PUBLIC RISK PERCEPTIONS TOWARD SOCIALLY CONTENTIOUS TECHNOLOGY: HOW CULTURAL VALUES AND BASIC KNOWLEDGE AFFECT NUCLEAR ENERGY RISK ASSESSMENTS

A Thesis Submitted to the College of

Graduate Studies and Research

In Partial Fulfillment of the Requirements

For the Degree of Masters

In the Johnson-Shoyama Graduate School of Public Policy

University of Saskatchewan

Saskatoon

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ACKNOWLEDGMENTS

I am grateful for the generous financial support received from the Johnson-Shoyama Graduate School of Public Policy for my Master's program, and from Professor Jeremy Rayner for funding this research project through the SSHRC Small Nuclear Partnership grant. I am also grateful for the research services and support from the Social Science Research Lab. Thanks in particular to Brianna Groot for her expertise and alacrity to help.

A special thanks to my thesis supervisor, Professor Michael Atkinson, for his guidance, incisive comments, and timely feedback. I am indebted to Professor Atkinson who went above and beyond his supervisory requirements. For all his support I wish to follow my many thanks with many more. Thanks to the members of the thesis committee, Distinguished Professor Peter Phillips and Professor Jeremy Rayner, and external examiner Professor Scott Bell, for thoughtful comments which improved the quality of this thesis. I owe gratitude to Professor Phillips who provided many fresh insights during our discussions; to Professor Rayner who was a mentor during my graduate studies and who gave me the opportunity to work with him researching nuclear energy policy; and to Professor Bell whose insightful comments led to the addition of key pieces which had been previously overlooked.

Thanks to my friends and colleagues – Luke Bendkowski, Colten Goertz, Miranda Gouchie, Daniel Hiatt, Crystal Koebel, and Victoria Taras – for helpful and thoughtful comments on earlier drafts. Thanks to my family and the Valkenburg family for continually reminding me that despite feeling defeated at times during the thesis writing process, all of the hard work will pay off. Finally, thanks to everyone else, from strangers on planes to experts in various fields, for taking the time to discuss with me aspects of my research project.

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Public Risk Perceptions Toward Socially Contentious Technology: How Cultural Values and Basic Knowledge Affect Nuclear Energy Risk Assessments

We cannot know with certainty the risks we must face, but we must act as if we do. To that end, experts are well equipped and trained to formulate risk assessments consistent with scientific evidence. But in the case of nuclear energy, most Canadians view the technology as dangerous despite expert assurances of safety. Nuclear energy policy must therefore square a contradiction whereby nuclear technology is accepted by most experts as safe yet perceived by most Canadians as dangerous.

This thesis explores the contradiction by asking why some members of the public refuse to accept the opinion of experts that nuclear technology is low-risk. One explanation asserts that, unlike experts, members of the public have poor science comprehension and are prone to perceiving risk in ways marred by cognitive bias. An alternative explanation contends that preexisting worldviews motivate members of the public to perceive risk in ways that do not necessarily align with the goal of accurate risk estimates. To understand why members of the public sometimes amplify nuclear energy risk, these two competing explanations were turned into testable hypotheses and empirically tested among 575 Canadians.

The present study found evidence which suggests those who strongly agree with egalitarians values are likely to hold amplified nuclear energy risk perceptions, and those who have greater knowledge of basic facts about nuclear energy tend to have reduced risk perceptions towards nuclear energy. Such results affirm the idea that education is an effective policy tool for reducing nuclear energy fears. However, egalitarian values may interfere with educational efforts to transmit facts, which is why educational efforts can prove more effective if nuclear energy facts are framed in a way that appeals to egalitarian values.

Keywords: Risk Perceptions, Nuclear Energy, Public Irrationality, Cultural Cognition, Canada

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LIST OF ABBREVIATIONS

CNSC. Canadian Nuclear Safety Commission

CCT. Cultural Cognition Thesis

GHG. Greenhouse Gas

GMO. Genetically Modified Organism

IAEA. International Atomic Energy Agency

NPRI. Nuclear Policy Research Initiative

PIT. Public Irrationality Thesis

SMR. Small Modular Reactor

SNR. Small Nuclear Reactor

UDP. Uranium Development Partnership

WNA. World Nuclear Association

CHAPTER I.

INTRODUCTION

Ordinary citizens are poor evaluators of technological risk. This phenomenon occurs because, unlike experts, most citizens lack the formal training, time, and motivation necessary to accurately assess risk. The inability to accurately estimate technological risk is also typically unproblematic because, rather than rigorously investigating risks for themselves, most citizens adopt risk attitudes consistent with expert precautions (Kahan et al., 2015). As a result, risk precautions from experts are largely uncontested by the public. Hazards from vehicle mechanical errors, side effects from medications, advisories to not drink untreated water, labels denoting expired food, and a whole gamut of risk precautions illustrate the fact that how the public perceive risk is largely a function of expert prescriptions.

There are, however, a few exceptions in which public risk ignorance is problematic. Technologies such as vaccines, genetically modified organisms (GMOs), and nuclear power are notorious for sparking heated public debate about their potential risks posed to human health, the environment, or the economy. Moreover, in these particular cases public risk attitudes do not reflect expert opinion. Meta analyses show that fears of vaccines causing autism (Taylor, Swerdfeger, & Eslick, 2014), of GMOs causing chronic illness (Nicolia, Manzo, Veronesi, & Rosellini, 2014), or of nuclear power causing cancer (Kim, Bang, & Lee, 2016) are unsubstantiated by available scientific evidence. In other words, despite the availability of facts, cases exist in which significant numbers of the public ignore or strongly disagree with experts. As a result, skeptical citizens perceive high risk in technologies developed to *protect* against existential threats such as diseases, food insecurity, and climate change. Why?

As political scientist Aaron Wildavsky outlines, it is puzzling why some members of the public mistake low-risk technologies as high-risk:

> How extraordinary! The richest, longest-lived, best-protected, most resourceful civilization, with the highest degree of insight into its own technology, is on its way to becoming the most frightened. [...]

> Even today there are risks from numerous small dams far exceeding those from nuclear reactors. Why is the one *feared* and not the other? Is it just that we are used to the old or are some of us *looking differently* at essentially the same sorts of experience? (1978, p. 32)[1]

Fear is one factor causing some individuals to mistake low-risk technology as high risk. In its simplest form, fear is a strong unpleasant emotional response driven by the belief that there is danger to be avoided (Merriam-Webster, 2016). But fear operates as a general purpose response mechanism, not as a response corresponding directly with the presence of danger. For instance, a rustling in the bushes will grab our attention whether caused by the wind, a small animal, or a predator. Fear can be imprecise. Together, its imprecision and compelling nature becomes problematic when an individual fears something which poses little danger. Phobias of ants (myrmecophobia), books (bibliophobia), or colours (chromophobia) illustrate cases in which we clearly recognize in others that their fear response is mistaken. To be sure, phobias are instances of abnormal psychology. But they nonetheless demonstrate how fear, a strong emotional response, can subsume rational thought when identifying danger. Similarly, if individuals fear a technology which experts and evidence indicate as safe, it may be fair to observe that fear is causing some individuals to mistake low-risk technology as high-risk.

One theoretical explanation for why citizens mistake technological risk is because they are irrational assessors of it. Experts rigorously assess risk by measuring hazards in accordance with the evidence and undergo training designed to ameliorate bias when interpreting such evidence; ordinary citizens do not (Marx et al., 2007; Weber, 2006; Sunstein, 2005, 2007, as cited in Kahan, 2015). Citizens, on the other hand, tend to assess risk by relying upon intuition and emotions including fear. And so, when trusting their own judgments independent from the norms of scientific inquiry, ordinary citizens are susceptible to formulating irrational risk assessments riddled with bias.

A second question Wildavsky poses is whether we are "looking differently at essentially the same sorts of experience?" (1978, p. 32). The above explanation that some members of the public are irrational risk assessors already suggests this to be the case. *Ceteris paribus*, a fearful individual will judge technological risk differently than an individual who is not fearful. Different judgments arise because the latter is likely to perceive much lower levels of risk than the former. However, perceiving greater

[1] Emphasis added.

risk where fear may be responsible does not clarify whether fear itself *causes* risk differences, or if fear is an *expression* of risk differences.

Just as sports fans predictably express outrage when a penalty is called against their team or a political supporter predictably expresses grave concern about an opponent's behaviour or policy, the expression of fear toward a technology may be biased along partisan lines. Thus, a second explanation for why citizens mistake technological risk is because individual risk perceptions are a product of cultural values (Thompson, Ellis, & Wildavsky, 1990). For example, those who believe that *individuals* are responsible for securing the conditions which enable human flourishing ('individualists' for short) tend to have much different risk perceptions than those with opposite values who believe that *communities* are responsible for providing the conditions sufficient for human flourishing ('communitarians' for short). Empirical evidence suggests that communitarians tend to perceive higher risk toward technologies such as GMOs and nuclear energy than individualists (Kahan & Braman, 2006). Interestingly, this pattern flips for vaccines, with individualists perceiving higher risk than communitarians. And similar patterns have been found between cultural values and risk perceptions on other contentious issues such as gun rights, climate change, and nanotechnology[2]. Therefore, based on theory and research examining the relationship between cultural values and risk perceptions, it appears citizens' risk assessments are predictably biased along partisan cultural lines.

The aforementioned irrationality and cultural value explanations for mistaken public risk perceptions are of course explanations for one and the same problem, namely the tendency of members of the public, in particular cases, to amplify technological risk despite evidence and expert opinion to the contrary. Whatever the root cause is – be it irrationality, pre-existing value bias, or something entirely different – a public convinced that low-risk technology is high-risk poses a problem for anyone interested in ensuring citizens' attitudes are consistent with facts and evidence.

For policymakers, conflicting public and expert attitudes make policymaking difficult. In a modern democratic society public attitudes can and should inform government policy. However, such an ideal is shaky when public fear of vaccines, GMOs, and nuclear energy technology fails to withstand scientific scrutiny. The dilemma for policymakers then becomes how to formulate policy when some

[2] See http://www.culturalcognition.net/papers-topical/ for a comprehensive and updated list of published papers.

members of the public strongly oppose the scientific community. If policies are formulated on controversial technologies consistent with available evidence, citizens skeptical of the evidence may react in protest. Yet if policies are formulated in ways to ameliorate public concern, experts and citizens who agree with them will point to the policy being inconsistent with evidence. Thus, formulating policy in ways that balance conflicting risk assessments is a difficult task.

Unfortunately, policymakers may not even have the luxury of balancing skeptical public and expert assessments. Similar to sports or political rivalries where groups of individuals support only one side, when public disagreement about hazards posed from controversial technologies becomes polarized those engaged in heated public debate tend to support only one side. When pro- and anti-vaccine, GMO, or nuclear energy groups form, the logic of polarization removes common ground and pits groups of individuals against one another. Like rivalries between the Boston Bruins and Montreal Canadiens or Republicans and Democrats, pro- and anti- controversial technology proponents are biased to promote only those reasons or pieces of evidence supportive of their group. Since both sides will claim to have evidence and experts which favour their respective positions, policy activity for a controversial technology will be interpreted by polarized groups as choosing a side to satisfy ends that are *political*, not scientific. As a result, even-handed policymaking becomes extremely difficult for controversial technologies. In such cases, neither expert consensus nor compelling evidence is enough to bridge the partisan divide.

The motivation for this research project is to understand and address public perception of risk for the purpose of ameliorating bias when interpreting facts. Taking as a starting point from Wildvasky two factors which distort public assessments of risk – fear and looking differently at the same sort of experience – the present research project has two aims: first, to understand how fear and cultural values[3] bias risk perceptions; and second, to examine how a communication-based treatment can ameliorate such bias. The first aim will be explored in this thesis and the second aim will be the focus point in a forthcoming project. The task in this thesis is to focus on what causes biased public risk perceptions.

[3] Note that the terms "cultural values" "worldview", and "way of life" will be used interchangeably to avoid repetition.

To understand how fear and cultural values bias risk perceptions, this thesis examines first the broad phenomenon of how cultural values affect risk perceptions toward controversial technologies among ordinary Canadians. This relationship is of importance in the Canadian context because, hitherto, only 1 published study has been conducted Canada-wide using the same cultural value measurement scale used in the present study (see Dragojlovic & Einsiedel, 2014). As such, this thesis aims to answer the broad research question: *Are risk perceptions a function of cultural values among Canadians?*

Second, this thesis will compare how cultural values and public irrationality affect risk perceptions in the context of nuclear energy. Since public irrationality is the conventional way of understanding how poor public risk assessments arise, using it will provide a baseline from which to measure how strongly cultural values affect perceptions of risk. As such, this thesis aims to answer a second more specific research question: *In the context of nuclear energy, do cultural values or public irrationality have more influence on how ordinary citizens mistake low-risk technology as high-risk?*

Though four different controversial technologies are referenced in this study – vaccines, homeopathic medicine, GMOs, and nuclear energy – nuclear energy will be the ultimate focus. Apart from helping to narrow the scope of analysis and providing a manageable context to answer the more specific second research question, nuclear energy is a technology that generates high levels of fear even though it is widely used in several countries. Further, nuclear energy is topical; it has recently entered the debate on climate change as an alternative to carbon emitting energy production technologies, and has recently benefited from technological developments. Both of these developments are prompting some policymakers to consider the viability of including nuclear energy as part of their energy policy. And so, before moving forward, the remainder of this introduction will provide a very brief exposition of the role risk perceptions occupy with respect to nuclear energy policy. The first chapter will investigate both the concept of risk and the different ways in which it is assessed. The second chapter will discuss the survey method used for gathering and analyzing data to provide an empirical insight. The third chapter will present the results, the fourth chapter will analyze the results, and the final chapter will draw some conclusions.

1.1 NUCLEAR ENERGY POLICY

Nuclear energy is on the policy agenda for many members of the global community as a feasible energy production option (WNA, 2014). Data collected by the International Atomic Energy Agency

(IAEA, 2015) shows some nations are capitalizing on this feasibility, as evidenced by an upward trend in the last decade in the number of new nuclear power facilities beginning construction around the globe. To put this into perspective, the IAEA (2015) claims there have been 79 new construction starts in the last decade compared with 32 during the prior decade. Hailed by some observers as a "nuclear renaissance", this revival has been attributed to three simultaneous drivers: a rise in demand for electricity, the recognition that greenhouse gas (GHG) emissions contribute to climate change, and the need to shift electricity production away from finite fossil fuels (Bratt, 2012). Even with the recent Fukushima nuclear accident, the nuclear renaissance shows no signs of slowing. Forecasts suggest that 160 or more reactors are planned to come online in the next decade with hundreds more down the pipeline (WNA, 2014). Therefore, faced with mounting pressure to meet increasing energy demands while taking action on climate change, many countries will likely include nuclear as part of their energy mix.

Some object to nuclear energy on the basis that these power plants are too large for use in small jurisdictions by dint of producing excessive energy. Some also object that such plants are too costly. As a response to these and other criticisms, recent technological advances in nuclear reactor designs have created a next generation nuclear energy producer known as small modular reactors (SMRs) (IAEA, 2014). Unlike existing nuclear reactors, which on average produce 867 megawatts of electricity[4], SMRs are designed to power up to 300 megawatts. Moreover, SMRs can be built and shipped from factories, potentially reducing both construction time and construction related costs. With SMR deployment projected between 2025-2030, Canada has been identified as an ideal market for the implementation of SMRs due to its infrastructure, historical nuclear industry knowledge, and its need to supply energy to both rural and northern populations (Canada's Public Policy Forum, 2013).

But technological advances are only impactful if they pass critical public policy tests. For SMR technology, the regulatory tests are demanding for what is an unproven energy producing product, but the political, economic, and social feasibility tests are even more daunting, particularly the requirement that public opinion be satisfied on matters of safety. Policy makers poised to pursue a SMR agenda must recognize that since SMRs are a member of the nuclear family, and since public opinion matters

[4] Average was calculated by dividing the MWe total net installed capacity (383,580) by the number of nuclear power reactors in operation (442) source as of Feb 25, 2016: https://www.iaea.org/pris/

more in nuclear policy than most other policy making areas, how the public perceives nuclear energy can make or break any nuclear agenda (OECD, 2010). The bottom line is that no nuclear agenda in Canada will be effective without dealing directly with public risk perceptions toward nuclear energy technology.

1.1.1 A Saskatchewan Case

Recent efforts in Saskatchewan at pursuing a nuclear agenda demonstrate the significance of public perception. In October 2008 the Uranium Development Partnership (UDP) was formed by Premier Brad Wall's Saskatchewan government. Comprised of twelve members from "the top reaches of the nuclear industry", the UDP was chiefly tasked with examining the nuclear sector and then creating recommendations for the government of Saskatchewan, and ultimately advising on value-added opportunities from the uranium industry (Bratt, 2012, p. 183). In a report released March 2009, one key recommendation from the UDP was that, in the medium term (2015-2025), the first nuclear generation units should be commissioned in the Province (Florizone, 2009).

