation of the "laws of nature" is strongly rejected.

53	It is not for a human being to modify the basic laws of nature.	-5

> *'Many of the statements with which I disagree reflect science bashing'* (A04).
>
> *'I know for a fact that the statements with which I disagree are wrong. For example, the statement that says it's not for a human being to modify the basic laws of nature - we do it all the time. If we didn't mess with corn, we wouldn't have corn, we'd have maize. Was it wrong? That's how improvements are made, how modern medicine has evolved. Is that a basic law or a natural thing? Humans always have exploited breeding to improve food'* (E03).
>
> *'I'm a scientist. It's part of my nature to explore and explain things. The statements with which I disagree most are those that seem to put a limit on my ability to explore'* (E09).

GMOs have been studied thoroughly by government agencies and the risks, including risks for causing allergies, are taken seriously. The science is clear that GMOs are not different from conventional agriculture in terms of safety to people or the environment. Although there are always some risks associated with all technologies, the health and environmental risks from GMOs are minimal when compared to their enormous potential benefits.

60	Conventional agricultural activity entails certain environmental and ecological risks.	+6
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	-5
1	Allergies are only minor inconveniences.	-5
7	Biotechnology can help farmers increase crop yields and feed even more people.	+4
61	We have looked very carefully at the use of recombinant DNA techniques, and we do not have any information that the simple use of the techniques creates a class of foods that is different in safety or quality from foods developed by other methods of plant breeding.	+4
13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	+1

> *I disagree that GMOs are not properly assessed, or that they pose potential risk'* (E08).
>
> *'Regulatory agencies and supporting agencies have done a lot of work on benefits and risks associated with the technology and the science has helped to inform how genetically engineered plants have been used. Agencies have been very public with how they did the assessments and reached their conclusions'* (E10).

> *'There's an acknowledgement that there's still a lot of uncertainty, but also that there's potential benefits to the technology'* (E07).
>
> *'The statements with which I agree reflect the potential benefits of genetic modification/biotechnology, and that consumers are already enjoying them without necessarily being aware. There is risk, and always will be a risk, and that should be evaluated and can't be avoided'* (E04).
>
> *'There are inherent risks associated with the introduction of any new technology (electricity, internal combustion engine, genetic engineering). There are also potential benefits'* (E10).
>
> *'The most important statements tended to all be on a similar topic: all get into whether there's a difference between genetically engineered and other foods that would relate to safety or environmental hazards'* (F02).
>
> *These statements with which I disagree capture a lot of the sentiment that we are being put in jeopardy, that we are guinea pigs. They reflect overstated fear. People can't understand what a minute risk there is. They just can't mentally grasp what the risk is, and consequently we have a disproportionate amount of regulation for what really isn't much risk. The people who are afraid are saying, well, there's a black swan that's going to arise from GMOs. The author of that book would say the danger is only when you're completely unfocused on something that the black swan could arise. With regard to GMOs, we're very focused'* (A03).
>
> *'We're not being put in jeopardy, we're not guinea pigs. We have the ability and obligation to help feed people who cannot feed themselves and we should use technology to help. It's only one technology though, and won't abolish conventional breeding techniques'* (E10).
>
> *'GMOs are pretty safe; they're the way of the future. There's always a risk (like with conventional pesticides)'* (E03).
>
> *'Lots of these statements assert the hopes for the technology in the future, which can happen. I think you could use genetic engineering to do lots of things'* (A04).
>
> *Allergies are not just inconveniences: if you have a relative with food allergies, you don't think that'* (E08).
>
> *'From a medical standpoint, people die from allergies, so they are not a minor inconvenience'* (S10).

Assertions that the government's oversight is inadequate, insufficiently protective, or that regulatory agencies lack qualified experts are unfounded: the current regulatory system is adequate to protect the food supply and the environment. Despite the low risks, however, government oversight is needed and protecting the public health and the environment should not be left to biotechnology companies or the courts. Given the scientific “facts,” the low risk and large potential benefits to farmers and society, however, the science and the debate are pretty well settled. A moratorium on GMOs is definitely not necessary or appropriate.

29	Existing laws are for the most part adequate for oversight of biotechnology products.	+3
55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-6
34	The scientific education of genetic engineers and regulators has been inadequate even to understand the technical challenges of biosafety, let alone to take appropriate precautions and conduct science-based testing.	-4
35	Genetically engineered foods are not being regulated and could enter the food supply without oversight.	-3
42	The threat of law suits will cause the biotech industry to try their best to market safe food.	-1

> *‘The technology is not inherently unsafe, and government has rigorous oversight for safety. GMOs get more scrutiny than conventional crops. People in this work in government are good people, good scientists: they have families too. The science and oversight and the people that do them give me confidence. I don’t agree with those who are saying the crops are not safe, that they're not adequately evaluated, that there's inadequate oversight, that the public are being put at risk’* (A01).
>
> *‘I don’t agree with statements that reflect attitudes of distrust, e.g., that we shouldn't be playing around with nature’* (E02).
>
> *‘I disagree that there's a lack of adequate assessment and testing. I agree that industry has influenced regulatory programs and agencies, but not to a point that it compromises the science’* (E04).
>
> *‘I don’t agree with statements that infer regulatory agencies should cater to political pressure and marketing schemes. There are life threatening allergies. Some statements with which I disagree are about a lot of policy stuff that reflects rash decisions, when people really don’t think about something’* (S06).

Factor 2: Cautious Optimism

Factor 2 accounts for 11 percent of the explained variance and includes significant loading for only 3 students. Though purposive-rational validity claims are most abundant among statements with the highest positive salience, they are equally split between statements that represent pro- and anti-GMO positions, and there is no clearly dominant argumentative frame (Table 21).

Table 21. Factor 2 - Statement typology salience

Factor Scores	**Greater than +3**	**Less than -3**
Preposition		
• Purposive-rational	7	4
• Normative	1	5
• Esthetic-Expressive	1	
Position		
• Pro-GMO	5	5
• Anti-GMO	4	4
Argumentative Frame		
• Economic prospect	1	2
• Ethical		
• Globalization		1
• Pandora's Box	2	
• Progress	4	3
• Public accountability	1	2
• Runaway	1	1

The students who loaded onto Factor 2 believe that GMOs are inevitable and the technology has great potential benefits, with some reservations. GMOs are already widespread within the food supply and we haven't seen anything bad happen yet. Because of their potential benefits, including fighting hunger and improving nutrition, and the lack of evidence of unacceptable risks, there should not be a moratorium on GMOs.

8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	+6
25	There is no need for genetically engineered organisms for feeding the world or solving nutritional deficiency problems.	-6
24	Biotechnology has tremendous potential to help fight hunger.	+5
55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-5

> *'Virtually all foods have been modified, either through selective breeding or genetic modification; points that get lost in GMO debate. Conventional agriculture contains some risk, and this is also lost in the debate. GMOs are already part of our society and food culture; the concerns have been overblown. GMOs in some cases may make the best balance between health and ecosystems. We've been modifying organisms since we figured out what they were'* (S05).

> *It's general knowledge that most of what we eat is corn-based, and therefore genetically modified. Many of the statements with which I disagree reflect scare tactics that I don't think are accurate, such as that there's no regulation of anything, and I'm pretty sure there is'* (S07).

> *'I do a lot of work in third world countries. I agree that GMOs are important, but also agree that they need to be regulated better. I understand all the enormous costs, but also the benefits'* (S03).

> *'I think we need GMOs to fight hunger. There's not enough organic food to feed us all. One can't prove anything in science, so we can't prove safety about a technology, and therefore it's not a legitimate argument against GMOs. I disagree that we are being put in jeopardy; it's just sensationalism'* (S04).

The main concern about GMOs is their potential risks to the environmental and contamination of non-GMO crops, but that we're not at any significant risk.

26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	+6
65	GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	+5
59	We are being put in jeopardy. We are guinea pigs in this experiment.	-5

Although we haven't yet seen major problems with GMOs, the potential for political influence on our regulatory system undermines public confidence that genetically engineered foods are tested thoroughly before entering the market. Therefore, GMOs should be labeled to provide consumers the information they need to make their own choices about what foods they purchase.

1	Allergies are only minor inconveniences.	-6
37	It has proved impossible to develop government regulatory programs that are truly science-based and not compromised by political pressures.	+5
48	To put a label on biotech foods, a mandatory label, would be an indication that something is wrong.	-5
30	Genetically engineered foods are thoroughly tested before they are allowed onto the market.	-2

Factor 3: Unfulfilled Promises

Factor 3 accounts for only 6 percent of the variance, but included significant loading for both of the NGO-consumer advocate participants. In Factor 3, there is a relative balance in the salience of all three validity claims, but statements opposing GMOs are clearly more positively salient and those supportive of GMOs more negatively salient (Table 22). The progress argumentative frame also appears to have negative salience in Factor 3.

Table 22. Factor 3 - Statement typology salience

Factor Scores	Greater than +3	Less than -3
Preposition		
• Purposive-rational	4	4
• Normative	5	4
• Esthetic-Expressive		1
Position		
• Pro-GMO	1	8
• Anti-GMO	8	1
Argumentative Frame		
• Economic prospect	1	
• Ethical	2	1
• Globalization		
• Pandora's Box	2	
• Progress	2	5
• Public accountability	2	2
• Runaway		1

Factor 3 emphasizes that while there is nothing philosophically wrong with genetic engineering, the potential benefits of GMOs have been greatly overstated and unfulfilled, and there is concern over potential risks to health and the environment.

11	Biotechnology can help farmers reduce their reliance on insecticides and herbicides.	-6
1	Allergies are only minor inconveniences.	-6
26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	+5
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	+5
53	It is not for a human being to modify the basic laws of nature.	-5

'Some of the statements with which I don't agree are overstatements of risk, some are overstatements of potential benefits. I don't go for hyperbole. I don't agree on a moratorium. Philosophically, I don't agree that it's not for humans to modify "basic laws of nature." I don't object to new technologies' (N02).

'The statements with which I most agree are strong statements that reflect my core thinking, generally that genetically engineered foods may present risk and if they do, they should be studied very intensely' (N01).

'Transgenic crops do pose ecological risks, although the crops we have right now do not pose health risks. The power of biotechnology to put a particular gene in a particular crop has led to overuse of Roundup and development of resistant weeds. We need to make more of an effort to evaluate risks' (N02).

While there is a need for careful regulation, the current system is inadequate to ensure GMOs are safe before they enter the market. The influence of biotechnology companies on universities calls their objectivity into question.

36	Because [GMOs} may present risks, they should be carefully regulated.	+5
30	Genetically engineered foods are thoroughly tested before they are allowed onto the market.	-5
20	All of our major universities are tied into all sorts of contractual relationships and consulting relationships with the life science companies.	+4

'The regulatory framework isn't built to handle the new risks, and people have a right to know if their food contains genetically engineered ingredients. GMOs are fundamentally different than their conventional counterparts' (N01).

'The regulatory system is inadequate. Technology has managed to tie itself into universities and regulatory agencies and give industry too much power' (N02).

NGOs are trying to ensure that there are necessary safeguards to protect public and the environment. Because trust in our institutions has been called into question, consumers should be given the information they need to make informed choices about their food.

57	Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	-6
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	+5
18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical, and emotional reasons.	+5

> *'NGOs are not out to scare people, rather to inform. The fact that NGOs are so transparent might intimidate business. I don't believe that risks are necessary to advance technology. Way more thought needs to be taken'* (N01).
>
> *'Consumers should be able to make choices for themselves'* (N02).

Factor 4: Factual

Factor 4 accounts for 7 percent of the explained variance and is defined by sorts from an EPA and a student participant. Statements reflecting purposive-rational validity claims are more positively salient than normative statements, which are most negatively salient. Neither pro- or anti-GMO statements appear to be more salient than the other, but progress argumentative statements appear to have the greatest positive salience, while runaway statements the greatest negative salience (Table 23).

Table 23. Factor 4 - Statement typology salience

Factor Scores	Greater than +3	Less than -3
Preposition		
• Purposive-rational	6	3
• Normative	3	5
• Esthetic-Expressive		1
Position		
• Pro-GMO	6	6
• Anti-GMO	3	3
Argumentative Frame		
• Economic prospect	2	1
• Ethical	1	
• Globalization	0	
• Pandora's Box	1	
• Progress	4	2
• Public accountability	1	2
• Runaway	0	4

Factor 4 focuses on technically factual aspects of the GMO discussion, with a strong emphasis on free enterprise. First, as a factual matter, genetically engineered vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers currently are not commercially available. Also, consumers do decide on their foods for a variety of reasons. Most of our foods are the result of genetic engineering because genetically engineered enzymes and corn products are used in many processed foods. And no one can seriously agree with a statement that food allergies are only of minor concern.

8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	-6
18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical, and emotional reasons.	+5
51	Virtually all of our foods have been genetically modified.	+5
1	Allergies are only minor inconveniences.	-5

'These statements are true, or should be true' (E06).

It is also factually correct to say that pollen can spread to neighboring fields, and theoretically in the future, biopesticide products could potentially harm non-target, beneficial organisms, and that that we could use biotechnology to develop ways to prevent food allergies.

13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	-6
26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	+5
3	Modern biotechnology can be used to reduce the allergenic risks associated with our current food supply.	+4

And don't believe we can ever fully contain GMOs' (S09)'

It also is correct to assert that we should not "exploit" technologies that could surprise us with unexpected risks, and we're not. We have thoroughly studied GMOs for some time, we understand the technology; and we have the best regulatory system in the world. We simply are not seeing the kind of risks people seem to be worried about, although they are "theoretically possible" in the future. So while unexpected risks are theoretically possible, practically, new risks won't surprise us and the public is safe.

54	It is not right to exploit a technology which may give rise to unexpected substances that may be damaging to health, before this risk has been carefully investigated.	+4
40	The U.S.'s food safety regulatory system is head and shoulders above anybody else's in the world.	+3
41	Some people in the agencies fear that they would be punished or even fired if they raised problems for biotech.	-4
50	It could be difficult or impossible to isolate a problem and prove its GMO related cause in a court against highly paid defense attorneys.	-4
59	We are being put in jeopardy. We are guinea pigs in this experiment.	-4
29	Existing laws are for the most part adequate for oversight of biotechnology products.	-4

The latest genetic engineering techniques will make it increasingly technically difficult and expensive to distinguish genetically modified foods. Therefore, unless there is a health-based reason to label genetically modified foods, regulatory agencies should not increase the burden unnecessarily on biotechnology companies. Unless there is evidence that GMOs increase their risks, consumers don't have an absolute right to know whether something is genetically modified. Consequently, the market should decide whether labeling is necessary, not the government.

48	To put a label on biotech foods, a mandatory label would be an indication that something is wrong.	-5
46	It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	+5
39	Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	+4
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	-1

> *'I don't believe you have a right to know what's in your food, only if a company believes it is in its interest'* (S09).

There always is a market for organic food and some countries and cultures will probably never accept GMOs, so genetic engineering will never completely replace conventional agriculture. The fact is, however, that some of the opposition to GMOs is not actually because of potential health or environmental risks; rather, because of competition and profit. Some NGOs are helpful in fine-tuning the regulatory process, others seem intent on causing distractions.

23	Nearly everything that the human race will be eating will soon be produced from genetically engineered plants and animals.	-5
28	Concerns about genetically modified crops arise mainly when novel, beneficial traits have the potential to spread to wild populations and cause them to become more invasive and difficult to control.	-3
57	Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	0

> *'There is a hesitancy by NGOs and organic farmers to accept GMOs. There's no correlation between those two groups. Organic farming is a market strategy that targets people who agree with the rule at Agricultural Marketing Service (organic foods cannot contain GMOs). NGOs mostly are invested heavily in law or science or both; they seek to fine-tune the regulatory process and tend to be professionally staffed. Most produce*

legitimate, heavily referenced papers, but some produce science-like papers (they cite fake news reports, etc.). Some countries take these publications seriously and even banned U.S. food aid during a famine. Not all NGOs are like that, but almost all European NGOs and university stuff is basically skewed, or downright false. Sometimes there are real problems (like the finding that Bt is toxic to monarch butterflies), but mostly these false reports just generate costly and unproductive work. They create fake fire drills to which regulators must respond, and ultimately may cause people not to pay attention to real issues' (E06).

Factor 5: Critical

Factor 5 also accounts for 7 percent of the explained variance and includes the sorts of an EPA and a student participant. None of the prepositional statement categories appear to be more dominant than the others, nor is there a clear distinction between the salience of statements reflecting either pro- and anti-GMO positions or argumentative frames (Table 24).

Table 24. Factor 5 - Statement typology salience

Factor Scores	**Greater than +3**	**Less than -3**
Preposition		
• Purposive-rational	4	6
• Normative	4	3
• Esthetic-Expressive	1	
Position		
• Pro-GMO	4	6
• Anti-GMO	5	3
Argumentative Frame		
• Economic prospect		1
• Ethical	2	1
• Globalization		
• Pandora's Box	2	
• Progress	2	4
• Public accountability	2	2
• Runaway	1	1

Factor 5 argues that there are risks from GMOs and that the regulatory system should be improved. While even conventional agriculture has some risks, GMOs are seen as intrinsically different and potentially can create environmental risks that would be difficult to address.

26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	+6
60	Conventional agricultural activity entails certain environmental and ecological risks.	+4
52	Genetically engineered organisms are not fundamentally different from nonmodified organisms.	-4
65	GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	-3

> *'Even though I believe generally in the advancement of technology, by being human, I'm willing to say we should not play around with mother nature -- the consequences could be far worse than the intent'* (E05).

Because of the potential risks from GMOs, to ensure adequate protection of the public and the environment we need a better regulatory system that assesses GMO risks more completely than what currently is in place.

36	Because [GMOs} may present risks, they should be carefully regulated.	+4
35	Genetically engineered foods are not being regulated and could enter the food supply without oversight.	+4
13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	-4
59	We are being put in jeopardy. We are guinea pigs in this experiment.	+2
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	+2
1	Allergies are only minor inconveniences.	-2

> *'We don't know enough about the technology now. We have a good food safety system, but it's a moving target because there's a lot of uncertainty and /unpredictability'* (E05).

The burden of proof to demonstrate the safety of GMOs should be on the biotechnology industry, not on the public. There already are many GMOs in the marketplace, and new GMOs are being developed that will have nutritional benefits. Although people make the decision on what foods to buy based on a variety of reasons, especially price, they have a right to know what’s in their foods and whether the food is genetically modified. And, we shouldn’t assume that as people become more informed they’ll be more supportive of GMOs.

49	The industry is not forced to prove relative safety. Rather, the burden of proof is on people like us to show that there's some risk.	-6
8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	+6
10	Researchers are creating ways to boost the nutritional value of foods using biotechnology.	+5
18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical and emotional reasons.	+5
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	+5
48	To put a label on biotech foods, a mandatory label, would be an indication that something is wrong.	-5
16	The American consumer probably cares more for cheap food … than about the ecology.	+4
56	If you made people aware and knowledgeable about genetic foods, they would tend to be more supportive.	-4

Despite the potential risks and the need to improve our regulatory system, we should not act emotionally and impose a moratorium on new GMOs. Biotechnology companies will not monopolize seeds, nor will all food be genetically modified.

55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-4
51	Virtually all of our foods have been genetically modified.	-5
44	Life science companies are turning seeds into intellectual property, so they have a virtual lock on the seeds upon which we all depend for our food and survival.	-5
23	Nearly everything that the human race will be eating will soon be produced from genetically engineered plants and animals.	-6

> *‘The statements with which I disagree could have been based on hearsay or emotion. They are based on misinformation or a lack of understanding about the science (e.g., organic farmers have been threatened)’* (E05).

Factor 6: Balance

Factor 6 explains 6 percent of the variance, and includes significant loading from one FDA participant and one student. There are no clearly dominant salient statement types in Factor 6 (Table 25).

Table 25. Factor 6 - Statement typology salience

Factor Scores	Greater than +3	Less than -3
Preposition		
• Purposive-rational	4	5
• Normative	4	4
• Esthetic-Expressive	1	
Position		
• Pro-GMO	6	5
• Anti-GMO	4	4
Argumentative Frame		
• Economic prospect		3
• Ethical	2	2
• Globalization		
• Pandora's Box	2	
• Progress	1	2
• Public accountability		2
• Runaway	3	

Like with any technology, there are risk with GMOs, especially the potential for food allergens and gene flow.

62	You can't prove that any new technology that we have in the world today is absolutely safe.	+6
60	Conventional agricultural activity entails certain environmental and ecological risks.	+5
26	Pollen from genetically engineered plants will inevitably be spread from one field to another.	+4
13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	-4
27	Eventually, it could be possible to reduce gene flow from cultivated plants with various containment methods.	-4

‘This reflects a recognition of potential risks and that safety assessment is necessary, about doing risk assessment and the need to look at potential risk. Gene flow and food allergens are the biggest risks’ (F01).

‘ *I look at it from more of a biological/ecological risk perspective, about how GMOs will affect the ecosystem’* (S02).

The risks need to be considered against the benefits. It’s a matter of balance and the public should play a role in the assessment and management of risks.

6	Transgenic pest-protected plants should not only be compared to the use of chemicals, but also to alternative methods such as biological control.	+6
8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	+5
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	+5
46	It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	-5
21	The problem is, the benefits are always here and now. The costs always come later.	+4

‘These statements are along the lines of legalistic or regulatory issues, labeling, right to know, as opposed to thinking about the science about things. But, I also recognize that there is a potential benefit to both consumers and the environment, and that consumers need to be engaged in assessing and managing risk. It's a matter of balancing. It's the only way new technologies will be accepted or used’ (F01).

‘I'm not too worried when crossing varieties of plants. No one was concerned about conventional hybridization, but we never really tested them. We modify everything, everyday, all the time. This is just another thing we're changing’ (S02).

The question of balance relates also to the amount and type of regulation and oversight that is needed to ensure we’re protective, that the industry is responsible, and that we’re not unnecessarily burdensome on the industry. It’s not us versus them.

49	The industry is not forced to prove relative safety. Rather, the burden of proof is on people like us to show that there's some risk.	-6
19	Biotechnology has developed in a way that has forced government agencies to choose between democratic principles and the technological vision of an elite group of scientists and entrepreneurs.	-5
31	We can expect that in the future genetically engineered food will be developed and grown in many countries, many of them with no premarket safety reviews.	+4
42	The threat of law suits will cause the biotech industry to try their best to market safe food.	-4
39	Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	-4

'We talk about the U.S. regulatory system and we're leaders in technology. Yeah, but so what? This is resting on laurels, a little bit of jingoism. Laws are means to an end to achieve values. There's a dichotomy of people making the statements, a demonization of institutions. Some statements recognize that there is a weakness in the system if looking for prescriptive controls. The question is whether that level of control is needed from a regulatory perspective to control the risks' (F01).

Threat of lawsuits are not a strong deterrent. Industry will do just enough, but not more than the minimal to get it to the market' (S02).

While the public focus is mostly on the appropriateness of the technology, many of the big questions are about social values and how we deal with new technologies as a society.

53	It is not for a human being to modify the basic laws of nature.	-6
45	Genes are a discovery, they should not be patented.	-5

'Some would argue that biotechnology was pushed too quickly (as opposed to nanotechnology). There are still issues that haven't yet come up in the U.S., like mandatory premarket reviews/approvals. There's no mention of the use of plants as pharmaceuticals or the use of enzymes and processing aids derived from GMOs, but that are not required to be labeled (such as in producing cheese, wine). Another challenge not captured is stacked genes, putting together a complex phenotype. How should those safety assessments be done? What catches the public's eye is the technology, the focus is not on whether it's appropriate to produce the phenotypes in the plant. Regulations are not an end to themselves, they are the tools and processes to achieve social values' (F01)'

'It costs a lot to discover genes and people who do that work should be rewarded' (S02).

Comparison of Factors

Specific statements statistically set each factor apart, others are common to multiple factors. For each factor, I examine the distinguishing statements to highlight areas of agreement and disagreement. Table 26-Table 31 provide statements for each factor that statistically distinguish one factor from another ($p < 0.05$, shaded indicates $p < 0.01$).

Factor 1: Positivism

Factor 1 is most distinguished from the other factors by the extent to which it supports the current legal and regulatory framework (Table 26). Unlike Factors 2, 4, 5, and 6, it rejects the notion that consumers are already enjoying genetically modified vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers. Factor 1 also is distinguished from the other factors by the extent it rejects assertions that the GMOs could create food safety problems, health or ecological risks, and that regulatory staff lack appropriate expertise.

Table 26. Factor 1 - Distinguishing statements

No.	Statement	Factor 1	2	3	4	5	6
61	We have looked very carefully at the use of recombinant DNA techniques, and we do not have any information that the simple use of the techniques creates a class of foods that is different in safety or quality from foods developed by other methods of plant breeding.	4	-4	-2	-1	-2	0
29	Existing laws are for the most part adequate for oversight of biotechnology products.	3	-3	-3	-4	-2	-1
13	Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	1	-4	-2	-6	-4	-4
42	The threat of law suits will cause the biotech industry to try their best to market safe food.	-1	-4	-3	-2	-2	-4
8	Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	-1	6	-4	-6	6	5
35	Genetically engineered foods are not being regulated and could enter the food supply without oversight.	-3	-1	0	0	4	-2
34	The scientific education of genetic engineers and regulators has been inadequate even to understand the technical challenges of biosafety, let alone to take appropriate precautions and conduct science-based testing.	-4	-4	-2	0	2	-3
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	-5	-1	5	-3	2	-2
55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-6	-5	1	-3	-4	-3

Factor 2: Cautious Optimism

Factor 2 is distinguished from the other factors by the relative importance it places on considering both potential benefits and risks, while also being somewhat critical of the adequacy of the current regulatory system (Table 27).

Table 27. Factor 2 - Distinguishing statements

No.	Statement	Factor 1	2	3	4	5	6
37	It has proved impossible to develop government regulatory programs that are truly science-based and not compromised by political pressures.	-2	5	0	-2	-1	1
24	Biotechnology has tremendous potential to help fight hunger.	3	5	-4	-1	0	1
65	GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	-1	5	3	0	-3	1
18	Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical and emotional reasons.	6	0	5	5	5	3
30	Genetically engineered foods are thoroughly tested before they are allowed onto the market.	1	-2	-5	2	0	0

Factor 3: Unfulfilled Promises

Factor 3 is distinguished from the other factors by the extent to which it represents a distrust of the regulatory system; the system’s possible inability to protect the food supply; and a suspicion of the biotechnology industry’s influence on universities and intent to produce GMOs that will yield environmental benefits (Table 28). It is the only factor that favors, even slightly, a moratorium on new GMOs, and it strongly rejects the assertion that NGOs are uninterested in a reasoned debate and are just out to scare people.

Table 28. Factor 3 - Distinguishing statements

No.	Statement	Factor 1	2	3	4	5	6
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	-5	-1	5	-3	2	-2
20	All of our major universities are tied into all sorts of contractual relationships and consulting relationships with the life science companies.	0	-3	4	0	-2	-1
55	There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	-6	-5	1	-3	-4	-3
30	Genetically engineered foods are thoroughly tested before they are allowed onto the market.	1	-2	-5	2	0	0
57	Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	0	-2	-6	0	-1	2
11	Biotechnology can help farmers reduce their reliance on insecticides and herbicides.	5	2	-6	1	3	2

Factor 4: Factual

The distinguishing statements in Factor 4 emphasize the appropriateness of regulatory and technological goals, and an assertion that the regulatory system is largely achieving these (Table 29). It rejects the idea that the regulatory system could allow GMOs to be released that could harm the environment. It also is distinguished from other factors by its rejection of the claim that people have a right to know if their food contains GMOs, partially because it will be technically difficult and expensive to do this.

Table 29. Factor 4 - Distinguishing statements

No.	Statement	Factor 1	2	3	4	5	6
46	It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	-1	-2	0	5	1	-5
54	It is not right to exploit a technology which may give rise to unexpected substances that may be damaging to health, before this risk has been carefully investigated.	-1	1	-2	4	1	-2
3	Modern biotechnology can be used to reduce the allergenic risks associated with our current food supply.	2	0	-3	4	0	-1
39	Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	-2	-3	-2	4	-3	-4
40	The U.S.'s food safety regulatory system is head and shoulders above anybody else's in the world.	0	-1	-4	3	0	0
47	People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	1	2	5	-1	5	5
28	Concerns about genetically modified crops arise mainly when novel, beneficial traits have the potential to spread to wild populations and cause them to become more invasive and difficult to control.	0	3	1	-3	1	1

Factor 5: Critical

The statements that distinguish Factor 5 from the other factors reflect moderate concern over possible inadequacy of the regulatory system and potential risks from GMOs to the food supply, health, and the environment (Table 30). Yet there appears to be some consideration that the risks, including allergy risks, are not too bad, and that GMOs are not so widespread that any problems that could arise could not be remediated.

Table 30. Factor 5 - Distinguishing statements

		Factor					
No.	**Statement**	**1**	**2**	**3**	**4**	**5**	**6**
35	Genetically engineered foods are not being regulated and could enter the food supply without oversight.	-3	-1	0	0	4	-2
59	We are being put in jeopardy. We are guinea pigs in this experiment.	-6	-5	-1	-4	2	-3
33	Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	-5	-1	5	-3	2	-2
1	Allergies are only minor inconveniences.	-5	-6	-6	-5	-2	2
65	GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	-1	5	3	0	-3	1
51	Virtually all of our foods have been genetically modified.	0	4	0	5	-5	0

Factor 6: Balance

Factor 6 emphasizes more strongly than other factors the similarity between GMOs and conventional plants, but rejects the assertion that it’s difficult to distinguish between them (Table 31). It also most strongly rejects any challenges to intellectual property rights, that genes should not be patentable.

Table 31. Factor 6 - Distinguishing statements

No.	Statement	Factor 1	2	3	4	5	6
6	Transgenic pest-protected plants should not only be compared to the use of chemicals, but also to alternative methods such as biological control.	1	2	1	0	1	6
1	Allergies are only minor inconveniences.	-5	-6	-6	-5	-2	2
45	Genes are a discovery, they should not be patented	-1	1	1	-1	-1	-5
46	It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	-1	-2	0	5	-1	-5

Areas of Consensus

Several statements do not statistically distinguish between any pair of factors at either confidence level (i.e., they are not significant: p>0.01 and p>0.05) (Table 32). All factors reflect agreement, or at least ambivalence, that GMOs hold the potential for reducing the demand on natural resources. None reject the idea that the credibility of the regulatory process depends on the public's understanding of it. All agree that the cost of food is probably more important to American consumers than concerns about the environment.

Table 32. Consensus statements

No.	Statement	Factors 1	2	3	4	5	6
12	Agricultural biotechnology products, like modified pulp trees for use in paper production, will allow manufacturers to use less water and other natural resources, and to produce less waste from the production stream, while producing higher-quality materials.	1	3	0	1	2	1
16	The American consumer probably cares more for cheap food … than about the ecology.	1	3	2	2	4	2
38	Ultimately, the credibility of the regulatory process depends on the public's ability to understand the process and the key scientific principles on which it is based.	3	1	1	0	0	0

Changes in Viewpoints Over Time

Most participants (21 of 31, about 68 percent) responded that their views about genetic engineering/GMOs had not changed over time,[115] or that their support for genetic engineering and confidence in the regulatory process increased, or that their opposition diminished.

> *'I've been in this job for [a number of] years. Before that I didn't give a lot of thought to the issues of genetically engineered foods. As a consumer, I never did anything to avoid genetically engineered foods. I am confident in safety of the U.S. food supply; it's not a concern to me. Technology generally has improved our standard of living here and around the world, such as in medicine and information technology. Sometimes science and technology get out in front of society's ability to deal with these things, and that raises ethical issues. I'm generally pro-technology and the last [several] years have reinforced my feelings as I've gotten to know the science better and interacted with people who spend their careers at this'* (A01).

> *'When I first came to this agency, every new variety needed animal testing, the full battery of tests for a new food ingredient. But as I became more familiar with the tests and the genetic modification process, I felt that the processes really eliminate any unintended consequential effects that might result from genetic engineering. There also are limitations to animal feeding studies: to determine a NOEL [no observed effects level], you're limited to 20 percent of the diet and so whole food animal feeding study won't tell you that much. Testing is not really the way to go'* (F01).

> *'As I learned more about what they are, how they've been developed, the costs involved in getting through the process (development, regulatory clearance, distribution), the more appreciation I have in what's entailed. As I became more informed, I became more embracing, more confident in the process, that it's protective'* (F02).