Between April and July 2009, the Saskatchewan government appointed a former provincial deputy minister, Dan Perrins, to lead a public consultation process to gather public feedback about the UDP report (Bratt, 2012). Tasked with the mandate to "summariz[e] public input and feedback from stakeholders and citizens", Perrins's findings revealed in a September 2009 report that 84 percent of respondents were opposed to nuclear power generation (Bratt, 2012, p. 21). However, the government of Saskatchewan received Perrins's report with caution. This caution was evident by Energy Minister Bill Boyd's public comment that, "when I look at this report, it's neither a green light nor a red light for the future uranium development. It's more like a yellow light – take any next steps with caution" (Bratt, 2012, p. 196).

Following months of deliberation, the Saskatchewan government decided against the UDP recommendation to commission a nuclear power plant in the medium term (Bratt, 2012). Further, the government characterized the report's findings as merely reflective of the views of 85 percent of *responders* – not Saskatchewan residents' writ large – who oppose nuclear power generation. In the affirmative, the government did encourage investing in small-scale reactor technology and directed SaskPower to include nuclear power as an energy generation option after 2020.

As Bratt notes, the government ultimately delayed its decision on nuclear power generation solely out of cost considerations (Bratt, 2012). The delayed decision claim is consistent with a remark made by Premier Wall in January 2011, who stated "this isn't the end of the nuclear centre story, either. You'll see us moving with private partners on the small reactor side" (Hall & Paulson, 2009). However, delaying solely out of presumably *financial* cost considerations is far from a foregone conclusion. An additional factor was the political cost of public opinion. That is to say, strong reported opposition meant that the government of Saskatchewan could not have proceeded with nuclear power *even if* it wanted to.

Although the government received the Perrins's report with caution, it is unclear how the broader public received the report. Such uncertainty meant the possibility of a strong public backlash, fueled by the 85 percent opposition cited in the Perrins' report, had Wall's government proceeded with implementing a nuclear agenda. In other words, public perception against nuclear energy was strategically leveraged by opponents of nuclear energy in a way that stifled a nuclear agenda in Saskatchewan. A lesson learned for the Saskatchewan government and other observant jurisdictions is that public perception exists as a very real and important kind of cost consideration.

1.2 NUCLEAR ENERGY RISK

Understanding how the public perceives nuclear energy matters a lot for nuclear energy development. Research has shown that there is a correlation between how the public perceives nuclear energy in a broad sense and how the public perceives nuclear energy risk (Sjöberg, 2000; Slovic, Finucane, Peters & MacGregor, 2004; Kahan, Braman, Gastil, Slovic & Mertz 2007). Yet as some in the nuclear energy debate contend, strong negative perception of nuclear energy risk is inconsistent with facts about the realities of risk. According to data produced by the Canadian Nuclear Safety Commission (CNSC, 2015), 40 years of nuclear operations in Canada have resulted in a total of zero nuclear accidents with consequences to human health or the environment. Globally, nuclear has the lowest number of accidents and fatalities (direct and indirect) compared with other energy sources (Figure 1). In fact, with the exception of Chernobyl, not a single person has died as a result of radiation exposure from a commercial nuclear reactor incident (WNA, 2015).

Global Fatal Accidents (Direct and Indirect) Across Fossil, Hydro, and Nuclear Energy (1969-2000)

Energy Source	Accidents	Fatalities
Coal	1,221	25,107
Oil	397	20,218
Natural Gas	135	2,043
Liquefied Petroleum Gas	105	3,921
Hydro	11	29,938
Nuclear	1	31

Figure 1. Number of accidents and fatalities across energy sources. Adapted from Burgherr, P., & Hirschberg, S. (2008). A comparative analysis of accident risks in fossil, hydro, and nuclear energy chains. *Human and Ecological Risk Assessment*, *14*(5), p. 959.

There is, in fact, a strong safety case for nuclear energy, and an even stronger case for harm avoided from producing energy with nuclear. According to a 2013 NASA study, between 1971 and 2009 a total of 1.84 million human deaths and 64 gigatonnes of CO_2 emissions were prevented by using nuclear energy (Kharecha & Hansen). As these authors note, when substituted for fossil fuels, nuclear energy has significantly reduced harmful impacts on human health and the environment. More specifically, nuclear energy has prevented significantly more human deaths than it has caused and has reduced the impact of climate change caused by burning fossil fuels.

Despite the testimony of experts to its safety and benefits, members of the public perceive nuclear energy as high risk. A 2012 public opinion survey found that 55 percent of Canadian respondents believe the word 'dangerous' describes nuclear energy 'very well' or 'extremely well' (Canadian Nuclear Association, 2012). In 2011, a public opinion poll conducted in twenty-four countries found that 62 percent of respondents opposed the use of nuclear energy (Ipsos-Mori). Nuclear energy fear and aversion likely arise from both history and imagination. The consequences of nuclear power plant accidents (such as Chernobyl or Three Mile Island) and the existential threat from

nuclear weapons are both frightening. Moreover, other problems such as waste storage and nuclear proliferation are largely unresolved and perceived as significant challenges confronting nuclear power production. From the public's perspective, nuclear energy development is a dangerous prospect because of accidents, waste, proliferation, and association with weapons and cancer.

Like all energy sources, nuclear energy does have a number of challenges. But unlike other energy sources, public fear is both unique among disruptive technologies. Whatever the reasons for opposing it, on a visceral level nuclear energy is generally perceived as a 'dread risk'. That is, psychometric indicators of perceived nuclear energy risk have been shown to correlate strongly with the following: "lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits" (Slovic, 1987, p. 283). Many individuals, it appears, fear nuclear energy and perceive its risk at an extreme level.

CHAPTER II.

RISK AND RISK PERCEPTIONS

This chapter explores the concept of risk by first tracing its historical roots and then describing how it can be known from a philosophical viewpoint. Establishing that the concept of risk is disputed among epistemological schools of thought reveals how and why multiple interpretations of risk arise on one and the same object. According to one interpretation, risk is a perceived phenomenon that is most congenial to how ordinary citizens assess risk. Why perceiving risk causes citizens to be poor assessors is addressed by two theories – one arguing that cognitive biases mar assessments and the other arguing that group allegiances befuddle accurate assessments.

2.1 THE CONCEPTUAL FOUNDATION OF RISK

In the course of human history, 'risk' has only recently emerged as a way of understanding the world. Peter Bernstein (1996) contends that prior to the concept of risk there was belief in fate –the idea that humans are at the mercy of forces beyond our agency. Risk as a new perspective blossomed in the wake of three key developments. First, the introduction of the Indian number system further refined our understanding of mathematics, thereby altering our ability to represent moments past, present, and future in a numerical, codified, and thus logically consistent way. Second, the scientific revolution introduced a means of systematically conceptualizing cause and effect relationships. With the scientific method as a tool in hand, humans became able to test and catalogue spatio-temporal relationships among variables, leading to a more sophisticated understanding of observed reality. Third, the Protestant Reformation and the Enlightenment period crumbled pillars of fatalistic thought, and from the rubble emerged a belief that human beings are in control of their own destiny. Thus, rather than being pawns in some metaphysical game of chance or relying on just-so causal stories to make sense of the world, the concept of risk was born.

Risk, however, is epistemologically complex. As Hannson (2014) contends, knowledge about risk *is* knowledge about lack of knowledge. Acknowledging the existence of risk signals that something is either unknown or has an uncertain outcome. The great cosmic mystery of black holes has an element of risk, as too does placing a bet in roulette. Further exacerbating this quagmire of what risk *is*

is our sheer ignorance of the overwhelming complexities which effect estimates of risk, such as the behaviour of complex systems – solar systems, political systems, climate systems, economic systems, etc. – systems which have a high volume of moving parts alongside innumerable possible interactions. Risk, therefore, is epistemologically a known unknown.

The epistemological complexity is undeniable: we cannot know with certainty the risks we confront. However, this is not a problem with risk *per se*, but part of a more general problem. No human or known-entity has complete knowledge, and as such, no human or known-entity can be aware of all hazards at all times. This limitation of the human condition has led thinkers such as Mary Douglas and Aaron Wildavsky (1982) to argue that we cannot know the dangers we face, but "we must act as if we do" (pg. 1). To this end, risk science acts by taking a step forward, wedding the existence of hazards with the constraints of human cognition. The result is that armchair musings about risk are replaced by a research enterprise aimed at better understanding fundamental questions, including but not limited to: how do individuals decide which risks to take and which to avoid? Why are some hazards safeguarded against while others are discounted or dismissed? And how do people know the nature and scale of the risks they are exposed to?

Contemporary risk science is not stifled by an absence of knowledge about risk in a philosophical sense. Rather, philosophical positions are adopted as axiomatic starting points necessary for arriving at the desired end point of understanding risk in a practical sense, as a piece of reality that can be *assessed*, *communicated*, and *managed* (Phillips, 2009). We will take up the assessment aspect of risk presently; it is fundamental to how individuals formulate their risk beliefs. A treatment on the communication and management of risk is scheduled for a forthcoming project. For now, however, to gain a glimpse into contemporary risk science and how this field makes sense of risk assessments, it is helpful to first touch upon positivist and naturalist interpretations of knowledge-gathering to observe the effect commitment to a particular philosophical school of thought has on downstream assessments of risk.

2.2 RISK AS A CALCULATED ASSESSMENT

Broadly speaking, positivists adopt the epistemic position that knowledge acquired can only preserve its rationality if arrived at by using a specific rule or method (Shrader-Frechette, 1990). While typically applied to philosophy of language, logic, or scientific inquiry, when applied to risk it follows that the

strongest assessments of risk are generally those derived from a standardized rule or method. Such an approach toward analyzing risk is therefore generally favoured by communities who privilege rules or methods as a form of knowledge gathering, such as communities of experts, analysts, and those in the so-called hard sciences. These communities assess risk using agreed upon methods that produce assessments deemed objective and technical. This is what it means to assess risk in a *calculated* sense.

According to Hannson (2014), a calculated risk assessment is the product of measuring the probability or statistical expectation of an unwanted event which may or may not occur. Concentrating efforts toward identifying unwanted events – unwanted because they may cause harm or damage – enables forecasting the occurrence of such an event. Forecasting the likelihood of an unwanted event, in turn, opens up the option to implement measures to safeguard against it. In cases whereby multiple interpretations regarding the likelihood of a risk event arise, the agreed upon assessment is settled by interpretation of probability. In sum, calculated risk assessments are typically quantitative, precise insofar as having numerical specificity, and are hallmarked by a focus on the likelihood of an event occurring and/or the magnitude of harm.

One example of a calculated risk assessment is a 'Probabilistic Risk Assessment'. This method is often used by experts when calculating risk in nuclear power plants (Goodfellow et al., 2011). For example, experts may calculate risk using the equation:

$$R = \sum_{i=1}^{n} P_i * C_i$$

This equation calculates risk (R) as the product of the probability (P_i) of a future risk event occurring and the magnitude of consequences (C_i) of such an event, summed over all previous occurrences (n) of the event. This equation, deceptively simple looking, can be enormously complex. This is because a large amount of data is required to arrive at a Probability Risk Assessment. Data are required not just for calculating each potential component failure, but also for sets of components, for interactions among components, and for multiple sequences of events.

2.3 RISK AS A PERCEIVED ASSESSMENT

An alternative philosophical risk position starts from the premise that there is no absolutely reliable method for guaranteeing certain knowledge (Shrader-Frechette, 1990). Rather than focusing on calculated risk generated by rule-following, a la positivists, this naturalistic perspective proposes

understanding how beliefs about risk are formulated. Understanding the cognitive mechanisms by which we humans formulate and propagate beliefs provides insight into how we humans *do* assess risk as opposed to how we *should*. A naturalistic perspective will, arguably, lead to greater insight into the psycho-social mechanisms individuals rely upon when they assess risk. This general approach to assessing risk is commonly referred to as subjective, multidimensional, or *perceived*.

A perceived risk approach is one that examines attitudes and expectations informing assessments of risk (Hannson, 2014). To be clear, the term 'perception' is a misnomer as risk in this sense is about beliefs and values, not perceiving in the narrow more literal sense of the term. A perceived risk assessment is a value-laden judgment about the cause of an unwanted event or the event itself, which may or may not occur. Perceived risk assessments are typically qualitative, comprehensive, and focused on the cause or the event itself rather than its likelihood.

Studies show that factors such as gender and political preferences are strongly correlated with risk assessments (Slovic, 1999). Moreover, these factors affect risk judgments in all persons, experts and laypersons alike and have been demonstrated in a number of studies. For example, a so-called 'white male effect' has been uncovered, suggesting white men assess risks as both smaller and less problematic than women or minorities (Flynn, Slovic, & Mertz, 1994; Kahan, Braman, Gastil, Slovic & Mertz 2007). Even among scientists, a group one might regard as relatively immune from risk bias, females were found to perceive risks in nuclear technology and toxicology as higher relative to their male counterparts. Similarly, political ideology and subjective assessments of nuclear energy risk show a strong persisting relationship within Eurobarometer data dating back to 1978 (Franchino, 2014). Results from Franchino (2014) show politically left-of-centre respondents have much stronger nuclear energy risk concerns than their right-of-centre counterparts – a finding he contends is consistent with other research.

2.4 RISK ASSESSMENT GULF

What then is the proper recourse in circumstances where disagreements emerge between expert and public assessments of risk on *one and the same* object or event? Before overstating the occurrence of such disagreement, research indicates that in most cases of risk, citizens tend to defer risk assessments to expert testimony (Kahan et al., 2015). For instance, hazards due to power lines, side-effects from medications, advisories to boil water, labels denoting expired products, and other similar kinds of cases

reflect the extent to which citizens entrust what science says and respond appropriately. However, there are cases in which strong disagreement occurs. On topics such as climate change, genetically modified foods, nuclear power, and vaccines, to varying degrees members of the public resist the risk assessment claims forwarded from the scientific community. In the nuclear energy context for example, there exists a gulf between some ordinary citizens who perceive nuclear energy as a high risk activity and the scientific community who largely agree nuclear energy is safer than many routine, daily activities (Goodfellow, 2011).

One response to public resistance is to distinguish each kind of risk assessment according to its utility. According to Kasperson et al., (1988), while calculated risk assessments are no doubt useful for decisions about precise items such as competing designs or materials, they are too dependent on a narrow set of assumptions to inform much broader societal decisions about technology. For example, assessing risk as a function of the probability of occurrence and the magnitude of harm neglects equity issues, such as harm in relation to time (future generations), space ('not in my back yard' or NIMBY), or social grouping (those marginalized or exploited). The fundamental problem is that equity issues are very difficult to quantify, and as such calculated risk assessments are "too narrow and ambiguous to serve as the crucial yardstick for policy making" (Kasperson et al. 1988, 178). Thus, some argue that a best practice application of calculated risk assessments toward technology appear most suitable for circumstances with clear, well-defined boundaries.

For nuclear energy technology, the contradiction is that this same technology is simultaneously accepted by most experts as safe and resisted by most Canadians as dangerous. Public fear toward its hazardous nature is flawed in contrast with expert testimony; however, expert calculations appear flawed by neglecting factors outside the scope of quantification. The result is a gulf between expert and public risk assessments toward nuclear energy. The proper recourse in addressing this gulf, then, is to properly locate wherein lies the problem. Both sides have their respective problems – calculated risk appears incomplete whereas perceived risk appears inaccurate. But since the label 'dangerous' is inconsistent with facts about harm from nuclear energy, and since attitudes toward nuclear energy matter a great deal for the prospects of a nuclear agenda, the focus hereafter will be on the domain of risk perception.

2.5 THE PUBLIC IRRATIONALITY THESIS

Both cognitive science and behavioural economics have long held that ordinary citizens are remarkably poor evaluators of risk. One predominant explanation begins with the observation that intuitive judgments are often marred by cognitive biases if left uncorrected (Kahneman, 2003). For risk research, acknowledging the role of bias in intuitive judgment is instructive precisely because those cognitive mechanisms responsible for bias may also be responsible for inaccurate assessments of hazards. Furthermore, ordinary citizens also tend to have a poor comprehension of what the science says. That is, most individuals are likely to be deficient in both their knowledge about technical literature as well as their capacity to think like experts trained to detect and ameliorate bias (Kahan, 2015). Instead of using the best available evidence, laypersons will rely upon intuition and emotion when making risk assessments. This interpretation of public risk perceptions is known as the public irrationality thesis (PIT).

Applying cognitive science insights to behavioural economics, Cass Sunstein contends that reliance upon intuitive modes of thinking is the source of a problem known as misfearing (2013). Misfearing is defined as a two-sided cognitive bias describing puzzling circumstances in which ordinary individuals are afraid of trivial risks or are neglectful of serious risks. Focusing on the fear toward the trivial risk side of misfearing, Sunstein (2013) identifies an intuitive bias known as the 'availability heuristic' as responsible for inducing misfearing among some individuals. This heuristic, a term synonymous with 'mental shortcut', efficiently brings to mind highly publicized and emotional events such as airplane crashes, nuclear power plant accidents, SARS, terrorism, etc. The idea is that our brains can readily bring these visceral events to mind, and that ease causes some individuals to overestimate the likelihood of a hazardous event occurring (Tversky & Kahneman, 1973). In short, misfearing toward nuclear power generation occurs because of the availability heuristic – that is, individuals overestimate nuclear energy risk due to mental associations tied to memorable high profile disasters such as Chernobyl, Three-Mile Island, and Fukushima (Sunstein, 2013).