> *'I haven't changed my opinions very much, in part because of my scientific training and that I've worked in this field before there were genetic engineered plants'* (F03).

> *'I've only been in this position for about a year, and didn't really deal with these issues before. I probably always had an open mind about GMOs'* (E02).

> *'I've never been against genetic engineering. I studied cell biology and biochemistry in college. I was concerned that genetic engineering should be thoroughly researched, but I*

[115] Participants A03 and A04 responded only that their opinions did not change much over time.

always had a pretty positive perspective. Genetic engineering has incredible power to solve a lot of world problems, nutrition. After seeing the test results, I feel the safety is there; I've confirmed that it's there. My opinions have changed, but more in a positive direction' (E03).

'In graduate school, I worked with a professor who was working with GM plants. I didn't know much before that. Based on what I learned from him and experience at my job, my belief in the benefits of biotechnology has strengthened. After graduate school, I was surprised by the negative reaction towards GMOs by NGOs and members of the public, because I thought they would be supportive since it would reduce conventional pesticide use' (E04).

'I've always thought technology should be advanced, and we should strive to improve oversight. I'd like to think oversight is sufficient. Evolution probably would have taken care of it anyway, we just quickened it' (E05).

'Yes, my opinions have evolved over time, and time itself has been the most critical factor. The large-scale commercialization and the amount of testing have increased my confidence that we can make responsible decisions' (E08).

'I was more skeptical when I first came to the agency. I'm still aware of the risks, that there are risks, but feel that the more experience I had and the more I knew about the technology, the more comfortable I became. Biotech is much more precise and predictable than traditional breeding. Risks with allergies have gotten a lot of attention and industry and regulatory agencies are very sensitive to the issues. Agencies go back to companies and ask for evidence that there won't be a problem' (E10).

'I was more concerned over a wider range of applications than I am now. The change was due to experience. I entered early on in this process, and once you get a chance to do enough assessments, you see that all organisms are not created equal, and you need to pay a lot of attention to a limited number of things. There are some problematic cases, but now I know what problems to look for and don't have to worry about everything' (E12).

'I don't think they changed over time. I really haven't had enough interaction with GMOs. I like Whole Foods and Trader Joes because I like their food, but not because its organic, and I'm just as likely to go to the Giant' (S01).

'I don't have a strong opinion, but we don't know enough. It's possible that GMOs could be good for economy and ecology. I'm not opposed to them and they still are collecting information. When I was an undergraduate, I was against GMOs, but now feel as though I don't know enough to be against. The media in [my home country] influences people against GMOs. But after taking classes in genetics, plant biology, biotech class, I no longer hold such strong opinions' (S02).

'I didn't know much in high school and became more knowledgeable in college. I'm not swayed that GMOs are harmful. Most of my thinking is about food, not about biopesticides: I haven't really heard much about them' (S04).

‘At first, I was hesitant. Looking at the population increase on the planet, however, I saw the value of GMOs for world-wide food supply. You need high crop yields. I saw a TV show about golden rice, about putting vitamin A in the rice. I thought it was pretty neat that you could make a food crop more nutritious. In terms of labeling, I’ve seen people in the grocery store seeking out pasta with increased Omega 3 fatty acid’ (S06).

‘When I first heard about GMOs, I thought they were probably terrible, but now I know that most of the food in my life has been genetically modified, so I’ve become more complacent’ (S07).

‘My opinions have not changed significantly. I learned more about GMOs during classes the past two years. It made me more interested in what are the real basic differences, understanding at the cell level’ (S08).

‘Yes, visiting third world countries contextualized issues, that organic has become a luxury, that we cannot afford to worry that much about [GE] food’ (S09).

No, my opinions haven’t changed. The emphasis right now is on organic. There hasn’t been a push on segregating GMOs. I see this as the agricultural way of trying to stay in the market. They are doing this with science and have been doing this for a while. I don’t know what they’re doing, but if it helps them and if there hasn’t been any fallout, I guess I never had a problem with it’ (S10).

Three of the participants (about 10 percent) indicated that while they generally have felt positive about genetic engineering, their concerns about uncertainties, potential risks, and/or the adequacy of the regulatory system increased over time.

‘I always had a positive view that GMOs have a lot of potential to solve problems that the human race must solve. It's a real powerful technology that's being underutilized. At the same time, I'm aware that there's more unknowns, more things we're learning about genetics, and that maybe we need more regulation, to prevent unintended consequences. I tend to agree with the statement that the risks from GMOs are no different from those of other organisms. The difference is more in scale and scope of the risks, rather than the types of risk’ (A02).

‘The more I know, the more I realize the more I need to know. I haven't become complacent. If I were in homeland security, I'd tell you about concerns of bio-terrorism, eco-terrorism, agro-terrorism from biotechnology’ (E06).

‘My opinions have changed in the sense that the complexity of the system in which we're operating has become more transparent to me (for example, biological regulatory control of RNAi). I've become more humbled by the things I don't know. Agriculture in and of itself is not safe: it leaves a huge footprint in the world. There are always unintended consequences. We always try to limit the damage, while meeting human needs’ (E09).

Another three participants, while generally positive about genetic engineering, expressed increased concerns over political and stakeholder influence.

> *'The more science I understood, the less I was concerned about the risk. But, it's been a pendulum. The hysteria to smear the products was reprehensible and people overstated the risk. On the other hand, politics has played a role in regulation and scientists are overly optimistic about our ability to control things'* (E01).

> *'My opinions haven't really changed. The threat of lawsuits and the ethical, religious, and emotional reasons people make decisions tend to be reinforced; they haven't changed much. For example, USDA determined that GMOs were not organic. That decision made me question the motivation behind the organic standards rule. I was surprised how the organic standards policy was driven more by an establishing organic niche market than protecting the environment. In contrast, Chesapeake Bay recovery is based on objective performance goals'* (E07).

> *'I only had positive opinions about genetic engineering, but I've been able to fine-tune my opinions with scientific information. Over time, I've gotten a greater appreciation of the consumer perspective, their right to information'* (E11).

Four participants (approximately 13 percent) consistently held or developed increasingly negative opinions about genetic engineering.

> *'My opinions haven't changed. I first developed feelings about GMOs in graduate school. I support the precautionary principle. We need to assess the risk and develop the regulatory system around them, not mold the existing system'* (N01).

> *'Yes. When I first came to the issues, I thought genetic engineering could achieve great things (increase food yield and nutrition, decrease pesticide use). That was before I understood genetic engineering or agriculture. I now think that genetic engineering − to modify plants in particular ways – technically is much more difficult than originally thought and I think it's less likely that those few successful modifications will have a big impact in agriculture. We've had 20 years of experience. I had no idea how powerful companies are, how they are able to manipulate the process, and how they determine what kind of products they chose to develop'* (N02).

> *'I've always been conflicted. That remains, maybe even more conflicted the more that I know. I definitely changed after I worked in policy because I realized how poorly regulated everything is. GMOs need to be regulated more'* (S03).

> *'I have friends that are trying to be organic farmers on the West Coast, and it never occurred to me that their entire business could be ruined by drifting pollen and pesticides. I'm very concerned about containment of GMOs to help people continue doing what they want to do, not because of GMOs taking over the world'* (S05).

With the exception of NGOs, Pearson's chi^2 reveals no significant associations between organizational affiliation of participants and changes in their opinions about GMOs (Table 33).

Table 33. Change over time in opinion about genetic engineering/biotechnology

Increase in	EPA	FDA	USDA	NGO	Student	Total
Positive opinion toward GMOs	7	3	3	0	8	21
Concern about risks	2	0	1	0	0	3
Concern over political influence	3	0	0	0	0	3
Opposition toward GMOs	0	0	0	2	2	4
Total	12	3	4	2	10	31

*Pearson chi2(12)=24.6032 Pr=0.017
Regulatory agency participants only: Pearson chi2(4)=3.0855 Pr=0.544
**Regulatory participants and NGOs only: Pearson chi2(9)=24.4103 Pr=0.004
Regulatory participants and students only: Pearson chi2(9)=11.4159 Pr=0.248
*NGOs and students only: Pearson chi2(1)=4.8000 Pr=0.028
(*=significance at p=0.05; **=significance at p=0.01)

Survey Data Treatment

The raw results of the survey were imported into a Microsoft Excel 2007 spreadsheet and into STATA IC version 11.2 statistical software (STATA Corporation, 2009). Before conducting statistical analyses, some of the raw survey data required transformation. Prior to calculating the NEP score (the sum of responses to all NEP items), 7 of the 15 items required reversing the scale so that agreement with items inconsistent with the new paradigm are scored lower. This was accomplished simply by subtracting the raw scores from 6. A similar transformation was necessary for 2 of the 3 items on support for science. Responses to the questions on whether institutions were doing a good job for society (items 51-60) were re-coded as “not doing a good job” = 1; “don't know” = 2; and “doing a good job” = 3. Similarly, I recoded the responses to the questions on the impacts of various technologies on our way of life in the next 20 years (items 61-70) as “negative” = 1, “no effect at all” = 2, and “positive” = 3. I also performed statistical tests for measures of central tendencies (mean, median), dispersion (variance, standard deviation), and deviation from normality (skewness, kurtosis, Shapiro-Francia W'). The survey responses adequately approximate normal distributions.

Following Slimak and Dietz (2006) and Slimak (2003), I used Armor’s (1973) factor scaling approach to construct reliable scales for independent and dependent variables. In addition to increasing reliability, the use of scales reduces colinearity that can complicate subsequent statistical modeling. For all scales I used principle-component factor analysis (Stata IC 11) to extract factors from the original items in each scale. I used the spree plot method (point of inflection) for multiple factors with eigenvalues greater than 1.0 as an initial estimate for the number of factor to retain for varimax rotation.[116] For each factor, I included only those items with factor loadings greater than 0.50. I calculated Cronbach’s alpha for all participants and separately for only regulators. I compared rotated factor alpha scores for different numbers of items and to determine scales with maximum reliability, dropping items to increase reliability. For all scales of

[116] For the NEP, 5 factors had eigenvalues greater than one, but explained variance for each diminished after the second factor.

independent social psychological variables, responses to each item are added together to yield a scale score (Table 34). I used the absolute scale scores for regression analysis. For comparative purposes, however, all scale scores presented in Table 35-Table 43 are divided by the number of valid responses so that the scales presented in these tables have the ranges of the original questions.

For the NEP, maximum validity was achieved using 2 factors, which accounted for 45 percent of the variance. I labeled these “Fragile Planet,” because all of the items reflect a concern over the vulnerability of the environment to human activity, and “Shared Planet,” because all three items reflect concern over the rights of people to exploit nature. Of the 9 statements on personal normative beliefs, 8 loaded heavily on one factor. I included all 9 statements, however, because dropping the item that did not load on the first factor did not increase the alpha reliability of the scale. Items from Schwartz’s altruism scale loaded significantly onto 2 factors, which collectively explained 74 percent of the variance. I labeled these subscales “ecological” and “social” altruism. Factor scaling did not increase the alpha validity of Schwartz’s “traditional” (or “conservative”) value cluster; therefore, I retained all 9 items. For the “self-interest (self-enhancement)” cluster, the first of the 2 factors with eigenvalues greater than 1.0 explained 48 percent of the variance. I retained 2 or the original 4 items for use in the scale. All 3 of the items in the “openness to change” cluster loaded onto one factor and were included in the scale. I also developed a scale for “support for science” using survey items 16-18.

Table 34. Independent social psychological variables

(all scales are additive)

New Ecological Paradigm Scale

Fragile Planet

(range=8–40; alpha=0.85-0.87)

1. We are approaching the limit of the number of people the earth can support.
2. When humans interfere with nature it often produces disastrous consequences.
3. Human ingenuity will insure that we do not make the earth unlivable. [reversed]
4. Humans are severely abusing the environment.
5. The balance of nature is strong enough to cope with the impacts of modern industrial nations. [reversed]
6. The so-called ‘ecological crisis’ facing human kind has been greatly exaggerated. [reversed]
7. The earth is like a spaceship with very limited room and resources.
8. If things continue on their present course, we will soon experience a major ecological catastrophe.

Shared Planet

(range=3–15; alpha=0.57-0.78)

1. Humans have the right to modify the natural environment to suit their needs. [reversed]
2. Plants and animals have as much right as humans to exist.
3. Humans were meant to rule over the rest of nature. [reversed]

Personal Normative Beliefs

(range 9–45; alpha=0.90)

1. The government should take stronger action to clean up toxic substances in the environment.
2. I feel a personal obligation to do whatever I can to prevent climate change.
3. I feel a sense of personal obligation to take action to stop the disposal of toxic substances in the air, water, and soil.
4. Business and industry should reduce their emissions to help prevent climate change.
5. The government should exert pressure internationally to preserve the tropical forests.
6. The government should take strong action to reduce emissions and prevent global climate change.
7. Companies that import products from the tropics have a responsibility to prevent destruction of the forests in those countries.
8. People like me should do whatever we can to prevent the loss of tropical forests.
9. The chemical industry should clean up the toxic waste products it has emitted into the environment.

Schwartz’s Value Clusters

Social Altruism

(range=3-15; alpha=0.71-0.73)

1. Social justice, correcting injustice, care for the weak.
2. Equality, equal opportunity for all.
3. A world of peace, free of war and conflict.

Ecological Altruism

(range=3-15; alpha=0.85-0.92)

1. Unity with nature, fitting into nature.
2. Respecting the earth, harmony with other species.
3. Protecting the environment, preserving nature.

Traditional (Conservative)

(range 9-45; alpha=0.80-0.83)

1. True friendship, close supportive friends.
2. Loyal, faithful to my friends.
3. Sense of belonging, feeling that others care about me.
4. Obedient, dutiful, meeting obligations.
5. Self-discipline, self-restraint, resistance to temptations.
6. Family security, safety for loved ones.
7. Honoring parents and elders, showing respect.
8. Honest, genuine, sincere.
9. Forgiving, willing to pardon others.

Self-interest (Self-Enhancement)

(range=2-10; alpha=0.66-0.72)

1. Influential, having an impact on people and events.
2. Authority, the right to lead or command.

Openness to Change

(range=3-15; alpha=0.74-0.77)

1. Curious, interested in everything, exploring.
2. A varied life, filled with challenge, novelty and change.
3. An exciting life, stimulating experiences.

Support for Science

(range=3-15; alpha=0.67)

1. We have a duty to allow research that might lead to important new treatments, even when it involves the creation or use of human embryos.
2. I feel scientific research often goes too far. [reversed]
3. I fear the potential impacts of scientific research. [reversed]

In addition to the independent variables, I also constructed a Support for Biotechnology scale that includes 17 items in the survey that asked participants to express their opinions about genetic engineering in agriculture and food. One factor accounted for 68 percent of the variance. I constructed the scale by taking the mean of the valid responses from each participant across all 17 items. The alpha for the 17 item Biotechnology Scale was 0.96. The other dependent variables included the rotated Q sort factor loadings described previously. Reliability of all independent social psychological and dependent scales fall within or exceed the ranges reported in the literature (Kalof et al., 2002, Slimak, 2003, Slimak and Dietz, 2006, Stern, et al., 1999).

Survey Results

For each scale, I tested the difference in the means for the five participant groups (EPA, FDA, USDA, NGOs, students) using one-way ANOVA with the Scheffe test for significance of difference between means, followed by simple regression when total variance was significant.[117] To prevent colinerarity, Stata automatically drops the categorical (indicator) variable with the largest number of cases from regression. Thus, all coefficients that I report are relative to the mean for EPA participants. In each of the following tables, items are arranged in order from overall highest to lowest score (right column). To be sure, these results are substantially affected by the small and

[117] Stata reports results up to 4 digits to the right of the decimal, including 0.000. I have rounded all results to 2 digits to the right of the decimal, and indicate when the results are less than 0.01 (e.g., 0.000 becomes <0.01).

disproportionate number of participants and are to be regarded as exploratory only. Nevertheless, the results provide some useful insights into areas of agreement and disagreement among participants, most of which are consistent with the discourses identified in the Q analysis. Other than for theoretical purposes, I make no claim of external validity.

New Ecological Paradigm

The mean scores for each NEP item and the overall mean NEP score for each participant group are provided in Table 35. Means scores for the complete NEP scale and the two subscales (Fragile Planet and Shared Planet) are provided at the bottom of the table. Note that in the survey, agreement with several NEP items indicates a lack of support for the NEP. For those items (2, 4, 6, 8, 10, 12, and 14), the scores are reversed in Table 35 so that a higher score consistently reflects support for the NEP.

Overall support for the NEP is high across all groups. FDA participants had the highest average scores on all three NEP scales. USDA scored lowest scores; however, intergroup variance and difference in means among organizations on individual NEP items, the NEP scale, and the two subscales are not statistically significant.

Table 35. New Ecological Paradigm (mean scores)

	Means (range=1-5)					
	EPA	FDA	USDA	NGO	Student	All
1. Despite our special abilities, humans are still subject to the laws of nature.	4.8	5.0	4.3	4.5	4.7	4.7
2. Humans were meant to rule over the rest of nature. [reversed]	4.5	5.0	4.5	5.0	3.8	4.3
3. Plants and animals have as much right as humans to exist.	3.9	4.3	3.5	4.0	4.8	4.2
4. The so-called 'ecological crisis' facing human kind has been greatly exaggerated. [reversed]	3.9	5.0	3.3	4.5	4.1	4.0
5. The balance of nature is strong enough to cope with the impacts of modern industrial nations. [reversed]	3.7	4.7	3.8	4.5	4.0	4.0
6. Humans are severely abusing the environment.	3.5	4.7	3.0	4.5	4.3	3.9
7. We are approaching the limit of the number of people the earth can support.	3.7	3.7	3.5	3.5	4.2	3.8
8. Humans will eventually learn enough about how nature works to be able to control it. [reversed]	3.6	2.3	3.8	4.0	4.2	3.7
9. If things continue on their present course, we will soon experience a major ecological catastrophe.	3.3	4.0	2.5	4.5	4.4	3.7
10. The earth is like a spaceship with very limited room and resources.	3.5	4.7	3.3	3.0	3.2	3.5
11. The earth has plenty of natural resources if we just learn how to develop them. [reversed]	2.9	4.3	4.0	3.0	3.4	3.4
12. Human ingenuity will insure that we do not make the earth unlivable. [reversed]	3.0	3.7	3.0	3.5	3.6	3.3
13. The balance of nature is very delicate and easily upset.	3.3	3.3	3.0	3.5	3.2	3.2
14. When humans interfere with nature it often produces disastrous consequences.	3.2	2.7	2.3	3.0	3.7	3.1
15. Humans have the right to modify the natural environment to suit their needs. [reversed]	2.8	3.3	2.5	3.0	3.2	3.0
Complete NEP Scale (15 items; alpha=0.82-0.86)	3.6	4.0	3.3	3.9	3.9	3.7
Fragile Planet Subscale (3 items; alpha=0.85-0.87)	3.5	4.1	3.1	3.9	3.9	3.7
Shared Planet Subscale (3 items; alpha=0.57-0.78)	3.7	4.2	3.5	4.0	3.9	3.8

Personal Normative Beliefs

For each participant group, the mean scores on items relating to personal normative beliefs are provided in Table 35. According to the value-belief-norm theory, higher scores indicate an increased "general predisposition" toward non-activist environmentalism (Stern, et al., 1999). Neither variance nor differences between group means are significant for any individual item or for differences in the additive scale.

Table 36. Personal normative belief (mean scores)

	Means (range=1-5)					
	EPA	FDA	USDA	NGO	Student	All
1. The chemical industry should clean up the toxic waste products it has emitted into the environment.	4.5	5.0	4.3	5.0	4.7	4.6
2. Business and industry should reduce their emissions to help prevent climate change.	4.4	5.0	4.3	5.0	4.2	4.4
3. The government should take stronger action to clean up toxic substances in the environment.	4.1	4.3	3.8	5.0	4.2	4.2
4. The government should take strong action to reduce emissions and prevent global climate change.	4.3	4.7	3.5	4.5	4.1	4.2
5. The government should exert pressure internationally to preserve the tropical forests.	4.2	4.0	4.0	5.0	3.9	4.1
6. Companies that import products from the tropics have a responsibility to prevent destruction of the forests in those countries .	4.1	4.3	3.3	5.0	4.1	4.1
7. I feel a sense of personal obligation to take action to stop the disposal of toxic substances in the air, water, and soil.	4.1	4.7	3.5	4.0	3.9	4.0
8. I feel a personal obligation to do whatever I can to prevent climate change.	4.0	4.3	3.3	4.0	3.9	3.9
9. People like me should do whatever we can to prevent the loss of tropical forests (Personal Normative.	3.8	3.7	3.0	4.5	3.6	3.7
Personal Norm Scale (alpha=0.90)	4.2	4.4	3.6	4.7	4.0	4.1

Schwartz's Value Clusters

Table 37 presents the mean results of the items from Schwartz's value clusters, arranged from highest to lowest for all participant groups within each cluster.

Table 37. Schwartz's value clusters (mean scores)

	Means (range=1-5)					
Altruism Value Cluster	EPA	FDA	USDA	NGO	Student	All
1. Preventing pollution, conserving natural resources.	4.5	4.3	4.3	4.0	4.2	4.3
2. Protecting the environment, preserving nature.	4.5	3.5	4.0	4.0	4.3	4.3
3. Equality, equal opportunity for all.	4.5	4.7	4.3	4.5	3.8	4.3
4. Respecting the earth, harmony with other species.	4.4	4.3	3.8	4.5	4.1	4.2
5. Unity with nature, fitting into nature.	4.1	3.7	3.5	4.0	4.2	4.0
6. Social justice, correcting injustice, care for the weak.	4.3	4.0	3.8	4.5	3.6	4.0
7. A world of peace, free of war and conflict.	4.2	4.3	4.0	3.5	3.3	3.9
Complete Altruism Scale (alpha=0.62)	4.4	4.2	3.9	4.1	3.9	4.1
Ecological Altruism Subscale (alpha=0.85-0.92)	4.3	4.0	3.8	4.2	4.2	4.2
Social Altruism Subscale (alpha=0.71-0.73)	4.3	4.4	4.0	4.2	3.6	4.0
Traditional (Conservative) Value Cluster						
1. Honest, genuine, sincere.	4.8	5.0	4.5	4.5	4.4	4.7
2. Loyal, faithful to my friends.	4.5	4.7	4.3	4.0	4.4	4.4
3. Family security, safety for loved ones.	4.7	4.7	4.5	5.0	3.8	4.4
4. True friendship, close supportive friends.	4.3	4.7	4.0	4.5	3.9	4.2
5. Obedient, dutiful, meeting obligations.	4.5	3.7	3.5	4.0	3.9	4.0
6. Forgiving, willing to pardon others.	4.4	4.3	4.3	3.5	3.4	4.0
7. Honoring parents and elders, showing respect.	4.3	4.0	3.8	4.5	3.6	4.0
8. Sense of belonging, feeling that others care about me.	4.5	4.3	3.3	3.5	3.2	3.8
9. Self-discipline, self-restraint, resistance to temptations.	4.0	3.7	3.8	3.5	3.4	3.7
Traditional (Conservative) Scale (alpha=0.80-0.83)	4.4	4.3	4.0	4.1	3.8	4.1
Self-interest (Self-Enhancement) Value Cluster						
1. Influential, having an impact on people and events.	3.7	3.7	2.8	3.5	2.8	3.3
2. Authority, the right to lead or command.	2.6	2.3	2.5	2.5	2.6	2.6
3. Wealth, material possessions, money.	2.5	2.3	2.3	2.0	2.8	2.5
4. Social power, control over others, dominance.	1.7	1.7	1.3	1.0	1.4	1.5
Complete Self Interest Scale (alpha=0.52-0.57)	2.6	2.5	2.2	2.3	2.4	2.5
Self-interest Subscale (alpha=0.66-0.72)	3.2	3.0	2.6	3.0	2.7	2.9
Openness to Change Value Cluster						
1. Curious, interested in everything, exploring.	4.5	4.7	4.5	4.0	4.4	4.4
2. A varied life, filled with challenge, novelty and change.	4.5	4.3	4.5	4.0	3.4	4.1
3. An exciting life, stimulating experiences.	3.9	4.0	4.3	4.5	3.7	3.9
Openness to Change Scale (alpha=0.74-0.77)	4.3	4.3	4.4	4.2	3.9	4.2
Schwartz value scale, all items (alpha=0.81-0.87)	4.1	4.0	3.7	3.8	3.6	3.8

Items from Schwartz's value clusters did not produce significant differences among group variance or mean responses from the different participant groups. With the exception of the self-interest value cluster, mean scores exceed 3.5 (out of a possible 5).

Of the 4 items in the self-interest value cluster, only “Influential, having an impact on people and events” has a mean score higher than 3 for any group of participants.

Support for Science/Unrestricted Research

The mean responses to survey items asking about the extent to which participants support unrestricted scientific research are presented in Table 38. Note that in the survey, agreement with items 1 and 2 indicates a lack of support for unrestrained scientific research. I reversed the scores for these two items in Table 38, so that a higher score consistently reflects support of unrestricted research. Oneway ANOVA indicates that the variance among mean scores from the different participant groups is significant ($F=4.52$; $p=0.01$) on the issue of whether scientific research with the potential for new treatments should be conducted even if it involves human embryos. The Schaffe test indicates that the scores of participants from NGOs are significantly lower than the scores of participants from EPA ($p=0.05$), FDA ($p=0.01$) and USDA ($p=0.03$). Regression indicates that NGOs have a significant negative coefficient ($t=-3.35$; $p<0.01$). There are no significant differences among participants from the three regulatory agencies.

On the support for science scale, oneway ANOVA indicates significant variance among all participant groups ($F=3.59$; $p=0.02$), and regression produces a significant negative coefficient for participants from NGOs ($t= -3.14$; $p<0.01$). Variance among only participants from the regulatory agencies is insignificant.

Table 38. Support for science (mean scores)

	Means (range=1-5)					
	EPA	FDA	USDA	NGO	Student	All
1. I feel scientific research often goes too far. [reversed]	4.2	3.7	4.8	4.5	4.3	4.3
2. I fear the potential impacts of scientific research. [reversed]	4.4	3.7	4.8	2.5	4.1	4.1
3. We have a duty to allow research that might lead to important new treatments, even when it involves the creation or use of human embryos.	3.5	4.7	4.0	1.0	3.7	3.6
Support for science scale scores (alpha=0.67)	4.0	4.0	4.5	2.7	4.0	4.0

Optimism Toward Technologies

Table 39 provides participants' mean responses on whether they felt these technologies will have a positive, a negative, or no effect on their way of life in the next 20 years.[118] Consistent with findings among the European public (Gaskell, et al., 2011, Gaskell, et al., 2010), participants in this study were consistently most optimistic about information technology and solar and wind energy technologies. Participants from NGOs appear more pessimistic than the other groups about emerging technologies that some might view as having potential health or environmental risks or impacts (biotechnology, nanotechnology) or about which there has yet to be much public discourse. Total variance for biotechnology is significant ($F=12.16$; $p<0.01$) and differences between the mean scores of participants from NGOs and all other groups are significant ($p<0.01$). Variance for nanotechnology also is significant ($F=6.20$; $p<0.01$) and scores for participants from NGOs were significantly lower than those of participants from EPA ($p=0.01$), USDA

[118] For statistical analysis, responses to these items were recoded to positive=3, no effect=2, negative=1.

(p<0.01) and student participants (p<0.01). The variance on the overall mean scores for optimism for technology is also significant (F=5.17; p<0.01), with participants from NGOs having significantly lower scores than participants from EPA (p=0.01) and USDA (p=0.02). The regression coefficient for NGO participants is negative and significant (t= -4.31; p<0.01).

Table 39. Optimism toward technologies (mean scores)

	Means (range=1-3)					
	EPA	FDA	USDA	NGO	Student	All
Computers and Information Technology	3.0	3.0	3.0	3.0	3.0	3.0
Solar energy	2.9	3.0	3.0	3.0	3.0	3.0
Wind energy	3.0	3.0	3.0	3.0	2.8	2.9
Biotechnology and genetic engineering (F=12.16, p<0.01)	3.0	3.0	3.0	1.0	2.8	2.8
Brain and cognitive enhancement	3.0	2.3	2.8	3.0	2.4	2.7
Nanotechnology (F=6.20, p<0.0115)	2.8	3.0	2.5	1.0	3.0	2.7
Synthetic biology	2.7	2.7	3.0	1.5	2.7	2.7
Nuclear energy	2.7	2.7	3.0	1.5	2.3	2.6
Space exploration	2.6	2.3	2.5	2.0	2.4	2.5
Biofuels made from crops like corn and sugar cane	2.5	1.7	2.5	1.0	1.7	2.1
Mean overall optimism toward technologies scores*	2.8	2.7	2.8	2.0	2.6	2.7

Views on Biotechnology

Table 40 presents the mean results (percent correct responses) for survey questions that asked about participants' basic factual knowledge about biotechnology. That any of the participants from the regulatory agencies — who are arguably among the most knowledgeable experts about biotechnology — provided any incorrect responses is more likely due to carelessness in reading or answering the question or ambiguity in the questions than lack of knowledge by the respondents. These questions come from published literature (Brossard and Nisbet, 2006) which should be reevaluated in light of the findings of this study. The questions should be reevaluated and likely modified before further use in research.

Table 40. Factual knowledge about biotechnology (mean correct responses)

	Means (percent correct responses)					
	EPA	FDA	USDA	NGO	Student	All
1. Manipulation of genetic material in plants to produce better crops has been performed by plant breeders for centuries. (True)	100%	100%	100%	100%	100%	100%
2. Genetic engineers can use 'gene guns' or bacteria to transfer genes into an organism. (True)	100%	100%	100%	100%	100%	100%
3. Genes are the cell's instructions for producing proteins. (True)	100%	100%	75%	100%	100%	97%
4. Organic tomatoes do not contain genes. (False)	91%	100%	100%	100%	100%	97%
5. In nature, plants transmit their genes to unrelated kinds of plants through the process of pollination. (False)	64%	67%	100%	100%	100%	83%
6. Through genetic engineering, scientists can produce genes that do not exist in nature. (True)	82%	100%	100%	100%	22%	69%
Mean overall knowledge scores (percent correct)	89%	94%	96%	100%	87%	91%

Table 41 provides the mean response by organization of participants' satisfaction with the performance of various actors in the biotechnology arena. All participant groups indicated they held university scientists and medical doctors in generally high regard for the work they are doing in biotechnology. Differences among participant groups are not statistically significant for these items.

Table 41. Satisfaction with actors in the biotechnology arena (mean responses)

	Means (range=1-3)					
	EPA	FDA	USDA	NGO	Student	All
1. University scientists who conduct research in biotechnology	2.6	2.3	3.0	2.0	2.9	2.7
2. Medical doctors	2.5	2.3	2.5	3.0	2.7	2.6
3. Industries which develop new products with biotechnology	2.7	3.0	2.5	1.0	2.0	2.4
4. Retailers who ensure our food is safe (F=3.14, p=.0330)	2.5	3.0	2.8	1.0	2.1	2.4
5. United States Government making laws about biotechnology (F=9.32, p<0.0101)	2.9	2.7	1.5	1.0	1.8	2.2
6. Consumer organizations which test biotechnological products	2.1	1.7	1.5	3.0	2.2	2.1
7. Ethics committees who consider the moral and ethical aspects of biotechnology	2.3	2.0	2.3	2.0	1.8	2.1
8. Newspapers, magazines, and television which report on biotechnology	2.0	1.7	1.0	2.0	1.7	1.7
9. Environmental groups who campaign about biotechnology	1.5	1.3	1.0	3.0	1.9	1.7
10. Religious leaders who say what is right and wrong in the development of biotechnology	1.6	1.3	1.5	3.0	1.2	1.6
Overall mean satisfaction	2.3	2.1	2.0	2.1	2.0	2.1

With regard to participants' satisfaction with the biotechnology industry, oneway ANOVA identifies an overall significant variance between participants from the different organizations ($F=3.02$; $p=0.038$). While the Scheffe test does not identify significant differences among participant group means, regression indicates a significant negative coefficient for participants from NGOs ($t=-2.83$; $p=0.01$) and for students ($t=-2.03$; $P=0.05$). A separate analysis of participants from only regulatory agencies did not identify significant differences.

Regarding satisfaction with retailers, overall variance among all participants is significant ($F=3.14$; $p=0.03$); however, the Scheffe test does not identify any significant differences between the group means. Variance is not significant among participants from regulatory agencies. Regression indicates a significant negative coefficient only for participants from NGOs ($t=-2.80$; $p=0.01$).

Variance is significant among all participant groups in their satisfaction with the U.S. government ($F=9.32$; $p<0.01$). Variance among only participants from federal regulatory agencies also is significant ($F=9.62$; $p<0.01$). If all participants are included in Scheffe tests, the FDA participants scored significantly lower than participants from EPA ($p=0.01$), NGOs ($p=0.01$) and students ($p=0.01$). Looking only at participants from regulatory agencies, USDA participants reported significantly lower scores on their satisfaction with the U.S. government than did either EPA ($p<0.01$) or FDA ($p=0.04$) participants. Regression identifies significant negative coefficients for participants from USDA ($t=-4.15$, $p<0.01$), NGOs ($t=4.27$; $p<0.01$) and students ($t=-4.32$; $p<0.01$). Regression among only participants from regulatory agencies also produces a significant negative coefficient for USDA ($t=-4.37$; $p<0.01$). The surprisingly low satisfaction of participants from the USDA with the U.S. government's role in overseeing biotechnology may be due to different reasons than the low rating of participants from NGOs or students, reflecting different opinions about how much government oversight of GMOs is desirable. Given what we know about the relative complexity of the regulations across the three different agencies and what was learned in the interviews conducted as part of the Q sort, USDA participants may feel the government is over-regulating biotechnology, while participants from NGOs believe the biotechnology industry is under-regulated. Both perspectives, while representing opposing views, could result in dissatisfaction with the U.S. government.

Oneway ANOVA finds significant variance among participants from different organizations in their satisfaction with environmental groups ($F=3.06$; $p=0.036$), but the Scheffe test does not indicate significant differences between individual pairs of group means. Regression indicates a significant positive coefficient for participants from NGOs ($t=2.64$; $p=0.01$). No significant differences are identified among participants from regulatory agencies.

Variance among all participants is significant for their satisfaction with religious leaders ($F=3.32$; $p=0.027$) and the difference between means of participants from NGOs and students is significant ($p=0.03$). Variance among participants from regulatory agencies is not significant. Regression indicates a significant positive coefficient for participants from NGOs and, while not statistically significant, negative coefficients for all other participants. One clue to this unexpected outcome may come from comments made during the Q sort interviews, cited earlier, about the role of religious leaders in deciding whether genetically engineered food is considered Kosher or Halal. A more complete understanding of these results, however, would require additional research.

Table 42 shows the extent to which participants agreed or disagreed with various statements about the potential impact of genetically modified crops and foods. I reversed the scales on items 1, 2, 9, 10, and 13, so that a higher value consistently reflects a more positive opinion about genetically modified food and crops. Variances are significant for all items. When considering all groups, oneway ANOVA indicates that variance is significant on whether genetically modified crops make participants feel uneasy ($F=4.61$;

p=0.01); however, the Scheffe test does not identify any significant differences between means and a significant Bartlett's test (p=0.05) casts doubt on the ANOVA results.

Table 42. Support of biotechnology (mean responses)

	Means (range=1-5)					
	EPA	FDA	USDA	NGO	Student	All
1. GM crops and food make you feel uneasy. [reversed]	4.5	5.0	5.0	3.5	3.4	4.2
2. GM foods are not good for you and your family. [reversed]	4.3	4.7	5.0	2.0	4.0	4.2
3. Overall, what are your feelings toward using biotechnology in agriculture and food production?	4.4	4.7	4.5	1.5	4.2	4.2
4. GM crops and food are good for the U.S. economy.	3.9	4.0	4.8	3.0	3.9	4.0
5. GM food is safe for your health and your family's health.	3.8	5.0	4.8	2.5	3.7	3.9
6. GM plants and food help people in developing countries.	3.6	3.7	4.3	2.0	4.3	3.8
7. GM crops and food are safe for future generations.	3.8	4.3	5.0	2.5	3.4	3.8
8. The development of GM crops and food should be encouraged.	4.1	4.3	4.3	1.0	3.8	3.8
9. GM crops and food are fundamentally unnatural. [reversed]	4.1	4.7	4.5	1.0	3.3	3.8
10. GM crops and food benefit some people but put others at risk. [reversed]	3.9	4.7	4.8	4.0	2.7	3.7
11. GM crops and food do no harm to the environment.	3.6	4.3	3.5	1.0	2.4	3.1
12. GM foods are the same as ordinary foods and would not need special labeling.	2.8	5.0	4.0	1.0	2.8	3.1
13. GM foods should be clearly identified with a special label.[reversed]	2.8	5.0	3.8	1.0	2.7	3.0
Mean overall biotechnology item scores (F-13.01, p<0.01)	3.8	4.6	4.5	2.0	3.4	3.7

Variance is significant across all groups on the question of whether genetically engineered food is good for participants and their families (F=6.21, p<0.01), but insignificant when considering only participants from regulatory agencies. The Schaffe test indicates that the participants from NGOs are significantly more concerned about the impact of genetically engineered foods than are participants from EPA (p=0.01), FDA (p=0.01), USDA (p<0.01), and students (p=0.04), and there is a significant negative regression coefficient (t=-4.04; p<0.01).

Variance on participants' overall support for genetic engineering in food and agriculture is also significant (F=7.76; p<0.01), and mean responses are significantly less for NGOs than for participants from EPA (p<0.01), FDA (p<0.01), USDA (p<0.01) and students (p<0.01). There is a significant negative regression coefficient for NGOs (t=-5.21; p<0.01). There are no significant differences when considering participants from regulatory agencies only.

Regarding the impact of genetically modified food on the U.S. economy, variance across all groups is significant (F=3.10; p=0.034). Mean scores from NGO participants are significantly less than those from USDA participants only (p=0.04), but the regression coefficient is not significant (t=-1.98; p=0.06). Participants from FDA have a significant positive regression coefficient (t=2.41; p=0.024) when assessed with all other groups, but the regression coefficient is insignificant when assessed only with participants from the other regulatory agencies. On the other hand, the mean score of USDA participants is significantly greater than that of EPA participants, and the positive regression coefficient is significant when calculated with participants from other regulatory agencies only (t=2.92; p=0.01), but not when considered with all other participants.

When considering the safety of genetically engineered foods for participants and their families, there again is significant variance across all participant groups (F=3.90; p=0.01), but no significant differences between means, as identified by the Schaffe test.

Regression does not identify any significant coefficients; however, the coefficient for participants from NGOs is negative and nearly significant ($t=-2.04$; $p=0.05$). Differences between participants from regulatory agencies also are not significant.

Mean scores of participants from NGOs are significantly lower than are those from USDA ($p=0.04$) and from students ($p=0.01$) when contemplating the impact of genetically modified plants and foods in developing countries. The variance across all participants is also significant ($F=4.37$; $p=0.01$), but not when considering federal regulatory agency participants by themselves. Participants from NGOs have a significantly negative regression coefficient ($t=-2.79$; $p=0.01$) and students have a positive coefficient ($t=2.00$; $p=0.05$).

The item on whether genetically modified crops and food are safe for future generations is a bit more interesting. Variance across all groups is significant ($F=7.39$; $p<0.01$) and also significant when considering regulatory agencies only ($F=7.32$; $p=0.01$). Differences in means indicate that USDA participants are significantly more positive than EPA participants ($p=0.05$) and regression produces a significant positive coefficient for USDA participants ($t=3.30$; $p<0.01$), when considered with all participant groups. The mean USDA response also is significantly greater ($p=0.01$) than the mean EPA response, variance remains significant ($F=7.32$; $p=0.01$) and the regression coefficient is significantly positive ($t=3.78$; $p<0.01$), when only participants from the three regulatory agencies are included in the model.

The difference between the NGO and other participants is clear when it comes to whether participants felt that genetically engineered food crops should be encouraged.

Variance across all groups is significant (F=11.09; p<0.01), and the mean score for participants from NGOs is significantly less than from all other groups (p<0.01 for all other participant groups), and the regression coefficient is negative (t=-6.27; p<0.01). Differences between regulatory agency participants are insignificant.

The pattern is similar on whether genetically engineered crops and food are fundamentally unnatural. The means indicate that only participants from NGOs agreed with this statement. Variance across all participant groups is again significant (F=6.04; p<0.01), as are differences between the means of NGO participants and participants from the three regulatory agencies (p=0.01). The regression coefficient for NGOs is also significant (t=4.15; p<0.01).

Students felt strongly that while genetically modified food provides benefits for some, others are placed at risk. Variance across all groups is significant (F=4.31;p=0.01) and the mean student score is significantly less than that of participants from USDA, with a significant regression coefficient (t=2.75; p=0.011). Interestingly, participants from NGOs did not share this perspective, perhaps because they did not agree with the first part of the statement, that genetically modified foods provide benefits. On the potential for genetically modified crops to harm the environment, participants from NGOs again are significantly different from the student or regulatory participants. Variance across all groups is significant (f=8.71; p<0.01), but differences among regulators are insignificant. The mean score of NGO participants is significantly lower than those of participants from EPA (p<0.016), FDA (p<0.01), and USDA (p=0.02). The mean score of students is also significantly less than that of EPA (p=0.39) and FDA (p=0.02) participants.

Federal regulators are clearly split on the issue of whether genetically modified foods should be required to carry special labeling. EPA participants are clearly less convinced that genetically engineered foods should be treated like all other foods and therefore should not require special labeling. Variance is significant for all participant groups ($F=11.22$; $p<0.01$) and when participants from regulatory agencies are considered separately ($F=8.26$; $p<0.01$). The mean score for EPA participants is significantly lower than for FDA participants when considered with all participants ($p<0.01$) and when considered alongside only participants from FDA and USDA ($p=0.01$). the mean score for NGO participant also is significantly lower than for FDA ($p<0.01$) and USDA ($p<0.01$) participants, and the students' mean score also is significantly lower than the mean score of FDA participants ($p<0.01$). Across all participants, the regression coefficient for FDA and USDA are both positive ($t=4.52$; $p<0.01$ and $t=2.73$; 0.012), while the coefficient for NGO participants is significantly negative ($t=-3.19$; $p<0.01$). Considering regulatory participants only, the regression coefficients for FDA and USDA are significant and positive ($t=3.80$; $p<0.01$ and $t=2.30$; $p=0.04$).

On the statement that specifically asserts that genetically modified foods should be labeled, variance across all participant groups is significant ($F=8.26$; $p<0.01$), as is variance across just federal regulators ($F=7.20$; $p=0.01$). The mean score of FDA participants is significantly higher than that for EPA participants, both when considering all participants ($p=0.01$) and only participants from regulatory agencies ($p=0.01$). Considering all participants, FDA and USDA participants have significant positive coefficients ($t=4.33$; $p<0.01$ and $t=2.06$; $p= 0.50$) relative to EPA participants, and the coefficient for NGO participants is significant and negative (t=-3.05; p<0.01). When looking only at participants from regulatory agencies, the coefficient for FDA is positive (t=3.69; p<0.01), but the coefficient for USDA is not significant.

The same pattern of responses is reflected in the overall mean score across all items in this section. Variance is significant (F=13.01; p<0.01) and the mean score of NGO participants is significantly lower than those of EPA (p<0.011), FDA (p<0.01), and USDA (p<0.01) participants. The mean score of students is significantly lower than that of FDA (p=0.026) and higher than that of NGO participants (p=0.013). Regression coefficients are significant and positive for FDA (t=2.55; p=0.22) and USDA (t=2.45; p=0.27) when considered among all participants. Considering all participants, the regression coefficient is positive for FDA (F=2.46; t=0.22) and USDA (t=2.36; p=0.27) and negative for participants from NGOs (t=-5.14; p<0.01). In summary there are significant differences between the participants from EPA and participants from FDA about the desirability of labeling foods containing genetically engineered ingredients. Participants from NGOs indicated that they see genetically engineered crops as fundamentally unnatural, a view not shared by participants from regulatory agencies or students.

Table 43 provides participants' mean responses to questions about the relative risks and benefits of genetic engineering and overall support for the technology. Higher scores indicate participants' opinions that the benefits of biotechnology outweigh any risks to humans or the environment and overall support for biotechnology. At the bottom of the table are the mean scores for the Biotechnology Scale, which consists of all 17 items from Table 42 and Table 43. With the exception of the participants from the NGOs, participants share the viewpoint that the benefits from biotechnology outweigh potential risks to humans or the environment. EPA participants again provided lower scores than their counterparts in FDA or USDA, but these differences are not significant. Significant variance is the result of lower scores by NGO participants.

Table 43. Biotechnology benefit/risk (mean scores)

	Means (range=1-5)					
	EPA	FDA	USDA	NGO	Student	All
1. Overall, do you think the benefits of developing and growing new plants and crops through genetic engineering outweigh the risks, or do you think the risks outweigh the benefits?	4.3	5.0	4.8	1.0	4.2	4.2
2. Overall, would you say you oppose or support the use of biotechnology in agriculture and food production?	4.4	5.0	4.5	1.5	4.1	4.2
3. Do you think the benefits for health outweigh the risks, or do you think the risks for health outweigh the benefits?	4.0	5.0	4.3	2.0	3.9	4.0
4. Do you think the benefits for the environment outweigh the risks, or do you think the risks outweigh the benefits?	4.0	4.7	4.5	1.0	3.2	3.7
Mean overall benefit/risk scores	4.2	4.9	4.5	1.4	3.9	4.0
Biotechnology Scale (mean scores; alpha=0.96)	3.9	4.6	4.5	1.9	3.5	3.8

Only participants from NGOs see risks from genetic engineering outweighing the benefits ($p<0.01$ for all pairs). Oneway ANOVA found significant variance across all participants ($F=21.87$, $p<0.01$). NGO participants also have a significant negative regression coefficient ($t=-8.19$; $p<0.01$). Variance across only participants from regulatory agencies also is significant ($F=4.01$; $p=0.04$), but the Scheffe test did not identify any significant differences between means. The regression coefficient for FDA is positive and significant ($t=2.53$; $p=0.023$).

On the issue of overall support for genetic engineering, variance is again significant ($F=11.55$; $p<0.01$), and participants from NGOs are significantly less supportive than are participants of any other group ($p<0.01$ for all groups) and have a significant negative regression coefficient ($t=-6.11$; $p<0.01$). Differences among participants from regulatory agencies are not significant.

Similarly, the variance across all participant groups is significant on whether health risks outweigh the benefits of genetic engineering ($F=4.98$; $t=0.00$). The mean response of NGO participants is significantly lower than that of participants from the EPA ($p=0.040$, FDA ($p=0.01$), and USDA ($p=0.04$) and has a significant negative regression coefficient ($t=-3.45$; $p<0.01$). Once again, there are no significant differences among participants from regulatory agencies.

Participants from NGOs view the risk to the environment from genetic engineering as greater than the potential benefits. Considering all participants, variance is significant ($F=9.06$, $p<0.01$), and the mean score of NGO participants is significantly lower than that of the participants from EPA ($p<0.01$), FDA ($p<0.01$), USDA ($p<0.01$) and students ($p=0.03$). Regression coefficients are significant and negative for participants from NGOs ($t=-4.90$; $p<0.01$) and for students ($t=-2.17$; $p=0.40$). Differences among participants from regulatory agencies are not significant.

Looking at the means scores across all the items in this group, the variance is significant for all participants ($F=16.09$; $p<0.01$), but not for participants from regulatory agencies when looked at separately from the NGO and student participants. Overall, the mean score for NGO participants is significantly lower than for all other groups ($p<0.01$

for all groups). The regression coefficient is significant and positive for FDA (t=2.21; p=0.04) and negative for participants from NGOs (t=-1.26; p<0.01).

Variance in the overall scale for support of biotechnology is significant for all participants (F=14.61; p<0.01) and when considering only participants from regulatory agencies (F=f.85; p=0.24). The mean score for participants from NGOs is significantly lower than that of participants from EPA, FDA, and USDA (p<0.01 for all three groups) and students (p<0.01). Students' mean score is significantly lower than that of FDA (p=0.02) and USDA (p=0.04) participants. When including all participants, regression coefficients are positive and significant for FDA (t=2.48; p=0.02) and USDA (t=2.11; 0.04) participants, and negative for participants from NGOs (t=-5.80; p<0.01). The Schaffe test did not identify significant differences between the mean scores of participants from the three regulatory agencies, but regression coefficients are significant for FDA (t=2.64; p=0.02) and USDA (t=2.24; p=0.04) participants. The adjusted r^2 of the scale is 0.66 for all participants and 0.31 for regulatory participants only.

As shown in Table 44, all groups reported scientific/technical and professional sources as their main sources of information about biotechnology. Total variance for national newspapers was significant (F=6.04; p<0.01), and students rated national newspapers as a significantly less important source of information than did EPA (p=0.01) and NGO participants (p=0.03). There is also significant variance in the degree to which scientific conferences, workshops, and meetings are important sources of participants' information about biotechnology (F=4.19; p=0.01), with the mean rating of students significantly less than that of EPA participants (p=0.02), with a significant negative regression coefficient (t=-3.71; p<0.01). On the other hand, total variance on the importance of classroom and other formal instruction is also significant (F=0.81; p=0.01), with students obviously finding these a more important source of information, significantly more important than participants from FDA (p=0.01) and NGOs (p=0.01). There are significant negative regression coefficients for FDA participants (t=-2.35; p=0.27) and participants from NGOs (t=-2.64; p= 0.01), and a positive coefficient for students (t=2.47; p=0.02). Differences between other information sources are not significant.

Table 44. Source of information on biotechnology (mean ratings)

	Means (range=1-4)					
Source of Information on Biotechnology	EPA	FDA	USDA	NGO	Student	All
Scientific/professional journals and magazines	3.8	3.7	4.0	4.0	3.2	3.7
Colleagues, co-workers, fellow students	3.6	3.7	4.0	4.0	3.2	3.6
Scientific conferences/workshops/meetings	3.5	3.0	3.5	3.5	2.0	3.0
National newspapers	3.2	2.7	3.3	4.0	1.8	2.8
University web sites	2.7	2.0	3.0	3.0	2.2	2.6
Your own research or first-hand experience	2.8	2.0	3.8	2.0	1.9	2.5
Classes/formal instruction	2.4	1.3	2.8	1.0	3.1	2.4
Television science programs	2.2	2.3	2.3	2.0	2.3	2.2
Radio news	2.5	2.7	2.3	2.0	1.6	2.1
Non-profit organization web sites	2.1	1.7	2.3	3.5	2.0	2.1
Television news	2.1	2.0	2.0	1.5	2.3	2.1
Local newspapers	2.3	1.3	2.0	2.5	1.4	1.9
Activist-run web sites	1.8	1.3	2.0	1.0	1.4	1.6

Analysis of Relationships among Dependent and Independent Variables

Similar to Stern, Dietz and Guagnano (1995a), I statistically analyzed the results of the survey (including demographic information) and the Q analysis to explore associations between independent social structural (demographic) variables, psychological variables, and dependent variables that reflect participants' opinions on biotechnology.[119] Once again, the small number of participants in this study limits the use and validity of many statistical analyses and severely limits their external validity. Therefore, these results should be considered preliminary and exploratory.

Rather than including all independent structural variables in multivariate analyses (because of insufficient degrees of freedom), I used linear regression to analyze groups of independent structural variables which I believed would likely be collinear. I also regressed all scales and factor loadings against:

- Fixed structural variables (gender, ethnicity, type of community where the participant was raised),
- Political/theological variables (political party affiliation, political leaning, religion, religiousness, belief in a supreme being)
- Socio-professional variables (age, income, biotechnology expertise, education, discipline).

[119] This approach follows closely that advocated by Stephenson: "[O]ne of the great services performed by the new technique [Q Method] of correlating persons [is that] it allows us to construct tests with *known* factor contents, and these again can be applied in due course by the older technique of correlation tests." Stephenson 1935a

Regression on the normative belief scale of ethnicity, gender, and type of community where participants were raised is significant ($F=-3.70$; $p=0.02$) with a significant negative coefficient for non-whites ($t=-3.63$; $p<0.01$), reflecting the perspectives of the 3 nonwhite (1 Asian and 2 Hispanic) participants in the study. There are no significant effects of these variables identified on beliefs or attitudes on biotechnology or on Q sort factor loadings.

Regression on the complete NEP scale score of political leaning, political party affiliation, religion, religiousness, and faith in a supreme deity shows a significant influence ($F=3.13$; $p=0.02$) with a significant negative coefficient for being a member of the Republican Party ($t=2.14$; $p=0.05$). Regression against the NEP Fragile Planet subscale is significant ($F=3.46$; $p=0.01$) with significant negative coefficients for membership in the Republic Party ($t=-2.43$; $p=0.03$), being a non-believer in a higher being ($t=-2.48$; $p=0.02$), and a significant positive coefficient for attending religious services at least several times a year ($t=2.40$; $p=0.03$). The effects of these variables on the social altruism subscale is significant ($F=2.83$; $p=0.03$) with significant positive coefficients for Jewish ($t=2.23$; $p=0.04$), nonbelievers ($t=3.11$; $p<0.01$), and Christians ($t=2.59$; $p=0.02$), and participants who worship at least several times a year ($t=2.12$; $p=0.05$). The regression also indicates a significant association with overall satisfaction with actors in the biotechnology arena ($F=2.36$; $p=0.05$) and a significant positive coefficient with participants who consider themselves non-believers ($t=2.16$; $p=0.04$). No significant effects of these variables are indicated on beliefs or attitudes on biotechnology or on Q sort factor loadings.

Regressing age, discipline, education level, income, expertise and years of experience with genetic engineering indicates a significant effect on the NEP Fragile Planet subscale ($F=4.77$; $p=0.01$), with significant coefficients for participants age 45-60 ($t=-2.19$; $p=0.05$), a positive coefficient for the one participant who has a public health discipline ($t=2.27$; $p=0.05$), and a positive coefficient for participants with doctoral degrees ($t=2.58$; $p=0.03$). A significant influence is also identified for Schwartz's self-interest value subscale ($F=3.20$; $p=0.03$), with a significant negative coefficients for participants younger than 30 years ($t=-2.21$; $p=0.05$) and participants with policy and law disciplines ($t=-2.33$; $p=0.04$), and significant positive coefficients for participants earning $40,000-$100,00 per year ($t=4.87$; $p<0.01$), $100,001- $150,000 per year ($t=2.81$, $p=0.02$) and more than $150,000 per year ($t=2.51$; $p=0.03$). A significant effect is also seen on the perceptions of risks and benefits for genetically modified organisms ($F=3.46$; $p=0.02$) with significant coefficients associated with participants age 45-60 ($t=2.92$; $p=0.01$) and a significant negative coefficient for the participant with a law degree ($t=-2.43$; $p=0.03$). These findings are consistent with those of Stern et al.(1999)

Regression of these variables on Q Factor 2 (Cautious Optimism) is significant ($F=4.51$; $p<0.02$), but no significant coefficients are identified. Regression on Q Factor 4 (Factual) is also significant ($F=3.58$; $p=0.02$). Significant negative coefficients are found for participants in agricultural sciences ($t= -3.64$; $p<0.01$) and genetics/biotechnology ($t=-4.22$; $p<0.01$), participants holding masters ($t=-2.71$; $p=0.22$) and law degrees ($t=-3.11$; $p=0.01$), and participants with less than one year of experience related to biotechnology ($t=-3.43$; $p=0.01$). Positive coefficients are observed for participants who are familiar with biotechnology ($t=3.36$; $p=0.01$) and who consider themselves experts ($t=3.58$; $p<0.01$).

I also regressed each scale against the others and against the Q factor loadings. The support of science scale (which reflects statements with implications for restricting research) significantly predicts the support for biotechnology scale ($F=23.57$; $p<0.01$) with a positive coefficient ($t=4.86$; $p= 0.0$) and an adjusted r^2 of 0.45. The effect is smaller but still significant when considering only participants from federal regulatory agencies ($F=4.32$; $p=0.05$), with a positive coefficient ($t=2.08$; $p=0.05$)) and an r^2 of 0.21. Participants' overall optimism for technologies also significantly predicts their support for biotechnology ($F=9.85$; $p<0.01$). The coefficient is positive ($t=3.14$; $p<0.01$) and the adjusted r^2 is 0.24. Using multivariate regression, the support for science scale and overall mean optimism toward technologies scale has an r^2 of 0.56 ($F=16.82$; $p<0.01$). The effect is not significant when considering only participants from regulatory agencies. Multivariate regression of the support for science scale against all Q analysis factor loadings is significant for Factor 1 (Positivism) ($F=7.28$; $p=0.01$), with a positive and significant coefficient ($t=2.70$). In contrast, Factor 3 (Unfulfilled Promises), on which the two participants from NGOs loaded, is almost significant ($F=4.00$; $p=0.06$) with a negative coefficient ($t=-2.00$) and a r^2 of 0.13. The mean support for technology significantly predicts regulatory participants' loading on Q Factor 4 (Factual) ($F=11.20$; $t=0.00$) with an r^2 of 0.41 and a negative regression coefficient ($t=-3.35$; $p<0.01$).

Multivariate regression of the different subscales from Schwartz's value clusters on the complete NEP scale and the two subscales (Fragile Planet and Shared Planet) yields significant findings for the complete NEP scale ($F=4.08$; $p=0.01$) and for the Shared Planet subscale ($F=4.31$; $p= 0.01$). The eco-altruism subscale has a significant positive coefficient on the complete NEP scale ($t=3.44$; $p<0.01$) and on the Shared Plant subscale ($t=4.33$; $p<0.01$).

The Normative Beliefs Scale significantly predicts the Fragile Planet scale ($F=7.80$, $p=0.01$, adjusted $r^2=0.19$) and has a significant coefficient of 0.5 ($t=2.29$). Normative beliefs also predict the complete NEP scale ($F=7.96$; $p=0.01$) with a positive coefficient ($t=2.82$; $p=0.01$) and an r^2 of 0.23, but do not significantly predict the Shared Planet subscale ($f=3.63$; $p=0.07$).This effect also is sustained when considering only participants from regulatory agencies ($f=4.50$; $p=0.05$). The coefficient is positive and significant ($t=2.12$) with an r^2 of 0.22. While findings of a relationship between normative beliefs and the NEP worldview are consistent with the findings of Stern et al. (1999), these results suggest that future research may need to reevaluate the NEP as a single factor scale.

11. CONCLUSIONS

The results of the Q sort, interviews, and survey provide a deep view of biotechnology discourses within the U.S. regulatory system and an insightful glimpse of the social forces that shape bureaucratic culture. The characterization of the Q statements according to Habermas' categories of implicit validity claims proved useful. Although the number of statements of each type of validity claim is unequal, the relative proportion with which participants agree versus disagree is a measure of the legitimacy participants place on each type of preposition/validity claim. Table 45 provides the differences between those statements with which participants most and least agreed (the most salient statements) according to the type of implicit validity claim of each statement.

Table 45. Legitimacy of validity claim in biotechnology discourses

	Factor					
	1	2	3	4	5	6
Preposition Validity Claim	Positivism	Cautious Optimism	Unfulfilled Promises	Factual	Critical	Balance
Purposive-rational	6	3	0	3	-2	-1
Normative	-4	-4	1	-2	1	0
Esthetic-Expressive	0	1	-1	-1	1	1

For each statement type, numbers are the differences between the number of statements rated greater than +3 and those rated less than -3.

It is clear by looking across the columns in Table 45 that a defining characteristic of each factor is the relative legitimacy given to each type of validity claim. Factor 1, which I label "Positivism," is characterized by an embracing of purposive-rational prepositions and a strong rejection of normative validity claims. Other factors deviate in the extent to which they accept or reject purposive-rational and normative statements. The interview statements made by some participants that they disagreed with many statements because they expressed opinions, rather than facts, reinforce this conclusion. In essence, normative claims are excluded from these participants' definition of rationality; the fundamental legitimacy of the claims as legitimate input into decisionmaking is rejected in favor of "facts," defined as what Mary Poovey calls, "a set of deracinated particulars" (1998:9). All but a few of the participants from the regulatory agencies loaded significantly on this factor (Table 46). All participants from USDA, and 2 out of the 3 participants from FDA loaded on this factor.

Table 46. Participants' distribution on Q sort factors, by organization

	Factor						
	1	2	3	4	5	6	
	Positivism	Cautious Optimism	Unfulfilled Promises	Factual	Critical	Balance	Total
EPA	10			1	1		12
FDA	2					1	3
USDA	4						4
NGO			2				2
Students	3	4		1	1	1	10
Total	19	4	2	2	2	2	31

Laffont and Tirole's theory of regulatory capture predicts that agencies with few, powerful stakeholders will evolve an internal incentive system that will produce relatively homogeneous cultures to reflect the stakeholder's interests. Agencies with more diverse stakeholders will have a more heterogeneous culture. The review of the literature, policies, and agency data indicates that from an industry stakeholder perspective, FDA and USDA have far more "efficient' regulatory systems than does EPA (see note 81). Arguably, the systems the USDA and FDA have established to oversee biotechnology reflect their mission orientation, as articulated in their planning and budget documents, to support agricultural and food and beverage industry interests while ensuring a safe and abundant food supply. EPA participants are spread over 3 factors, FDA over only 2, and all USDA participants load on just Factor 1, seemingly consistent with the predictions of agency capture theory.

Taking these observations by themselves, one might be tempted to accept Laffont and Tirole's hypothesis: the vast majority of participants from the regulatory agencies all load onto one factor that its face is very supportive of biotechnology and the current regulatory system, and the agency predicted to have the most diverse subculture loaded onto more factors than those agencies predicted to have more homogeneous cultures. There are several practical and theoretical problems with accepting this theory based on this evidence.

One difficulty is determining what constitutes "capture" and how to assess outcomes of any subsequent incentive system. Although the number of participants in this study represents a significant portion of the target population, the target population is really very small, and one would need a near census to draw definitive conclusions. To demonstrate the effect of agency capture on an organization's internal incentive structure, is it sufficient to demonstrate that one individual decided to leave the organization because, in part, she/he was dissatisfied with a position or policy decision she/he viewed as adopting an industry position? What about 2 people, or 10? Or what about the one FDA participant who loaded onto Factor 6? Does the FDA's continued support of an individual whose views diverge from colleagues' views argue against a theory that stakeholders influence the internal culture of the agency? In my opinion, these questions are unanswerable; to do so would require understanding the motives underlying the career decisions of every individual who ever worked for an organization, the individual's satisfaction with the organization's policies and positions, and the rationale for every personnel decision made by the organization to account for possible selective hiring, promotion, raises, recognition, and discipline.

Another confounding issue is that while the factors from the Q analysis represent different points of view, they also share many common features. The factors are not mutually exclusive and several are moderately correlated with each other. The r^2 of Factors 1, 4, and 6 are between 0.42 and 0.45. All factors on which participants from regulatory agencies loaded share general support for biotechnology and, with some caveats, express confidence in the overall adequacy of the regulatory process.

Notwithstanding the arguments to the contrary, some of the results are consistent with the possibility that the culture at EPA may be different from the culture at USDA and FDA. The overall support of EPA participants for biotechnology may be a bit softer than the support of colleagues at USDA and FDA, and EPA participants are more supportive of labeling. While the culture at EPA may be different, cultural differences may arise from a number of influences and the limited number of participants in the study precludes any definitive conclusions.

The agency capture model rests on several implicit assumptions: that the individuals who comprise these institutions have little or no influence on policy; that their values and beliefs are malleable in response to externally imposed incentive systems; and that external pressure is the predominate influence on organizational culture. There are several compelling arguments to support a conclusion that the values and beliefs of regulators are influences by much more than the influence of external stakeholders on organizational incentive structures.