If misfearing is a problem confronting nuclear energy, what then is an effective corrective? Cognitive science studies show that those few who are adept at correcting their own errors of judgments tend to have two characteristics: comparatively higher cognitive capacities and the ability to utilize analytic reasoning to resolve bias (Stanovich, 1999). One way to mitigate intuitive bias, then, is through a deliberative corrective (Kahneman, 2002). Rather than permitting error prone intuitions to

formulate assessments of risk, if individuals instead think carefully about risks they will produce a more even-handed risk assessment. A more even-handed risk assessment will, *ipso facto*, eliminate misfearing. Thus, to counteract misfearing toward nuclear energy, those individuals able to think carefully and systematically about risks should fairly assess nuclear energy hazards.

Given the popularity of PIT as an explanation for public risk perceptions, this study will analyze the relationship between risk perceptions and those individuals who are *most likely* to overcome bias taken as those who think carefully about risks. This study assumes that those who are most likely to think carefully about nuclear energy risk are those who have a greater knowledge about the subject matter. While there is an argument that level of education promotes careful thinking, formal education is an unlikely surrogate for understanding risk. Education is a strong predictor of a number of skills, but those do not include understanding computer troubleshooting, retirement savings, or risk perceptions. Further, as Kahan & Braman (2006) argue, factual disagreements on controversial technologies continue even after controlling for education. Thus, while we will examine the effects of general education, our main focus will be on specific knowledge: do participants with greater knowledge about nuclear energy assess nuclear risk largely free from misfearing?

Knowledge is being used for two reasons. First, it is unclear to this researcher how one might measure public irrationality. Second, if individuals have knowledge about nuclear energy that is consistent with experts, then they should also perceive nuclear energy as low risk like experts. To turn PIT into a testable hypothesis, three true or false questions about nuclear energy will serve as a proxy for measuring public irrationality. Scores from these three questions will allow the researcher to analyze whether *basic* knowledge of nuclear energy correlates with risk perceptions of nuclear energy (see section 3.4.3 for a discussion of the basic knowledge questions used).

2.6 MOTIVATED REASONING

If having a public that independently assesses risk consistent with the norms of scientific research is the benchmark of public rationality, then public irrationality may be inevitable. This strong claim about public irrationality is derived from a phenomenon known as motivated reasoning – a tendency to conform assessments of evidence to a goal unrelated to accuracy (Kahan, 2015; Kunda 1990). Motivated reasoning among sports fans illustrates how such bias operates. In the 1950s a psychological experiment by Hastorf & Cantril (1954) presented a series of controversial referee calls to students

from two rival colleges whose teams had recently competed in a football game. The researchers selected a series of calls that penalized only one particular team, showed the footage to participants from both colleges, and then gave participants an opportunity to provide feedback on those calls. Rather than identify each illegal play as illegal, students from the penalized team's college reported half as many illegal plays relative to students from the rival college. Hastorf & Cantril (1954) concluded that group allegiances motivated student assessments in a way that favoured their own school.

Research from Kahan et al. (2015) suggests a similar group allegiance effect in the domain of risk perceptions. They found that individuals with opposing cultural values are reliably guided toward opposing views on risk. For example, those who value individualism are more likely to oppose mandatory vaccinations citing infringement on personal liberties than those who value collectivism and are more likely to support vaccinations citing lives saved. As a result, both groups are likely to have opposing interpretations of vaccination risks. What these findings illuminate is one possible alternative explanation for misfearing. That is, it may be the case that significant numbers of people who misfear nuclear energy do so not because their risk perceptions are the product of defective intuitive judgements, but because their risk perceptions are motivated by cultural groups with whom they identify.

There exists evidence in support of the assertion that assessments can be biased in a way that favours the group to which the assessor identifies with at the expense of accuracy. Just as sports fans are motivated to support their team, ordinary citizens are motivated to adopt risk assessments in a way that is consistent with their group's evaluation. Behaving this way could mean an individual will likely stand a better chance of continuing emotional and material support from in-group members in comparison with an individual who adopts a position contrary to the group (Kahan et al., 2015). It is simple to imagine, for example, the benefits for an anti-nuclear activist working at Greenpeace versus the costs for that identical person working in a pro-nuclear industry. Another plausible motivator is that an ordinary citizen may adopt a position consistent with her cultural group because she is not in a position to fully investigate the evidence, and as a kind of heuristic adopts a position based on whom she trusts (Kahan & Braman, 2006). The trusted source is likely to be someone who belongs to a shared group espousing similar points of view. Thus, there are strong motivators which steer assessments toward a goal of consistency with group commitments rather than a goal of accuracy.

As Lodge & Taber (2013, p. 150) argue, underlying all human reasoning is a "competitive tension between the drive for accuracy and belief perseverance". Indeed, some individuals are motivated by accuracy goals insofar as they deliberately consider evidence by weighing the validity and fairness of competing claims before arriving at correct or good-enough conclusions. Such behaviour is akin to established norms of science. However, some individual behaviour is more responsive to social cues. That is, some individuals are motivated by *partisan* goals, and as such fit the evidence to a pre-existing conclusion. What motivated reasoning explains is that ordinary citizens' assessments of risk are simply behaviour consistent with norms other than those relied upon by science. Thus, accuracy is but one goal. And as such, narrowly defining public rationality as pursuit of the privileged goal of accuracy discounts perfectly rational behaviour associated with pursuing some other goal.

2.7 A CULTURAL THEORY OF RISK

According to cultural theory, perceptions of risk are the product of a social process (Thompson, Ellis & Wildavsky 1990). On this view, individual risk perceptions are a function of a particular set of beliefs, values, and social relationships – a 'way of life' for short. The main idea is that individual risk perceptions are thought to *reflect* and *reinforce* a cultural way of life (Kahan, 2012). But before describing the relationship between ways of life and risk perceptions, knowing first the kinds of social organizations or ways of life to which individuals subscribe will aid in an exposition of how and why the relationship exists.

To characterize different ways of life, cultural theorist Mary Douglas pioneered a framework with two dimensions consisting of two sets of parsimonious values called 'group' and 'grid' (1970). According to Thompson et al., (1990):

> Group refers to the extent to which an individual is incorporated into bounded units. The greater the incorporation, the more individual choice is subject to group determination. Grid denotes the degree to which an individual's life is circumscribed by externally imposed prescriptions (p. 5)

Depicted in Figure 2 is a contemporary adaptation of the cultural framework used by a group of scholars working on the Cultural Cognition Project[5]. The framework has retained the group-grid values distinction a la Douglas, but includes also four ways of life: *individualism, hierarchical,*

[5] http://www.culturalcognition.net/

communitarian, and *egalitarianism*. Located on the left side of the X-axis is a low group worldview, termed individualism. The far left extreme represents a worldview whereby individuals themselves are responsible for securing the conditions which enable human flourishing, emphasizing that such activity is free from collective interference or assistance (Kahan, 2012; Braman, Kahan, Slovic, Gastil, & Cohen, 2007). On the opposite side of the spectrum is a high group worldview, or communitarian. Here, collective interests trump individual interests, designating society as responsible for providing the conditions necessary for individual flourishing (Kahan, 2012; Braman et al., 2007).

Cultural Framework

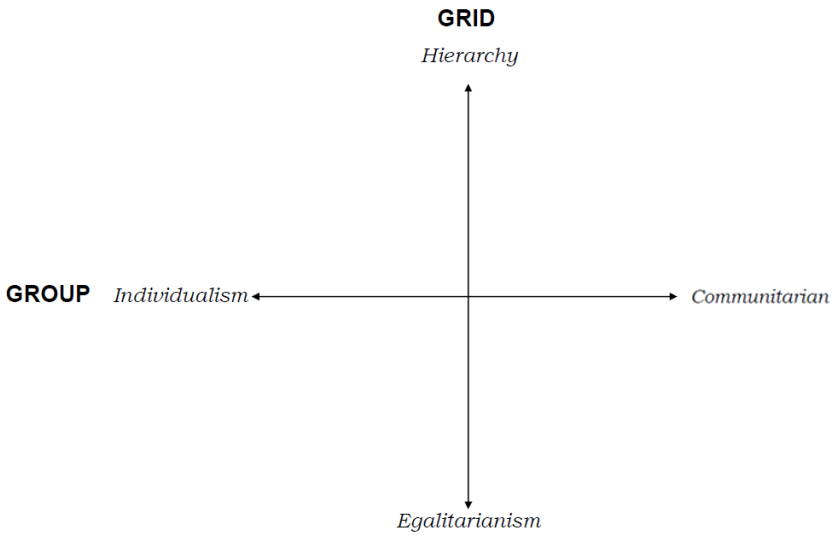

Figure 2. Contemporary 'group-grid' cultural framework. Kahan, D. M. (2012). Cultural cognition as a conception of the cultural theory of risk. In *Handbook of risk theory* (p 725-759). Springer Netherlands.

On the top of the Y-axis is a high grid worldview. On this view, social factors such as rights, duties, goods, and offices should be distributed differentially and in accordance with established social characteristics (e.g., gender, wealth, lineage, ethnicity) (Kahan, 2012; Braman et al., 2007). Alternatively, a low grid worldview suggests that those same social factors should be distributed equally, independent from any social characteristic. The former denotes hierarchy whereas the latter denotes egalitarianism.

Returning now to how and why there exists a relationship between cultural ways of life and risk perceptions, cultural theory offers two responses. First, individuals perceive risk in ways that *reflect* existing cultural ways of life. As a reflective relationship, cultural theorists make no claims regarding

the causal ordering between risk perceptions and cultural ways of life (Thompson et al., 1990). What matters is not the order in which the relationship functions, but that there is a reflective function to the relationship. A mirroring effect occurs because individuals with similar values will have similar fears and will coalesce toward particular ways of life – meanwhile a particular way of life is the sum total of a set of shared values and fears (Douglas & Wildavsky, 1982).

Second, individuals perceive risk in a manner that *reinforces* their commitments with a worldview. According to Douglas & Wildavsky (1982) each worldview (individualism, hierarchy, communitarian, and egalitarianism) represents different positions regarding how an ideal society ought to be arranged. For those who place a high personal value on their way of life, the preoccupation with transforming a societal arrangement from *ought* to *is* strengthens commitments to that way of life. Being aligned with a particular way of life, resulting from reflecting and reinforcing mechanisms, means individuals are inheriting a particular way of looking at the world. Bundled into that worldview is a particular risk portfolio which highlights some risks and neglects others. For risk perceptions, therefore, subscribing to a particular way of life and an accompanying risk portfolio gives rise to a group-based bias when assessing risk.

Piecing together worldviews with motivations opens up a coherent explanation for why individuals sometimes disagree strongly on risk despite available evidence that could conceivably be employed to settle the disagreement. When individuals hold cultural commitments their risk perceptions are constructed to reflect and reinforce those commitments. As such, individuals with similar values will assess risk in allegiance with a cultural way of life, independent from and sometimes conflicting with the best available evidence. Similar to the clear bias sports fans display when interpreting referee calls in favour of their preferred team, those individuals who value cultural allegiances more strongly than evidence will form biased risk assessments in allegiance with cultural commitments.

Empirical evidence suggests that, in the case of nuclear energy, the more egalitarian and communitarian an individual is the more likely he or she will perceive high risk toward nuclear energy (Kahan & Braman, 2006). Conversely, those who are more hierarchical and individualist are more likely to perceive a lower level of risk. As shown in Figure 3, the authors point to the strength of these results for nuclear power as consistent with previous studies which find similar patterns of risk

perceptions on a range of polarizing issues which divide across cultural lines, such as environmental pollution and genetically modified foods (Kahan & Braman, 2006).

2.8 THE CULTURAL COGNITION THESIS

One research enterprise empirically investigating patterns between risk perceptions and cultural values is known as the cultural cognition thesis (CCT). As outlined by Dan Kahan (2012), the CCT is distinct from cultural theory insofar as it is designed primarily for three practical, methodological purposes. First, to measure individual cultural worldviews; second, to empirically test cultural theory claims that individual risk perceptions are indeed connected to their cultural worldviews; and third, to enable the management of strong public risk disagreement in an effort to promote "scientifically sound public policies that are congenial to persons of diverse outlooks" (Kahan, 2012, p. 726). This thesis focuses on the first two.

Relationship Between Cultural Values and Risk Perceptions on Cultural Framework

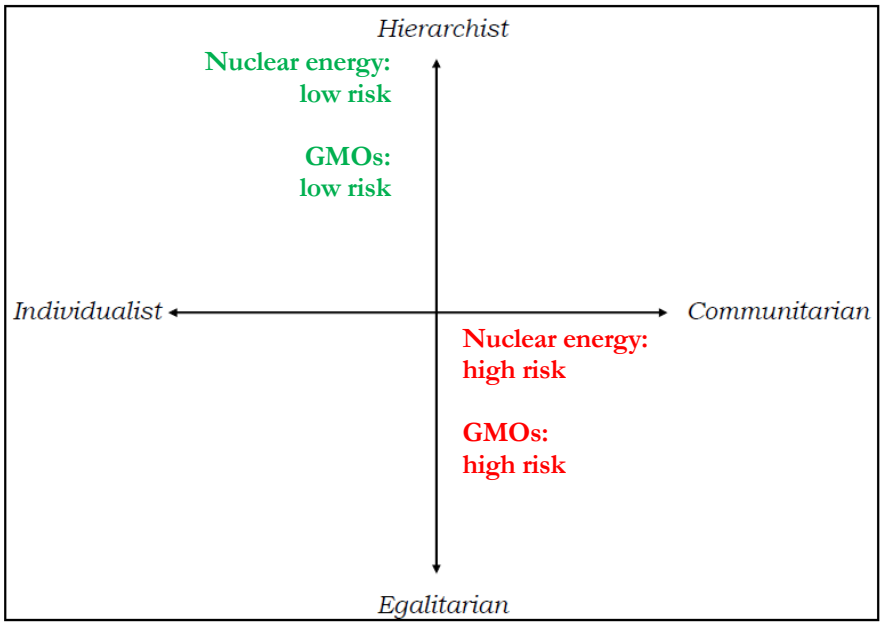

Figure 3. Patterns of risk perceptions toward technologies and the environment, plotted on the cultural framework. Adapted from Kahan & Braman (2006, p. 155).

To measure individual worldviews CCT uses two attitudinal scales, one short-form and one long-form, to plot respondents on the group-grid cultural framework (Kahan, 2012). In total, there are 30 questions for the long-form version and 12 for the short-form, with the latter being as reliable as

the former. Participants respond to a series of 'agree-disagree' Likert-type questions designed to measure cultural values derived from the ways of life typology from the cultural theory of risk. These scales are considered highly reliable when used for studies in the United States. Thus, the scales appear appropriate for empirically testing cultural theory. For a continued discussion of CCT scale usage in the present study, turn to section 2.4.2 in the Methodology chapter.

Consistent with the claims made by cultural theory, previous empirical studies from CCT researchers show a relationship between cultural values and risk perception[6]. In addition to cultural theory which suggests that risk perceptions reflect and reinforce cultural ways of life, CCT posits that there are certain psychological *mechanisms* that are the root cause of the relationship between risk perceptions and ways of life (Kahan, 2012). According to Kahan et al., (2015):

> [C]ultural values are cognitively prior to facts in public risk conflicts: as a result of a complex of interrelated psychological mechanisms, groups of individuals will credit and dismiss evidence of risk in patterns that reflect and reinforce their distinctive understandings of how society should be organized. (p. 194)

While there are a number of different mechanisms posited by CCT, the most noteworthy for this research project is 'cultural availability' (Kahan, 2012).

Cultural availability is based on the aforementioned availability heuristic. This heuristic is, to reiterate, responsible for causing misfearing because hazards are overestimated due to the ease with which high profile disasters, such as Chernobyl, come to mind. But as Kahan (2012) argues, the availability heuristic does not explain why individuals can simultaneously agree that a certain high profile disaster is horrific, yet disagree about risk-relevant facts. For example, most would agree Fukushima was a horrific disaster. Yet there is strong disagreement about what caused the damage (i.e. a tsunami, a backup generator in the basement, human error, or something different) and what the consequences are (ranging from zero to Chernobyl-like). As a result, responses to the disaster differ; some believe nuclear energy production itself is to blame, others believe improper safety policies and procedures are to blame, and others pin responsibility on the tsunami. Why? As Kahan & Braman (2003) claim, such disagreement may be the result of culture:

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[6] See http://www.culturalcognition.net/papers-topical/ for a comprehensive and updated list.

> If people are more likely to notice risk-related contingencies congenial to their cultural predispositions, to assign them significance consistent with their cultural predispositions, and recall instances of them when doing so is supportive of their cultural predispositions, then the availability effect will generate systematic individual differences among culturally diverse individuals. (cited in Kahan, 2012)

Thus, if cultural values bias assessments of risk, do participants with shared cultural values assess nuclear risk similarly?