First, when asked if and how their opinions about genetically modified organisms have changed over time, virtually all participants from the regulatory agencies stated either that their opinions had not changed, or that their opinions had been reinforced by experience. Also, participants from the regulatory agencies referred to their experience and their acquired knowledge about the science underlying genetically modified organisms and the regulatory system to deepen their understanding, and in most cases their confidence, in the safety of biotechnology and the adequacy of the regulatory system. One might expect that at least one of the participants from regulatory agencies would have alluded to external pressure, internal sanctions, or incentives had any been at play.[120] While in the course of the Q sorts and interviews I did hear about a few people who had left federal agencies to pursue positions with consumer activist organizations, I never got the impression that there was widespread dissatisfaction with agency policy or positions. To the contrary, participants generally expressed support for their organizations. Third, when looking across all the survey data, the most remarkable finding is the lack of significant differences across any group on the NEP, Schwartz's values cluster scales, or the Normative Belief scale. One would certainly expect to observe some differentiation if the personal values and beliefs of participants were capable of being influenced by organizational incentives systems. Building on these points, it is plausible that all participants are heavily vested in and identify with a model of science based on teleological rationality that was probably developed in primary and secondary schools and reinforced in higher education. This hypothesis is strongly supported by the relationship I identified between support for unrestricted research, overall optimism toward technologies, and support for biotechnology. The common responses to the social psychological items in the survey may reflect common underlying values that were and continue to be influential in the participants' academic and career choices, whether or not they agree on specific technologies and their consequences.

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[120] It is possible that given the long federal tenure of the majority of the participants in the study, those who would have left as a result of any externally induced internal incentive systems would already have done so. I believe this is unlikely, however, given the candidness of the interviews and the diversity, even if limited, of opinions, values, and beliefs that are observed among the participants.

From a theoretical perspective, the attempt to apply macroeconomic theory on institutional behavior and membership likely oversimplifies the complexity of institutions, their legal frameworks and mandates, and the social systems that operate and interface internally and externally with the organization's members. That is not to say that the theory of agency capture lacks validity. Certainly in a democratic society, one expects and desires the institutions of government to be responsive to the public, including public corporations and consumer advocates who may have competing agendas, and certainly each stakeholder will be expected to use its influence on regulatory agencies. Consequently, a theory that describes the intended behavior of a democratic society is of questionable utility. The danger of accepting the validity of this model is that it has little utility for improving public policy or government institutions to more effectively engage and balance competing interests.

Taking all the data from this study as a whole, the weight of evidence supports a different model. As an analytical framework, I modified the causal model developed by Slimak and Dietz (2006) and Slimak (2003) to include the communicative lifeworld described in Habermas' *Theory of Communicative Action* (Figure 11). The modified model builds on the value-belief-norm system by integrating Habermas' concept of the lifeworld as the primary integrative social subsystem. The revised model illustrates how the cultures of formally organized government regulatory agencies may be influenced by purposive-rational steering media (money, power), both indirectly through external pressure brought about by agency capture, as well more directly through the ubiquitous processes of colonization and reification of the communicative lifeworld, from which members of the regulatory are not exempt. In fact, the disciplinary training necessary to actively and effectively participate in the regulatory process likely accelerates and intensifies the reification process.

Implications for Policy

Although participants' responses to value and normative items on the survey varied, statistically they were not significantly different. All participants, including those from NGOs, identified with the New Ecological Paradigm and shared common normative beliefs and values. I posit that these results may be associated with the participant's choices (or aspirations) of careers as environmental scientists, policy analysts, public servants, and consumer advocates. These findings may provide a fruitful ground for outreach and communication, building on a common set of core values and normative beliefs. Of special interest is the awareness that different actors embrace different types of validity claims. Efforts to bridge policy divides could begin with an acknowledgement of the legitimacy of different types of validity claims, a necessary prerequisite to developing an intersubjective understanding of issues and concerns that can lead to a solution based on and derived from communicative rationality. As a start, I intend to provide all participants with an abbreviated version of this study.

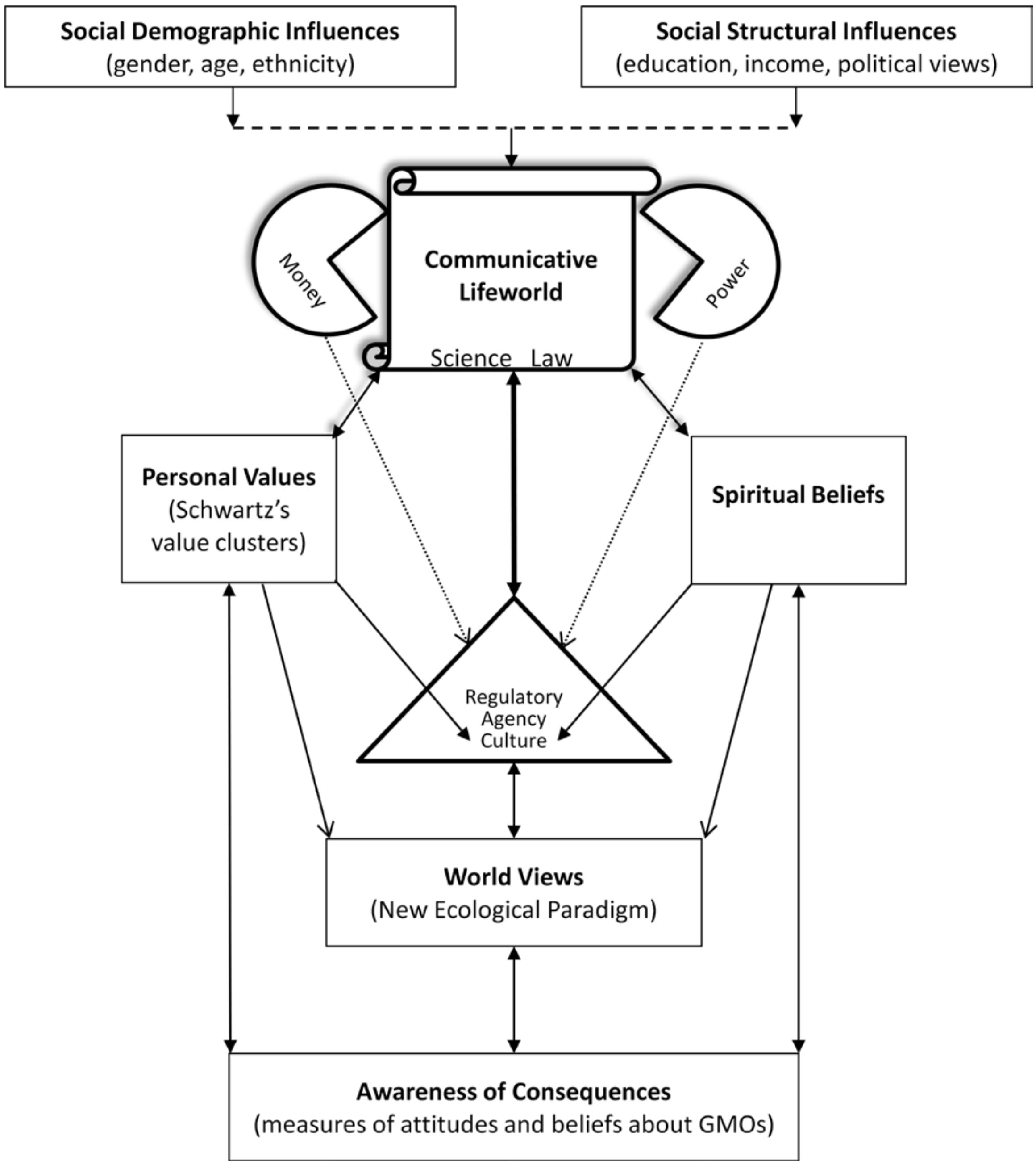

Figure 11. Modified causal model showing complex relationship between social subsystems.

Adapted from Slimak and Dietz (2006) and Slimak (2003). As they noted, social demographic influences are generally fixed, but may directly affect social structural influence. Both social demographic and social structural influences indirectly affect social psychological influences (personal values, normative beliefs) through the lifeworld, and which therefore are not fixed. The illustration highlights the importance of the communicative lifeworld and the colonization of purposive-rational steering media on both the lifeworld and the legally structured regulatory agency.

Implications for Additional Analyses

The results of the analysis in this dissertation provide insight into the influence of bureaucratic culture on regulatory decision making, Further, the results provide empirical data to evaluate theories of bureaucratic behavior and the effects of incentives on the culture of regulatory agencies and to gain possible insight into the extent that teleological/instrumental/purposive rationality has colonized other the social lifeworld of participants in the regulatory system. A thorough understanding of these relationships, however, also would require additional quantitative and qualitative analysis of a variety of information-sources, such as:

- Corporate and NGO annual reports
- Regulatory agency Congressional budget justifications, budgets, and Congressional Committee reports
- Federal notice of and comments on proposed rulemakings
- *Federal Register* notices of public meetings, hearings, and workshops
- Court filings and records of litigation (using LEXIS/NEXIS)
- Code of Federal Regulation chapters relevant to GMO regulation (e.g., Federal Plant Pest Act; Federal Insecticide, Fungicide and Rodenticide Act; Federal Food, Drug and Cosmetic Act; Toxic Substances Control Act)

Given the international political rancor over agricultural biotechnology, it would also be interesting to use my methodology to compare discourses identified in the United States with discourses in Europe and other regions. Such an effort outside of English-speaking countries would require appropriate translation to ensure faithful and consistent communication across languages and cultures.

Two of the more interesting findings were the identification of two distinct factors within the NEP, which I named Fragile Planet and Shared Planet. These two differ in the types of validity claims they assert. Fragile Planet asserts purposive-rational claims about the consequences of human action on the environment. Shared Planet asserts normative claims about the rights of humans and nature. Future research can determine how robust the findings of this study are within a larger population. Similarly, I found two distinct factors for Schwartz's altruism value cluster scale. The social and ecological altruism scales may be tapping into different underlying values, supported by the findings of association with the different subscales I identified in the NEP. These should provide fruitful topics for further environmental sociology research projects.

A significant and unexpected finding was the strong relationship between the support for science (for unrestricted research), technologies, and biotechnology. Additional research is needed to understand the underlying psychosocial dimensions of these findings and whether they are replicated among larger and more diverse populations.

Finally, Habermas' *Theory of Communicative Action* as an analytical framework was useful and provided additional insight into the different discourses held by study participants. Future research, including survey research, could build off this approach and the study's results by using the *Theory of Communicative Action* as a basic framework for study design and interpretation and in further refining the value-belief-norm theory.

APPENDIX A: COMPLETE Q STATEMENTS AND TOPOLOGY

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
1. Allergies are only minor inconveniences.	Allergies	Dismissive of problem	Normative	Progress	Agrifood (‘green’)	Independent science	Pro	(Regal, 1999)
2. GM foods could pose some potentially serious allergenic and toxic reactions among consumers.	Allergies	Health risk	Purposive-Rational	Pandora’s Box	Agrifood (‘green’)	Interest groups, NGOs	Anti	(Rifkin, 2001)
3. Modern biotechnology can be used to reduce the allergenic risks associated with our current food supply.	Allergies	Technological solution	Purposive-Rational	Progress	Agrifood (‘green’)	Independent science	Pro	(National Research Council, 2000)
4. The allergenic potential of newly introduced microbial proteins is uncertain, unpredictable, and untestable.	Allergies	Uncertainty of risk	Purposive-Rational	Pandora’s Box	Generic research	Independent science	Anti	(Regal, 1999)
5. The safety assessment of a recombinant DNA-modified organism should be based on the nature of the organism and the environment into which it will be introduced, not on the method by which it was modified.	Assessment	Appropriate risk endpoints	Purposive-Rational	Progress	Regulation	Business	Pro	(Leisinger, 1998)
6. Transgenic pest-protected plants should not only be compared to the use of chemicals, but also to alternative methods such as biological control.	Assessment	Comparative risk	Normative	Public accountability	Public Opinion/ policy	Independent science	Pro	(National Research Council, 2000)
7. Biotechnology can help farmers increase crop yields and feed even more people.	Benefits	Farmers	Purposive-Rational	Progress	Agrifood (‘green’)	US	Pro	(U.S. Department of State, 2003a)
8. Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	Benefits	Food	Esthetic-Expressive	Runaway	Agrifood (‘green’)	Business	Pro	(Biotechnology Industry Organization, 2000)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
9. Environmental biotechnology products make it possible to more efficiently clean up hazardous waste without the use of caustic chemicals.	Benefits	Hazardous waste cleanup	Purposive-Rational	Progress	Generic research	Business	Pro	(Biotechnology Industry Organization, 2000)
10. Researchers are creating ways to boost the nutritional value of foods using biotechnology.	Benefits	Nutrition	Purposive-Rational	Progress	Agrifood ('green')	US	Pro	(U.S. Department of State, 2003a)
11. Biotechnology can help farmers reduce their reliance on insecticides and herbicides.	Benefits	Reduced pesticide use	Purposive-Rational	Progress	Agrifood ('green')	US	Pro	(U.S. Department of State, 2003a)
12. Agricultural biotechnology products, like modified pulp trees for use in paper production, will allow manufacturers to use less water and other natural resources, and to produce less waste from the production stream, while producing higher-quality materials.	Benefits	Resource conservation	Purposive-Rational	Progress	Agrifood ('green')	Business	Pro	(Biotechnology Industry Organization, 2000)
13. Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	Benefits	Safer biopesticides	Purposive-Rational	Progress	Agrifood ('green')	Business	Pro	(Biotechnology Industry Organization, 2000)
14. We can be pleased with ourselves that, in the U.S., we've really been the leaders in developing the new technology and implementing it safely in this country.	Benefits	Technology leadership	Purposive-Rational	Economic prospect	Economics	Independent science	Pro	(Arntzen, 2001)
15. Gene technology can expand our options to improve our health, create a safer, more secure food supply, generate prosperity and attain a more sustainable agriculture.	Benefits	Welfare	Purposive-Rational	Progress	Generic research	Media, public opinion	Pro	(Environment News Service, 2001)
16. The American consumer probably cares more for cheap food … than about the ecology.	Consumer preferences	Price	Normative	Ethical	Agrifood ('green')	Business	Anti	(Muller, 2001)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
17. Consumers have a perfect right to chose and eat transgenic foods if they so wish.	Consumer preferences	Right-to-know	Normative	Ethical	Moral issues	EU	Anti	(Busquin, 2000)
18. Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical and emotional reasons.	Consumer preferences	Varying factors	Normative	Progress	Public Opinion/ policy	Interest groups, NGOs	Pro	(Mourin, 1998)
19. Biotechnology has developed in a way that has forced government agencies to choose between democratic principles and the technological vision of an elite group of scientists and entrepreneurs.	Credibility	Democratic government	Normative	Public accountability	Moral issues	Independent science	Anti	(Regal, 1999)
20. All of our major universities are tied into all sorts of contractual relationships and consulting relationships with the life science companies.	Credibility	Universities	Purposive-Rational	Economic prospect	Moral issues	Interest groups, NGOs	Anti	(Rifkin, 2001)
21. The problem is, the benefits are always here and now. The costs always come later.	Fairness	Inter-generational equity	Normative	Ethical	Moral issues	Interest groups, NGOs	Anti	(Rifkin, 2001)
22. Developing countries should have access to any technologies that we have here.	Fairness	Intra-generational equity	Normative	Globalization	Moral issues	Business	Anti	(Muller, 2001)
23. Nearly everything that the human race will be eating will soon be produced from genetically engineered plants and animals.	Feed the world	inevitability	Purposive-Rational	Runaway	Generic research	Independent science	Pro	(Regal, 1999)
24. Biotechnology has tremendous potential to help fight hunger.	Feed the world	Potential	Purposive-Rational	Progress	Agrifood ('green')	US	Pro	(U.S. Department of State, 2000)
25. There is no need for genetically engineered organisms for feeding the world or solving nutritional deficiency problems.	Feed the world	Unnecessary	Normative	Globalization	Moral issues	Interest groups, NGOs	Anti	(PSRAST, 2003)
26. Pollen from genetically engineered plants will inevitably be spread from one field to another.	Gene flow	Contamination of non-GE crops	Purposive-Rational	Pandora's Box	Agrifood ('green')	Independent science	Anti	(Regal, 1999)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
27. Eventually, it could be possible to reduce gene flow from cultivated plants with various containment methods.	Gene flow	Technology solution	Purposive-Rational	Progress	Agrifood ('green')	Independent science	Pro	(National Research Council, 2000)
28. Concerns about genetically modified crops arise mainly when novel, beneficial traits have the potential to spread to wild populations and cause them to become more invasive and difficult to control.	Gene flow	Weeds	Purposive-Rational	Pandora's Box	Agrifood ('green')	Independent science	Anti	(National Research Council, 2000)
29. Existing laws are for the most part adequate for oversight of biotechnology products.	Government Oversight	Adequate oversight: laws	Normative	Public accountability	Public opinion/ policy	Independent science	Pro	(National Research Council, 2000)
30. Genetically engineered foods are thoroughly tested before they are allowed onto the market.	Government Oversight	Adequate oversight: testing	Purposive-Rational	Public accountability	Regulation	Independent science	Pro	(Regal, 1999)
31. We can expect that in the future genetically engineered food will be developed and grown in many countries, many of them with no premarket safety reviews.	Government Oversight	Inadequate in developing countries	Purposive-Rational	Runaway	Public opinion/ policy	Interest groups, NGOs	Anti	(Mourin, 1998)
32. There's not really much monitoring of this technology once it's released into the environment or into the food supply.	Government Oversight	Inadequate monitoring	Normative	Public accountability	Regulation	Interest groups, NGOs	Anti	(Margulis, 2001)
33. Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	Government Oversight	Inadequate assessments	Purposive-Rational	Progress	Regulation	Independent science	Anti	(National Research Council, 2000)
34. The scientific education of genetic engineers and regulators has been inadequate even to understand the technical challenges of biosafety, let alone to take appropriate precautions and conduct science-based testing.	Government Oversight	Inadequate expertise	Normative	Public accountability	Moral issues	Independent science	Anti	(Regal, 1999)
35. Genetically engineered foods are not being regulated and could enter the food supply without oversight.	Government Oversight	Inadequate regulation	Purposive-Rational	Public accountability	Regulation	Independent science	Anti	(Regal, 1999)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
36. Because [GMOs} may present risks, they should be carefully regulated.	Government Oversight	Mandate for regulation	Normative	Public accountability	Regulation	Interest groups, NGOs	Anti	(Rissler, 2001)
37. It has proved impossible to develop government regulatory programs that are truly science-based and not compromised by political pressures.	Government Oversight	Political pressure	Normative	Public accountability	Regulation	Independent science	Anti	(Regal, 2001)
38. Ultimately, the credibility of the regulatory process depends on the public's ability to understand the process and the key scientific principles on which it is based.	Government Oversight	Public understanding	Normative	Progress	Regulation	Independent science	Pro	(National Research Council, 2000)
39. Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	Government Oversight	Regulatory costs	Purposive-Rational	Economic prospect	Regulation	Independent science	Pro	(National Research Council, 2000)
40. The U.S.'s food safety regulatory system is head and shoulders above anybody else's in the world.	Government Oversight	Superior US laws	Normative	Public accountability	Public opinion/ policy	Politics	Pro	(Glickman, 2001)
41. Some people in the agencies fear that they would be punished or even fired if they raised problems for biotech.	Government Oversight	Whistle-blower, fear of reprisal	Normative	Public accountability	Moral issues	Independent science	Anti	(Regal, 1999)
42. The threat of law suits will cause the biotech industry to try their best to market safe food.	Incentives	Litigation risk	Purposive-Rational	Economic prospect	Agrifood ('green')	Independent science	Pro	(Regal, 1999)
43. Biotechnology is a high-pressure, competitive enterprise. There are always pressures to cut costs and move quickly to commercialization.	Incentives	Profit motive	Purposive-Rational	Economic prospect	Economics	Independent science	Anti	(Regal, 1999)
44. Life science companies are turning seeds into intellectual property, so they have a virtual lock on the seeds upon which we all depend for our food and survival.	Intellectual property rights	Unfair competitive advantage	Normative	Ethical	Moral issues	Interest groups, NGOs	Anti	(Rifkin, 2001)
45. Genes are a discovery, they should not be patented	Intellectual property rights	Genes are discoveries	Normative	Ethical	Moral issues	EU	Anti	(Busquin, 2000)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
46. It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	Labeling	Difficult to isolate GEs	Purposive-Rational	Economic prospect	Agrifood ('green')	US	Pro	(Maryanski, 2001)
47. People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	Labeling	Right-to-know: food	Normative	Ethical	Moral issues	Independent science	Anti	(Hotchkiss, 2001)
48. To put a label on biotech foods, a mandatory label, would be an indication that something is wrong.	Labeling	Stigma	Purposive-Rational	Economic prospect	Regulation	Business	Pro	(Grabowski, 2001)
49. The industry is not forced to prove relative safety. Rather, the burden of proof is on people like us to show that there's some risk	Liability	Burden of proof: Industry	Normative	Public accountability	Public opinion/ policy	Interest groups, NGOs	Anti	(Rissler, 2001)
50. It could be difficult or impossible to isolate a problem and prove its GMO related cause in a court against highly paid defense attorneys.	Liability	Difficult to relate causality	Normative	Runaway	Moral issues	Independent science	Anti	(Regal, 1999)
51. Virtually all of our foods have been genetically modified.	Not really different	Foods	Purposive-Rational	Progress	Agrifood ('green')	Independent science	Pro	(Hotchkiss, 2001)
52. Genetically engineered organisms are not fundamentally different from nonmodified organisms.	Not really different	GE organisms	Purposive-Rational	Progress	Public opinion/ policy	Independent science	Pro	(National Research Council, 2000)
53. It is not for a human being to modify the basic laws of nature.	Playing God	Laws of nature	Normative	Ethical	Moral issues	Politics	Anti	(Glickman, 2001)
54. It is not right to exploit a technology which may give rise to unexpected substances that may be damaging to health, before this risk has been carefully investigated.	Precautionary principle	Inadequate science: health risks	Normative	Ethical	Moral issues	Interest groups, NGOs	Anti	(PSRAST, 2003)
55. There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	Precautionary principle	Need for further debate	Normative	Public accountability	Regulation	Interest groups, NGOs	Anti	(Campbell, 2000)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
56. If you made people aware and knowledgeable about genetic foods, they would tend to be more supportive.	Public dialogue	Awareness	Purposive-Rational	Progress	Public opinion/ policy	Interest groups, NGOs	Pro	(Rifkin, 2001)
57. Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	Public dialogue	NGO motives	Normative	Progress	Public opinion/ policy	Business	Pro	(Grabowski, 2001)
58. These genetically engineered foods have never been subject to long-term testing, and yet there are millions of acres of them growing in the United States and pervading the food system here.	Risk	Inadequate science: Food	Normative	Runaway	Agrifood ('green')	Interest groups, NGOs	Anti	(Margulis, 2001)
59. We are being put in jeopardy. We are guinea pigs in this experiment.	Risk	Involuntary mass experiment	Normative	Runaway	Public opinion/ policy	Interest groups, NGOs	Anti	(Rifkin, 2001)
60. Conventional agricultural activity entails certain environmental and ecological risks.	Risk	Not really different: Ecological risk	Purposive-Rational	Pandora's Box	Agrifood ('green')	Independent science	Pro	(Westwood and Traynor, 1999)
61. We have looked very carefully at the use of recombinant DNA techniques, and we do not have any information that the simple use of the techniques creates a class of foods that is different in safety or quality from foods developed by other methods of plant breeding.	Risk	Not really different: Food risk	Purposive-Rational	Progress	Agrifood ('green')	US	Pro	(Maryanski, 2001)
62. You can't prove that any new technology that we have in the world today is absolutely safe.	Risk	Necessary for progress	Normative	Progress	Public opinion/ policy	Interest groups, NGOs	Pro	(Conway, 2001)
63. Risks - calculable risks - must be taken, otherwise technological progress becomes impossible.	Risk	Necessary for progress	Purposive-Rational	Progress	Economics	Business	Pro	(Leisinger, 1998)
64. Organic farmers are very concerned, because these (GM) crops are a major threat to organic farming.	Risk	Threat to organic farming	Purposive-Rational	Economic prospect	Agrifood ('green')	Interest groups, NGOs	Anti	(Margulis, 2001)

Q Statement	Topic	Sub-topic	Preposition	Frame	Theme	Actor	Posi-tion	Source
65. GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	Risk	Uncontrollable	Purposive-Rational	Pandora's Box	Moral issues	Interest groups, NGOs	Anti	(Rifkin, 2001)
66. Genetically modified products are alive. So at the get-go, they're inherently more unpredictable in terms of what they'll do once they're out into the environment.	Risk	Unpredictable: environment	Purposive-Rational	Pandora's Box	Public opinion/ policy	Interest groups, NGOs	Anti	(Rifkin, 2001)

Abbreviated Q Statements used in Statistical Analysis

Full Q Statement	Short Q Statement
1. Allergies are only minor inconveniences.	Allergies minor inconveniences.
2. GM foods could pose some potentially serious allergenic and toxic reactions among consumers.	Potentially allergen/toxic
3. Modern biotechnology can be used to reduce the allergenic risks associated with our current food supply.	Reduce allergen risk
4. The allergenic potential of newly introduced microbial proteins is uncertain, unpredictable, and untestable.	Can't predict allergenicity
5. The safety assessment of a recombinant DNA-modified organism should be based on the nature of the organism and the environment into which it will be introduced, not on the method by which it was modified.	Do not base assessments on technology
6. Transgenic pest-protected plants should not only be compared to the use of chemicals, but also to alternative methods such as biological control.	Compare with chems./bio alternatives
7. Biotechnology can help farmers increase crop yields and feed even more people.	Increase crop yields, feed more people
8. Consumers are already enjoying biotechnology foods such as vine-ripened, longer-lasting tomatoes and better-tasting carrots and peppers.	Enjoying GM tomatoes, carrots, peppers
9. Environmental biotechnology products make it possible to more efficiently clean up hazardous waste without the use of caustic chemicals.	Clean up hazardous waste without chems.
10. Researchers are creating ways to boost the nutritional value of foods using biotechnology.	Creates better nutritional foods
11. Biotechnology can help farmers reduce their reliance on insecticides and herbicides.	Reduces insecticides and herbicides use
12. Agricultural biotechnology products, like modified pulp trees for use in paper production, will allow manufacturers to use less water and other natural resources, and to produce less waste from the production stream, while producing higher-quality materials.	Reduces resources use, less waste
13. Biopesticide products are based on natural agents such as microorganisms and fatty acid compounds. They are toxic to targeted pests (such as the European corn borer) and do not harm humans, animals, fish, birds and beneficial insects.	Doesn't harm humans, animals, good insects
14. We can be pleased with ourselves that, in the U.S., we've really been the leaders in developing the new technology and implementing it safely in this country.	Proud U.S. technology leader

Full Q Statement	Short Q Statement
15. Gene technology can expand our options to improve our health, create a safer, more secure food supply, generate prosperity and attain a more sustainable agriculture.	Improves health, foods, prosperity, sustainable ag.
16. The American consumer probably cares more for cheap food than about the ecology.	Care about cheap food more than ecology
17. Consumers have a perfect right to chose and eat transgenic foods if they so wish.	Right to chose and eat GM foods
18. Consumers make decisions about what they eat for a wide variety of religious, ethical, philosophical and emotional reasons.	Food decisions for variety of reasons
19. Biotechnology has developed in a way that has forced government agencies to choose between democratic principles and the technological vision of an elite group of scientists and entrepreneurs.	Agencies must choose democracy or GE
20. All of our major universities are tied into all sorts of contractual relationships and consulting relationships with the life science companies.	Universities tied to companies
21. The problem is, the benefits are always here and now. The costs always come later.	Benefits now, costs later
22. Developing countries should have access to any technologies that we have here.	Developing countries should have GE
23. Nearly everything that the human race will be eating will soon be produced from genetically engineered plants and animals.	All food will be GM
24. Biotechnology has tremendous potential to help fight hunger.	Potential to fight hunger
25. There is no need for genetically engineered organisms for feeding the world or solving nutritional deficiency problems.	Not needed to feed world/improve nutrition
26. Pollen from genetically engineered plants will inevitably be spread from one field to another.	Pollen will spread
27. Eventually, it could be possible to reduce gene flow from cultivated plants with various containment methods.	Possible to reduce gene contamination
28. Concerns about genetically modified crops arise mainly when novel, beneficial traits have the potential to spread to wild populations and cause them to become more invasive and difficult to control.	Concerns mainly from possibility to spread
29. Existing laws are for the most part adequate for oversight of biotechnology products.	Existing laws adequate
30. Genetically engineered foods are thoroughly tested before they are allowed onto the market.	Thoroughly tested
31. We can expect that in the future genetically engineered food will be developed and grown in many countries, many of them with no premarket safety reviews.	Grown in countries without safety reviews

Full Q Statement	Short Q Statement
32. There's not really much monitoring of this technology once it's released into the environment or into the food supply.	Inadequate monitoring
33. Transgenic crops present substantial human health and ecological risks, and these are not properly assessed by the regulatory framework.	Risk not properly assessed by gov.
34. The scientific education of genetic engineers and regulators has been inadequate even to understand the technical challenges of biosafety, let alone to take appropriate precautions and conduct science-based testing.	GE scientists' education inadequate
35. Genetically engineered foods are not being regulated and could enter the food supply without oversight.	Inadequate regulation to protect food
36. Because [GMOs} may present risks, they should be carefully regulated.	Risks, therefore need regulation
37. It has proved impossible to develop government regulatory programs that are truly science-based and not compromised by political pressures.	Can't avoid political pressure on regs.
38. Ultimately, the credibility of the regulatory process depends on the public's ability to understand the process and the key scientific principles on which it is based.	Reg. credibility related to public's science understanding
39. Regulatory agencies should aggressively seek to reduce regulatory costs for biotechnology companies.	Agencies should reduce costs for companies
40. The U.S.'s food safety regulatory system is head and shoulders above anybody else's in the world.	US's food safety system is best
41. Some people in the agencies fear that they would be punished or even fired if they raised problems for biotech.	Agency staff fear punishment
42. The threat of law suits will cause the biotech industry to try their best to market safe food.	Legal threats cause industry to try their best
43. Biotechnology is a high-pressure, competitive enterprise. There are always pressures to cut costs and move quickly to commercialization.	Pressure to cut costs and commercialize
44. Life science companies are turning seeds into intellectual property, so they have a virtual lock on the seeds upon which we all depend for our food and survival.	Companies have lock on the food seeds
45. Genes are a discovery, they should not be patented	Genes are a discovery, should not be patented
46. It's very difficult to distinguish which products contain material from modern biotechnology or any other particular technology.	Difficult to distinguish GMO products

Full Q Statement	Short Q Statement
47. People have the right to know what's in their food. And if they want to know if it's from genetically modified sources, then they have a right to know that.	Right to know GM food
48. To put a label on biotech foods, a mandatory label, would be an indication that something is wrong.	Label would indicate something's wrong
49. The industry is not forced to prove relative safety. Rather, the burden of proof is on people like us to show that there's some risk	Industry not forced to prove safety
50. It could be difficult or impossible to isolate a problem and prove its GMO related cause in a court against highly paid defense attorneys.	Difficult to prove GMO-caused problem
51. Virtually all of our foods have been genetically modified.	All foods GM
52. Genetically engineered organisms are not fundamentally different from nonmodified organisms.	GMOs not fundamentally different
53. It is not for a human being to modify the basic laws of nature.	Should not modify laws of nature
54. It is not right to exploit a technology which may give rise to unexpected substances that may be damaging to health, before this risk has been carefully investigated.	Shouldn't exploit risky technology
55. There should be a moratorium on approving new uses of genetically engineered organisms while the public and legislators debate and adopt a coherent strategy to ensure safety of GE organisms.	Should be moratorium
56. If you made people aware and knowledgeable about genetic foods, they would tend to be more supportive.	Support would grow with GM knowledge
57. Non-governmental organizations (NGOs) are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people.	NGOs want to scare people
58. These genetically engineered foods have never been subject to long-term testing, and yet there are millions of acres of them growing in the United States and pervading the food system here.	GMOs not subject to long-term testing
59. We are being put in jeopardy. We are guinea pigs in this experiment.	We are guinea pigs
60. Conventional agricultural activity entails certain environmental and ecological risks.	Risks from conventional agricultural

Full Q Statement	Short Q Statement
61. We have looked very carefully at the use of recombinant DNA techniques, and we do not have any information that the simple use of the techniques creates a class of foods that is different in safety or quality from foods developed by other methods of plant breeding.	No information GE creates unsafe foods
62. You can't prove that any new technology that we have in the world today is absolutely safe.	Can't prove safety
63. Risks - calculable risks - must be taken, otherwise technological progress becomes impossible.	Risks taking needed for progress
64. Organic farmers are very concerned, because these (GM) crops are a major threat to organic farming.	Organic farmers concerned
65. GMOs can migrate and proliferate over wide regions, and you cannot easily recall them to the laboratory or clean them up.	Can migrate over wide regions, can't be recalled
66. Genetically modified products are alive. So at the get-go, they're inherently more unpredictable in terms of what they'll do once they're out into the environment.	Inherently unpredictable

APPENDIX B: RECRUITMENT AND FOLLOW-UP CORRESPONDENCE

Pilot Study Recruitment Email

RESEARCH STUDY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

As Professor __________ wrote to you (and thank you Professor)...

My name is Joe Greenblott and I am an Environmental Science and Policy Ph.D. student here at George Mason University.

I am asking you to volunteer to participate in a pilot study for my doctoral research on values, attitudes and beliefs about genetically modified/genetically engineered organisms. This pilot stage will identify what, if any refinements I need to make in my methodology, administration, and statistical treatments, and will provide a baseline sample of attitudes towards agricultural biotechnology. The result of this pilot may be included as part of the study if they are determined reliable.

My research study has three parts. First, I will ask participants to complete an in-person exercise that involves sorting a number of statements related to genetically modified organisms. Second, I will then ask a few follow-up questions. These together should take around 45 minutes. The third part of the study is a conventional survey that should take less than 20 minutes to complete. I will send participants a separate email with instruction for completing the survey. Participants can complete the survey confidentially on-line or through email.

Following completion of the exercises, I will explain and answer any answer questions about my research. This may be particularly informative for those of you interested in alternative social science research methods.

This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

If you would like to participate, please complete the attached form and send it back to me at this email address (JGreenbl@gmu.edu). I will follow up with a phone call and/or email within the next few days to schedule, **at a time and place of your convenience**, the in-person exercise.

I will keep your responses confidential and emphasize that your participation is voluntary; you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or adverse consequences to you.

Thank you very much for considering participating in my study and best wishes for a successful exam period!

Joe

RESEARCH STUDY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

PILOT STUDY VOLUNTEER CONTACT INFORMATION

Thank you for volunteering to participate in a pilot study for my doctoral research on values, attitudes and beliefs about genetically modified/genetically engineered organisms.

As I explained, I will ask you to complete an in-person exercise that involves sorting a number of statements related to genetically modified organisms. I will then ask a few follow-up questions. These together should take around 45 minutes.

The third part of the study is a conventional survey that should take you less than 20 minutes to complete. I will send you a separate email with instruction for completing the survey. You can complete the survey confidentially on-line or through email.

I will keep your responses confidential and emphasize that your participation is voluntary; you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or adverse consequences to you.

Please feel free to contact me by email at jgreenbl@gmu.edu, or call me at 202-564-4250 or 240-338-5053 to answer any questions you may have about my research project. You may also contact Professor Lee Talbot, my dissertation faculty advisor, at ltalbot@gmu.edu, or 703-993-4037. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

Please provide me with your contact information, either on this form or email your information to me if you later decide you would like to participate. I will follow up with a phone call and/or email within the next few days to schedule, **at a time and place of your convenience**, the in-person exercise.

Volunteer Name:	
Phone:	Alternate phone (optional):
Email:	
Alternate email (optional):	

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Advance recruitment telephone script (1st Contact)

Hello Mr/Ms/Dr. __________________.

My name is Joe Greenblott and I am a Environmental Science and Policy Ph.D. student at George Mason University. I am calling to invite you to participate in my doctoral research on values, attitudes and beliefs about genetically modified/genetically engineered organisms. Do you have a few minutes to chat, or could I call back at a more convenient time? **[Schedule time to call back]**

Because of your education and work, you are one of a small number of people that I will ask to participate in my study. The results of my research are intended to better inform legislators, government agencies, and the public who must make decisions and policy about new technologies and how best to protect health and the environment, while promoting progress and growing the economy.

If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology.

My research study has three parts. I will ask you to complete an in-person exercise that involves sorting a number of statements related to genetically modified organisms. I will then ask you a few follow-up questions. These together should take around 45 minutes. The third part of the study is a conventional survey that should take you less than 20 minutes to complete. I will send you a separate email with instruction for completing the survey. You can complete the survey confidentially on-line or through email. I will keep all your responses confidential.

Your participation is voluntary; you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or adverse consequences to you. This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

I will be very grateful if you agree to participate in my research study. In addition to the important findings from the study, its successful completion will allow me to complete the requirements for a doctoral degree in environmental science and policy. I am happy to answer any questions **[answer any questions]**

Will you participate? **[If yey]** Thank you so much. Is there a time and location that we could schedule for us to get together for the in-person exercise? **[Schedule time and location for Q sort and interview]**

I realize that your time is very valuable and I greatly appreciate your participation, as the successful conclusion of this study will allow me to complete my doctoral degree in environmental science and policy. Thank you very much for your participation.

[If unwillingness to participate] I understand that right now you'd prefer not to participate in my research. I hope you will change your mind, because only by asking people like you can understand how we perceive and form opinions about new technologies like modern biotechnology/genetic engineering. Would you mind if I sent you an email with additional information, just in case you might reconsider? **[If yes, send recruitment email in two weeks]**

Please feel free to email me at JGreenbl@gmu.edu, or call me 202-564-4250 or 240-338-3053. Thanks you for your time and participation [consideration].

Advance recruitment email (Alternative 1st Contact)

George Mason University
Fairfax, Virginia 22030-4444

Date

To [potential participant]:

Within a few days, I will contact you to request your participation in a research study about your values, attitudes and beliefs about modern biotechnology/genetic engineering. Because of your education or work, you are one of a small number of people that I will ask to give their opinions. The results of this research are intended to better inform legislators, government agencies, and the public who must make decisions and policy about new technologies and how best to protect health and the environment, while promoting progress and growing the economy.

If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology. This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

I will be very grateful if you agree to participate in my research study. In addition to the important findings from the study, its successful completion will allow me to complete the requirements for a doctoral degree in environmental science and policy.

Please look for my request for your participation in your e-mail mail or a phone call from me very soon. It is only with the generous help of people like you that our research can be successful.

Sincerely,

Joseph M. Greenblott
Ph.D. Candidate
George Mason University

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Recruitment email (2nd Contact)

George Mason University
Fairfax, Virginia 22030-4444

[Date]

To [potential participant]:

A few days ago, I sent you an email [left you a message/spoke with you] inviting you to participate in research I am conducting on perceptions about modern biotechnology/genetic engineering. Because of your education or work, you are one of a small number of people that I am asking to give their opinions. While your participation is voluntary, I encourage you to participate in the study so that the results truly represent the thinking of informed people like you. Your views are very important! A low response rate reduces the validity of the study.

Understanding the values, attitudes, and beliefs of highly informed individuals like you is very important in determining appropriate policy. If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology. In a democracy such as ours, your views are vital in helping legislators, government officials, and others make decisions about new technologies and how best to protect health and the environmental, while promoting progress and growing the economy.

The research has three parts. First, I would like to schedule, **at a time and place of your convenience**, an in-person exercise that involves sorting a number of statements related to genetically modified organisms. I will then ask you a few follow-up questions. These should take around 45 minutes. The third part of the study is a conventional survey that should take you less than 20 minutes to complete. You can complete the survey over the internet or via email.

This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

Please contact me by email at jgreenbl@gmu.edu, or call me at 202-564-4250 or 240-338-5053 to find a convenient time and place for us to meet, and to answer any questions you may have about my research project. You may also contact Professor Lee Talbot, my dissertation faculty advisor, at ltalbot@gmu.edu, or 703-993-4037. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

I realize that your time is very valuable and I greatly appreciate your participation, as the successful conclusion of this study will allow me to complete my doctoral degree in environmental science and policy. Thank you very much for your participation.

Sincerely,

Joseph M. Greenblott, Ph.D. Candidate
George Mason University
Fairfax, VA 22030-4444

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First follow-up recruitment email (3rd Contact)

George Mason University
Fairfax, Virginia 22030-4444

[Date]

To [potential participant]:

I recently left you a message [sent you an email] requesting your participation in a research study on personal values, attitudes and beliefs about modern biotechnology/genetic engineering.

You are one of a small number of people selected to participate in this study because of your work experience or education. Because of the small number of people involved, every participant is important to validity of the study. If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology.

This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

The research has three parts. First, I would like to schedule, **at a time and place of your convenience**, an in-person exercise that involves sorting a number of statements related to genetically modified organisms. I will then ask you a few follow-up questions. These should take around 45 minutes. The third part of the study is a conventional survey that should take you less than 20 minutes to complete. You can complete the survey confidentially over the internet or via email.

Please contact me at your convenience so we can schedule a convenient time and a place for you to participate in the study. While your participation is voluntary, I encourage you to participate in the study so that the results truly represent the thinking of informed people like you.

If you did not receive my message, or if it was misplaced, please email me at JGreenbl@gmu.edu or call me at call me at 202-564-4250 or 240-338-5053.

I am personally very grateful for your involvement, as the successful conclusion of this study will allow me to complete my doctoral degree in environmental science and policy. Thank you very much for your cooperation.

Joseph M. Greenblott

Ph.D. Candidate

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Second (final) recruitment email (4th Contact)

[Date]

To [potential participate]:

Some weeks ago, you received a message (an emailed) from me requesting you to participate in a study about personal values, beliefs and attitudes about modern biotechnology/genetic engineering. If you have decided not to participate, please reconsider my request and contact me so we can schedule a time and place at your convenience. Your views and participation are important!

Please know that your participation is voluntary. I know that your time is valuable and if you've chosen not to respond, that's fine.

I sincerely would appreciate it, however, if you could find the time to participate. If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology.

This research has been reviewed according to both the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

If you did not receive my request for your participation in the study, or if it was misplaced, please e-mail me at JGreenbl@gmu.edu or call me at 202-564-4250 or 240-338-5053.

Since the study is drawing to a close, this is the last time I will attempt to contact you. I greatly appreciate your willingness to consider this request as I conclude this effort to understand perceptions of new technologies.

If you have not responded, I sincerely hope you will, and that you will help me with this study.

Joseph M. Greenblott, Ph.D. Candidate
George Mason University
Fairfax, VA 22030-4444

SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

jgreenbl
Sent: Friday, April 20, 2012 9:10 AM
To: [redacted]
Attachments: 325 333 GMO Survey.pdf (1 MB)

SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY / GENETIC ENGINEERING

Dear [redacted]

Thank you so much for taking the time to meet with me last night. It was really a great pleasure.

As we discussed, the third and final component of my study involves a conventional survey that I ask you to complete. Please follow these instruction for completing and returning your responses.

INSTRUCTIONS FOR COMPLETING AND RETURNING THE GMO SURVEY

The easiest way to complete the survey is online. To complete the survey online, please click on the following URL, or cut and paste it into your web browser: https://docs.google.com/spreadsheet/viewform?formkey=dF9nVzlYaGwyTE9Lelg2R2xLaWY3eWc6MQ

IMPORTANT: To protect your confidentiality -- in lieu of your name or other personally identifiable information -- please cut and paste the following unique identification code were required in the on-line survey:

325 333

If more convenient, however, you may complete the survey using this attached Adobe pdf form. To use this form you will need the Adobe Acrobat Reader, available for free download at: http://get.adobe.com/reader/.

- You unique identification code is already included in the attached pdf.
- If you would like to use this pdf form to submit your responses electronically via email, please click on the "Submit by Email" button at the end of the survey and follow the instruction that pop up. Note that this will transmit a file containing only your responses without questions or other instructional text.
- Alternatively, you may click on the "Print Form" button, print the entire survey including your responses, and mail it to:

Joseph M. Greenblott
14713 Soft Wind Drive
North Potomac, MD 20878

Please e-mail me if you have questions or comments at: JGreenbl@gmu.edu. You may also reach me during the day at 202-564-4250, in the evening at 301-309-8087, or on my cell phone at 240-338-3053.

Thank you again for your time and willingness to contribute to my research.

First GMO survey reminder [sent one week before deadline]

REMINDER: DEADLINE APPOACHING FOR SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING
I would greatly appreciate it you could complete and return your responses to the survey by [deadline date]. Your responses to this survey are important to understanding attitudes and beliefs about modern biotechnology/genetic engineering in agriculture and food.

As we discussed, this survey is the final part of my research project. It should take you about 20 minutes to complete. For your convenience, I provide you three ways to complete and return the survey.

Please send me your responses no later than [1 month following Q sort and interview].

INSTRUCTIONS
For your convenience, I provide you three ways to complete and return the survey.

1. On line: The easiest way to complete the survey is online. To complete the survey online, please click on the following URL, or cut and paste it into your web browser:
https://docs.google.com/spreadsheet/viewform?formkey=dF9nVzlYaGwyTE9Lelg2R2xLaWY3eWc6MQ

2. pdf: You may complete the survey using this attached Adobe pdf form. To submit your responses electronically via email, please click on the "Submit by Email" button at the end of the survey and follow the instruction that pop up. This will transmit a file containing only your responses without questions or other instructional text.
(The Adobe Acrobat Reader isavailable for free download at: http://get.adobe.com/reader/)

3. Mail
You may click on the "Print Form" button in the pdf file, print the entire survey including your responses, and mail them to:

Joseph M. Greenblott
14713 Soft Wind Drive
North Potomac, MD 20878

IMPORTANT
When answering the questions in this survey, it is extremely important that your responses reflect your own personal opinions; whether or not you believe they reflect the positions or policies of the organization for which you work or study.

The survey asks some personal question about you, such as your race, gender, religion, income, politics, and education. Some people are uncomfortable providing this kind of information. I only ask for this information because it is essential to understand if people with similar backgrounds share common beliefs: I will keep all your responses confidential. You do not have to answer any questions that you are uncomfortable answering.

To protect your confidentiality, please ensure that you accurately include only the identification number I provide you; exclude your name or other information that someone could use to identify you. Before completing the survey and sending me your results, you must check where indicated on the survey that you have read and understand the informed consent information.

CONTACT INFORMATION
Please feel free to call me at 240-338-3053 ,email me at JGreenbl@gmu.edu , or write me at the above address if you have any questions.

Thank you for your time and important contribution to this research.

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Second (final) GMO survey reminder [sent on deadline]

FINAL REMINDER! DEADLINE FOR SURVEY ON BIOTECHNOLOGY/GENETIC ENGINEERING
Some weeks ago, you received an email from me requesting you to complete a survey on attitudes and beliefs about modern biotechnology/genetic engineering. If you have decided not to complete the survey, please reconsider my request complete and return your responses to the survey as soon as possible. It should take you about 20 minutes to complete.

Please contact me at 240-338-3053 or email me at JGreenbl@gmu.edu if you need additional time, or if you have any questions, concerns. Please know that your participation is voluntary. I know that your time is valuable and if you've chosen not to respond, that's fine. I sincerely would appreciate it, however, if you could find the time to complete the survey.

Your responses to this survey are important. In addition to the important findings, **the successful conclusion of this study will allow me to complete my doctoral degree in environmental science and policy. Since the study is drawing to a close, this is the last time I will attempt to contact you.**

I greatly appreciate your willingness to consider this request as I conclude this effort to understand perceptions of new technologies. I sincerely hope you will help me with this study.

INSTRUCTIONS
For your convenience, I provide you three ways to complete and return the survey.

1. On line: The easiest way to complete the survey is online. To complete the survey online, please click on the following URL, or cut and paste it into your web browser:
https://docs.google.com/spreadsheet/viewform?formkey=dF9nVzlYaGwyTE9Lelg2R2xLaWY3eWc6MQ

2. pdf: You may complete the survey using this attached Adobe pdf form. To submit your responses electronically via email, please click on the "Submit by Email" button at the end of the survey and follow the instruction that pop up. This will transmit a file containing only your responses without questions or other instructional text.
(The Adobe Acrobat Reader isavailable for free download at: http://get.adobe.com/reader/)

3. Mail: You may click on the "Print Form" button in the pdf file, print the entire survey including your responses, and mail them to:

Joseph M. Greenblott
14713 Soft Wind Drive
North Potomac, MD 20878

IMPORTANT
When answering the questions in this survey, it is extremely important that your responses reflect your own personal opinions; whether or not you believe they reflect the positions or policies of the organization for which you work or study.

The survey asks some personal question about you, such as your race, gender, religion, income, politics, and education. Some people are uncomfortable providing this kind of information. I only ask for this information because it is essential to understand if people with similar backgrounds share common beliefs: I will keep all your responses confidential. You do not have to answer any questions that you are uncomfortable answering.

To protect your confidentiality, please ensure that you accurately include only the identification number I provide you; exclude your name or other information that someone could use to identify you. Before completing the survey and sending me your results, you must check where indicated on the survey that you have read and understand the informed consent information.

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APPENDIX C: INFORMED CONSENT

INFORMED CONSENT

I am very grateful that you have agreed to participate in my research on attitudes and beliefs about genetically engineered organisms (also known as genetically modified organisms) in agriculture and in ingredients in food. Despite these potential benefits, the acceptability of genetically engineered plants, animals, and foods containing the products of modern biotechnology/genetic engineering is still the focus of an ongoing debate, including disagreement over possible risks to the environment and human health.

This research will help characterize the reasons for the various beliefs people have about genetically modified organisms, which can lead to more informed discussions and policies. This research also is part of my academic requirements for my doctoral degree at George Mason University.

RESEARCH PROCEDURES

My research study has three parts. First, I will ask you to participate in an in-person exercise that involves sorting a number of statements related to genetically modified organisms. Second, I will then ask you a few follow-up questions. These together should take around 45 minutes.

The third part of the study is a conventional survey that should take you less than 20 minutes to complete. I will send you a separate email with instruction for completing the survey. You can complete the survey confidentially on line or through email.

The survey asks some personal question about you, such as your race, gender, religion, income, politics, and education. Some people are uncomfortable providing this kind of information. I only ask for this information because it is essential to understand if people with similar backgrounds share common beliefs: I will keep all your responses confidential. You do not have to answer any questions that you are uncomfortable answering.

To ensure you understand the steps I am taking to protect your confidentiality and any risk or benefits to you for participating in the survey, the survey also begins with an "informed consent" statement. Before you can complete the survey, you must check where indicated that you read and understand the informed consent statement.

RISKS

I will not ask you to provide me with any information that could identify you as part of the sorting exercise and follow up questions, however, it is important that you understand the risk and benefits to you for participating in the study, and the voluntary nature of your participation.

There is a small risk that someone with additional information about you could relate your survey responses to you. As I describe below, I will take a number of steps to ensure your confidentiality is protected.

BENEFITS

There are no direct benefits to you as a participant other than to further research in environmental policy. This results of this research are intended to better inform legislators, government agencies, and the public who must make decisions and policy about new technologies and how best to protect health and the environment, while promoting progress and growing the economy.

CONFIDENTIALITY

The data in this study will be kept confidential. To protect your confidentiality:

- I will provide you with a unique identification code that will be placed on all collected data. Information like your name or contact information that identifies you as the person providing responses will be excluded from any response forms.
- Using an identification key, I will be able to link your results to you. Only I will have access to the identification key and I will destroy the key before publishing the results.
- I will publish only statistically aggregated results that protect you from being identified.
- If I paraphrase any of your responses, I will do so without attribution and will exclude and, prior to publication, I will destroy any information that can identify you as the source.
- I will not keep any personally identifiable information on any computer or email owned or under the control of the Federal government, or in a Federal government controlled facility.
- While it is understood that no computer transmission can be perfectly secure, I will make reasonable efforts to protect the confidentiality of your transmission. Prior to publication of the results, I will delete any emails to or from you that contain information that could be used to identify you.

PARTICIPATION

If you agree, I will ask you to participate in your private capacity and I will ask you to share own personal attitudes, opinions and beliefs about genetic engineering and biotechnology. Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.

CONTACT INFORMATION

This research is being conducted Joseph Greenblott, Department of Environmental Science and Policy at George Mason University. I may be reached at 240-338-3053 or at jgreenbl@gmu.edu for questions or to report a research-related problem. You may also contact Professor Lee Talbot, my dissertation faculty advisor, at 703-993-4037 or at ltalbot@gmu.edu. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to the U.S. Environmental Protection Agency and George Mason University procedures governing your participation in this research.

APPENDIX D: INSTRUCTIONS TO PARTICIPANTS

ATTITUDES AND BELIEFS ABOUT
MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

INTRODUCTORY INSTRUCTIONS

I am very grateful that you have agreed to participate in my research study on attitudes and beliefs about genetically engineered organisms (also known as genetically modified organisms) in agriculture and in ingredients in food. This research is part of my academic requirements for my doctoral degree at George Mason University.

> As you may know, modern biotechnology, or genetic engineering, involves moving genetic material from one type of organism into another organism to alter its genes and produce new traits. For example, a plant may have its genes altered to give it resistant to a particular plant disease, to improve its food quality, or to help it grow faster.

The research has two parts. First, I will ask you to participate in an in-person exercise that involves sorting a number of statements related to genetically modified organisms and answering a few follow-up questions. This should take around 30 minutes.

The second part of the study is a conventional survey that should take you less than 20 minutes to complete. You may complete the survey at any time after the sorting exercise, over the internet, via email, or you can send me a printed copy of the completed survey instrument.

INSTRUCTIONS FOR Q SORT

1. I have identified sixty-six (66) individual statements that express different opinions about genetically modified organisms, and placed each on a business card, one statement per card. First, please read each business card, just to familiarize you with the statements.

2. Now that you read though each statement, I am going to ask you to please sort the cards into three piles based on your personal opinion about genetically modified organisms.
   - There is not right or wrong answer or way to sort these.
   - It is very important, however, that you sort the statements to reflect your authentic personal opinion, not your official position or the opinion of the organization for which you work. The results of your sort, as will all your responses, will be kept strictly confidential and anonymous

3. Please read each card again, and place those cards containing statements with which you generally reflect how you think in a pile on your right.
   - Place those cards containing statements with which you generally don't reflect how you think in a pile on your left.
   - In the middle, please place those cards with statement on which you are neutral.

4. Now, I am going to ask you to sort the cards again – this time using the matrix I am placing before you – to organize each according to the *extent* to which it reflects how you think about genetically modified organisms. Remember this should reflect your personal opinion.

5. In the box over +6, please place those cards containing statements that most closely reflects how you think. In the box over -6, please place each card that contains a statement that least reflects how you think about genetically modified organisms.

6. Next, reading only through the cards in the +6 pile (those that most reflect how you think), choose the two statements with which most closely reflects how you think about genetically modified organisms, and place them in the +6 blanks. Place the remaining cards in the place over +5.

7. Now, reading only the cards in the -6 pile (those that least reflect how you think), choose the two statements which least reflect how you think and leave then in the -6 boxes, and place the remaining cards in the place over -5.

8. Please continue in this manner, working toward the middle, until you have sorting all the cards according to the distribution, one card in each box. If you feel that to reflect your personal opinion best you need to place more statements in a column than there are boxes, you may deviate from the distribution and place the additional statements at the top of the appropriate column.

9. After you have sorted all of the cards, please look over them and adjust them as necessary to reflect your personal opinion best. Ask yourself if can you see meaningful differences between them, such as between + 5 and + 6? If not, take another moment to adjust the statements.

10. Now that you are satisfied with your sort, I will take a photograph of the sort for quality control purposes, and then we will record the number of the each statement in the appropriate box on the response sheet. The order of the statements within each column is unimportant and has no effect on the outcome.

APPENDIX E: SAMPLE Q SORT AND FOLLOW-UP QUESTIONS RESPONSE RECORDING SHEET

Participant Code: 277 40

RESEARCH STUDY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

Q SORT AND FOLLOWUP QUESTIONS RESPONSE SHEET

Date: 09/01/13
Location: Washington, DC
Start Time: 16:00
Completion Time: 16:45

						3						
						45						
						61						
						64						
						44						
					49	39	2					
					4	54	9	24	8	31		
					34	27	28	26	38	30		
		55	57	43	66	36	62	13	7	47	10	
		48	37	58	25	5	32	15	42	56	63	
	50	33	59	21	65	6	12	60	16	22	14	11
35	41	19	53	51	1	20 23	46	40	52	18	17	29
-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6

Least how I think Neutral Most how I think

Participant Code: 277 40

Follow-up Questions

Finally, I would like to ask you a series of questions about how your sorted the statements.

Q1. Did you understand the instruction? If not, what was unclear? How could they be improved?
A1. OK

Q2. Where there any particular statements that you did not understand or that were problematic? If so, which statements? In the end, how did you resolve the problems and why did you sort those statement(s) in the way you did?
A2. No

Q3. Looking at only those statements that <u>most reflect how you think</u>, is there anything about them you feel is important in explaining why you sorted them the way you did?
A3. GMOs are OK things. As we understand and learn more, we do apply precautionary approaches to make sure what we do is safe. It's a good thing.

Q4. Looking at only those statements that <u>least reflect how you think</u>, is there anything about them that you feel is important in explaining why you sorted them the way you did?
A4. Reflects attitude of distrust, e.g., that we shouldn't be playing around with nature.

Q5. Looking only at those statements in the middle of the distribution (neutral), is there anything about that them you feel is important in why you sorted them the way you did?
A5. Statements that I don't know one way or the other, that they are true or not. Scientific statements of fact that I don't know.

Q6. Looking across all the statements, are there any perspectives or sentiments you think are not represented at all, or are over- or under-represented? Are there any statements you think should be added?
A6. No

Q7. Have your opinions about genetically modified organisms changed over time? How? What do you think were the most important factors in changing your opinions?
A7. I've only been in this position for about a year, and didn't really deal with these issues before. I probably always had an open mind about GMOs.

Q8. Is there anything else you would like to add, either about the survey, the statement sorting, or about genetically modified organisms?
A8. No

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APPENDIX F: SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

The questions and design of the survey were based on Dillman's Tailored Design Method (Dillman, 2000) and Slimak (2003). Participants were given the option of completing the survey on the internet or using the pdf file that is illustrated below.

Submit by Email Print Form

SURVEY ON ATTITUDES AND BELIEFS ABOUT MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

As you probably know, modern biotechnology, or genetic engineering, involves moving genetic material from one type of organism into another organism to alter its genes and produce new traits. For example, a plant may have its genes altered to give it resistance to a particular plant disease, to improve its food quality, or to help it grow faster.

Despite these potential benefits, the acceptability of genetically engineered plants, animals, and foods containing the products of modern biotechnology/genetic engineering is still the focus of an ongoing debate, including disagreement over possible risks to the environment and human health.

This survey will help characterize the reasons for the various beliefs people have about genetically modified organisms, which can lead to more informed discussions and policies.

INFORMED CONSENT

RESEARCH PROCEDURES

I am conducting this research to improve our understanding of attitudes and values related to agricultural biotechnology. I ask that you complete this survey about your attitudes and beliefs about modern biotechnology/genetic engineering. The survey also asks some personal question about you, such as your race, gender, religion, income, politics, and education. Some people are uncomfortable providing this kind of information. I only ask for this information because it is essential to understand if people with similar backgrounds share common beliefs: I will keep all your responses confidential. You do not have to answer any questions that you are uncomfortable answering. The survey should take around 20 minutes to complete.

RISKS

There is a small risk that someone with additional information about you could relate your survey responses to you. As I describe below, I will take a number of steps to ensure your confidentiality is protected.

BENEFITS

The results of this research study may increase your understanding of the various value and belief systems associated with support for or opposition to modern agricultural biotechnology. There are no other direct benefits to you as a participant, however, other than to further research in environmental policy.

This results of this research are intended to better inform legislators, government agencies, and the public who must make decisions and policy about new technologies and how best to protect health and the environment, while promoting progress and growing the economy. In addition to the important findings from the study, its successful completion will allow me to complete the requirements for a doctoral degree in environmental science and policy at George Mason University.

CONFIDENTIALITY

The data in this study will be kept confidential. To protect your confidentiality:

- I will provide you with a unique identification code that will be placed on all collected data. Information like your name or contact information that identifies you as the person providing responses will be excluded from any response forms.

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- Using an identification key, I will be able to link your results to you. Only I will have access to the identification key and I will destroy the key before publishing the results.
- I will publish only statistically aggregated results that protect you from being identified.
- If I paraphrase any of your responses, I will do so without attribution and will exclude and, prior to publication, I will destroy any information that can identify you as the source.
- I will not keep any personally identifiable information on any computer or email owned or under the control of the Federal government, or in a Federal government controlled facility.
- While it is understood that no computer transmission can be perfectly secure, I will make reasonable efforts to protect the confidentiality of your transmission. Prior to publication of the results, I will delete any emails to or from you that contain information that could be used to identify you.

PARTICIPATION
Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.

CONTACT INFORMATION
This research is being conducted Joseph Greenblott, Department of Environmental Science and Policy at George Mason University. I may be reached at 301-309-8087 or at jgreenbl@gmu.edu for questions or to report a research-related problem. You may also contact Professor Lee Talbot, my dissertation faculty advisor, at 703-993-4037 or at ltalbot@gmu.edu. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to George Mason University procedures governing your participation in this research.

CONSENT*

☐ I have read and understand this form and agree to participate in this study.

Date: 2/18/13

Please enter (or copy and paste) your participant code.*
I provided you a participant code in the email I sent you. To protect your confidentiality, please do not include your name or other personally identifiable information on the survey.

***Required**

2

SURVEY ON ATTITUDES AND BELIEFS ABOUT
MODERN BIOTECHNOLOGY/GENETIC ENGINEERING

INSTRUCTIONS FOR COMPLETING AND RETURNING THIS SURVEY

The easiest way to complete the survey is online. To complete the survey online, please click on the following URL, or cut and paste it into your web browser:
https://docs.google.com/spreadsheet/viewform?formkey=dF9nVzlYaGwyTE9LeIg2R2xLaWY3eWc6MQ

If more convenient, however, you may complete the survey using this attached Adobe pdf form. To use this form you will need the Adobe Acrobat Reader, available for free download at:
http://get.adobe.com/reader/.

- If you would like to use this pdf form to submit your responses electronically via email, please click on the "Submit by Email" button at the end of the survey and follow the instruction that pop up. Note that this will transmit a file containing only your responses without questions or other instructional text.

- Alternatively, you may click on the "Print Form" button, print the entire survey including your responses, and mail it to:

  Joseph M. Greenblott
  14713 Soft Wind Drive
  North Potomac, MD 20878

Again, please be sure your accurately include only the identification number I provide you; exclude your name or other information that someone could use to identify you.

Please e-mail me if you have questions or comments at: JGreenbl@gmu.edu. You may also reach me during the day at 202-564-4250 or in the evening at 301-309-8087.

VERY IMPORTANT!

When answering the questions in this survey, it is extremely important that your responses reflect **your own personal opinions**, whether or not you believe they reflect the positions or policies of the organization for which you work or study. As discussed above, I will keep your responses and identity confidential.

Please answer **all** questions in this survey to the best of your ability. If you do not answer a question, I may not be able to use any of your responses.

Thank you your time and important contribution to this research.

Please indicate the extent to which you personally agree or disagree with each of the following statements.

1. We are approaching the limit of the number of people the earth can support.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

2. Humans have the right to modify the natural environment to suit their needs.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

3. When humans interfere with nature it often produces disastrous consequences.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

4. Human ingenuity will insure that we do not make the earth unlivable.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

5. Humans are severely abusing the environment.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

6. The earth has plenty of natural resources if we just learn how to develop them.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

7. Plants and animals have as much right as humans to exist.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

9. Despite our special abilities, humans are still subject to the laws of nature.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

10. The so-called 'ecological crisis' facing human kind has been greatly exaggerated.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

11. The earth is like a spaceship with very limited room and resources.

Strongly Disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ Strongly Agree

12. Humans were meant to rule over the rest of nature.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

13. The balance of nature is very delicate and easily upset.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. Humans will eventually learn enough about how nature works to be able to control it.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

15. If things continue on their present course, we will soon experience a major ecological catastrophe.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. We have a duty to allow research that might lead to important new treatments, even when it involves the creation or use of human embryos.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

17. I feel scientific research often goes too far.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

18. I fear the potential impacts of scientific research.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

19. The government should take stronger action to clean up toxic substances in the environment.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

20. I feel a personal obligation to do whatever I can to prevent climate change.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

21. I feel a sense of personal obligation to take action to stop the disposal of toxic substances in the air, water, and soil.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

22. Business and industry should reduce their emissions to help prevent climate change.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

23. The government should exert pressure internationally to preserve the tropical forests.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

24. The government should take strong action to reduce emissions and prevent global climate change.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. Companies that import products from the tropics have a responsibility to prevent destruction of the forests in those countries.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. People like me should do whatever we can to prevent the loss of tropical forests.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. The chemical industry should clean up the toxic waste products it has emitted into the environment.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please indicate the extent to which each of the following statements is a guiding principle in your life.