2.9 CONCLUSION

Risk is epistemologically complex. We cannot know with certainty the dangers we face, but must act as if we do. One way of making sense of risk is by assessing unwanted events which may cause harm or damage. Whereas experts generally rely upon calculating risk to minimize bias from perceiving risk, ordinary citizens tend not to use such a corrective. These different approaches yield different conclusions, in effect creating a risk assessment gulf between expert and public conceptions of risk. When inconsistent assessments arise, PIT emphasizes that the conflict exists because of a knowledge deficit between science and the public pitting public irrationality as the culprit. Motivated reasoning and cultural theories of risk emphasize that different segments of the population fit their interpretations of risk in a way that reflects and reinforces their competing ways of life. It is not a matter of widespread irrationality as much as different groups that assess risk differently.

To respond to Aaron Wildavsky's question "are some of us looking differently at essentially the same sorts of experience?" the answer is yes. There is strong evidence indicating both that bias exists, and that such bias result in vastly different interpretations of one-and-the-same technology. Whether these differences are a function of knowledge or values is hotly contested between CCT and PIT. As for Wildavsky's question "why is the one *feared* and not the other?", both PIT and CCT point toward cognitive constraints – heuristics, biases, and motivated reasoning – as root causes of fear. The remainder of this thesis will be devoted to describing an empirical investigation conducted to test these two theories' claims of how controversial technology risk is assessed: as a function of basic knowledge or as a function of pre-existing cultural values.

CHAPTER III.

METHODS AND HYPOTHESES

3.1 STUDY OVERVIEW

An online survey instrument was used to conduct the empirical investigation portion of this thesis. The survey method was chosen because it enabled the effective and efficient gathering of a wide variety of risk perceptions toward different controversial technologies. Further, a survey also allowed for the measurement of individual cultural worldviews and basic nuclear energy knowledge. Gathering information about risk perceptions (the key dependent variable) as well as cultural values and basic knowledge (key independent variables) enabled the researcher to analyze the relationship between these variables – a procedure necessary for both providing evidence in regards to the claims made by CCT, and for answering the two research questions. First, do risk perceptions run across cultural lines among Canadians; second, in the context of nuclear energy, do cultural worldviews or basic knowledge have more influence on how ordinary citizens mistake low-risk technology as high-risk?

Admittedly, there is a kind of incongruity studying a naturalistic phenomenon (perceptions of risk) using a positivist approach (a survey method using measurement scales for key variables). A positivist approach was ultimately used because the present study has borrowed its methodological approach from similar studies which examined risk perceptions which themselves used positivist approaches. Further, a positivist approach provided results that are simpler to gather and interpret than a naturalistic approach. Certainly a naturalistic methodological approach could offer rich attitudinal results by examining participant self reports which detail how subjects' themselves assess technological risk. However, the validity of participant reports may be compromised due to the fact that some individuals have a limited introspective ability to report on their own cognitive processes (Lipshitz, Klein, and Orasanu, 2001). A positivist approach avoids this introspective limitation while still providing a measure of risk perceptions. Measuring attitudes on a predetermined scale gives participants a chance to identify which scale item they most strongly agree with, and although the response chosen may not wholly reflect their attitude, a positivist approach avoids both the difficult task of organizing a wide array of attitudes and the impossible task of comparing qualitatively different levels of concern towards a technology.

3.2 DESIGN

The study was carried out through the Social Science Research Lab located at the University of Saskatchewan. Participants were recruited through the online service Probit (http://www.probit.com), a professional research vendor. Probit supplied a panel of respondents who were randomly selected and invited to join the survey. To ensure the selected sample of respondents composed a statistically significant representative sample of Canadian adults, two features were built into the survey. First, a quota was administered to counteract overrepresentation in regions. Second, the survey was made available in both English and French for participants to toggle between at any time. Since this survey aimed at sampling a representative number of Canadians, and since Canada is officially a bilingual country, setting a quota and providing participants with a copy of the survey in both languages were built-in as necessary features.

A quota was used primarily to achieve sizable regional samples. This selection criterion addresses the uneven samples used in two of the three known published studies in Canada which also examined the connection between cultural values and risk (Dragojlovic & Einsiedel, 2014; Lachapelle, Montpetit, & Gauvin, 2014; Perella & Kiss, 2015). Of the three studies, only Dragojlovic & Einseidel (2014) was conducted across Canada whilst the others were distributed regionally. Thus, one aim of the present study is to fill a research gap with respect to research concerning cultural values and risk perceptions among Canadians coast to coast to coast.

For the recruitment phase, participants were invited to participate in a survey study concerned with understanding how Canadians view scientific technologies. Concealing the true nature of the study – measuring risk perceptions toward controversial technologies – was deemed necessary so as to not arouse pre-existing attitudes toward these technologies, which could in turn jeopardize the validity and reliability of the results. Instead, respondents were told that their responses will help inform research that looks at ways to improve communicating science with citizens.

The survey study was conducted in two waves. The first wave (W1) was administered from February 12-29, 2016 and the second wave (W2) was from March 7-14, 2016. Participants were incentivized with a gift card draw to return for W2 after a one-week delay. For the purpose of this thesis, the results from W1 will be the primary data examined. This is because W2 was constructed with the assumption that egalitarians and communitarians in Canada overestimate nuclear energy risk.

As such, W2 was designed as a communication based treatment to ameliorate nuclear energy misfearing due to cultural commitments – a topic ripe for the focus of a future paper. The only questions from W2 included in this thesis are those pertinent to basic knowledge of nuclear energy.

3.3 THE SAMPLE

Shown in Figure 4, the W1 sample size consisted of 575 Canadians. The target was to have a nationally representative sample of 384, based on a 95% confidence level and the population of Canada (35,344,962). This was a two-part study, and as such W1 was oversampled in anticipation of the attrition rate between waves. Oversampling W1 ensured the data gathered was statistically significant for W2.

Number of Respondents (Wave 1)

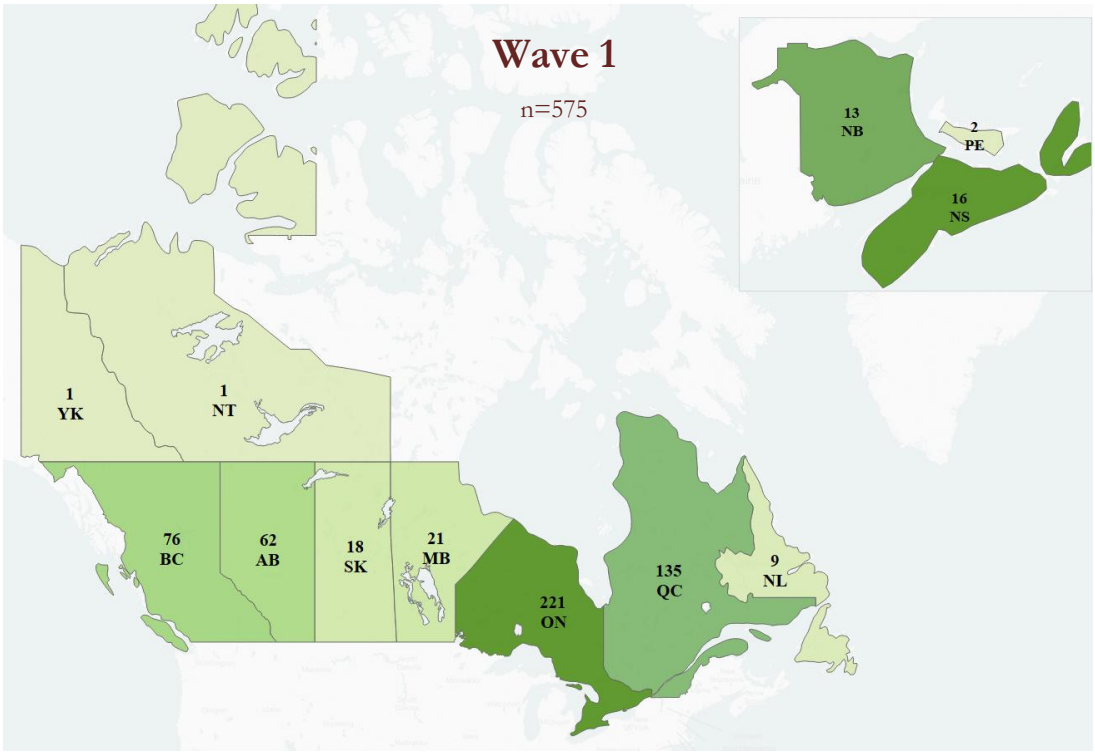


Figure 4. Number of survey participants from each province or territory in Canada.

In the end a nationally representative sample was nearly achieved in W1. Nearly because achieving representativeness proved difficult in small jurisdictions, and ultimately Nunavut was left unrepresented. As such, this study can be called a nationally representative sample of Canadian

attitudes with the caveat that Nunavut was not included. Moreover, it is important to note that there are no major demographic discrepancies detected between the W1 sample and Canadians.

3.4 MEASUREMENTS

In W1 of the survey, participants responded to a series of measures on risk perceptions, cultural values, and demographics (see Appendix A-C for each scale, respectively). After agreeing to participate in the study participants were immediately asked to identify their region. To reiterate, quotas were set for each province and territory to control for regional representativeness. In terms of additional demographic questions, information was gathered about gender, income, level of education, Federal political party preference, and age. In sum, the demographic data were intended primarily as control variables in the subsequent analysis while the most pertinent questions probed for attitudes toward controversial technologies, basic knowledge, and cultural predispositions.

3.4.1 Risk Perceptions

The survey study gauged Canadian citizens risk perceptions toward four so-called controversial technologies: vaccines, homeopathic medicine, GMOs, and nuclear energy. Recall that the primary technology of interest is nuclear energy. The other technologies were added to mask the fact that this study is primarily interested in nuclear energy. However, some consideration was given to choosing technologies in anticipation of their interactions with cultural values. Vaccines, for example, have been shown in previous studies to be viewed as risky by those who hold strong individualist values (Kahan et al., 2015). Homeopathic medicine was speculated to be viewed as high risk by hierarchists, given that homeopathic medicine is not proven by experts and as such may be viewed as high risk. Finally, it was unclear if GMO risk perceptions would run across cultural lines, but speculated that the same groups who view nuclear as high risk (egalitarians and communitarians) would also view GMOs as high risk. Both GMOs and nuclear energy have uncertain long term consequences which could impact perceived collective safety.

Shown in **Error! Reference source not found.**[7], responses were measured using a 7-point Likert-type scale with each response option having a verbal label and corresponding number. The scale asked for risk perception responses across four separate domains: society, the economy, human health,

[7] All risk scales are listed in Appendix B.

and the environment. It is important to note that there is no standardized risk scale. As such, the scale developed in the present study was adapted from Kahan et al., 2012. In that study, the scale measured risk perceptions between 0 ('no risk') to 10 ('extreme risk') and participants were asked "How much risk" they believed issues of "climate change" and "nuclear power" "posed to human health, safety, or prosperity" (p. 4).

The scale used in the present survey study diverged from Kahan et al., 2012 in two key ways. First, each scale response has a verbal label and number. This change emerged from e-mail correspondence with Paul Slovic, a leading expert on risk perception research, who recommended using this kind of scale setup because it would help both the rater and reader know what each response means. Second, instead of asking how much risk was "posed to human health, safety, or prosperity", these items were separated to avoid conflated responses. The domains were separated after a conversation with research facilitators at the Social Science Research Lab, in part to remove ambiguity during data interpretation. For example, it clarifies whether participants perceive nuclear energy to be high risk for the environment yet low risk for the economy. Designing the scale with these two suggestions allowed the present study to probe for specificity by making it clear the degree to which participants perceived a specific level of risk in a specific domain.

Risk Perception Scale

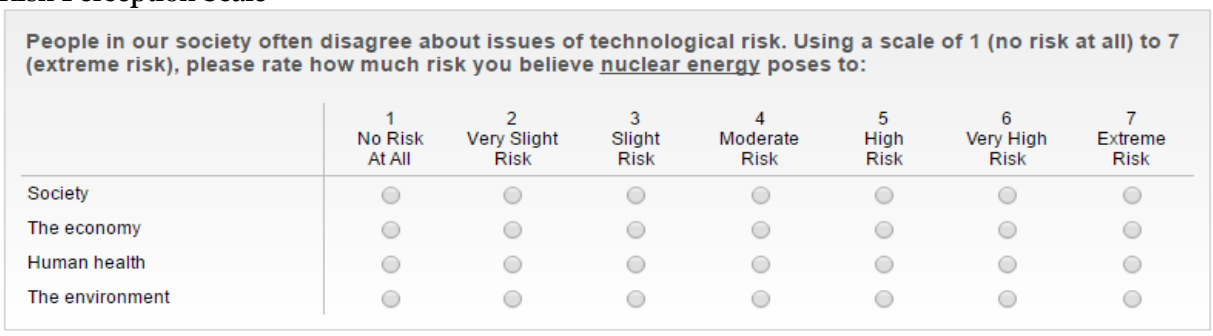


Figure 5. Risk perception scale for nuclear energy.

3.4.2 Cultural Values

Subjects' cultural values were measured using an adapted form of the short-form worldview scale by Kahan (2012). This 12-question scale measured agreement with a culturally charged statement using a 6-point Likert scale (Strongly Disagree, Moderately Disagree, Slightly Disagree, Slightly Agree, Moderately Agree, Strongly Agree). The scale was chosen because it is the standard scale used by CCT

researchers, and has been validated in the United States. It must be noted, however, an adapted version was used because Dan Kahan, one of the lead CCT researchers, has found that there are difficulties with operationalizing the CCT scales in societies other than the United States (e-mail correspondence). He was unsure why Canada in particular has been a difficult jurisdiction for creating a cross-culturally valid scale, even more so than the UK, Australia, and Austria, but did comment the results illustrate that Canadians are more than simply Americans who play hockey (a sentiment seconded by this author).

Acknowledging the difficulty operationalizing the CCT scale in Canada, and also acknowledging that there is only one cross-Canada study using the cultural scale, I chose to use the same scale operationalized in the cross-Canada study (Dragojlovic & Einsiedel, 2014). In effect, Dragojlovic & Einsiedel's scale is identical to the CCT but with two slight variants. Shown below in Figure 6 are the scale measures. The underlined text denotes language used in the Dragojlovic & Einsiedel study and subsequent square brackets denotes language used in the CCT short-form worldview scale. Given the close resemblance of the Dragojlovic & Einsiedel scale with the CCT short-form scale, testing this proximate scale provided an independent measure to validate the CCT claim that risk perceptions are predictable across cultural lines.

Cultural Cognition Scale (Dragojlovic & Einseidel Version)

Group (Individualism – Communitarianism)	Grid (Hierarchy – Egalitarianism)
People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly do you agree or disagree with each of these statements?	People in our society often disagree about issues of equality and discrimination. How strongly do you agree or disagree with each of these statements?
Individualism	Hierarchy
-The government interferes far too much in our everyday lives.	-We have gone too far in pushing equal rights in this country.
-It's not the government's business to try to protect people from themselves.	-It seems like <u>ethnic minorities</u> [blacks], women, homosexuals and other groups don't want equal rights, they want special rights just for them.
-The government should stop telling people how to live their lives.	-Society as a whole has become too soft and feminine.
Communitarianism	Egalitarianism
-Sometimes government needs to make laws that keep	-Our society would be better off if the

people from hurting themselves. -The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals. -Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.	distribution of wealth was more equal. -We need to dramatically reduce inequalities between the rich and the poor, whites and <u>visible minorities</u> [people of color], and men and women. -Discrimination against minorities is still a very serious problem in our society.

Figure 6. Cultural cognition scale. Note: underlined text denotes language used in this study's scale items, subsequent square brackets denotes language used in the CCT short-form worldview scale.

3.4.3 Basic Knowledge

The survey also measured subjects' basic knowledge of nuclear energy. Basic knowledge was collected to test the assertion from PIT that increased knowledge reduces misfearing. According to previous research, support for nuclear development increases among those who have higher levels of knowledge about nuclear (Ertor-Akyazi et al., 2012; Stoutenborough et al., 2013, as cited in Bourassa et al., 2014). As such, of the three basic knowledge questions asked, the first was from a nuclear energy regulator (CNSC), the second from a nuclear energy information library (WNA), and the third from a previous study examining nuclear energy attitudes (Nuclear Policy Research Initiative (NPRI)). Basic knowledge information was gathered in W2 from follow-up questions for a nuclear energy treatment. Although fewer responses were collected (n=402), gathering additional information specific to nuclear energy in W1 would likely have provoked suspicion among some respondents that the overall survey was nuclear energy specific.

Shown below in Figure 7 are three True or False basic knowledge questions. The information on which the first question is based was found on an infographic produced from the CNSC (2015). Though the first statement is technically 'True', it is worth noting that there was a partial meltdown at the NRX reactor in 1952 (Lewis, 1953) as well as a fire accident at the NRU reactor in 1958 (Greenwood, 1959). While it is true that there have been no accidents in over 40 years, there have been accidents as recently as 58 years ago. The second question is 'True' as well, with the WNA stating that about 15% of electricity generated in Canada comes from nuclear (WNA, 2016). The third question was adopted from a Saskatchewan nuclear energy attitudes survey conducted by the NPRI (Bourassa et al., 2014, p. 4; adopted from McBeth & Oakes, 1996, p. 426). Only this particular question was used from the NPRI survey because the other objective knowledge measures were specific to Saskatchewan. A correct response to this third question is 'False' for two reasons. First, potentially

harmful radiation is not a man-made substance. According to the United Nations Environment Programme (2016), the greatest exposure of potentially harmful radiation (known as "ionizing") is caused by natural sources from the environment. Second, only one type of radiation produced by humans can damage living tissue. There are two types of radiation created by humans: non-ionizing (such as transmission signals for TV and radio) and ionizing (such as nuclear energy and medical x-rays). Only ionizing radiation exposure in large doses causes harm.

Basic Knowledge Questions

Question 1: There have been no nuclear accidents with environmental or health consequences in over 40 years of operations in Canada. **True**

Question 2: Nuclear power provided electricity in Canada last year. **True**

Question 3: Potentially harmful radiation is a man-made substance that only comes from sources such as nuclear power facilities and X-ray machines. **False**

Figure 7. Basic nuclear energy knowledge questions with correct answers.

3.5 HYPOTHESES

The main argument of this thesis is that non-experts will differ in their assessments of risk associated with controversial technologies. As such, one broad research question is: *Do risk perceptions run across cultural lines among Canadians?* But since it is unclear whether Canadians risk assessment differences are better explained by cultural predispositions or knowledge, a second research question was formulated. Namely, in the context of nuclear energy, *do cultural worldviews or basic knowledge have more influence on how ordinary citizens misfear risk?*

As cultural cognition researchers explain, strong cultural predispositions interfere with evaluations of risks by distorting the interpretation of facts that underpin such evaluations. Individualists privilege individual interests over that of the group. They believe individuals themselves are responsible for securing the conditions that enable human flourishing, emphasizing that such activity is free from collective interference or assistance. As such, they are inclined to trust their own judgments in matters including risk, and view government regulations to mitigate risk as an infringement upon individual autonomy. For this reason, I predict individualists will perceive low risk toward all technologies except vaccines, since there is a broad agreement that vaccines are in effect forced public health measures. Thus, *H1: Those who score high on the 'individualist' index will evaluate the risks from all technologies except vaccines as significantly lower than the sample average.*

Hierarchists value rigid social order and tend to trust authorities. They believe social factors such as rights, duties, goods, and offices should be distributed differentially and in accordance with established social characteristics (e.g., gender, wealth, lineage, ethnicity). They see the world as ordered in terms of authority relations and are comfortable complying with experts in the presence of uncertainty. As such, they are inclined to accept the testimony of experts on matters related to the risks associated with technologies. I anticipate hierarchists will perceive low risk toward all technologies except homeopathic medicine, given it is an unproven technology among experts. Thus, *H2: Those who score high on the 'hierarchy' index will evaluate the risks from all technologies except homeopathic medicine as significantly lower than the sample average.*

Communitarians are willing to set aside their individual interests for the benefit of the group. They believe collective interests trump individual interests, designating society as responsible for providing the conditions necessary for individual flourishing. For some technologies such as GMOs and nuclear energy, communitarians can be expected to magnify uncertain consequences beyond expert testimony and pressure government to regulate safety on the presumption that there exist high perceived risks for large numbers of individuals, including future generations. Thus H3: *Those who score high on the 'communitarian' index will evaluate the risks from GMOs and nuclear energy as significantly higher than the sample average.*

Egalitarians value a society free from externally imposed prescriptions. They believe social factors such as rights, duties, goods, and offices should be distributed equally, independent from any social characteristic. They see the world as a place of equal opportunity for all. For egalitarians, expert opinion will not automatically trump the opinions of non-experts especially if the latter are large in number or intense in their beliefs. Trusted sources such as loved ones or some media outlets can serve as alternatives to experts on matters of risk, and while expert opinion is seldom dismissed, egalitarians are disinclined to discount the opinions of fellow citizens. As such, I expect egalitarians will perceive technological risks in GMOs and nuclear energy at relatively high levels. Specifically, H4: *Those who score high on the 'egalitarian' index will evaluate the risks from GMOs and nuclear energy as significantly higher than the sample average.*

As public irrationality researchers argue, ordinary citizens' assessments of risk are often marred by cognitive bias. However, those individuals with more subject matter knowledge are more likely than their ignorant counterparts to formulate more even-handed assessments of risk. As some cognitive

scientists and behavioral economists explain, increased knowledge operates as a kind of constraint on cognitive bias, thus enabling individuals to hold temperate risk perceptions even in cases of controversy. Thus, H5: *Those who score high on the 'basic nuclear energy knowledge' question set will evaluate the risks from nuclear energy as significantly lower than the sample average.*

As Kahan & Braman (2006) claim, cultural worldviews predicted nuclear energy risk perceptions "more powerfully than any other factor, including gender, race, income, education, and political ideology" (pg. 156). Since those other factors are known to correlate strongly with risk perceptions of nuclear energy, I anticipate that cultural worldviews will be a stronger predictor of nuclear risk than basic knowledge. Thus, H6: *Cultural values will be more strongly correlated with nuclear energy risk perceptions than basic knowledge of nuclear.*

CHAPTER IV.

PATTERNS OF RISK PERCEPTIONS AND CULTURAL COGNITION

4.1 RISK PERCEPTIONS

As shown in Table 1, the mean score of all technologies is listed with the highest domain score in red text and the lowest in green. Risk responses for both homeopathic medicine and vaccines are highest in the domain of human health and lowest for the environment. For GMOs and nuclear energy, risk perceptions for both technologies are much higher toward human health and the environment than the economy and society.

Risk Perceptions

	Human Health		Environment		Economy		Society	
	M	SD	M	SD	M	SD	M	SD
Homeopathic Medicine	**3.41**	1.728	**2.06**	1.390	2.34	1.485	2.85	1.644
Vaccines	**2.32**	1.433	**1.95**	1.278	1.97	1.406	2.06	1.375
GMOs	4.18	1.921	**4.43**	1.880	**3.51**	1.880	3.85	1.861
Nuclear Energy	4.16	1.775	**4.48**	1.708	**3.20**	1.790	3.67	1.804

Table 1. Risk perception means and standard deviations for four technologies across four domains.
Note. M = Mean. SD = Standard Deviation. Risk perception scores ranges from 1 (No Risk At All) to 7 (Extreme Risk).

Figure 8 is a graphical representation of risk perceptions for each technology across each domain. Homeopathic medicine has a low risk profile in the domains of the environment, the economy, and society. However, the domain of human health has a low-moderate risk profile with nearly one-quarter (24%) of respondents reporting 'High Risk', 'Very High Risk', or 'Extreme Risk'.

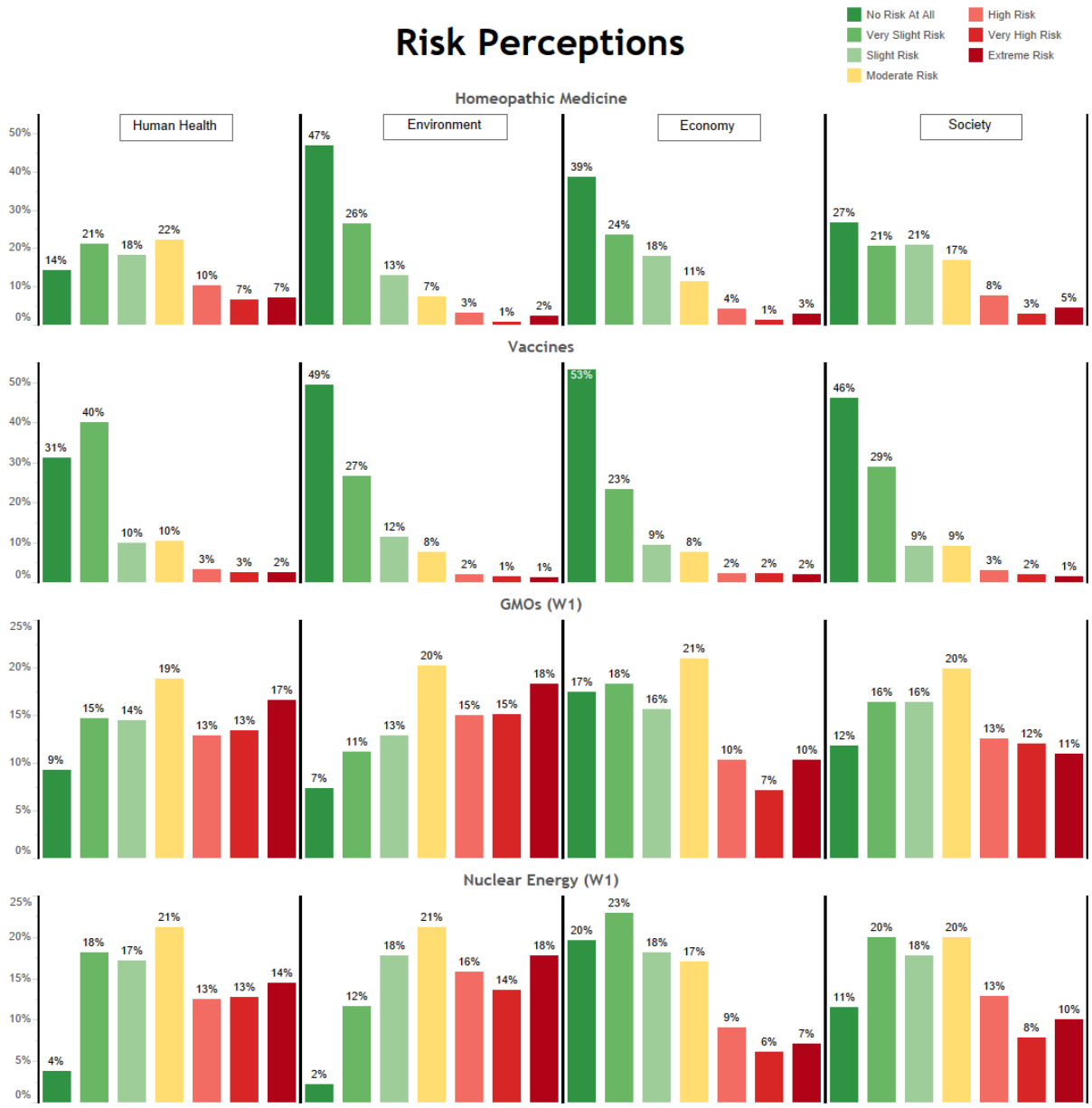


Figure 8. Percentage of reported risk perceptions for homeopathic medicine, vaccines, GMOs, and nuclear energy.

Vaccines have a low risk profile across all domains. Notably, only 8% of respondents reported 'High Risk', 'Very High Risk' and 'Extreme Risk' toward human health, the domain with the highest mean score for vaccine technology.

Relative to homeopathic medicine and vaccines, GMOs have a high risk profile. In total, 48% of the respondents in the domain of the environment and 43% in the domain of human health

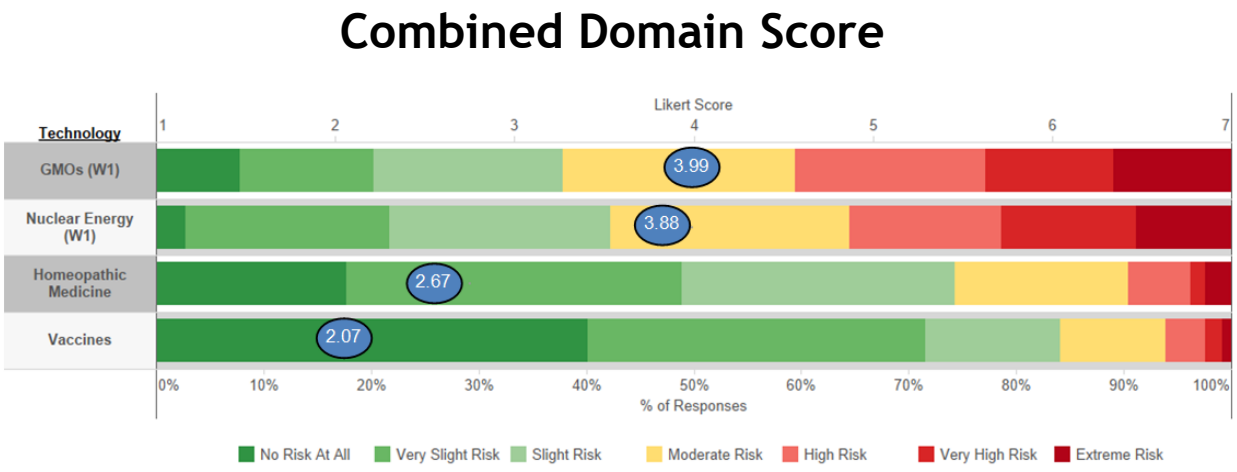
reported 'High Risk', 'Very High Risk', or 'Extreme Risk'. By contrast, fewer participants reported these same high risk scores for GMOs in the domains of the economy (27%) and society (36%).

Like GMOs, nuclear energy has a high risk profile in the domains of the environment and human health. Nearly half of the respondents (48%) perceived 'High Risk', 'Very High Risk', or 'Extreme Risk' in the domain of the environment. In the domain of human health 40% of respondents reported the same high risk scores. By contrast, those same risk scores were reported less frequently, with 27% in the domain of the economy and 31% in the domain of society.

Worth highlighting is the similar risk profile shared between homeopathic medicine and vaccines, on the one hand, and GMOs and nuclear, on the other. Both Table 1 and Figure 8 show that human health predominates homeopathic medicine and vaccines risk perceptions, while human health and the environment predominate GMOs and nuclear energy.

Shown below in Figure 9 are risk perceptions for each technology when all of the domains (human health, environment, economy, and society) are combined. Domains were combined to compare the overall risk perception between technologies to determine which are the most likely to indicate misfearing. The original purpose behind creating domains was to identify possible nuance; but since there are no particular domains which stand as outliers from the others, there is therefore no reason to not combine all domains for each technology.

When domain scores are combined there is a clear similarity of overall risk profiles for homeopathic medicine and vaccines on the one hand, and GMOs and nuclear energy on the other. However, the standard deviations suggest more agreement in the assessment of the former, and less agreement on the latter. This takeaway point is that misfearing is more likely to occur toward GMO and nuclear energy technologies than homeopathic medicine and vaccines.

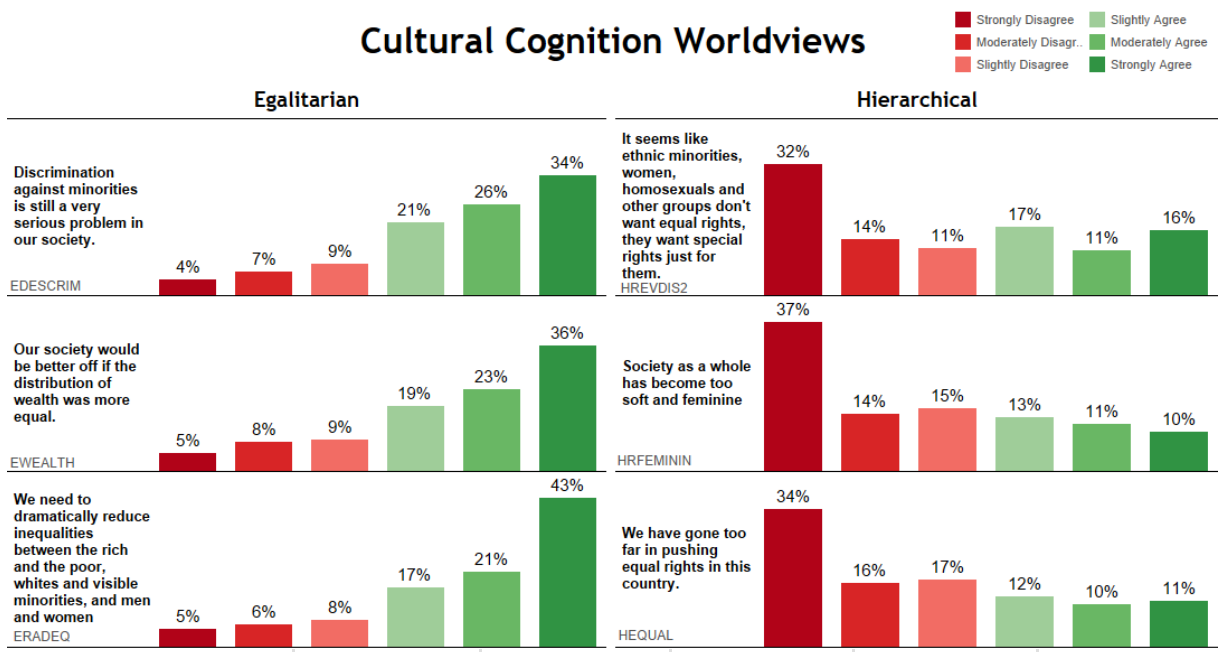


	GMOs	Nuclear Energy	Homeopathic Medicine	Vaccines
M	**3.99**	**3.88**	**2.67**	**2.07**
SD	**1.728**	**1.619**	**1.327**	**1.243**

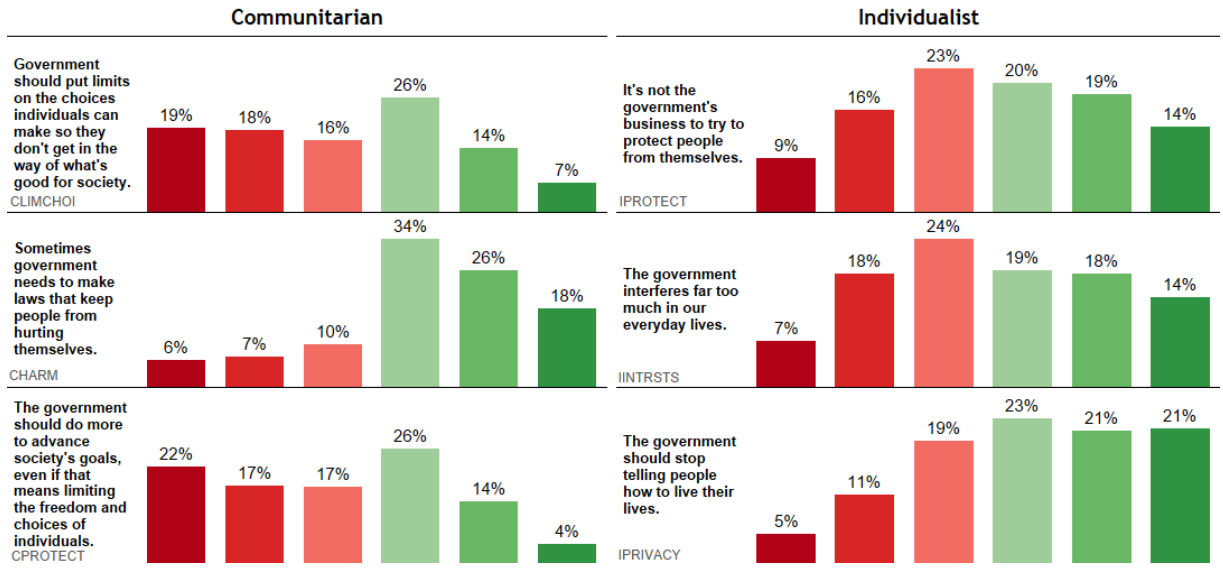
Figure 9. Risk perception for each technology with combined domains.