28. Social justice, correcting injustice, care for the weak

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

29. Preventing pollution, conserving natural resources

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

30. Equality, equal opportunity for all

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

31. Unity with nature, fitting into nature

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

32. A world of peace, free of war and conflict

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

33. Respecting the earth, harmony with other species

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

34. Protecting the environment, preserving nature

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

35. True friendship, close supportive friends

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

36. Loyal, faithful to my friends

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

37. Sense of belonging, feeling that others care about me

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

38. Obedient, dutiful, meeting obligations

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

39. Self-discipline, self-restraint, resistance to temptations

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

40. Family security, safety for loved ones

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

41. Honoring parents and elders, showing respect

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

42. Honest, genuine, sincere

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

43. Forgiving, willing to pardon others

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

44. Social power, control over others, dominance

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

45. Influential, having an impact on people and events

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

46. Wealth, material possessions, money

	1	2	3	4	5	
Unimportant	◯	◯	◯	◯	◯	Extremely Important

47. Authority, the right to lead or command

	1	2	3	4	5	
Unimportant	○	○	○	○	○	Extremely Important

48. Curious, interested in everything, exploring

	1	2	3	4	5	
Unimportant	○	○	○	○	○	Extremely Important

49. A varied life, filled with challenge, novelty and change

	1	2	3	4	5	
Unimportant	○	○	○	○	○	Extremely Important

50. An exciting life, stimulating experience

	1	2	3	4	5	
Unimportant	○	○	○	○	○	Extremely Important

For each of the following people and groups, do you think they are doing a good job for society or not doing a good job for society?

51. Newspapers, magazines, and television which report on biotechnology

○ Doing a good job
○ Not doing a good job
○ Don't know

52. Industries which develop new products with biotechnology

○ Doing a good job
○ Not doing a good job
○ Don't know

53. University scientists who conduct research in biotechnology

○ Doing a good job
○ Not doing a good job
○ Don't know

54. Consumer organizations which test biotechnological products

○ Doing a good job
○ Not doing a good job
○ Don't know

55. Environmental groups who campaign about biotechnology

○ Doing a good job
○ Not doing a good job
○ Don't know

56. United States Government making laws about biotechnology

- Doing a good job
- Not doing a good job
- Don't know

57. Retailers who ensure our food is safe

- Doing a good job
- Not doing a good job
- Don't know

58. Ethics committees who consider the moral and ethical aspects of biotechnology

- Doing a good job
- Not doing a good job
- Don't know

59. Religious leaders who say what is right and wrong in the development of biotechnology

- Doing a good job
- Not doing a good job
- Don't know

60. Medical doctors

- Doing a good job
- Not doing a good job
- Don't know

For each of the following areas where new technologies are being developed, please indicate if you think it will have a positive, a negative, or no effect on our way of life in the next 20 years?

---

61. Solar energy

- Positive
- Negative
- No effect at all

62. Computers and Information Technology

- Positive
- Negative
- No effect at all

63. Biotechnology and genetic engineering

- Positive
- Negative
- No effect at all

64. Space exploration
- Positive
- Negative
- No effect at all

65. Nuclear energy
- Positive
- Negative
- No effect at all

66. Nanotechnology
- Positive
- Negative
- No effect at all

67. Wind energy
- Positive
- Negative
- No effect at all

68. Brain and cognitive enhancement
- Positive
- Negative
- No effect at all

69. Synthetic biology
- Positive
- Negative
- No effect at all

70. Biofuels made from crops like corn and sugar cane
- Positive
- Negative
- No effect at all

Please indicate the extent to which you agree or disagree with each of the following statements about genetically modified (GM) crops and food.

71. Genetically modified (GM) crops and food are good for the U.S. economy

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

72. GM foods is not good for you and your family

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

73. GM plants and food helps people in developing countries

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

74. GM crops and food are safe for future generations

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

75. GM crops and food benefit some people but puts others at risk

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

76. GM crops and food are fundamentally unnatural

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

77. GM crops and food make you feel uneasy

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

78. GM food is safe for your health and your family's health

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

79. GM crops and food do no harm to the environment

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

80. The development of GM crops and food should be encouraged

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

81. GM foods should be clearly identified with a special label

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

82. GM foods are the same as ordinary foods and would not need special labeling

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Please answer the following questions about genetic engineering/biotechnology.

83. Overall, what are your feelings toward using biotechnology in agriculture and food production?

	1	2	3	4	5	
Strongly Oppose	○	○	○	○	○	Strongly Support

84. Some people say that genetically engineered crops are good for the environment because among other benefits, they can help decrease the use of pesticides. Others say genetically engineered crops are bad for the environment because, among other risks, they can affect existing plant or animals in nature.

Do you think the benefits for the environment outweigh the risks, or do you think the risks outweigh the benefits?

	1	2	3	4	5	
Risks strongly outweigh the benefits	◯	◯	◯	◯	◯	Benefits strongly outweigh the risks

85. Some people say that genetically engineered crops are good for human health because, among other benefits, they can be used to produce more nutritious foods. Others say genetically engineered crops are bad for human health because, among other risks, they can induce allergic reactions.

Do you think the benefits for health outweigh the risks, or do you think the risks for health outweigh the benefits?

	1	2	3	4	5	
Risks strongly outweigh the benefits	◯	◯	◯	◯	◯	Benefits strongly outweigh the risks

86. Overall, do you think the benefits of developing and growing new plants and crops through genetic engineering outweigh the risks, or do you think the risks outweigh the benefits?

	1	2	3	4	5	
Risks strongly outweigh the benefits	◯	◯	◯	◯	◯	Benefits strongly outweigh the risks

87. Overall, would you say you oppose or support the use of biotechnology in agriculture and food production?

	1	2	3	4	5	
Strongly Oppose	◯	◯	◯	◯	◯	Strongly Support

Please indicate whether each of the following statements is true or false.

88. Genes are the cell's instructions for producing proteins.

◯ True

◯ False

89. In nature, plants transmit their genes to unrelated kinds of plants through the process of pollination.

◯ True

◯ False

90. Through genetic engineering, scientists can produce genes that do not exist in nature.

◯ True

◯ False

91. Manipulation of genetic material in plants to produce better crops has been performed by plant breeders for centuries.

◯ True

◯ False

12

92. Genetic engineers can use 'gene guns' or bacteria to transfer genes into an organism.

- ◯ True
- ◯ False

93. Organic tomatoes do not contain genes.

- ◯ True
- ◯ False

Please indicate how often you get information on modern biotechnology/genetic engineering, genetically modified (engineered) crops or food from each of the following sources.

---

94. Local newspapers

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

95. National newspapers

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

96. Scientific/professional journals and magazines

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

97. Scientific conferences/workshops/meetings

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

98. Your own research or first-hand experience

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

99. Television science programs

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

100. Colleagues , co-workers, fellow students

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

101. Television news

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

102. Radio news

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

103. Non-profit organization web sites

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

104. University web sites

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

105. Activist-run web sites

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

106. Classes/formal instruction

	1	2	3	4	
Never	◯	◯	◯	◯	Very Often

Please answer the following questions about you.

The final set of questions relate to your background, such as your race, gender, religion, income, politics, and education. Some people are uncomfortable providing this kind of information. I only ask for this information because it is essential to determine if people with similar backgrounds share common beliefs: all your responses will be kept confidential.

107. Please provide the name of the organization(s) for which you currently work or study. Please spell out all words. Please spell out all acronyms.

- If you work for the government, please provide your State- or Cabinet-level organization (e.g., Maryland Department of Environmental Quality, United States Department of Homeland Security, United Sates Environmental Protection Agency, or United States Social Security Administration).
- If you work for a private company or non-government organization, please provide its name.
- If you are a student, please provide the name of your school (e.g., college, university)
- If you both work professionally at for more than one organization, or if you both work and are a student, please provide the names of all institutions.

108. Please provide the name of your second-level organization(s). Please spell out all words. Do not use acronyms

- If you work for the government, this may be your division, bureau, or program office (e.g., Coast Guard, Centers for Disease Control, or Office of the Chief Financial Officer).
- If you work for a private company or non-government organization, this may be your division or department name.
- If you are a student, please the name of your department.
- If you both work professionally at for more than one organization, or if you both work and are a student, please provide the names of all institutions.

109. What is your age?

(years)

110.a. What is the highest educational degree (or certificate, license) you have received?

- ◯ High School Diploma (or GED)
- ◯ Associate Degree (2 year or junior college)
- ◯ Bachelor Degree (4 year college or university)
- ◯ Vocational (such as plumber, electrician)
- ◯ Master's Degree (graduate school)
- ◯ Doctorate
- ◯ Professional Degree (such as medical, dental, law, pharmacy)
- ◯ Other: __________

110.b. Please provide the name of the field/discipline in which you received your highest degree, certificate, or license.

____

111.a. Please place a check in the box that best describes your current profession, and please provide the name of your profession in the field that follows.

- ◯ Student (high school, college, graduate school)
- ◯ Professional (scientist, doctor, lawyer, engineer, accountant, teacher)
- ◯ Clerical (secretary, administrative assistant)
- ◯ Blue collar worker (mechanic, printer, painter, baker, brick layer, bus driver)
- ◯ Sales or service industry (sales, banking/finance, shop owner, insturance agent, police, barber)
- ◯ Farmer/agriculture (farmer, farm laborer, tractor driver)
- ◯ Homemaker (homemaker, care-giver, stay at home parent)
- ◯ Artist/Musician (sculptor, painter, conductor, musician, dancer, choreographer, phototographer)
- ◯ Government worker (municipal, county, state, federal government)
- ◯ Other: __________

111.b. Please provide the name of your profession.

____

112. What is your personal annual income?

- ◯ $15,000 or less
- ◯ $15,001-$25,000
- ◯ $25,001-$40,000
- ◯ $40,001-$80,000
- ◯ $80,001-$100,000
- ◯ $100,001-$125,000
- ◯ $125,001-$150,000
- ◯ More than $150,001

113. If you work for the Federal government, what is your current grade/rank?

- I do not work for the Federal government
- GS 5
- GS 6
- GS 7
- GS 8
- GS 9
- GS 10
- GS 11
- GS 12
- GS 13
- GS 14
- GS 15
- Senior Executive Service, Senior Technical, or equivalent
- Political appointee or equivalent
- Congressional staff
- Elected (member of Congress)
- Other:

114. In what kind of setting did you grow up?

- Major city
- Suburb of a major city
- Small city or town
- Rural (country), but not on a farm
- On a farm or ranch
- Other:

115. How would you describe your political leanings?

- Very Conservative
- Somewhat Conservative
- Moderate
- Somewhat Liberal
- Very Liberal
- Libertarian
- Other:

116. What is your political party affiliation?

- Democrat
- Republican
- Socialist
- Libertarian
- Independent
- Other:

117. Do you consider yourself to be ...?

- Catholic
- Orthodox
- Protestant
- Mormon/Church of Latter Day Saints
- Other Christian
- Jewish
- Moslem
- Sikh
- Buddhist
- Hindu
- Atheist
- Non believer\Agnostic
- Other:

118. Apart from weddings or funerals, about how often do you attend religious services?

- More than once a week
- Once a week
- About once a month
- About each 2 or 3 month
- Only on special holy days
- About once a year
- Less often than once a year
- Never
- Don't know

119. Which of these statements comes closest to your beliefs?

- You believe there is a God
- You believe there is some sort of spirit or life force
- You don't believe there is any sort of spirit, God or life force
- You don't know

120. How would you describe yourself?

- American Indian, Native American, or Alaskan Native
- Black or African-American
- White or Caucasian
- Asian, Pacific-Islander, or Filipino
- Indian
- Middle Eastern
- Hispanic, Chicano, or Spanish-speaking American
- Other:

121. What is your gender?
- Male
- Female
- Other:

122. How familiar are you with modern biotechnology/genetic engineering, genetically modified (engineered) organisms or food?
- Unfamiliar/never heard of them
- Somewhat unfamiliar/heard of them
- Slightly familiar/some knowledge
- Very familiar
- Recognized expert

123. How many years have you worked with some aspect of modern biotechnology/genetic engineering, genetically modified (engineered) organisms or food, if any?
- Never
- Less than 1 year
- l - 5 years
- 6 - 10 years
- 11 - 15 years
- More than 15 years

124. Which of the following best describes your most recent job as it directly relates to modern biotechnology/genetic engineering, genetically modified (engineered) organisms or food?
- Research and development
- Manufacturing/production/breeding
- Developing government regulations/standards/procedures
- Conducting government inspections or enforcement activities
- Issuing government permits, authorizations, or licenses
- Legal/regulatory compliance by industry
- Sales or marketing
- Farming
- Industry or business advocacy/lobbying
- Public interest advocacy/lobbying
- Developing legislation/laws
- My job does not directly relate to modern biotechnology
- Other:

125. ADDITIONAL COMMENTS, IDEAS, SUGGESTIONS

Please use this space to provide any comments, suggestions, or ideas related to this survey or research study

Submit by Email   Print Form

Thank you for completing this survey.

I greatly appreciate you taking the time to share your personal opinions and beliefs about modern biotechnology/genetic engineering.

APPENDIX G: INDIVIDUAL Q SORTS

U.S. Environmental Protection Agency

Participant No: E01

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
 !----!----!----!----!----!----!----!----!----!----!----!----!----!
 !  1 ! 23 ! 22 ! 25 ! 13 ! 43 !  2 ! 32 !  9 ! 15 ! 20 !  5 !  6 !
 !  4 ! 42 ! 31 ! 48 ! 19 ! 46 !  3 ! 37 ! 24 ! 28 ! 30 ! 26 ! 16 !
    8 !    ! 33 ! 63 ! 29 ! 65 !  7 ! 40 ! 27 ! 36 !    ! 45 ! 17
   34      !    !    ! 49 !    ! 10 ! 64 ! 52 !    !    ! 54   18
   35           !    !    !    ! 11 ! 66 !    !    !      57   38
   39                !    !    ! 12 !    !    !           61   47
   41                     !    ! 14 !    !                     56
   50                     !    ! 21 !    !                     60
   53                          ! 44 !                          62
   55                          ! 51 !
   58
   59
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Participant No: E02

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
 !----!----!----!----!----!----!----!----!----!----!----!----!----!
 ! 35 ! 41 ! 19 ! 37 ! 21 !  1 !  3 !  2 ! 13 !  7 ! 18 ! 10 ! 11 !
 !    ! 50 ! 33 ! 53 ! 43 !  4 !  5 !  9 ! 15 !  8 ! 22 ! 14 ! 29 !
      !    ! 48 ! 57 ! 51 ! 25 !  6 ! 12 ! 24 ! 16 ! 30 ! 17 !
           ! 55 ! 59 ! 58 ! 34 ! 20 ! 28 ! 26 ! 38 ! 31 ! 63
                !    !    ! 49 ! 23 ! 32 ! 40 ! 42 ! 47
                     !    ! 65 ! 27 ! 46 ! 60 ! 52   56
                          ! 66 ! 36 ! 62 !
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                               ! 44 !
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                                 54
                                 61
                                 64
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Participant No: E03

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5    -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
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  !  1 ! 21 !  4 ! 23 ! 39 !  2 ! 12 ! 26 !  3 !  5 !  6 ! 14 !  7 !
  ! 25 ! 33 ! 19 ! 44 ! 50 ! 30 ! 20 ! 28 ! 13 !  9 !  8 ! 47 ! 11 !
    55 ! 34 ! 37 ! 48 !    ! 31 ! 45 ! 29 ! 22 ! 10 ! 35 ! 54 ! 15
         53 ! 49 !    !    !    ! 57 ! 32 ! 36 ! 16 ! 38 ! 65   17
         59   58 !    !    !    !    ! 56 ! 41 ! 42 ! 40   66   18
                      !    !    !    !    ! 64 ! 52   46        24
                           !    !    !    !      62   51        27
                           !    !    !    !           61        43
                                !    !                63        60
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Participant No: E04

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
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  !  1 ! 21 ! 34 ! 16 !  4 ! 19 !  3 ! 26 !  2 !  6 !  7 !  5 !  8 !
  ! 25 ! 49 ! 44 ! 32 ! 35 ! 23 ! 17 ! 38 ! 22 !  9 ! 12 ! 30 ! 10 !
    33 ! 58 ! 48 ! 40 ! 37 ! 45 ! 27 ! 39 ! 28 ! 13 ! 20 ! 43 ! 11
    53      !    ! 41 ! 52 ! 51 ! 66 ! 42 ! 47 ! 14 ! 29 ! 46   15
    55           !    !    !    !    ! 56 ! 57 ! 31 ! 50   54   18
    59                !    !    !    ! 65 ! 64 !           61   24
                           !    !    !    !                63   36
                           !    !    !    !                     60
                                !    !                          62
                                !    !
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Participant No: E05

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
  !----!----!----!----!----!----!----!----!----!----!----!----!----!
  ! 25 ! 27 ! 19 ! 13 ! 51 !  2 !  3 !  6 !  1 ! 24 !  8 !  7 !  5 !
  ! 52 ! 42 ! 41 ! 20 ! 58 !  4 ! 12 ! 11 ! 21 ! 28 ! 15 ! 10 ! 17 !
       ! 44 ! 48 ! 23 ! 65 !  9 ! 14 ! 32 !    ! 35 ! 18 ! 16 ! 47
            ! 49 ! 37 !    ! 39 ! 29 ! 43 !    ! 38 ! 26 ! 22   62
                 ! 55 !    ! 45 ! 30 ! 46 !    ! 53 ! 36   31
                      !    ! 56 ! 33 ! 50 !    !      63   60
                           ! 57 ! 34 ! 54 !
                           ! 59 ! 40 ! 66 !
                                ! 61 !
                                ! 64 !
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Participant No: E06

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
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!  8 ! 29 ! 24 ! 17 ! 21 ! 61 ! 20 ! 11 !  9 ! 43 ! 30 ! 40 ! 18 !
  13 ! 33 ! 44 ! 37 ! 25 ! 65 ! 34 ! 16 ! 12 ! 60 ! 39 !    ! 26
  23   48 ! 50 ! 42 ! 38 !    ! 36 ! 31 ! 14 ! 62 !    !      32
  41        59 ! 49 ! 45 !    ! 47 ! 63 ! 27 !    !           46
  56        64   52 ! 58 !    ! 53 !    !    !                51
                 55   66 !    ! 57 !    !                     54
                         !    !    !    !
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                              !    !
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Participant No: E07

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   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 53 !  1 !  2 !  3 ! 16 ! 21 !  4 ! 12 !  6 !  5 !  7 ! 11 ! 51 !
! 55 ! 35 !  8 ! 34 ! 17 ! 27 ! 18 ! 20 !  9 ! 14 ! 10 ! 13 ! 60 !
  59 !    ! 25 ! 44 ! 28 ! 31 ! 19 ! 24 ! 32 ! 37 ! 15 ! 22 !
          ! 33 ! 49 ! 30 ! 41 ! 23 ! 38 ! 42 ! 43 ! 26 !
            48 ! 54 ! 39 ! 56 ! 29 ! 63 ! 45 ! 58 ! 46
                 64 ! 47 !    ! 36 !    ! 52 !      61
                 65   50 !    ! 40 !    !
                         !    ! 57 !    !
                              ! 62 !
                              ! 66 !
```

Participant No: E08

```
   -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 33 ! 53 !  1 !  8 ! 21 !  4 !  9 !  2 !  6 ! 13 !  5 ! 11 ! 10 !
! 55 ! 54 ! 37 ! 19 ! 31 ! 32 ! 42 !  3 ! 12 ! 16 !  7 ! 18 ! 40 !
     ! 59 ! 66 ! 25 ! 49 ! 34 ! 44 ! 28 ! 15 ! 27 ! 14 ! 22 !
          !    ! 50 ! 58 ! 35 ! 45 ! 38 ! 20 ! 30 ! 17 ! 26
               !    ! 62 ! 41 ! 57 ! 47 ! 36 ! 43 ! 23   29
                    !    ! 46 ! 63 ! 48 ! 39 ! 52   24
                         !    !    ! 64 ! 51   61   60
                         !    !    ! 65 ! 56
                              !    !
                              !    !
```

Participant No: E09

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 34 !  1 ! 33 !  2 ! 14 !  8 ! 12 !  4 !  7 !  6 !  3 ! 13 ! 18 !
! 55 ! 19 ! 41 ! 16 ! 37 ! 21 ! 17 ! 11 ! 22 !  9 !  5 ! 60 ! 38 !
     ! 51 ! 48 ! 23 ! 50 ! 26 ! 24 ! 15 ! 35 ! 20 ! 10 ! 62 !
       59 ! 49 ! 29 ! 52 ! 32 ! 25 ! 31 ! 36 ! 64 !    !
               ! 53 ! 57 ! 42 ! 27 ! 46 ! 39 !    !
                    ! 58 ! 43 ! 28 ! 47 ! 44 !
                         ! 54 ! 30 ! 61 !
                         ! 65 ! 40 ! 63 !
                           66 ! 45 !
                              ! 56 !
```

Participant No: E10

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 25 !  4 ! 23 ! 66 ! 21 !  9 !  3 !  2 ! 12 ! 17 ! 10 !  7 !
! 19 ! 46 ! 34 ! 33 !    ! 22 ! 31 !  5 !  8 ! 26 ! 20 ! 11 ! 14 !
     ! 53 ! 35 ! 37 !    ! 39 ! 44 !  6 ! 15 ! 36 ! 24 ! 16 !
       55 ! 41 !    !    ! 49 ! 45 ! 13 ! 27 ! 63 ! 28 ! 18
       59   58 !    !    !    ! 47 ! 48 ! 30 ! 64 ! 29   38
                    !    !    ! 52 ! 50 ! 32 ! 65   42   40
                         !    ! 57 ! 51 ! 43        62   60
                         !    ! 61 ! 54 ! 56
                              !    !
                              !    !
```

Participant No: E11

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 55 !  1 ! 33 ! 19 ! 23 !  4 !  2 !  9 !  8 !  3 ! 13 !  6 !  5 !
! 59 ! 34 ! 39 ! 42 ! 45 ! 14 ! 12 ! 21 ! 22 !  7 ! 20 ! 11 ! 18 !
     ! 35 ! 53 ! 49 ! 46 ! 25 ! 32 ! 24 ! 36 ! 10 ! 29 ! 60 ! 38
          ! 58 ! 54 ! 48 ! 26 ! 41 ! 28 ! 37 ! 15 ! 57 ! 62   52
               !    ! 50 ! 30 ! 61 ! 31 ! 56 ! 16 ! 64
                    ! 51 ! 40 !    ! 43 ! 63 ! 17
                         !    !    ! 44 ! 65   27
                         !    !    ! 66 !      47
                              !    !
                              !    !
```

Participant No: E12

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 19 ! 13 ! 35 ! 39 !  1 ! 23 !  8 !  2 ! 15 !  3 !  7 !  6 !  5 !
! 44 ! 25 ! 50 ! 46 !  4 ! 33 ! 11 ! 34 ! 28 ! 22 ! 12 ! 10 !  9 !
  55 ! 37 ! 58 ! 52 !    ! 41 ! 27 !    ! 56 ! 40 ! 14 ! 16 ! 17
  59   48 !    !    !    !    ! 29 !    ! 64 ! 54 ! 31 ! 24   18
       49      !    !    !    ! 30 !    ! 66 ! 65 ! 57   26   20
                    !    !    ! 32 !    !    !      61   43   21
                         !    ! 42 !    !                51   36
                         !    ! 53 !    !                63   38
                              ! 62 !                          45
                              !    !                          47
                                                              60
```

U.S. Food and Drug Administration

Participant No: F01

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 19 ! 33 !  4 ! 13 ! 25 ! 16 ! 10 ! 11 !  8 !  3 ! 22 !  1 ! 18 !
! 55 ! 49 ! 37 ! 20 ! 27 ! 21 ! 14 ! 17 !  9 !  5 ! 26 !  2 ! 62 !
  59 ! 50 ! 39 ! 34 ! 29 ! 42 ! 15 ! 23 ! 12 !  6 ! 28 ! 61 !
       53 ! 43 ! 41 ! 32 ! 44 ! 24 ! 31 ! 30 !  7 ! 54 !
            66 ! 46 ! 35 ! 63 ! 36 ! 45 ! 48 ! 38 !
                    !    ! 64 ! 40 ! 47 ! 60 !
                         !    ! 52 ! 51 !
                         !    ! 56 ! 57 !
                              ! 58 !
                              ! 65 !
```

Participant No: F02

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 23 !  1 ! 19 !  8 ! 22 ! 21 !  7 ! 15 !  3 ! 10 !  2 !  5 ! 51 !
! 53 !  4 ! 39 ! 31 ! 25 ! 24 ! 14 ! 17 !  9 ! 12 !  6 ! 52 ! 61 !
     ! 34 ! 55 ! 33 ! 35 ! 36 ! 16 ! 18 ! 11 ! 13 ! 20 ! 60 !
          ! 59 ! 41 ! 46 ! 37 ! 26 ! 27 ! 43 ! 32 ! 62 !
               ! 50 ! 49 ! 47 ! 28 ! 29 ! 63 ! 56 !
                    ! 64 ! 57 ! 30 ! 38 ! 66 !
                         ! 58 ! 40 ! 44 !
                         ! 65 ! 42 ! 54 !
                              ! 45 !
                              ! 48 !
```

Participant No: F03

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 45 !  2 ! 21 ! 32 ! 47 !  6 !  4 ! 18 ! 12 !  9 !  7 !  3 !
! 19 ! 49 ! 36 ! 23 ! 44 !    ! 11 !  5 ! 40 ! 13 ! 10 ! 22 ! 26 !
  33 ! 54 ! 43 ! 28 ! 65 !    ! 25 !  8 ! 42 ! 14 ! 24 ! 29 ! 48
  34      !    ! 64 ! 66 !    ! 39 ! 16 ! 46 ! 15 ! 38 ! 30   51
  35           !    !    !    ! 50 ! 17 ! 56 ! 20 !      52   61
  37                !    !    ! 62 !    !    ! 27        60
  41                     !    !    !    !      31
  53                     !    !    !    !      57
  55                          !    !           63
  58                          !    !
  59
```

U.S. Department of Agriculture

Participant No: A01

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 33 ! 34 ! 19 ! 23 !  1 !  4 ! 12 !  2 !  9 ! 10 ! 11 !  5 ! 29 !
! 55 ! 35 ! 41 ! 25 ! 21 !  6 ! 13 !  3 ! 16 ! 15 ! 27 !  7 ! 61 !
     ! 59 ! 49 ! 39 ! 31 ! 20 ! 14 !  8 ! 22 ! 18 ! 30 ! 60 !
          ! 53 ! 58 ! 46 ! 32 ! 17 ! 36 ! 26 ! 24 ! 64 !
               ! 66 ! 50 ! 37 ! 44 ! 42 ! 38 ! 28 !
                    ! 51 ! 40 ! 45 ! 43 ! 52 ! 63
                         !    ! 47 ! 54 ! 56
                         !    ! 48 ! 62 !
                              ! 57 !
                              ! 65 !
```

Participant No: A02

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 !  8 !  6 ! 16 ! 25 ! 44 !  4 ! 12 ! 14 ! 17 !  2 !  9 !  7 !
! 59 ! 33 ! 13 ! 20 ! 28 ! 47 ! 23 ! 21 ! 18 ! 22 !  3 ! 11 ! 51 !
     ! 35 ! 19 ! 31 ! 38 !    ! 36 ! 26 ! 43 ! 27 !  5 ! 15 ! 62
       41 ! 34 ! 45 ! 49 !    ! 37 ! 29 ! 46 ! 32 ! 10 ! 24   65
       66   55 ! 53 ! 50 !    ! 40 ! 48 ! 52 ! 39 ! 60   30
                 58 !    !    ! 42 ! 64 ! 56 ! 54   63   57
                         !    !    !    !      61
                         !    !    !    !
                              !    !
                              !    !
```

Participant No: A03

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 19 ! 25 !  1 !  4 ! 21 !  8 ! 14 !  2 !  7 !  3 ! 18 !  5 ! 57 !
! 55 ! 33 ! 35 ! 44 ! 36 ! 20 ! 23 !  6 ! 10 ! 12 ! 24 ! 16 ! 62 !
  59 ! 34 ! 41 ! 64 ! 43 ! 29 ! 28 !  9 ! 11 ! 17 ! 60 ! 63 !
       58 ! 53 ! 65 ! 45 ! 37 ! 40 ! 27 ! 13 ! 22 ! 61 !
               ! 66 ! 46 ! 39 ! 42 ! 30 ! 15 ! 26 !
                    ! 49 ! 48 ! 47 ! 31 !    !
                         ! 50 ! 51 ! 32 !
                         !    ! 52 ! 38 !
                              ! 54 !
                              ! 56 !
```

Participant No: A04

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  8 ! 38 !  1 ! 13 ! 36 ! 23 ! 14 ! 10 !  2 !  9 ! 12 ! 27 !  3 !
! 19 ! 42 !  4 ! 21 ! 50 ! 30 ! 25 ! 20 !  6 ! 37 ! 15 ! 28 !  5 !
  34 ! 53 ! 24 ! 45 !    !    ! 31 ! 51 !  7 ! 64 ! 35 ! 29 ! 16
  41   66 ! 33 !    !    !    ! 39 ! 54 ! 11 !    ! 43 ! 32   17
  46           !    !    !    ! 40 ! 57 !    !    !           18
  48                !    !    ! 44 !    !    !                22
  55                     !    ! 49 !    !                     26
  56                     !    ! 58 !    !                     47
  59                          ! 65 !                          52
                              !    !                          60
                                                              61
                                                              62
                                                              63
```

Non-Governmental Organizations-Consumer Advocates

Participant No: N01

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 11 ! 24 !  7 !  8 !  3 !  6 !  2 ! 10 ! 17 !  5 ! 18 ! 33 !
! 52 ! 42 ! 29 ! 14 ! 13 ! 23 !  9 !  4 ! 12 ! 21 ! 46 ! 19 ! 36 !
  57 ! 63 ! 30 ! 15 ! 34 ! 25 ! 22 ! 16 ! 20 ! 37 ! 54 ! 26 ! 47
          ! 48 ! 39 ! 62 ! 35 ! 45 ! 27 ! 28 ! 50 ! 64 ! 43   55
               ! 40 !    ! 49 ! 53 ! 31 ! 32 ! 58 ! 66
                 61 !    ! 51 ! 56 ! 41 ! 38 ! 65
                         !    !    ! 44 ! 59
                         !    !    ! 60 !
                              !    !
                              !    !
```

Participant No: N02

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 11 ! 30 !  1 !  3 !  9 !  7 !  5 ! 15 !  6 !  4 ! 17 !  2 ! 20 !
! 53 ! 54 !  8 ! 10 ! 23 ! 12 ! 21 ! 28 ! 31 ! 16 ! 18 ! 22 ! 33 !
     !    ! 19 ! 24 ! 29 ! 13 ! 27 ! 38 ! 35 ! 50 ! 25 ! 32 ! 36
          ! 57 ! 40 ! 46 ! 14 ! 39 ! 44 ! 45 ! 62 ! 26 ! 41   47
               ! 59 ! 55 ! 34 ! 42 ! 48 ! 49 ! 66 !
                    ! 56 ! 37 ! 43 ! 51 ! 65 !
                         ! 52 ! 58 ! 60 !
                         !    ! 61 ! 63 !
                              !    ! 64
                              !    !
```