4.2 CULTURAL VALUES

Shown in Figure 10 are the responses to the cultural worldview scale. Recall that egalitarian and hierarchical worldviews are opposites on the dimension identified as 'grid' and communitarian and individualist are opposites on the 'group' dimension. On the grid spectrum, respondents agreed more strongly with egalitarian scale items than hierarchical. The group spectrum, however, is much more evenly split with at least 40% of participants reporting the middle values of 'Slightly Disagree' or 'Slightly Agree' for each communitarian or individualist scale item.



	EDESCRIM	EWEALTH	ERADEQ	HREVDIS2	HRFEMININ	HREQUAL
M	4.58	4.54	4.71	3.08	2.78	2.84
SD	1.421	1.503	1.481	1.849	1.734	1.745



	CLIMCHOI	CHARM	CPROTECT	IPROTECT	IINTRSTS	IPRIVACY
M	3.18	4.20	3.06	3.65	3.65	4.09
SD	1.526	1.360	1.495	1.501	1.500	1.452

Figure 10. Cultural Cognition Scale (Dragojlovic & Einseidel Version).

Shown in Figure 11 are the grid and group dimension scores. These scores were computed by first adding together the level of agreement for each cultural scale item (3 items with a 0-5 score, outlined in Figure 10) to create a combined score for each worldview (0-15 score). Since egalitarian-hierarchical are opposites on the same grid dimension, as too are individualist-communitarian on the group dimension, then one score on each dimension was reverse scored to create separation (0-(-15) score). This is why 'egalitarian' and 'individualist' scores scale toward -15. Finally, the difference between the worldview values ((-15)-15 score) were calculated to locate respondents on each group-grid continuum. For example, an individual scoring 7 on hierarchical and -9 on egalitarian would be at -2 on the grid continuum. Thus, Figure 11 shows where respondents fall along group and grid lines.

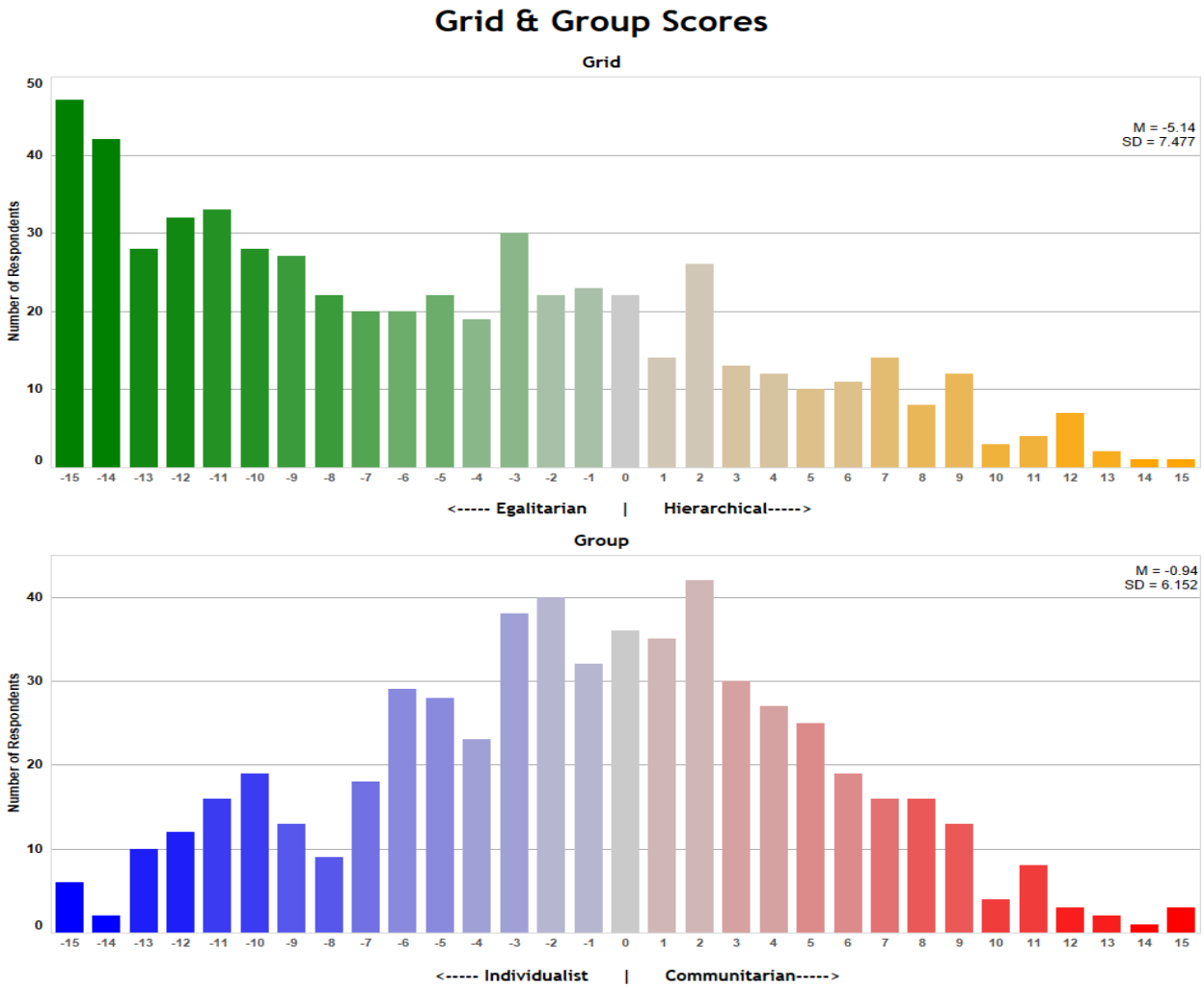


Figure 11. Cultural values scored along 'grid' and 'group' dimensions.

It is important to highlight that the values located on the outer edges of the bar charts (i.e. -15 & 15) indicate not just strong agreement with a particular worldview, but strong agreement with a particular worldview *and* strong disagreement with the opposing worldview. For example, scoring -15 on the grid dimension means strong agreement with all egalitarian scale items and strong disagreement with all hierarchical items. The results emphasize the strong egalitarian leaning of the sample's grid values compared with the more normal distribution of their group values. Figure 11 also shows how few participants identify strongly with hierarchical, individualist, and communitarian values.

A scatterplot, shown in Figure 12, was created to visualize the distribution of respondents across cultural lines. Each point represents at least one participant at an x, y cultural value coordinate with larger points representing more than one. The 'x' coordinate represents where an individual scored on the group dimension and the 'y' coordinate represents that same individuals' grid value. For example, a score of 7 on Communitarian and 7 on Individualist would be a '0' group score, and would be 0 on the x-axis. A score of -15 on Egalitarian and 2 on Hierarchical would be a '-13' grid score, and as such -13 on the y-axis. Taken together, this score – high on Egalitarian values in the group scale and equally split on grid values – would therefore be located at '0, -13'. This scatterplot is for visualizing the distribution of respondents across cultural lines only; analysis looking at combinations of worldviews falls outside the scope of the present analysis and skill of the researcher.

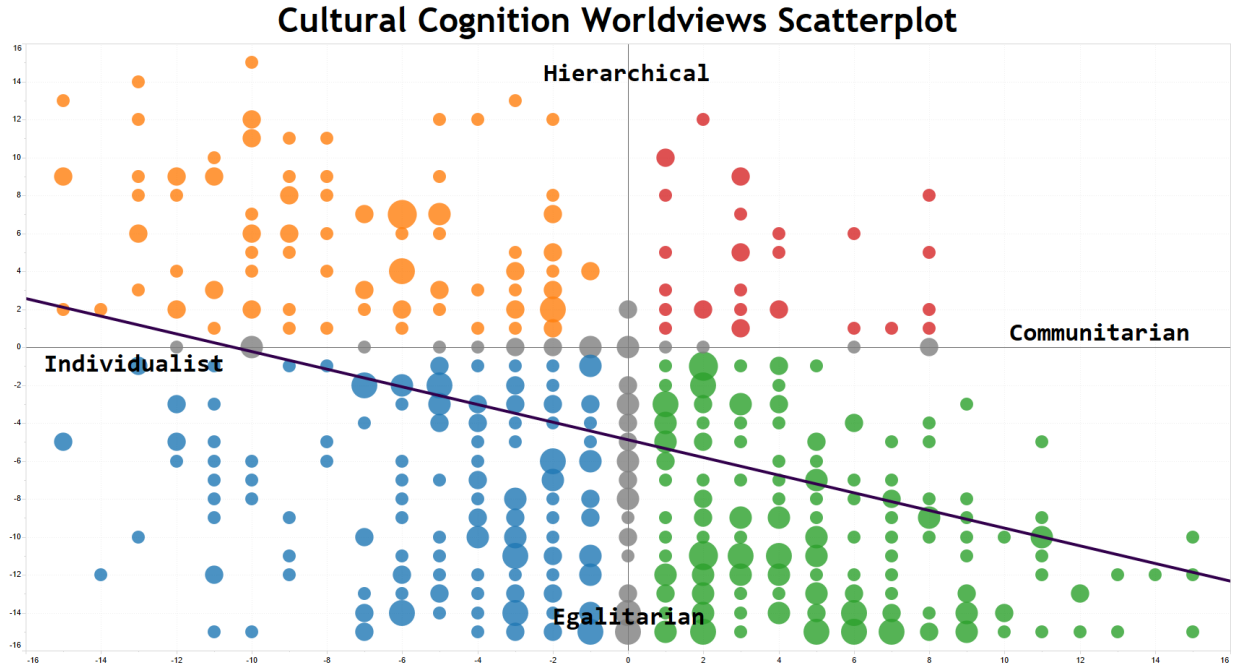
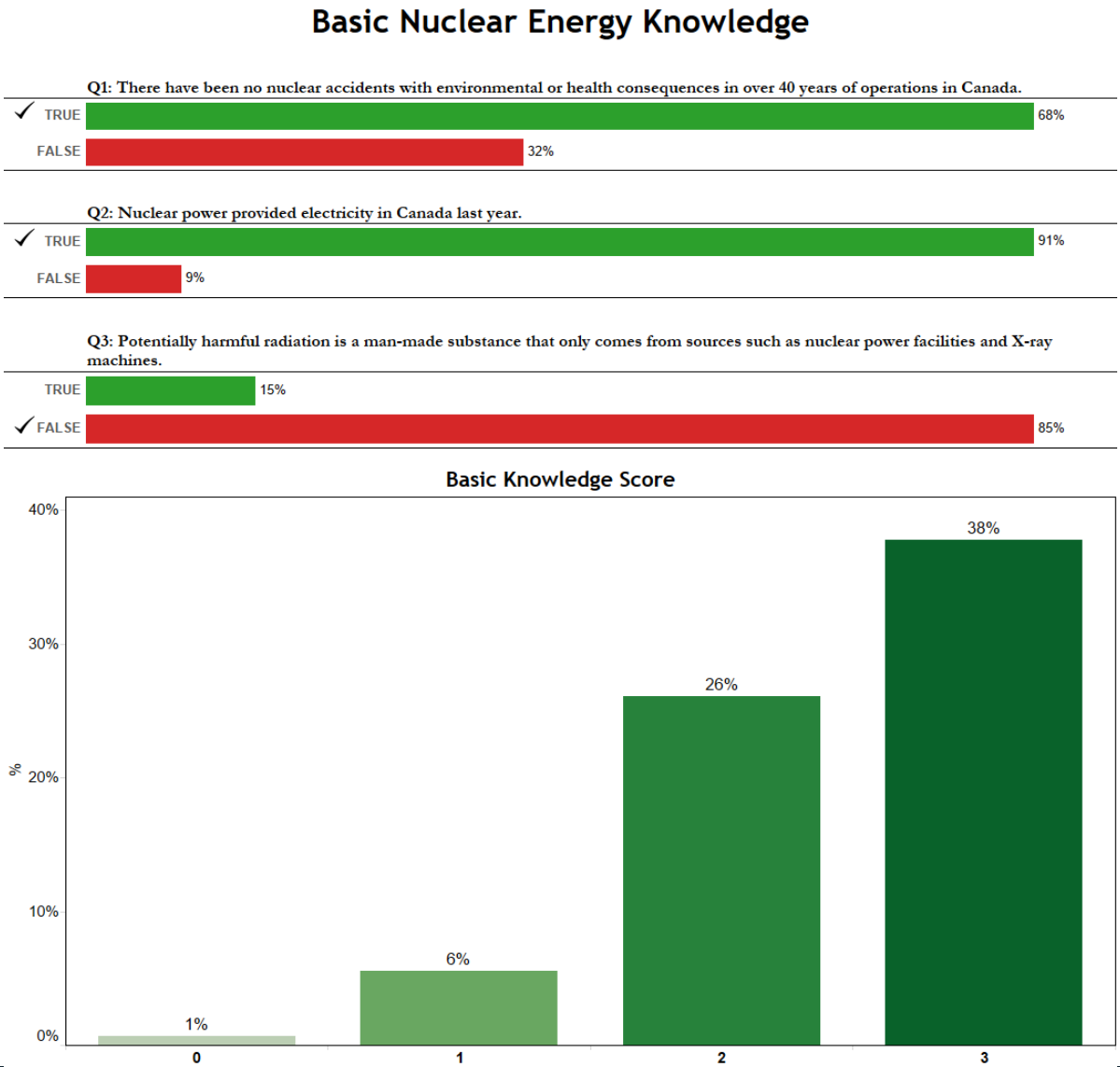


Figure 12.Combined grid and group scores plotted on the cultural worldview framework.

4.3 BASIC KNOWLEDGE

Shown below in Figure 13 are the results from the nuclear energy basic knowledge scale developed specifically for the present study. The results show that most participants responded correctly to each of the three individual T/F questions (68%, 91%, and 85%). When the scores were added together, 38% of respondents' correctly answered all 3 questions, 26% correctly answered two questions, 6% correctly answered one question, and 1% correctly answered none of the questions.



	Q1	Q2	Q3	SCORE
M	0.68	0.91	0.85	2.44
SD	0.465	0.289	0.358	0.683

Figure 13. Basic knowledge questions and score.

CHAPTER V.

CULTURAL VALUES AND BASIC KNOWLEDGE:

ANALYSIS AND FINDINGS

5.1 CULTURAL WORLDVIEWS AND CONTROVERSIAL TECHNOLOGIES

The broad research question set out in this project is to examine the relationship between risk perceptions and cultural values to identify if estimates of risk run along cultural lines. One key finding from the Results Chapter was that mean risk perceptions, and accompanying standard deviations, were much higher for GMO and nuclear energy than vaccines and homeopathic medicine. This suggests that identifying misfearing along cultural lines is more likely to occur in the former than latter technologies.

Shown below in Table 2 are a series of bivariate regressions, with technological risk perceptions as the dependent variables and cultural cognition worldviews as the independent variables. The first column presents the standardized error and the second column presents standardized regression coefficients. Technological risk perception measured using the combined domain scores from section 3.2 (see Figure 9); the cultural cognition worldviews measured using the 0-15 scores from section 3.3 (see Figures 10 & 11). Both scores were used for the regression analysis.

Individualists, as predicted, have lower than sample mean levels of risk perceptions toward all technologies except vaccines. Individualists privilege individual over collective interests, are averse to collective interference, and are inclined to trust their own judgments in matters involving risk. According to the theory put forward in this thesis, individualists are motivated to reject technological risk claims as long as doing so does not interfere with individual interests. This conjecture fits with the results in Table 2 insofar as individualists otherwise low-risk attitude flip toward high-risk in the case of vaccines. Individualists perceive high risk towards vaccines, not necessarily because vaccines are risky technologies, but because individualists anticipate that if vaccines are indeed low-risk then mandatory vaccination programs would follow – a clear interference disruptive to individual

autonomy. Individualists misfearing vaccines and no other technologies supports Hypothesis 1 that they do so in a way that reinforces and reflects their preexisting values.

Hierarchicals had lower than average levels of risk perceptions toward nuclear and GMOs. This result is consistent with Hypothesis 2. However, high risk perceptions toward vaccines and low risk assessments of homeopathic medicine are both counter to what was hypothesized. According to cultural theory, hierarchicals value social order and tend to trust authorities. As such, they should be expected to comply with expert opinion on matters of risk and should not misfear technologies which experts deem safe. This conjecture fits with the results found for GMOs and nuclear energy, but not for vaccines and homeopathic medicine.

Bivariate Regression for Cultural Cognition Variables Predicting Risk Perceptions (N = 575)

Variable	*SE B*	*β*
Nuclear		
Individualist	0.01	-.07
Communitarian	0.01	.02
Hierarchical	0.01	-.22***
Egalitarian	0.01	.25***
GMOs		
Individualist	0.01	-.02
Communitarian	0.02	.03
Hierarchical	0.01	-.11*
Egalitarian	0.01	.23***
Vaccines		
Individualist	0.01	.15***
Communitarian	0.01	-.04
Hierarchical	0.01	.11*
Egalitarian	0.01	.00
Hom. Med.		
Individualist	0.01	-.06
Communitarian	0.01	.17***
Hierarchical	0.01	-.00
Egalitarian	0.01	.00

Table 2. Note: * $p < .10$. ** $p < .05$. *** $p < .01$.

It is not clear why hierarchicals in the sample misfear vaccines, a technology promoted as safe by medical experts, and fail to misfear homeopathic medicine, a technology which medical experts tend to warn is an ineffective substitute for proper medical care. One possibility is that if an individual holds both hierarchical *and* individualist values, their individualist values may override their hierarchical

values. This very well may be the case for vaccines; however, this point will remain speculative as examining combinations of cultural values falls outside the scope of this analysis. In the case of homeopathic medicine, it could be that hierarchicals, like experts, perceive very little risk toward homeopathic medicine because they simply do not think it is effective. If it is not effective at treating illness (no benefit), then how could it effectively cause harm (no risk)? When creating the original hypothesis that hierarchicals would perceive high risk toward homeopathic medicine because medical experts view it as a poor substitute for proven medicine, applying Occam's razor would have helped with the hypothesis formulation: hierarchicals, like experts, perceive homeopathic medicine as low risk because it is ineffective, both at treating and causing illness.

Communitarians did not evaluate the risks from GMOs and nuclear energy as significantly higher than the sample average. This result is contrary to Hypothesis 3. According to cultural theory, communitarians believe collective interests outweigh individual ones. Further, communitarians tend to promote collective interference if it promotes individual flourishing (i.e. pressuring government to take action when there are perceived risks for large numbers of individuals). Thus, since GMOs and nuclear energy technologies pose uncertainties for the safety of present and future generations, communitarians were hypothesized to magnify the risks from these technologies relative to the sample average. However, this hypothesis was wrong.

One possibility for why communitarians fail to misfear GMOs is because it is a fairly recent technology and as such has not had enough time to mature into a controversial technology. While plausible, the fact that communitarians failed to misfear nuclear energy (a mature technology that has been controversial for decades) undermines this speculation. Whatever is driving communitarian risk perceptions towards GMOs and nuclear energy, they appear content with both the safety and existing regulations of these two technologies. Admittedly, this result was puzzling. Yet even more puzzling is why communitarians perceived significantly higher levels of risk than the sample average toward homeopathic medicine. While the relatively small numbers of individuals who identify strongly as communitarians may be part of the problem, these unexpected results nonetheless suggest that the theoretical work describing those who hold communitarian values may be in need of refinement for the Canadian context.

Finally, egalitarians, as predicted in Hypothesis 4, have higher than the sample average risk perceptions toward GMOs and nuclear energy. Those with strong egalitarian values believe that

society should be a place of equal opportunity for all regardless of externally imposed prescriptions, and regardless of factors such as race, wealth, and gender, etc. These predispositions support the argument that, for egalitarians, expert opinion does not automatically trump non-expert opinions. As a result, trusted sources can serve as alternatives to experts on risk, which appears to be the case for GMOs and nuclear energy. Yet egalitarians and expert opinion are not consistently at odds. This is evident by egalitarians moderate risk perceptions toward vaccines and homeopathic medicine.

Outlined above is evidence that individuals perceive risk across cultural lines. In sum, misfearing occurs among both individualists and hierarchicals who perceive higher than the sample average risk perceptions toward vaccines. Egalitarians misfear both GMOs and nuclear energy. Similarly, communitarians misfear homeopathic medicine. Thus, there is some evidence that individualists and egalitarians do perceive risk across cultural lines in predicted ways, and that hierarchical and communitarians perceive risk across cultural lines but in unpredicted ways.

5.2 CULTURAL VALUES AND BASIC KNOWLEDGE IN THE CONTEXT OF NUCLEAR ENERGY

A more specific research question was developed to test the claims of CCT and PIT in the context of nuclear energy. That is, to compare how cultural values affect nuclear risk perceptions with how basic knowledge of nuclear energy affects perceptions of nuclear risk. The ultimate aim of this analysis is to determine whether basic knowledge or cultural values matter more for misfearing nuclear energy. Figure 14 shows nuclear risk perceptions for each cultural worldview. Consistent with what was predicted, both Figure 14 and Table 2 show that individualists and hierarchicals have relatively lower levels of risk perceptions than egalitarians and communitarians who are statistically significantly more likely to believe that nuclear power constitutes a serious risk. This finding is consistent with other findings from previous CCT research (see section 1.9 for discussion).

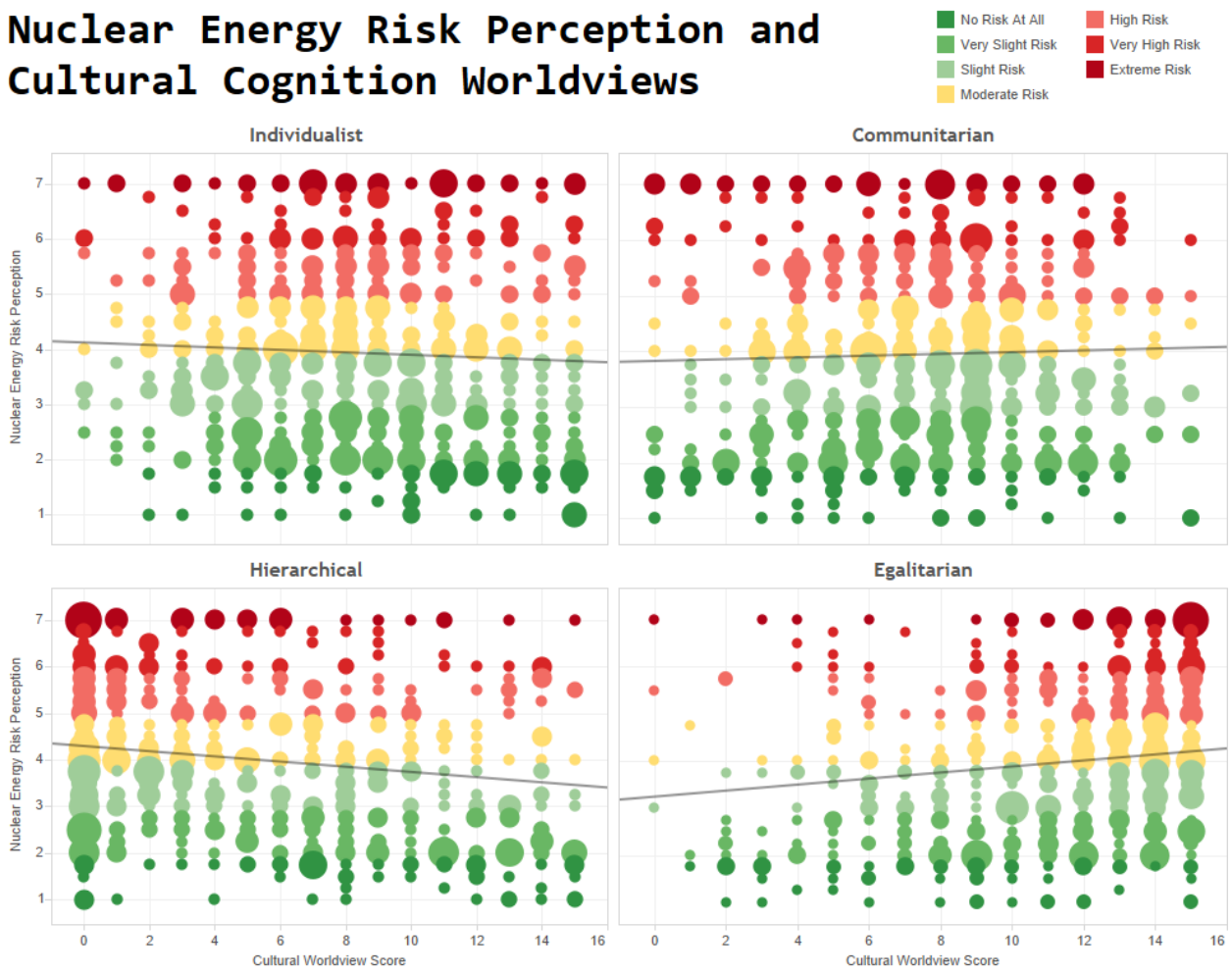


Figure 14. Nuclear energy risk perceptions across cultural lines.

Interestingly, nuclear risk perceptions differ across the grid-group continuums with the difference much more pronounced for grid (egalitarian-hierarchical) than group (individualist-communitarian). The group regression results are difficult to interpret given the similarity between individualists and communitarians standardized beta scores for nuclear energy risk, and given the puzzling communitarian sample results in general. As such, group results will be discarded for the remainder of the analysis.

For the grid regression results, the standardized beta score is *lower* than the hierarchical score. Recall that the grid variable is a calculated value representing the difference between hierarchical-egalitarian values on the same continuum ((-15)-15 score). As such, the grid variable balances out the contrasting hierarchical-egalitarian values. The unexpected but interesting low standardized beta score

suggests that those who hold moderate grid cultural values have lower than average nuclear risk perceptions, lower than even the hierarchical scale.

Bivariate Regression for Grid & Group Variables Predicting Nuclear Energy Risk Perceptions (N = 575)

Variable	*B*	*SE B*	*β*
Grid (Ega-Hie)	-0.05	0.00	-.26***
Group (Ind-Com)	0.01	0.01	.06
Hierarchical	*add*	0.01	-.22***

Note:
Table 3. * $p < .10$. ** $p < .05$. *** $p < .01$.

Looking at basic knowledge, Table 4 shows that Q1 and Q2 had the same standardized beta scores. But even though these scores were identical, answering Q2 correct had a bigger effect on nuclear risk perceptions as indicated by the non-standardized scores. As such, one explanation for the larger error for Q2 could be the result of it being a question unrelated to risk (requiring participants to know that nuclear power provided electricity in Canada last year) versus Q1 being slightly more risk-focused (requiring participants to know that there have been zero nuclear accidents with environmental or health consequences in over 40 years in Canada). Furthermore, Q1 may have caused some individuals to experience cognitive dissonance. Believing that nuclear energy is risky *and* knowing that there have been no major accidents in 40 years are conflicting propositions. The risk focus and cognitive dissonance involved in Q1 may explain why it was incorrectly answered by almost a third (32%) of respondents, and why it has a lower standard error for predicting nuclear risk perceptions.

Compared to Q1 and Q2, Q3 is an outlier. It appears as though knowing that harmful radiation is not a man-made substance does not affect nuclear risk perceptions as much as answering correctly Q1 or Q2. This result suggests participants with basic knowledge about radiation may have other risk concerns about nuclear energy than its radioactivity.

Bivariate Regression for Basic Knowledge Variables Predicting Nuclear Energy Risk Perceptions (N = 402)

Variable	*B*	*SE B*	*β*
Q1_correct	-0.83	0.16	-.23***
Q2_correct	-1.33	0.27	-.23***
Q3_correct	-0.64	0.22	-.14**
Basic Knowledge	-0.80	0.11	-.34***

Note: The correct response was coded as '1' and the incorrect response as '0'; BasicKnowledge is the total score (0-3) calculated for each participant.

Table 4. * $p < .10$. ** $p < .05$. *** $p < .01$.

A key finding from the previous Chapter was that less than 4 out of 10 participants answered all 3 basic T/F question correctly. The BasicKnowledge variable is a variable which calculated the total number of correct responses for each participant. BasicKnowledge had both the highest standardized beta and smallest error relative to any individual question. This result affirms hypothesis 5, indicating that there is a strong negative correlation between basic knowledge and nuclear energy risk perceptions. Namely, as basic knowledge about nuclear energy increases, risk perceptions toward nuclear energy decreases.

5.3 MULTIVARIATE REGRESSION

Table 5 presents the multivariate regression results for Models 1 through 5. All models used nuclear energy risk perceptions as the dependent variable and all models used ordinary least squares as the method for analysis. The coefficients reported are standardized Betas with corresponding standard errors.

A multivariate model was constructed to determine, first, whether basic knowledge or cultural values matter more for nuclear energy risk perceptions and, second, whether other variables, prominent in previous research, continued to exert influence. To that end, Models 2 through 5 use the BasicKnowledge score (described in section 3.4) as a variable of interest for measuring basic knowledge of nuclear power while Models 3 through 5 use grid and egalitarian variables (described in section 3.3) for measuring cultural values. Models 1 through 4 are additive while Model 5 uses one interaction term to estimate the combined effects of basic knowledge and egalitarian cultural values.

Gender, political preference, and education were used as control variables. As discussed in section 1.4, previous studies have shown that gender and political worldviews are strongly correlated with risk assessments (Slovic, 1999). Men assess risks as both smaller and less problematic than women (Flynn, Slovic, & Mertz, 1994; Kahan, Braman, Gastil, Slovic & Mertz 2007) and politically left-of-centre respondents have much stronger nuclear energy risk concerns than their right-of-centre counterparts (Franchino, 2014). Education was also used as a control but not as a variable of interest because, as discussed at the end of section 1.6, evidence suggests that level of education is independent from understanding risk (Kahan & Braman, 2006). However, education is being used as a control given that it could have an effect on other independent variables.

For the multivariate regression analysis, the *Female* variable was coded '0' for male and '1' for female. The *Education* variable was coded from '0' to '9' with 0 as 'Some high school' or lowest level of education and 9 as 'Doctoral degree' or highest level of education. Responses between 0 and 9 are consistent with the available selections from which participants chose during the survey (see Appendix D for full list). Finally, *Left* was coded '0' for Conservative, '1' for Liberal, '2' for NDP, and '3' for Green to create a progressive political dimension, with 0 being most politically right-of-centre and 3 being most politically left-of-centre.

Multivariate Regression for Independent Variables Predicting Nuclear Energy Risk Perceptions

	Model 1	Model 2	Model 3	Model 4	Model 5
Dependent	*Nuclear Risk*	*Nuclear Risk*	*Nuclear Risk*	*Nuclear Risk*	*Nuclear Risk*
Method	OLS	OLS	OLS	OLS	OLS
Female	**0.13*** (0.17)	**0.10*** (0.16)	**0.07** (0.16)		**0.08*** (0.16)
Education	**-0.03** (0.04)	**0.00** (0.04)	**-0.02** (0.04)		
Left	**0.31***** (0.09)	**0.29***** (0.10)	**0.19***** (0.10)	**0.18***** (0.18)	**0.23***** (0.10)
BasicKnowledge		**-0.32***** (0.11)	**-0.32***** (0.11)	**-0.33***** (0.11)	**-0.42***** (0.15)
Grid (Ega-Hie)			**-0.20***** (0.01)	**-0.21***** (0.01)	
Interaction (Ega X BasicKnowledge)					**0.16**** (0.00)
N	323	322	322	330	330
Adjusted R^2	.10	.21	.23	.23	.21
F	13.691	21.829	20.586	33.887	23.640

Table 5. Standard error in parentheses; legend: * $p < .10$. ** $p < .05$. *** $p < .01$.