Environmental Science and Policy Students

Participant No: S01

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 23 ! 49 ! 31 !  1 ! 14 ! 22 !  9 !  2 !  4 ! 12 ! 10 ! 11 !  8 !
! 51 ! 50 ! 39 !  7 ! 19 ! 24 ! 20 !  3 !  5 ! 16 ! 34 ! 18 ! 26 !
     ! 56 ! 44 ! 13 ! 29 ! 38 ! 25 ! 15 !  6 ! 27 ! 35 ! 59 !
          ! 48 ! 55 ! 52 ! 43 ! 28 ! 21 ! 17 ! 33 ! 36 !
               ! 65 ! 61 ! 45 ! 32 ! 30 ! 54 ! 47 ! 41
                    !    ! 46 ! 40 ! 37 ! 58 ! 60   66
                         ! 57 ! 42 ! 62 ! 63
                         !    ! 53 ! 64 !
                              !    !
                              !    !
```

Participant No: S02

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 45 ! 42 ! 13 ! 15 !  3 ! 30 !  1 !  2 !  9 ! 16 ! 23 ! 21 !  6 !
! 53 ! 46 ! 19 ! 22 !  4 ! 35 ! 14 !  5 ! 11 ! 26 ! 25 ! 47 !  8 !
     ! 49 ! 27 ! 39 !  7 ! 38 ! 20 ! 10 ! 17 ! 37 ! 31 ! 62 !
          ! 54 ! 56 ! 34 ! 44 ! 28 ! 12 ! 24 ! 50 ! 60 !
               ! 58 ! 48 ! 51 ! 29 ! 18 ! 43 ! 63 !
                    ! 61 ! 55 ! 32 ! 36 ! 57 !
                         ! 59 ! 33 ! 52 !
                         ! 66 ! 40 ! 65 !
                              ! 41 !
                              ! 64 !
```

Participant No: S03

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 27 ! 13 ! 34 ! 18 !  3 !  5 ! 16 !  2 !  6 !  4 ! 21 ! 26 !
! 25 ! 30 ! 29 ! 40 ! 39 ! 14 !  9 ! 23 ! 10 ! 12 !  7 ! 24 ! 37 !
     ! 42 ! 55 ! 44 ! 48 ! 17 ! 22 ! 35 ! 11 ! 28 !  8 ! 65 !
          ! 61 ! 52 ! 49 ! 19 ! 31 ! 38 ! 32 ! 43 ! 15 !
               ! 57 ! 59 ! 20 ! 33 ! 41 ! 36 ! 54 !
                    ! 64 ! 46 ! 45 ! 51 ! 66 !
                         ! 53 ! 47 ! 60 !
                         ! 63 ! 50 ! 62 !
                              ! 56 !
                              ! 58 !
```

Participant No: S04

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 25 !  2 !  1 ! 19 ! 34 !  4 !  5 !  3 ! 12 !  8 ! 10 !  7 ! 24 !
! 59 ! 33 ! 22 ! 35 ! 39 ! 18 !  6 ! 13 ! 26 ! 14 ! 15 ! 51 ! 62 !
     ! 55 ! 36 ! 50 ! 44 ! 29 !  9 ! 17 ! 28 ! 23 ! 16 ! 56 !
          ! 48 ! 53 ! 45 ! 32 ! 11 ! 42 ! 49 ! 30 ! 40 !
               ! 58 ! 46 ! 52 ! 20 ! 43 ! 64 ! 31 !
                    ! 66 ! 54 ! 21 ! 47 ! 65 !
                         !    ! 27 ! 57 !
                         !    ! 37 ! 63 !
                              ! 38 !
                              ! 41 !
                                60
                                61
```

Participant No: S05

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 19 ! 39 ! 13 !  1 ! 25 !  4 !  2 ! 23 !  6 !  7 !  9 ! 17 !  8 !
! 59 ! 48 ! 21 ! 20 ! 27 ! 16 !  3 ! 36 ! 11 ! 10 ! 26 ! 18 ! 51 !
     ! 49 ! 52 ! 33 ! 28 ! 32 !  5 ! 37 ! 14 ! 12 ! 38 ! 60 !
          ! 53 ! 34 ! 50 ! 35 ! 15 ! 47 ! 31 ! 22 ! 62 !
               ! 46 ! 61 ! 42 ! 29 ! 57 ! 43 ! 24 !
                    !    ! 44 ! 30 ! 63 ! 45 !
                         ! 54 ! 40 ! 65 ! 56
                         ! 55 ! 41 ! 66 !
                              ! 58 !
                              ! 64 !
```

Participant No: S06

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 25 ! 19 !  4 !  9 ! 26 !  2 !  3 ! 10 !  6 !  5 ! 16 !  7 !
! 39 ! 48 ! 37 ! 21 ! 22 ! 38 ! 14 ! 17 ! 11 !  8 ! 23 ! 18 ! 15 !
     ! 55 ! 53 ! 33 ! 30 ! 43 ! 27 ! 20 ! 13 ! 12 ! 42 ! 62 ! 24
          !    ! 57 ! 31 ! 45 ! 29 ! 36 ! 54 ! 28 ! 44 !
               ! 64 ! 40 ! 52 ! 32 ! 41 ! 61 ! 51 !
                    ! 49 ! 56 ! 34 ! 47 ! 66 !
                         ! 58 ! 35 ! 50 !
                         ! 60 ! 46 ! 65 !
                              ! 59 !
                              ! 63 !
```

Participant No: S07

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 20 ! 13 ! 19 ! 14 ! 22 !  2 !  6 !  3 ! 17 ! 28 ! 16 !  8 !
! 59 ! 35 ! 48 ! 34 ! 25 ! 30 !  5 !  9 !  4 ! 21 ! 44 ! 26 ! 47 !
     ! 63 ! 57 ! 41 ! 29 ! 33 ! 18 ! 11 !  7 ! 23 ! 45 ! 37 !
          ! 61 ! 46 ! 39 ! 38 ! 27 ! 12 ! 10 ! 43 ! 65 !
               ! 55 ! 40 ! 50 ! 31 ! 58 ! 15 ! 51 !
                    ! 42 ! 52 ! 32 ! 60 ! 24 !
                      56 ! 53 ! 36 ! 64 !
                         ! 54 ! 49 ! 66 !
                              ! 62 !
                              !    !
```

Participant No: S08

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 25 ! 14 ! 13 !  4 ! 19 !  2 !  6 !  3 ! 26 ! 10 !  7 !  5 !
! 53 ! 34 ! 23 ! 33 ! 16 ! 20 ! 28 ! 31 !  9 ! 32 ! 11 !  8 ! 18 !
  55 ! 59 ! 30 ! 42 ! 29 ! 21 ! 39 ! 35 ! 37 ! 38 ! 12 ! 24 ! 62
          ! 40 ! 44 ! 36 ! 22 ! 45 ! 54 ! 43 ! 41 ! 15 ! 46
               !    ! 48 ! 27 ! 49 ! 57 ! 52 ! 56 ! 17   63
                    ! 51 ! 50 ! 61 !    ! 65 ! 60   47
                      58 ! 64 !    !    ! 66
                         !    !    !    !
                              !    !
                              !    !
```

Participant No: S09

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
! 27 !  8 ! 13 !  1 ! 14 ! 20 !  4 !  2 !  6 !  7 ! 18 ! 17 ! 16 !
! 47 ! 50 ! 22 !  9 ! 25 ! 23 !  5 !  3 ! 10 ! 24 ! 26 ! 62 ! 53 !
     ! 55 ! 48 ! 36 ! 29 ! 30 ! 12 ! 11 ! 21 ! 39 ! 38 ! 66 !
          ! 59 ! 42 ! 44 ! 37 ! 19 ! 15 ! 31 ! 43 ! 51 !
               ! 52 ! 61 ! 40 ! 34 ! 28 ! 32 ! 46 ! 63
                    ! 64 ! 49 ! 41 ! 33 ! 54 ! 56
                         ! 57 ! 45 ! 35 ! 60
                         !    ! 58 ! 65 !
                              !    !
                              !    !
```

Participant No: S10

```
  -6   -5   -4   -3   -2   -1    0    1    2    3    4    5    6
!----!----!----!----!----!----!----!----!----!----!----!----!----!
!  1 ! 20 ! 34 !  4 ! 13 !  2 !  6 !  5 !  3 ! 10 ! 14 ! 11 ! 18 !
! 21 ! 25 ! 50 ! 33 ! 32 ! 16 !  8 !  7 ! 12 ! 28 ! 15 ! 24 ! 63 !
     ! 48 ! 57 ! 35 ! 42 ! 27 ! 23 !  9 ! 22 ! 29 ! 17 ! 62 !
          ! 59 ! 49 ! 44 ! 30 ! 26 ! 19 ! 43 ! 45 ! 46 !
               ! 53 ! 54 ! 31 ! 36 ! 37 ! 52 ! 47 !
                    ! 55 ! 41 ! 40 ! 38 ! 56 !
                         ! 58 ! 51 ! 39 !
                         ! 65 ! 60 ! 66 !
                              ! 61 !
                              ! 64 !
```

Means and Standard Deviations of Q Sorts

Q SORT	MEAN	ST.DEV.
E01	0.00	4.17
E02	0.52	2.89
E03	1.12	3.83
E04	0.83	3.93
E05	0.50	3.31
E06	-0.41	3.73
E07	-0.08	3.16
E08	0.65	3.14
E09	-0.20	2.97
E10	0.68	3.36
E11	0.56	3.25
E12	1.21	3.96
F01	-0.17	3.15
F02	0.00	2.98
F03	0.06	4.06
A01	0.11	3.00
A02	0.46	3.56
A03	-0.18	3.11
A04	0.47	4.28
N01	0.35	3.35
N02	0.36	3.14
S01	0.24	3.07
S02	0.00	2.98
S03	0.00	2.98
S04	0.03	2.97
S05	0.06	2.98
S06	0.15	3.02
S07	-0.03	2.99
S08	0.33	3.34
S09	0.15	3.05
S10	0.00	2.98

APPENDIX H: COMPARISON OF FULL AND PARTIAL Q FACTOR ANALYSES

Comparison of Q statement scores on factors extracted from regulatory system participants only (f#a) and from combined regulatory system and student participants (f#)

No.	Statement	f1a	f1	f2	f2a	f3	f3a	f5	f4r	f4	f6
1	Allergies are minor inconveniences	-5	-5	-6	-6	-6	1	-2	-6	-5	2
2	Potentially causes allergen/toxic	0	0	0	3	3	-1	0	1	1	3
3	May reduce allergen risk	1	2	0	-2	-3	0	0	6	4	-1
4	Can't predict allergenicity	-3	-3	2	2	2	-2	1	-2	-1	-3
5	Do not base assessments on technology	5	5	0	2	2	6	3	2	1	2
6	Compare with chems./bio alternatives	2	1	2	0	1	1	1	-2	0	6
7	Increase crop yields, feed more people	4	4	4	-3	-3	4	-1	3	3	-1
8	Enjoying GM tomatoes, carrots, peppers	-1	-1	6	-4	-4	2	6	-6	-6	5
9	Clean up hazardous waste without chems	1	2	1	-1	-1	0	-1	2	1	3
10	Creates better nutritional foods	5	5	3	-1	-1	4	5	4	4	1
11	Reduces insecticides and herbicides use	5	5	2	-6	-6	1	3	1	1	2
12	Reduces resources use, less waste	1	1	3	0	0	0	2	1	1	1
13	Doesn't harm humans, animals, good insects	2	1	-4	-2	-2	-3	-4	-5	-6	-4
14	Proud that U.S. is technology leader	1	1	0	-3	-3	0	-2	2	1	0
15	Improves health, foods, prosperity, sustainable ag.	3	4	4	-1	-1	2	2	1	1	-3
16	Care about cheap food more than ecology	2	1	3	2	2	3	4	0	2	2
17	Right to chose and eat GM foods	3	3	1	4	4	5	3	0	0	2
18	Food decisions for variety of reasons	6	6	0	5	5	4	5	4	5	3
19	Agencies must chose democracy or GE	-4	-4	-3	0	-1	-5	-3	-3	-2	-5
20	Universities tied to companies	2	0	-3	4	4	-2	-2	0	0	-1
21	Benefits now, costs later	-2	-2	3	1	1	2	1	0	0	4
22	Developing countries should have GE	1	2	-1	2	3	4	1	3	2	-1
23	All food will be GM	-3	-2	2	-1	-2	-3	-6	-4	-5	4
24	Potential to fight hunger	2	3	5	-4	-4	2	0	-1	-1	1
25	Not needed to feed world/improve nutrition	-3	-4	-6	1	2	-6	-3	-1	-1	3
26	Pollen will spread	1	2	6	5	5	3	6	4	5	4
27	Possible to reduce gene contamination	2	2	-3	0	0	-4	0	2	0	-4
28	Concerns mainly from possibility to spread	0	0	3	1	1	2	1	-4	-3	1
29	Existing laws adequate	3	3	-3	-4	-3	-1	-2	-3	-4	-1
30	Thoroughly tested	1	1	-2	-5	-5	0	0	4	2	0
31	Grown in countries without safety reviews	-1	-1	1	1	1	3	-1	0	1	4
32	Inadequate monitoring	0	0	0	4	4	0	0	5	4	-1
33	Risk not properly assessed by gov.	-5	-5	-1	5	5	-2	2	-5	-3	-2
34	GE scientists' education inadequate	-4	-4	-4	-2	-2	-1	2	0	0	-3
35	Inadequate regulation to protect food	-4	-3	-1	0	0	1	4	-1	0	-2
36	Risks, therefore need regulation	0	0	0	5	5	3	4	0	-1	1
37	Can't avoid political pressure on regs.	-2	-2	5	1	0	-3	-1	-2	-2	1
38	Reg. credibility related to public understand science	4	3	1	1	1	2	0	-1	0	0
39	Agencies should reduce costs for companies	-2	-2	-3	-2	-2	-2	-3	3	4	-4
40	US's food safety system is best	0	0	-1	-4	-4	0	0	3	3	0
41	Agency staff fear punishment	-3	-3	-1	3	3	-4	1	-6	-4	-1
42	Legal threats cause industry to try their best	-1	-1	-4	-3	-3	-4	-2	-2	-2	-4
43	Pressure to cut costs and commercialize	0	0	4	3	2	1	-1	2	3	0
44	Companies have lock on the food seeds	-1	-1	-1	0	0	-5	-5	-3	-3	-1
45	Genes are a discovery, should not be patented	-1	-1	1	0	1	0	-1	-1	-1	-5
46	Difficult to distinguish GM products	-2	-1	-2	1	0	-1	-1	4	5	-5
47	Right to know GM food	0	1	2	5	5	5	5	0	-1	5
48	Label would indicate something's wrong	-2	-2	-5	-2	-1	-3	-5	-3	-5	-1
49	Industry not forced to prove safety	-3	-3	-1	0	0	-5	-6	-2	-2	-6

No.	Statement	f1a	f1	f2	f2a	f3	f3a	f5	f4r	f4	f6
50	Difficult to prove GMO-caused problem	-2	-3	-1	3	3	-1	-3	-3	-4	0
51	All foods are GM	0	0	4	-1	0	-1	-5	6	5	0
52	GMOs not fundamentally different	3	2	-2	-5	-4	-6	-4	0	-2	1
53	Should not modify laws of nature	-5	-5	-2	-3	-5	1	1	0	2	-6
54	Shouldn't exploit risky technology	-1	-1	1	-1	-2	1	1	5	4	-2
55	Should be moratorium	-6	-6	-5	2	1	-4	-4	-2	-3	-3
56	Support would grow with GM knowledge	1	1	0	-1	-1	-1	-4	-4	-3	-3
57	NGOs want to scare people	0	0	-2	-6	-6	-1	-1	1	0	2
58	GMOs not subject to long-term testing	-4	-4	0	1	1	-2	0	-1	-1	-3
59	We are guinea pigs	-6	-6	-5	-1	-1	-3	2	-4	-4	-3
60	Risks from conventional agricultural	6	6	1	0	0	5	4	2	3	5
61	No information GE creates unsafe foods	4	4	-4	-2	-2	1	-2	0	-1	0
62	Can't prove safety	4	4	2	0	0	5	3	3	3	6
63	Risks taking needed for progress	3	3	-2	-3	-2	3	2	1	2	2
64	Organic farmers concerned	0	0	0	3	2	0	0	-2	-3	0
65	Can migrate over wide regions, can't be recalled	-1	-1	5	2	3	-2	-3	1	0	1
66	Inherently unpredictable	-1	-2	1	4	4	0	3	-2	1	-2
	r =		**0.98**	--		**0.98**		**0.70**		**0.93**	--
	p =		0	--		0		0		0	--

Pairwise correlations of Q statement scores on factors extracted from regulatory system participants only (f#a) and from combined regulatory system and student participants (f#)

p<0.01

	f1a	f2a	f3a	f4a	f1	f2	f3	f4	f5	f6
f1a	1									
f2a	-0.0754	1								
	0.5474									
f3a	0.5557	0.1522	1							
	0	0.2226								
f4a	0.4488	0.024	0.3885	1						
	0.0002	0.8483	0.0013							
f1	**0.9809**	-0.0894	0.603	0.4972	1					
	0	0.4753	0	0						
f2	0.3281	0.2104	0.4768	0.2382	0.3767	1				
	0.0072	0.09	0.0001	0.0541	0.0018					
f3	-0.0192	**0.9797**	0.1535	0.0186	-0.042	0.2011	1			
	0.8782	0	0.2185	0.8822	0.7379	0.1054				
f4	0.401	0.122	0.4623	**0.9279**	0.4384	0.3083	0.1054	1		
	0.0008	0.3293	0.0001	0	0.0002	0.0118	0.3998			
f5	0.2986	0.2752	**0.7029**	0.2141	0.3333	0.3889	0.264	0.3493	1	
	0.0149	0.0253	0	0.0844	0.0062	0.0013	0.0322	0.004		
f6	0.4146	0.0852	0.504	0.1043	**0.4163**	0.4215	0.1336	0.0988	0.3749	1
	0.0005	0.4966	0	0.4048	0.0005	0.0004	0.285	0.4301	0.0019	

Comparison of participant Q sort loadings on factors extracted from regulatory system participants only (f#a) and from combined regulatory system and student participants (f#)

Sort	f1a	f1	f2	f2a	f3	f3a	f5	f4a	f4	f6
E01	0.6492	0.6355	0.1662	0.296	0.2931	0.3005	0.0576	0.1937	0.2314	0.2144
E02	0.6028	0.669	0.0847	-0.3005	-0.3251	0.4507	0.2096	0.0328	0.0383	0.2146
E03	0.6416	0.7435	0.3036	0.022	-0.0322	0.3864	0.2962	0.2523	0.1262	-0.085
E04	0.5848	0.7289	0.2237	-0.1089	-0.1453	0.4884	0.368	0.2071	0.0643	-0.0395
E05	0.0883	0.1992	0.2877	0.1259	-0.0625	0.8959	0.6342	0.1223	0.3414	0.3609
E06	0.0845	0.3182	-0.0268	0.0512	0.054	0.3046	0.1335	0.8802	0.8237	-0.0156
E07	0.5819	0.6448	0.2504	-0.0288	0.0329	-0.0486	-0.1072	0.4343	0.2009	-0.2644
E08	0.7239	0.7736	0.074	-0.1808	-0.1153	0.172	-0.0851	0.2534	0.1106	0.1267
E09	0.5932	0.6612	-0.0005	0.179	0.1754	0.3718	0.3575	0.1064	0.0984	0.0153
E10	0.7432	0.7574	0.2486	-0.0639	-0.0722	0.3857	0.0526	0.1192	0.0747	0.25
E11	0.8479	0.7875	0.1858	0.1458	0.192	0.2432	0.1433	-0.0506	-0.1319	0.2196
E12	0.4401	0.4838	0.295	0.1884	0.0904	0.6223	0.2404	0.2581	0.3764	0.3677
F01	0.4477	0.5086	0.0246	-0.1248	-0.1027	0.4925	0.1332	0.1995	0.2415	0.519
F02	0.7706	0.7696	0.0335	0.1553	0.2672	-0.0676	-0.1217	0.3498	0.1799	-0.0058
F03	0.69	0.7541	-0.075	-0.3401	-0.2266	0.0888	-0.1678	0.2926	0.1507	0.1557
A01	0.7869	0.8462	0.0439	-0.221	-0.1367	0.3331	0.0896	0.1457	0.0374	0.1882
A02	0.4843	0.621	0.1492	-0.2571	-0.1644	0.1446	-0.2029	0.6444	0.4829	0.0583
A03	0.6823	0.7606	0.1263	-0.1462	-0.1199	0.3969	0.0694	0.3522	0.2917	0.3168
A04	0.5207	0.5837	-0.001	0.2146	0.2931	0.198	0.0299	0.4618	0.3051	0.3311
N01	-0.2479	-0.2582	0.2617	0.8078	0.6977	0.1531	0.2783	0.0433	0.0906	-0.1261
N02	0.1716	0.063	0.0477	0.7685	0.7603	-0.0342	0.0334	-0.0497	-0.04	0.1595
S01		0.0048	0.0497		0.2244		0.7433		0.0401	0.1235
S02		0.1064	0.3065		0.1683		0.1565		-0.1644	0.7048
S03		-0.0138	0.8168		0.1902		0.1637		0.1656	0.0619
S04		0.4869	0.583		-0.3583		-0.1479		0.0986	0.1584
S05		0.4395	0.5067		-0.0423		0.2275		0.1732	0.3346
S06		0.5054	0.4806		-0.0446		0.1959		-0.1126	-0.0414
S07		0.1175	0.7468		0.2087		-0.0563		0.0142	0.2916
S08		0.5279	0.4785		0.1055		0.3752		0.1659	-0.057
S09		0.0206	0.4479		-0.0108		0.1561		0.6176	-0.0384
S10		0.5782	0.3912		-0.1637		0.3154		0.1385	-0.1638
r =	**0.98**		––	**0.97**		**0.78**		**0.88**		––
p =	**0.00**		––	**0.00**		**0.00**		**0.00**		––

Pairwise correlations of participant Q sort loads on factors extracted from regulatory system participants only (f#a) and from combined regulatory system and student participants (f#)

p<0.01

	fl1	**fl2**	**fl3**	**fl4**	**fl5**	**fl6**	**fl1a**	**fl2a**	**fl3a**	**fl4a**
fl1	1									
fl2	-0.1024	1								
	0.6502									
fl3	-0.7166	-0.0368	1							
	0.0002	0.8707								
fl4	-0.076	-0.0832	-0.2593	1						
	0.7369	0.7129	0.2439							
fl5	-0.2925	0.4409	-0.009	-0.0294	1					
	0.1865	0.04	0.9683	0.8968						
fl6	0.064	-0.158	-0.1614	0.028	0.1351	1				
	0.7773	0.4826	0.4729	0.9017	0.5488					
fl1a	**0.9625**	-0.1086	-0.5509	-0.2855	-0.3624	0.1088	1			
	0	0.6304	0.0079	0.1978	0.0974	0.6298				
fl2a	-0.7982	0.1081	**0.9749**	-0.2322	0.1858	-0.1265	-0.6514	1		
	0	0.6322	0	0.2984	0.4078	0.5748	0.001			
fl3a	0.0796	0.4022	-0.4875	0.2396	**0.7797**	0.4989	-0.0459	-0.3068	1	
	0.7248	0.0635	0.0214	0.2828	0	0.0181	0.8394	0.1649		
fl4a	0.2018	-0.195	-0.3466	**0.8794**	-0.3428	-0.2256	-0.0006	-0.4012	-0.0765	1
	0.3678	0.3844	0.114	0	0.1184	0.3128	0.9978	0.0642	0.7352	

APPENDIX I: SURVEY SUMMARY STATISTICS AND FREQUENCY TABLES

(Items 1-27: Please indicate the extent to which you personally agree or disagree with each of the following statements: 1=Strongly disagree, 5= strongly agree.)

Items 1-15. NEP

1. We are approaching the limit of the number of people the earth can support.

Score	EPA	FDA	USDA	NGO	Student	Total
2	2	1	1	0	0	4
3	3	0	1	1	2	7
4	2	1	1	1	3	8
5	4	1	1	0	4	10
Total	11	3	4	2	9	29

Pearson chi2(12)=6.1392 Pr=0.909

2. Humans have the right to modify the natural environment to suit their needs.

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	1	1	2
2	2	1	1	0	1	5
3	5	2	0	0	6	13
4	4	0	3	0	1	8
5	0	0	0	1	0	1
Total	11	3	4	2	9	29

*Pearson chi2(16)=31.2971 Pr=0.012

Regulatory agency participants only: Pearson chi2(4)=5.0601 Pr=0.281

3. When humans interfere with nature it often produces disastrous consequences.

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	1	0	0	1
2	3	2	2	0	0	7
3	3	0	0	2	3	8
4	5	1	1	0	6	13
Total	11	3	4	2	9	29

Pearson chi2(12)=20.4415 Pr=0.059

4. Human ingenuity will insure that we do not make the earth unlivable.

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	0	0	0	1	2
2	1	2	1	1	4	9
3	6	1	2	1	3	13
4	3	0	1	0	1	5
Total	11	3	4	2	9	29

Pearson chi2(12)=7.1247 Pr=0.849

5. Humans are severely abusing the environment.

Score	EPA	FDA	USDA	NGO	Student	Total
2	2	0	1	0	1	4
3	3	0	2	0	1	6
4	4	1	1	1	1	8
5	2	2	0	1	6	11
Total	11	3	4	2	9	29

Pearson chi2(12)=11.5194 Pr=0.485

6. The earth has plenty of natural resources if we just learn how to develop them.

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	1	1	0	2	5
2	3	2	2	0	4	11
3	1	0	1	2	0	4
4	6	0	0	0	2	8
5	0	0	0	0	1	1
Total	11	3	4	2	9	29

Pearson chi2(16)=24.1524 Pr=0.086

7. Plants and animals have as much right as humans to exist.

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	1	0	0	2
3	2	0	1	1	0	4
4	5	2	1	0	2	10
5	3	1	1	1	7	13
Total	11	3	4	2	9	29

Pearson chi2(12)=12.8757 Pr=0.378

8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.

Score	EPA	FDA	USDA	NGO	Student	Total
1	3	2	1	1	4	11
2	5	1	2	1	2	11
3	0	0	0	0	2	2
4	3	0	1	0	1	5
Total	11	3	4	2	9	29

Pearson chi2(12)=8.6174 Pr=0.735

9. Despite our special abilities, humans are still subject to the laws of nature.

Score	EPA	FDA	USDA	NGO	Student	Total
3	0	0	1	0	0	1
4	2	0	1	1	3	7
5	9	3	2	1	6	21
Total	11	3	4	2	9	29

Pearson chi2(8)=8.9134 Pr=0.35

10. The so-called ‘ecological crisis’ facing human kind has been greatly exaggerated.

Score	EPA	FDA	USDA	NGO	Student	Total
1	4	3	1	1	2	11
2	3	0	0	1	6	10
3	3	0	2	0	1	6
4	1	0	1	0	0	2
Total	11	3	4	2	9	29

Pearson chi2(12)=15.5836   Pr=0.211

11. The earth is like a spaceship with very limited room and resources.

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	1	1
2	3	0	1	1	1	6
3	3	0	1	0	4	8
4	1	1	2	1	1	6
5	4	2	0	0	2	8
Total	11	3	4	2	9	29

Pearson chi2(16)=14.2101   Pr=0.583

12. Humans were meant to rule over the rest of nature.

Score	EPA	FDA	USDA	NGO	Student	Total
1	6	3	2	2	4	17
2	4	0	2	0	2	8
3	1	0	0	0	1	2
4	0	0	0	0	1	1
5	0	0	0	0	1	1
Total	11	3	4	2	9	29

Pearson chi2(16)=9.7334   Pr=0.88

13. The balance of nature is very delicate and easily upset.

Score	EPA	FDA	USDA	NGO	Student	Total
2	2	0	2	0	3	7
3	5	2	0	1	2	10
4	3	1	2	1	3	10
5	1	0	0	0	1	2
Total	11	3	4	2	9	29

Pearson chi2(12)=7.5074   Pr=0.822

14. Humans will eventually learn enough about how nature works to be able to control it.

Score	EPA	FDA	USDA	NGO	Student	Total
1	3	0	0	1	5	9
2	2	0	3	0	2	7
3	5	1	1	1	1	9
4	1	2	0	0	1	4
Total	11	3	4	2	9	29

Pearson chi2(12)=19.1706 Pr=0.084

Regulatory agency participants only: Pearson chi2(6)=12.2078 Pr=0.057

15. If things continue on their present course, we will soon experience a major ecological catastrophe.

Score	EPA	FDA	USDA	NGO	Student	Total
2	2	1	2	0	0	5
3	5	0	2	0	0	7
4	3	0	0	1	5	9
5	1	2	0	1	4	8
Total	11	3	4	2	9	29

*Pearson chi2(12)=21.0188 Pr=0.05

Regulatory agency participants only: Pearson chi2(6)=9.9792 Pr=0.126

Items 16-18. Support for Unrestricted Science Research

16. We have a duty to allow research that might lead to important new treatments, even when it involves the creation or use of human embryos.

Score	EPA	FDA	NGO	Student	USDA	Total
1	0	0	2	1	0	3
2	1	0	0	1	0	2
3	3	0	0	1	1	5
4	7	1	0	3	2	13
5	0	2	0	3	1	6
Total	11	3	2	9	4	29

*Pearson chi2(16)=28.8049 Pr=0.025

Regulatory agency participants only: Pearson chi2(6)=8.3614 Pr=0.213

17. I feel scientific research often goes too far.

Score	EPA	FDA	NGO	Student	USDA	Total
1	5	1	1	4	3	14
2	3	0	1	4	1	9
3	3	2	0	1	0	6
Total	11	3	2	9	4	29

Pearson chi2(8)=7.4947 Pr=0.484

18. I fear the potential impacts of scientific research.

Score	EPA	FDA	NGO	Student	USDA	Total
1	6	1	0	4	3	14
2	3	0	0	3	1	7
3	2	2	1	1	0	6
4	0	0	1	1	0	2
Total	11	3	2	9	4	29

Pearson chi2(12)=15.398 Pr=0.22

Items 19-27. Personal Normative Beliefs

19. The government should take stronger action to clean up toxic substances in the environment.

Score	EPA	FDA	USDA	NGO	Student	Total
3	1	0	2	0	1	4
4	8	2	1	0	5	16
5	2	1	1	2	3	9
Total	11	3	4	2	9	29

Pearson chi2(8)=10.8826 Pr=0.208

20. I feel a personal obligation to do whatever I can to prevent climate change.

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	0	0	0	0	1
2	0	0	1	0	1	2
3	1	0	1	0	2	4
4	5	2	2	2	3	14
5	4	1	0	0	3	8
Total	11	3	4	2	9	29

Pearson chi2(16)=10.4278 Pr=0.843

21. I feel a sense of personal obligation to take action to stop the disposal of toxic substances in the air, water, and soil.

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	1	2
3	3	0	0	0	2	5
4	4	1	3	2	2	12
5	4	2	0	0	3	9
Blank	0	0	0	0	1	1
Total	11	3	4	2	9	29

Pearson chi2(16)=14.6526 Pr=0.55

22. Business and industry should reduce their emissions to help prevent climate change.

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	0	1	1
3	1	0	1	0	0	2
4	5	0	1	0	4	10
5	5	3	2	2	4	16
Total	11	3	4	2	9	29

Pearson chi2(12)=9.8534 Pr=0.629

23. The government should exert pressure internationally to preserve the tropical forests

Score	EPA	FDA	USDA	NGO	Student	Total
3	1	1	1	0	2	5
4	7	1	2	0	6	16
5	3	1	1	2	1	8
Total	11	3	4	2	9	29

Pearson chi2(8)=7.9622 Pr=0.437

24. The government should take strong action to reduce emissions and prevent global climate change

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	0	1
3	2	0	1	0	1	4
4	4	1	1	1	6	13
5	5	2	1	1	2	11
Total	11	3	4	2	9	29

Pearson chi2(12)=10.7448 Pr=0.551

25. Companies that import products from the tropics have a responsibility to prevent destruction of the forests in those countries

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	0	1
3	3	0	2	0	1	6
4	4	2	0	0	6	12
5	4	1	1	2	2	10
Total	11	3	4	2	9	29

Pearson chi2(12)=16.9777 Pr=0.15

26. People like me should do whatever we can to prevent the loss of tropical forests

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	1	0	2	4
3	1	1	2	0	2	6
4	8	2	1	1	3	15
5	1	0	0	1	2	4
Total	11	3	4	2	9	29

Pearson chi2(12)=10.4417 Pr=0.577

27. The chemical industry should clean up the toxic waste products it has emitted into the environment

Score	EPA	FDA	USDA	NGO	Student	Total
4	5	0	3	0	3	11
5	6	3	1	2	6	18
Total	11	3	4	2	9	29

Pearson chi2(4)=5.7354 Pr=0.22

Items 28-50. Values

(Please indicate the extent to which each of the following statements is a guiding principle in your life: 1=unimportant, 5=very important)

28. Social justice, correcting injustice, care for the weak.

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	0	2	2
3	0	1	2	0	2	5
4	8	0	1	1	3	13
5	3	1	1	1	2	8
Blank	0	1	0	0	0	1
Total	11	3	4	2	9	29

Pearson chi2(16)=22.8092 Pr=0.119

29. Preventing pollution, conserving natural resources

Score	EPA	FDA	USDA	NGO	Student	Total
3	0	0	1	1	1	3
4	6	2	1	0	5	14
5	5	1	2	1	3	12
Total	11	3	4	2	9	29

Pearson chi2(8)=7.4767 Pr=0.486

30. Equality, equal opportunity for all

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	0	1	1
3	1	0	1	0	2	4
4	3	1	1	1	4	10
5	7	2	2	1	2	14
Total	11	3	4	2	9	29

Pearson chi2(12)=6.6029 Pr=0.883

31. Unity with nature, fitting into nature

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	0	1
3	2	2	1	0	1	6
4	6	0	1	2	5	14
5	3	1	1	0	3	8
Total	11	3	4	2	9	29

Pearson chi2(12)=14.0968 Pr=0.295

32. A world of peace, free of war and conflict

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	1	1
2	0	0	0	0	1	1
3	3	0	1	1	2	7
4	3	2	2	1	4	12
5	5	1	1	0	1	8
Total	11	3	4	2	9	29

Pearson chi2(16)=9.6593 Pr=0.884

33. Respecting the earth, harmony with other species

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	0	1
3	1	0	0	0	1	2
4	5	2	2	1	6	16
5	5	1	1	1	2	10
Total	11	3	4	2	9	29

Pearson chi2(12)=8.7055 Pr=0.728

34. Protecting the environment, preserving nature

Score	EPA	FDA	USDA	NGO	Student	Total
3	0	1	1	1	1	4
4	5	1	2	0	4	12
5	6	0	1	1	4	12
Blank	0	1	0	0	0	1
Total	11	3	4	2	9	29

Pearson chi2(12)=16.3552 Pr=0.176

35. True friendship, close supportive friends

Score	EPA	FDA	USDA	NGO	Student	Total
3	1	0	1	0	4	6
4	6	1	2	1	2	12
5	4	2	1	1	3	11
Total	11	3	4	2	9	29

Pearson chi2(8)=6.6175 Pr=0.578

36. Loyal, faithful to my friends

Score	EPA	FDA	USDA	NGO	Student	Total
3	0	0	1	0	1	2
4	6	1	1	2	3	13
5	5	2	2	0	5	14
Total	11	3	4	2	9	29

Pearson chi2(8)=6.8255 Pr=0.556

37. Sense of belonging, feeling that others care about me

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	1	0	0	1
2	0	0	0	0	3	3
3	1	1	1	1	2	6
4	4	0	1	1	3	9
5	6	2	1	0	1	10
Total	11	3	4	2	9	29

Pearson chi2(16)=20.4709 Pr=0.2

38. Obedient, dutiful, meeting obligations

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	1	0	1	2
3	1	1	1	1	1	5
4	4	2	1	0	5	12
5	6	0	1	1	2	10
Total	11	3	4	2	9	29

Pearson chi2(12)=10.7005 Pr=0.555

39. Self-discipline, self-restraint, resistance to temptations

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	0	3	3
3	2	1	1	1	1	6
4	7	2	3	1	3	16
5	2	0	0	0	2	4
Total	11	3	4	2	9	29

Pearson chi2(12)=11.3434 Pr=0.5

40. Family security, safety for loved ones

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	0	0	0	1
3	0	0	0	0	3	3
4	0	1	2	0	5	8
5	10	2	2	2	1	17
Total	11	3	4	2	9	29

*Pearson chi2(12)=21.2955 Pr=0.046

Regulatory agency participants only: Pearson chi2(4)=6.3247 Pr=0.176

41. Honoring parents and elders, showing respect

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	0	0	0	1
3	1	0	2	0	4	7
4	3	3	1	1	5	13
5	6	0	1	1	0	8
Total	11	3	4	2	9	29

Pearson chi2(12)=16.4905 Pr=0.17

42. Honest, genuine, sincere

Score	EPA	FDA	USDA	NGO	Student	Total
3	0	0	0	0	2	2
4	2	0	2	1	1	6
5	9	3	2	1	6	21
Total	11	3	4	2	9	29

Pearson chi2(8)=8.896 Pr=0.351

43. Forgiving, willing to pardon others

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	2	2
3	2	0	1	1	0	4
4	3	2	1	1	6	13
5	6	1	2	0	1	10
Total	11	3	4	2	9	29

Pearson chi2(12)=14.5938 Pr=0.264

44. Social power, control over others, dominance

Score	EPA	FDA	USDA	NGO	Student	Total
1	5	1	3	2	7	18
2	4	2	1	0	1	8
3	2	0	0	0	0	2
4	0	0	0	0	1	1
Total	11	3	4	2	9	29

Pearson chi2(12)=10.7275 Pr=0.552

45. Influential, having an impact on people and events

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	1	0	2	3
2	0	0	1	0	3	4
3	4	1	0	1	0	6
4	6	2	2	1	3	14
5	1	0	0	0	1	2
Total	11	3	4	2	9	29

Pearson chi2(16)=15.4825 Pr=0.49

46. Wealth, material possessions, money

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	0	1	1	2	5
2	5	2	1	0	1	9
3	4	1	2	1	3	11
4	1	0	0	0	3	4
Total	11	3	4	2	9	29

Pearson chi2(12)=10.4517 Pr=0.576

47. Authority, the right to lead or command

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	1	0	3	4
2	5	2	0	1	1	9
3	5	1	3	1	2	12
4	1	0	0	0	3	4
Total	11	3	4	2	9	29

Pearson chi2(12)=15.5781 Pr=0.211

48. Curious, interested in everything, exploring

Score	EPA	FDA	USDA	NGO	Student	Total
3	2	0	1	0	1	4
4	2	1	0	2	3	8
5	7	2	3	0	5	17
Total	11	3	4	2	9	29

Pearson chi2(8)=8.1062 Pr=0.423

49. A varied life, filled with challenge, novelty and change

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	1	1
3	1	0	0	1	3	5
4	4	2	2	0	4	12
5	6	1	2	1	1	11
Total	11	3	4	2	9	29

Pearson chi2(12)=10.6542 Pr=0.559

50. An exciting life, stimulating experiences

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	1	1
3	3	0	1	0	2	6
4	6	3	1	1	4	15
5	2	0	2	1	2	7
Total	11	3	4	2	9	29

Pearson chi2(12)=8.1096 Pr=0.777

Items 51-60. Support for Actors in the Biotechnology Arena

(For each of the following people and groups, do you think they are doing a good job for society or not doing a good job for society?)

51. Newspapers, magazines, and television which report on biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	5	1	0	1	3	10
Don't know	1	0	0	0	0	1
Not doing a good job	5	2	4	1	6	18
Total	11	3	4	2	9	29

Pearson chi2(8)=5.0481 Pr=0.752

52. Industries which develop new products with biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	5	1	0	1	3	10
Don't know	1	0	0	0	0	1
Not doing a good job	5	2	4	1	6	18
Total	11	3	4	2	9	29

Pearson chi2(8)=5.0481 Pr=0.752

52. Industries which develop new products with biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	9	3	3	0	4	19
Don't know	1	0	0	0	1	2
Not doing a good job	1	0	1	2	4	8
Total	11	3	4	2	9	29

Pearson chi2(8)=10.8254 Pr=0.212

53. University scientists who conduct research in biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	8	2	4	1	8	23
Don't know	2	0	0	0	1	3
Not doing a good job	1	1	0	1	0	3
Total	11	3	4	2	9	29

Pearson chi2(8)=8.1808 Pr=0.416

54. Consumer organizations which test biotechnological products

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	3	1	0	2	4	10
Don't know	6	0	2	0	3	11
Not doing a good job	2	2	2	0	2	8
Total	11	3	4	2	9	29

Pearson chi2(8)=10.5834 Pr=0.226

55. Environmental groups who campaign about biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	1	0	0	2	3	6
Don't know	4	1	0	0	2	7
Not doing a good job	6	2	4	0	4	16
Total	11	3	4	2	9	29

Pearson chi2(8)=14.0083 Pr=0.082

56. United States Government making laws about biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	10	2	1	0	1	14
Don't know	1	1	0	0	5	7
Not doing a good job	0	0	3	2	3	8
Total	11	3	4	2	9	29

**Pearson chi2(8)=25.6379 Pr=0.001

**Regulatory agency participants only: Pearson chi2(4)=14.0979 Pr=0.007

57. Retailers who ensure our food is safe

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	7	3	3	0	4	17
Don't know	3	0	1	0	2	6
Not doing a good job	1	0	0	2	3	6
Total	11	3	4	2	9	29

Pearson chi2(8)=12.8379 Pr=0.118

58. Ethics committees who consider the moral and ethical aspects of biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	5	0	2	1	2	10
Don't know	4	3	1	0	3	11
Not doing a good job	2	0	1	1	4	8
Total	11	3	4	2	9	29

Pearson chi2(8)=8.7504 Pr=0.364

59. Religious leaders who say what is right and wrong in the development of biotechnology

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	1	0	0	2	1	4
Don't know	5	1	2	0	0	8
Not doing a good job	5	2	2	0	8	17
Total	11	3	4	2	9	29

**Pearson chi2(8)=20.0247 Pr=0.01

Regulatory agency participants only: Pearson chi2(4)=0.9621 Pr=0.915

60. Medical doctors

	EPA	FDA	USDA	NGO	Student	Total
Doing a good job	6	2	3	2	7	20
Don't know	5	0	0	0	1	6
Not doing a good job	0	1	1	0	1	3
Total	11	3	4	2	9	29

Pearson chi2(8)=9.9706 Pr=0.267

Items 61-70. Attitudes towards technologies

(For each of the following areas where new technologies are being developed, please indicate if you think it will have a positive, a negative, or no effect on our way of life in the next 20 years? Positive, Negative, No effect at all.)

61. Solar energy

	EPA	FDA	USDA	NGO	Student	Total
No effect at all	1	0	0	0	0	1
Positive	10	3	4	2	9	28
Total	11	3	4	2	9	29

Pearson chi2(4)=1.6948 PR=0.792

62. Computers and Information Technology

	EPA	FDA	USDA	NGO	Student	Total
Positive	11	3	4	2	9	29
Total	11	3	4	2	9	29

63. Biotechnology and genetic engineering

	EPA	FDA	USDA	NGO	Student	Total
Negative	0	0	0	2	1	3
Positive	11	3	4	0	8	26
Total	11	3	4	2	9	29

**Pearson chi2(4)=19.4160 PR=0.001

64. Space exploration

	EPA	FDA	USDA	NGO	Student	Total
Negative	1	0	0	1	1	3
No effect at all	2	2	2	0	3	9
Positive	8	1	2	1	5	17
Total	11	3	4	2	9	29

Pearson chi2(8)=7.4898 PR=0.485

65. Nuclear energy

	EPA	FDA	USDA	NGO	Student	Total
Negative	0	0	0	1	3	4
No effect at all	3	1	0	1	0	5
Positive	8	2	4	0	6	20
Total	11	3	4	2	9	29

Pearson chi2(8)=13.4235 PR=0.098

66. Nanotechnology

	EPA	FDA	USDA	NGO	Student	Total
Negative	1	0	0	0	0	1
No effect at all	1	0	1	2	0	4
Positive	9	3	3	0	9	24
Total	11	3	4	2	9	29

*Pearson chi2(8)=16.7244 PR=0.033

Regulatory agency participants only: Pearson chi2(4)=1.8409 Pr=0.765

67. Wind energy

	EPA	FDA	USDA	NGO	Student	Total
Negative	0	0	0	0	1	1
Positive	11	3	4	2	8	28
Total	11	3	4	2	9	29

Pearson chi2(4)=2.3016 PR=0.68

68. Brain and cognitive enhancement

	EPA	FDA	USDA	NGO	Student	Total
Negative	0	1	0	0	2	3
No effect at all	0	0	1	0	1	2
Positive	11	2	3	2	6	24
Total	11	3	4	2	9	29

Pearson chi2(8)=8.6262 Pr=0.375

69. Synthetic biology

	EPA	FDA	USDA	NGO	Student	Total
Negative	1	0	0	1	1	3
No effect at all	1	1	0	1	1	4
Positive	9	2	4	0	7	22
Total	11	3	4	2	9	29

Pearson chi2(8)=9.2062 PR=0.325

70. Biofuels made from crops like corn and sugar cane

	EPA	FDA	USDA	NGO	Student	Total
Negative	2	2	1	2	6	13
No effect at all	1	0	0	0	0	1
Positive	8	1	3	0	3	15
Total	11	3	4	2	9	29

Pearson chi2(8)=9.5405 Pr=0.299

Items 71-87. Attitudes towards GMOs

(Please indicate the extent to which you agree or disagree with each of the following statements about genetically modified (GM) crops and food: 1=strongly disagree, 5=strongly agree.)

71. GM crops and food are good for the U.S. economy

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	1	0	1
3	2	0	0	0	2	4
4	8	3	1	1	6	19
5	1	0	3	0	1	5
Total	11	3	4	2	9	29

** Pearson chi2(12)=26.2896 Pr=0.010

Regulatory agency participants only: Pearson chi2(4)=9.4091 Pr=0.052

72. GM foods is not good for you and your family

Score	EPA	FDA	USDA	NGO	Student	Total
1	5	2	4	0	2	13
2	4	1	0	0	5	10
3	2	0	0	1	2	5
5	0	0	0	0	0	1
Total	11	3	4	2	9	29

*Pearson chi2(12)=24.2861 Pr=0.019

Regulatory agency participants only: Pearson chi2(4)=4.1554 Pr=0.385

73. GM plants and food helps people in developing countries

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	1	0	1
2	1	0	0	0	0	1
3	3	1	1	1	0	6
4	6	2	1	0	6	15
5	1	0	2	0	3	6
Total	11	3	4	2	9	29

Pearson chi2(16)=24.5548 Pr=0.078

74. GM crops and food are safe for future generations

Score	EPA	FDA	USDA	NGO	Student	Total
2	0	0	0	1	0	1
3	3	0	0	1	6	10
4	7	2	0	0	2	11
5	1	1	4	0	1	7
Total	11	3	4	2	9	29

**Pearson chi2(12)=36.1427 Pr=0.000

*Regulatory agency participants only: Pearson chi2(4)=11.7576 Pr=0.019

75. GM crops and food benefit some people but puts others at risk

Score	EPA	FDA	USDA	NGO	Student	Total
1	3	2	3	1	1	10
2	5	1	1	0	1	8
3	2	0	0	1	2	5
4	1	0	0	0	4	5
5	0	0	0	0	1	1
Total	11	3	4	2	9	29

Pearson chi2(16)=17.9401 Pr=0.327

76. GM crops and food are fundamentally unnatural

Score	EPA	FDA	USDA	NGO	Student	Total
1	4	2	2	0	1	9
2	5	1	2	0	4	12
3	1	0	0	0	2	3
4	1	0	0	0	1	2
5	0	0	0	2	1	3
Total	11	3	4	2	9	29

Pearson chi2(16)=25.0861 Pr=0.068

77. GM crops and food make you feel uneasy

Score	EPA	FDA	USDA	NGO	Student	Total
1	6	3	4	1	1	15
2	5	0	0	0	4	9
3	0	0	0	0	2	2
4	0	0	0	1	2	3
Total	11	3	4	2	9	29

Pearson chi2(12)=20.6678 Pr=0.055

78. GM food is safe for your health and your family's health

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	0	1	0	2
3	4	0	0	1	4	9
4	2	0	1	0	4	7
5	4	3	3	0	1	11
Total	11	3	4	2	9	29

Pearson chi2(12)=19.4704 Pr=0.078

79. GM crops and food do no harm to the environment

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	2	1	3
2	0	0	0	0	3	3
3	6	1	2	0	4	13
4	3	0	2	0	0	5
5	2	2	0	0	0	4
Total	11	3	4	2	8	28

**Pearson chi2(16)=38.6224 Pr=0.001

Regulatory agency participants only: Pearson chi2(4)=5.3939 Pr=0.249

80. The development of GM crops and food should be encouraged

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	2	0	2
3	1	0	1	0	3	5
4	8	2	1	0	5	16
5	2	1	2	0	1	6
Total	11	3	4	2	9	29

**Pearson chi2(12)=34.9663 Pr=0.000

Regulatory agency participants only: Pearson chi2(4)=3.2888 Pr=0.511

81. GM foods should be clearly identified with a special label

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	3	1	0	0	4
2	2	0	1	0	0	3
3	7	0	2	0	6	15
4	0	0	0	0	3	3
5	2	0	0	2	0	4
Total	11	3	4	2	9	29

**Pearson chi2(16)=45.5761 Pr=0.000

*Regulatory agency participants only: Pearson chi2(6)=14.4886 Pr=0.025

82. GM foods are the same as ordinary foods and would not need special labeling

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	0	0	2	0	3
2	2	0	0	0	2	4
3	6	0	2	0	7	15
4	2	0	0	0	0	2
5	0	3	2	0	0	7
Total	11	3	4	2	9	29

**Pearson chi2(16)=44.3300 Pr=0.000

Regulatory agency participants only: Pearson chi2(8)=14.1955 Pr=0.077

(Please answer the following questions about genetic engineering/biotechnology:

83. Overall, what are your feelings toward using biotechnology in agriculture and food production?

(1= strongly oppose, 5=strongly support)

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	1	0	1
2	0	0	0	1	0	1
3	1	0	1	0	1	3
4	5	1	0	0	5	11
5	5	2	3	0	3	13
Total	11	3	4	2	9	29

**Pearson chi2(16)=33.8576 Pr=0.006

Regulatory agency participants only: Pearson chi2(4)=3.4273 Pr=0.489

84. Some people say that genetically engineered crops are good for the environment because among other benefits, they can help decrease the use of pesticides. Others say genetically engineered crops are bad for the environment because, among other risks, they can affect existing plant or animals in nature. Do you think the benefits for the environment outweigh the risks, or do you think the risks outweigh the benefits?

(1=risks strongly outweigh the benefits, 5=benefits strongly outweigh the risks)

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	2	0	2
2	0	0	0	0	2	2
3	2	0	1	0	4	7
4	7	1	0	0	2	10
5	2	2	3	0	1	8
Total	11	3	4	2	9	29

**Pearson chi2(16)=46.2360 Pr=0.000

Regulatory agency participants only: Pearson chi2(4)=6.6039 Pr=0.158

85. Some people say that genetically engineered crops are good for human health because, among other benefits, they can be used to produce more nutritious foods. Others say genetically engineered crops are bad for human health because, among other risks, they can induce allergic reactions. Do you think the benefits for health outweigh the risks, or do you think the risks for health outweigh the benefits?

(1=risks strongly outweigh the benefits, 5=benefits strongly outweigh the risks)

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	1	0	1
3	2	0	1	1	3	7
4	7	0	1	0	4	12
5	2	3	2	0	2	9
Total	11	3	4	2	9	29

* Pearson chi2(12)=25.4148 Pr=0.013

Regulatory agency participants only: Pearson chi2(4)=7.4878 Pr=0.112

86.Overall, do you think the benefits of developing and growing new plants and crops through genetic engineering outweigh the risks, or do you think, or do you think the risks outweigh the benefits?

(1=risks strongly outweigh the benefits, 5=benefits strongly outweigh the risks)

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	2	0	2
3	0	0	0	0	1	1
4	8	0	1	0	5	14
5	3	3	3	0	3	12
Total	11	3	4	2	9	29

**Pearson chi2(12)=38.6274 Pr=0.000

*Regulatory agency participants only: Pearson chi2(2)=6.2727 Pr=0.043

87. Overall, would you say you oppose or support the use of biotechnology in agriculture and food production?

(1=strongly oppose, 5=strongly support)

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	1	0	1
2	0	0	0	1	0	1
3	0	0	1	0	1	2
4	7	0	0	0	6	13
5	4	3	3	0	2	12
Total	11	3	4	2	9	29

**Pearson chi2(16)=41.3730 Pr=0.000

*Regulatory agency participants only: Pearson chi2(4)=10.0227 Pr=0.040

Items 88-93. Factual knowledge about biotechnology

(Please indicate whether each of the following statements is true or false.)

88. Genes are the cell's instructions for producing proteins. (True)

	EPA	FDA	USDA	NGO	Student	Total
Incorrect	0	0	1	0	0	1
Correct	11	3	3	2	9	28
Total	11	3	4	2	9	29

Pearson chi2(4)=6.4732 Pr=0.166

89. In nature, plants transmit their genes to unrelated kinds of plants through the process of pollination. (False)

	EPA	FDA	USDA	NGO	Student	Total
Incorrect	4	1	0	0	0	5
Correct	7	2	4	2	9	24
Total	11	3	4	2	9	29

Pearson chi2(4)=6.4884 Pr=0.166

90. Through genetic engineering, scientists can produce genes that do not exist in nature. (True)

	EPA	FDA	USDA	NGO	Student	Total
Incorrect	2	0	0	0	7	9
Correct	9	3	4	2	2	20
Total	11	3	4	2	9	29

**Pearson chi2(4)=14.0866 Pr=0.007

Regulatory agency participants only: Pearson chi2(2)=1.4318 Pr=0.489

91. Manipulation of genetic material in plants to produce better crops has been performed by plant breeders for centuries. (True)

	EPA	FDA	USDA	NGO	Student	Total
Correct	11	3	4	2	9	29
Total	11	3	4	2	9	29

92. Genetic engineers can use 'gene guns' or bacteria to transfer genes into an organism. (True)

	EPA	FDA	USDA	NGO	Student	Total
Correct	11	3	4	2	9	29
Total	11	3	4	2	9	29

93. Organic tomatoes do not contain genes. (False)

	EPA	FDA	USDA	NGO	Student	Total
Incorrect	1	0	0	0	0	1
Correct	10	3	4	2	9	28
Total	11	3	4	2	9	29

Pearson chi2(4)=1.6948 Pr=0.792

Number of correct responses to factual questions on biotechnology (88-92)

No. Correct (out of max. 6)	EPA	FDA	USDA	NGO	Student	Total
4	1	0	0	0	0	1
5	5	1	1	0	7	14
6	5	2	3	2	2	14
Total	11	3	4	2	9	29

Pearson chi2(8)=8.0242 Pr=0.431

Items 94-106. Source of Information on biotechnology

(Please indicate how often you get information on modern biotechnology/genetic engineering, genetically modified (engineered) crops or food from each of the following sources: 1=never, 4=very often.)

94. Local newspapers

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	2	1	1	6	12
2	5	1	2	0	2	10
3	3	0	1	0	1	5
4	1	0	0	1	0	2
Total	11	3	4	2	9	29

Pearson chi2(12)=13.7347 Pr=0.318

95. National newspapers

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	4	4
2	3	1	0	0	3	7
3	3	2	3	0	2	10
4	5	0	1	2	0	8
Total	11	3	4	2	9	29

*Pearson chi2(12)=23.2505 Pr=0.026

96. Scientific/professional journals and magazines

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	0	0	2	3
3	0	1	0	0	3	4
4	10	2	4	2	4	22
Total	11	3	4	2	9	29

Pearson chi2(8)=9.8353 Pr=0.277

97. Scientific conferences/workshops/meetings

Score	EPA	FDA	USDA	NGO	Student	Total
1	0	0	0	0	4	4
2	2	0	0	0	2	4
3	2	3	2	1	2	10
4	7	0	2	1	1	11
Total	11	3	4	2	9	29

*Pearson chi2(12)=21.1322 Pr=0.048

98. Your own research or first-hand experience

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	2	0	1	3	8
2	2	0	0	0	4	6
3	3	0	1	1	2	7
4	4	1	3	0	0	8
Total	11	3	4	2	9	29

Pearson chi2(12)=15.9145 Pr=0.195

99. Television science programs

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	0	1	0	1	4
2	6	2	1	2	5	16
3	2	1	2	0	2	7
4	1	0	0	0	1	2
Total	11	3	4	2	9	29

Pearson chi2(12)=5.5166 Pr=0.938

100. Colleagues , co-workers, fellow students

Score	EPA	FDA	USDA	NGO	Student	Total
2	1	0	0	0	1	2
3	2	1	0	0	5	8
4	8	2	4	2	3	19
Total	11	3	4	2	9	29

Pearson chi2(8)=8.1249 Pr=0.421

101. Television news

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	1	0	1	3	7
2	7	1	4	1	2	15
3	1	1	0	0	2	4
4	1	0	0	0	2	3
Total	11	3	4	2	9	29

Pearson chi2(12)=10.3906 Pr=0.582

102. Radio news

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	0	0	0	5	7
2	3	1	3	2	3	12
3	5	2	1	0	1	9
4	1	0	0	0	0	1
Total	11	3	4	2	9	29

Pearson chi2(12)=14.9042 Pr=0.247

103. Non-profit organization web sites

Score	EPA	FDA	USDA	NGO	Student	Total
1	2	1	0	0	3	6
2	6	2	3	0	3	14
3	3	0	1	1	3	8
4	0	0	0	1	0	1
Total	11	3	4	2	9	29

Pearson chi2(12)=19.2849 Pr=0.082

104. University web sites

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	1	0	0	2	4
2	2	1	2	0	4	9
3	7	1	0	2	2	12
4	1	0	2	0	1	4
Total	11	3	4	2	9	29

Pearson chi2(12)=14.6871 Pr=0.259

105. Activist-run web sites

Score	EPA	FDA	USDA	NGO	Student	Total
1	3	2	1	2	6	14
2	7	1	2	0	1	11
3	1	0	1	0	1	3
Total	11	3	4	2	8	28

Pearson chi2(8)=9.2025 Pr=0.326

106. Classes/formal instruction

Score	EPA	FDA	USDA	NGO	Student	Total
1	1	2	0	2	0	5
2	5	1	1	0	2	9
3	5	0	3	0	4	12
4	0	0	0	0	3	3
Total	11	3	4	2	9	29

**Pearson chi2(12)=26.3885 Pr=0.009

Regulatory agency participants only: Pearson chi2(4)=8.0657 Pr=0.089

Items 107-124. Spirituality and Demographics

(Please answer the following questions about you.)

Religion/Religiousness

Religious affiliation

	EPA	FDA	USDA	NGO	Student	Total
Agnostic	2	0	2	1	0	5
Jewish	2	2	0	0	0	4
Catholic	1	0	1	1	1	4
Protestant	3	0	0	0	1	4
Other Christian	2	0	0	0	1	3
Atheist/Non believer	0	0	1	0	1	2
Spiritual/no religious affiliation	0	0	0	0	2	2
Buddhist	0	0	0	0	1	1
Unitarian Universalist	0	0	0	0	1	1
Blank	1	1	0	0	1	3
Total	11	3	4	2	9	29

Pearson chi2(36) = 35.6410 Pr = 0.486

Religiousness

	EPA	FDA	USDA	NGO	Student	Total
More than once a week	1	0	0	0	0	1
Once a week	4	0	0	1	1	6
About once a month	0	1	0	0	1	2
About each 2 or 3 month	0	0	0	0	2	2
Less often than once a year	3	0	0	0	2	5
About once a year	0	1	1	0	1	3
Only on special holy days	1	1	1	0	1	4
Never	2	0	2	1	1	6
Total	11	3	4	2	9	29

Pearson chi2(28) = 25.7839 Pr = 0.585

Spirituality

	EPA	FDA	USDA	NGO	Student	Total
You believe there is God	5	0	1	1	3	10
You believe there is some sort of spirit or life force	5	1	1	0	4	11
You don’t believe there is any sort of spirit, God or life force	0	1	2	1	1	5
You don't know	1	1	0	0	1	3
Total	11	3	4	2	9	29

Pearson chi2(12) = 11.3353 Pr = 0.500

Demographic Data

Gender

	EPA	FDA	USDA	NGO	Student	Total
Female	7	0	1	2	8	18
Male	5	3	3	0	2	12
Total	11	3	4	2	9	31

Pearson chi2(4)=9.374 Pr=0.052

Regulatory agency participants only: Pearson chi2(2)=3.96 Pr=0.12

Ethnicity

	EPA	FDA	USDA	NGO	Student	Total
White or Caucasian	11	3	4	2	8	28
All other	1	0	0	0	2	3
Total	12	3	4	2	10	31

Pearson chi2(4)=2.21 Pr=0.70

Annual income

	EPA	FDA	USDA	NGO	Student	Total
Less than $40,000	0	0	0	0	5	5
$40,001-$100,000	0	0	1	2	2	5
$100,001-$150,000	7	1	1	0	1	10
More than $150,000	5	2	2	0	1	10
Total	12	3	4	2	9	30

Pearson chi2(16)=30.75   Pr=0.002

Regulatory agency participants only: Pearson chi2(4)=4.93   Pr=0.3

Grade of participants from federal regulatory agencies

Grade	EPA	FDA	USDA	Total
GS 13	3	0	1	4
GS 14	2	1	1	4
GS 15	6	0	0	6
Senior Executive Service	1	2	2	5
Total	12	3	4	19

Pearson chi2(6)=8.79   Pr=0.19

Setting in which participants grew up

	EPA	FDA	USDA	NGO	Student	Total
Farm or ranch	0	0	1	0	0	1
Rural (country)	3	0	0	0	2	5
Suburb	3	1	2	2	3	11
Military base	0	0	0	0	1	1
Small city or town	4	0	0	0	2	6
Major city	1	2	1	0	1	5
Total	11	3	4	2	9	29

Pearson chi2(20)=21.91   Pr=0.35

Highest educational degree

	EPA	FDA	USDA	NGO	Student	Total
High School Diploma	0	0	0	0	1	1
Bachelor Degree	0	0	0	0	3	3
Master's Degree	1	0	1	1	5	8
Doctorate	9	3	3	0	0	15
Law Degree	2	0	0	0	0	2
Law and Ph.D	0	0	0	1	0	1
Total	11	3	4	2	9	30

**Pearson chi2(20)=40.88   Pr=0.004

Regulatory agency participants only: Pearson chi2(4)=2.53   Pr=0.64

Categories of professional disciplines

	EPA	FDA	USDA	NGO	Student	Total
Public Health	0	0	0	0	1	1
Biological/Environmental Sciences	3	0	0	0	6	9
Agricultural Sciences	4	0	2	0	0	6
Policy, Administration, and Law	2	0	1	1	2	6
Genetics and Molecular Biology	3	3	1	1	0	8
Total	11	3	4	2	9	30

Pearson chi2(16)=25.35 Pr=0.06

Years experience working with modern biotechnology/genetic engineering

	EPA	FDA	USDA	NGO	Student	Total
More than 15 years	7	2	3	1	0	13
11 - 15 years	1	1	0	0	0	2
6 - 10 years	1	0	1	0	0	2
l - 5 years	0	0	0	1	0	1
Less than 1 year	2	0	0	0	1	3
Never	0	0	0	0	8	8
Total	11	3	4	2	9	29

** Pearson chi2(20) =46.01 Pr=0.001

Regulatory agency participants only: Pearson chi2(6) =4.22 Pr=0.65

Familiarity with modern biotechnology/genetic engineering

	EPA	FDA	USDA	NGO	Student	Total
Recognized expert	5	1	3	1	0	10
Very familiar	5	2	1	1	0	9
Slightly familiar/some knowledge	1	0	0	0	6	7
Somewhat unfamiliar/heard of them	0	0	0	0	3	3
Total	11	3	4	2	9	29

**Pearson chi2(12)=27.18 Pr=0.007

Regulatory agency participants only: Pearson chi2(4)=2.025 Pr=0.73

Political leanings

	EPA	FDA	USDA	NGO	Student	Total
Somewhat Conservative	1	0	1	0	1	3
Moderate	3	0	0	0	3	6
Progressive	0	1	0	0	0	1
Somewhat Liberal	4	1	1	1	4	11
Very Liberal	3	1	2	1	1	8
Total	11	3	4	2	9	29

Pearson chi2(16)=15.22 Pr=0.51

Political party affiliation

	EPA	FDA	USDA	NGO	Student	Total
Democrat	7	3	1	2	4	17
Republican	1	0	0	0	1	2
Green	0	0	1	0	0	1
Independent/Unaffiliated	3	0	2	0	4	9
Total	11	3	4	2	9	29

Pearson chi2(12)=12.35 Pr=0.42

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