As expected, and consistent with previous research, *Left* was strongly correlated with heightened nuclear energy risk perceptions. This result was found across Models 1 through 5. Regardless of the effects of other variables, the more progressive a respondent, the more likely he or she is to perceive a high risk associated with nuclear energy. These results are robust across a number of specifications. The effect of gender breaks down once basic knowledge and cultural values are added to the equations, but reemerge when cultural values focus specifically on egalitarian cultural values. Overall, women may be more inclined to fear nuclear energy, but as Model 3 illustrates, this effect is likely attributable to the fact that women are more politically progressive (as defined here). A higher (or lower) level of education has no effect on nuclear risk perceptions and the values of other

coefficients remain stable across specifications. This result is important because it suggests that nuclear misfearing is not a function of education. As we will see is that it is specific knowledge, not general education, that matters.

In Model 2 *BasicKnowledge* was added to the set of control variables. Model 2 shows that *BasicKnowledge* has a negative and statistically significant effect on *Nuclear Risk*. The more basic nuclear energy knowledge respondents exhibit, the more likely they are to offer lower estimates of nuclear risk. Adding *Grid* to the specification in Models 3 and 4 shows that cultural lens is important for risk assessment. As grid scores increase (meaning as respondents evince an increasing preference for hierarchical values rather than egalitarian ones), the tendency to see nuclear energy as risky declines. Relative to Model 2, the addition of *Grid* values reduced both the statistical significance of *Female* and the standardized beta score for *Left*. Interestingly, the coefficient on *BasicKnowledge* is virtually unchanged between Models 2 and 4.

In Model 4, *Female* and *Education* control variables were removed due to lack of statistical significance while *Left, BasicKnowledge,* and *Grid* remain in the analysis. This leads to a substantial increase in the F score of Model 4 relative to Model 3. Model 4 shows that all the variables in the Model are statistically significant predictors of nuclear energy risk. Similar to previous models, *Left* has a positive and statistically significant effect on nuclear energy risk perceptions and the two variables of interest, *BasicKnowledge* and *Grid*, have a negative and statistically significant effect on nuclear energy risk perceptions. In other words, those who lean politically left tend to perceive heightened risk perceptions towards nuclear. Further, regarding the two variables of interest, those with increased basic knowledge and those with more hierarchical values tend to perceive lower levels of risk towards nuclear energy.

While both *BasicKnowledge* and *Grid* are statistically significant in Model 4, the standardized beta score for *Grid* values are lower than *BasicKnowledge*. As the values of these two variables increase, the effect on risk perceptions is greater for *BasicKnowledge*. This finding suggests that we should reject Hypothesis 6 regarding the relative importance of cultural variables. It is important not to place too much emphasis on this finding, however, since the differences are small. What they suggest is that while cultural values influence risk perceptions, basic knowledge is a strong and independent predictor independent from the cultural lens one employs.

It is possible, of course, that those who hold more egalitarian values will be inclined to continue misfearing nuclear energy despite having more knowledge. In this case, egalitarian values would override basic knowledge. Model 5 maintains political preference as a control, reintroduces gender as a control variable, and introduces an interaction variable to capture the potential effects of combining egalitarian values and basic knowledge. Since egalitarian cultural values are positively correlated with nuclear energy risk (see Table 2), and since Models 2 through 4 show the strength of basic knowledge, an interaction variable was created to measure how egalitarian values interact with basic knowledge.

Model 5 shows that, after controlling for political preference and gender, the *BasicKnowledge* coefficient increased relative to other models. Model 5 also shows that the interaction between egalitarian and basic knowledge is positively correlated with nuclear risk perceptions. Those respondents who are high of egalitarian values and high on basic knowledge represent a group that is unusually conscious of nuclear risk. Consistent with previous models *BasicKnowledge* appears to be a strong predictor of risk perceptions; however, the interaction suggests that those with more egalitarian values increase their fear levels even as basic knowledge increases.

5.4 LIMITATIONS

5.4.1 Risk Scale

One limitation of this study is locating where expert risk perceptions are or where evidence suggests risk perceptions should be. A benchmark value would take the form of telling respondents where experts assume the overall risk to be. By not setting a benchmark risk perception value (i.e. overall nuclear energy risk perceptions should be 'Slight Risk (3)' on the risk perception scale) all technologies used were presumed to be low-risk. But 'low-risk' is a vague and non-specific attribute. A benchmark value would have clarified this vagueness, and further, would have identified those participants whose risk estimates were higher than the benchmark value. In turn, risk perceptions greater than the benchmark value could then be said to be overestimates of risk. This study used overestimate relative to the sample average because, other than ostensibly setting an expert score, additional information would have been required to reliably locate an expert score. But using the sample average as the benchmark value is not the best approach.

A second limitation with the risk scale design was the response 'No Risk At All'. When participants rated a technology as posing 'No Risk At All' it was unclear whether their response indicated that they believed the technology poses zero risk or if the benefits outweighed the risks. The latter interpretation may have confounded results, as risk perception research suggests that risk and benefit are negatively correlated. That is, when an individual assesses a hazard, perceived risk is lower if perceived benefit is greater, and vice versa (Finucane, Alhakami, Slovic, & Johnson, 2000). Therefore, broadening the scale (i.e. 'Extreme Benefit – Extreme Risk') would aid in discerning between whether 'No Risk At All' means zero risk *or* some risk but outweighed by benefits.

More than clarifying a 'No Risk At All' response, the present research project would have been improved by using a benefit and risk scale to observe the other side of the misfearing coin. Namely, to identify those who *underestimate* serious risks. Future research into the problem of misfearing should use a benefit-and-risk scale rather than a risk-only scale in order to fully observe the relationship between misfearing proper[8] and independent variables of interest.

One broad suggestion to improve risk perception research is for researchers in this area to develop a standardized risk scale. Not having a standardized scale means that it is not meaningful to compare different risk perception results from different studies and samples. If instead both the present study and a separate study examined nuclear energy risk perceptions using the same risk scale, it would allow for meaningful comparisons to detect spatio-temporal differences.

5.4.2 Cultural Values

Not knowing the extent to which grid values influence group values, or vice versa, is a limitation of the cultural worldview methodology. As shown on the cultural cognition worldviews scatterplot (Figure 12), each respondent has a grid and group score. Having two scores is problematic because grid and group values can interact with one another in undetectable ways. For example, if an individual scored high on both 'hierarchical' (grid value) and 'individualist' (group value), it is difficult to determine which cultural worldview is responsible for, say, vaccine risk perceptions. In fact, this limitation may have confounded the results for hierarchicals risk perceptions towards vaccines which were unexpectedly high.

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[8] Mistaking low-risk as high-risk *and* mistaking high-risk as low-risk

Second, the CCT scale itself has some limitations in the Canadian context. Results for communitarians were quite puzzling because, contrary to both what was predicted and stated in previous research, this worldview failed to drive overestimates of GMO and nuclear energy risk. To be fair, the puzzling results for communitarians were not entirely unexpected. Lachapelle, Montpetit & Gauvin (2014) removed communitarians from analysis in their study citing the "relatively unsatisfactory reliability scores" to be a function of "cultural cleavages in Quebec [which] are not reducible to two continuums" (p. 684). But one possible factor confounding the communitarian results in Canada is that the group scale items (see 2.4.2) all ask participants to rate their level of agreement with statements describing government activity. As such, being communitarian or being individualist is predicated on how respondents' perceive government should function, ranging from heavy involvement in individual affairs to virtually no involvement.

Yet in Canada government interference is fairly moderate because the political spectrum is fairly moderate. Relative to the United States, the region in which the cultural cognition worldview scale was developed and validated, Canadian political parties tend to disagree about government activity in a narrower range than between communitarian-individualist extremes. Such moderation may be what was captured in the grid results (3.2) where nearly half (40%) of participants reported middle values of 'Slightly Disagree' or 'Slightly Agree' for each of the six scale items. As such, replacing questions about government interference with other questions designed to appeal to individualist and communitarian Canadians could provide more meaningful results for group scale items in Canada.

5.4.3 Basic Knowledge

One limitation of the basic knowledge scale is that responses were only acquired for nuclear energy. To be fair, this study was intended to focus on nuclear energy specifically. However, additional knowledge questions would have provided a point of comparison. Without basic knowledge questions for other technologies, the only conclusion that can be drawn from basic knowledge results is that it does reduce risk overestimates towards nuclear specifically.

A second limitation is the reliability of Q2 which asks "True or False: There have been no nuclear accidents with environmental or health consequences in over 40 years of operations in Canada." This question is problematic in two ways. First, it did not specifically state nuclear *energy*. Since nuclear could refer to nuclear research reactors, nuclear medicine, nuclear waste, etc., clarifying nuclear energy would have improved the reliability of this question. Second, replacing "in over 40 years

of operation" with "in the past 40 years of operation" would have ruled out the possibility that some individuals with advanced nuclear energy knowledge would be correct in answering False. They would be correct because of a partial meltdown at the NRX reactor in 1952 and fire accident at the NRU reactor in 1958, both of which likely had some degree of environmental or health consequence. While neither of these problems was considered limiting enough to remove the question from analysis, carelessly constructing a knowledge-based question challenges the reliability of results for this question.

Finally, it is not clear how to methodologically turn PIT into a testable hypothesis because it is unclear how to measure cognitive bias when participants are assessing information. The present study opted to use basic knowledge as a measure. At minimum, this approach meant that participants with basic knowledge were not irrational precisely because their risk perceptions were consistent with those produced from experts who presumably arrived at their risk perceptions free from bias. Though the common denominator is 'knowledge', the inference that both are free from cognitive bias requires granting some logical flexibility. Whether respondents with higher basic knowledge are parroting risk beliefs or whether respondents with higher basic knowledge comprehend the evidence without bias like experts remains unclear. Therefore, developing a valid measurement to turn PIT into a testable hypothesis would allow for improved collection of evidence to test its claims.

CONCLUSION

6.1 STUDY SUMMARY

This thesis aimed to understand how and why individuals mistake low-risk technology as high-risk. While it is true that individuals accept expert risk precautions most of the time, in a slim number of cases individuals form their own assessments independent from experts. Two theoretical explanations for these infrequent cleavages are, first, PIT which asserts that bias and emotions cause individuals to arrive at inaccurate assessments of risk; and second, CCT which asserts that individuals are motivated to perceive risk along cultural lines. The present thesis turned these two claims into testable hypotheses to answer two research questions. One research question investigated the extent to which public risk perceptions are a function of pre-existing cultural values. Another more specific research question examined whether cultural values or public irrationality is a stronger predictor of misfearing in the context of nuclear energy.

Arguments for motivated reasoning and pre-existing values influencing technological risk perceptions are compelling. The idea that risk assessments are motivated by partisan rather than accuracy goals explains how and why risk assessments are biased by worldviews. Yet more than mere conjecture, results from the present survey study provide some evidence that cultural values do indeed affect risk perceptions across cultural lines. Just as sports fans and political party loyalists are predictably biased in their interpretations of information, so too are individualists who perceive heightened risk towards vaccines, and egalitarians who perceive heightened risk towards both GMOs and nuclear energy. These cultural value and risk perception relationships were predicted, are consistent with cultural theory, and are consistent with CCT research.

Caution must be taken before overstating the significance of cultural values affecting risk perceptions. The *expected* results were also mixed with two *unexpected* yet statistically significant relationships between cultural values and heightened risk perceptions. Results that communitarians misfear homeopathic medicine and hierarchicals misfear vaccines are puzzling because these relationships were not predicted, are not consistent with cultural theory, and are not consistent with CCT research. However, since this survey study is only the second cross-Canada study to use the CCT worldview scale and the first to examine homeopathic medicine and vaccines, it is unclear whether

such unexpected results were due to an error in the sample or constitute a new finding in the Canadian context. More research is needed with cultural values and risk perceptions in Canada to verify these findings for communitarians and hierarchicals.

In the context of nuclear energy, results in the present study found that grid values (egalitarian-hierarchical) were statistically significant predictors of nuclear risk perceptions whereas group values (individualist-communitarian) were not. Yet the predictive strength of grid values relative to basic knowledge was not as strong. Moreover, when an interaction between basic knowledge and egalitarian values was analyzed, basic knowledge became an even stronger predictor of nuclear energy risk perceptions. Such results support PIT, which claims that citizens who mistake low-risk technology as high-risk do so because they fail to assess risk methodically and rigorously like experts. The theory in conjunction with the findings in this study supports the conjecture that public irrationality significantly affects nuclear energy risk perceptions.

What is unclear is how public irrationality strongly affects nuclear energy risk. The effort undertaken in the present study was to turn PIT into a testable hypothesis by assessing basic knowledge. Basic facts were used as a proxy for irrationality because it is unknown to the researcher how else one might measure irrationality. However, knowing basic facts about nuclear energy is not the best measure of irrationality because knowing facts is dissimilar from the process experts undergo when formulating their assessments. As such, basic knowledge is clearly not an adequate substitute for testing irrationality. Yet if the definition of rationality is conforming one's beliefs with reasons to believe, then some individuals may be motivated to conform their beliefs with goals other than accuracy (see section 2.6). Thus, it is perfectly rational for individuals to misfear nuclear energy (their beliefs) if their trusted sources of information purport to have facts reinforcing claims that nuclear is dangerous (their reasons to believe). Of course that is not what PIT argues, arguing instead that citizens' views are rational when aligned with expert's accurate views, which makes defining and testing cases of irrationality rather puzzling.

The main problem with testing basic knowledge is that it is unclear how simply knowing basic facts causes individuals to assess nuclear risk like experts. It may be that individuals who accept expert facts about nuclear energy do so because they also accept expert views of virtually all matters of risk. Or equally plausible is that knowing facts which indicate nuclear is not dangerous directly contradicts any belief that nuclear energy is unsafe. Thus, while evidence suggests that even simple basic

knowledge of nuclear energy reduces inaccurate overestimates of nuclear risk, it is not clear how individuals with increased basic knowledge arrive at lower risk perceptions. More research is needed with public irrationality to improve its testability for empirical study and more research is needed into how basic knowledge appears to bridge the gulf between public and expert views on matters of risk.

6.2 POLICY RECOMMENDATIONS

The basic knowledge and cultural value results gathered in this study offer three insights into why most Canadians perceive nuclear energy as dangerous. First, basic knowledge results suggest that increasing nuclear energy knowledge decreases nuclear energy misfearing. The present study has shown that the kind of knowledge required to eliminate nuclear misfearing is remarkably basic. As such, it may be the case that most Canadians perceive nuclear energy as dangerous because most do not comprehend basic facts about nuclear energy. Second, egalitarian values influenced individuals in the study sample to perceive nuclear as high risk. If egalitarian values resonate as strongly with Canadians as they do with participants in the present study, then egalitarian values may also be responsible for most Canadians perceiving nuclear energy as dangerous. Third, those with progressive political views also appear to misfear nuclear energy. Thus, public ignorance about nuclear energy, strong adherence to egalitarian values, and being politically progressive may be three factors driving Canadians to fear nuclear energy. From these observations, two policy recommendations emerge.

6.2.1 Let the global nuclear renaissance pass Canada

Regardless of the aspirational technological developments of nuclear energy (such as small modular reactors) any Canadian governments contemplating nuclear energy as part of an energy mix will face difficulties developing nuclear as part of their energy mix. Despite an upward trend in new builds around the world, a nuclear renaissance appears unlikely in Canada because many Canadians perceive nuclear energy as a high-risk technology. Those who are politically progressive, who hold egalitarian values, and to a lesser extent females are likely to hold opinions that nuclear energy is a dangerous, high risk prospect. Importantly, these factors influence the opinions of significant numbers of Canadians, not merely fringe groups, which makes the prospects for nuclear energy in Canada bleak. If the bottom line is that no nuclear agenda in Canada will be effective unless the public is satisfied on matters of safety, then the prospects for domestic nuclear energy development are very low.

In a democracy such as Canada, public consultation is necessary. Despite the fact that strong negative perceptions of risk towards nuclear energy are inconsistent with facts about consequences to human health or the environment, the public continues to appear unconvinced by expert assurance of safety. And in a democracy, the perceptions of the many (the public) often outweigh the conclusions of the few (experts). Public perceptions may not be determinative, but they slow decision making and challenge governments to devise ways of consulting that are not ultimately prejudicial to their energy goals. Governments would be wise to observe the public consultation experiences in Saskatchewan which demonstrated how public consultation can ultimately derail a nuclear agenda.

Finally, nuclear energy may be too controversial for any government wishing to remain popular among the public. Citizens who oppose nuclear energy tend to be much more outspoken and engaged on nuclear energy issues than those who support it. Despite potential to gain support as a low carbon emitting energy source in a post Paris Agreement political world attuned to emissions outputs, nuclear energy simply lacks the kind of enthusiasm that renewable energy such as solar and wind have. Oddly enough, progressives and egalitarians are likely the same individuals who are enthusiastic for renewables yet fear nuclear. Therefore, given the lack of a public appetite for nuclear energy in Canada, funding and support for future energy mixes appear better spent fueling the growth of renewable energy and not nuclear.

6.2.2 Increase education and improve communication

If the bottom line is that no nuclear agenda in Canada will be effective unless the public is satisfied on matters of safety, then confronting the problem of nuclear energy misfearing is necessary for any government wishing to develop nuclear energy. To counteract overestimates of nuclear energy risk, education regarding nuclear energy specifically appears to be an effective policy instrument. Education is a tool that can increase knowledge about nuclear energy, which according to the results in the present study is important because basic knowledge ameliorates overestimates of nuclear energy risk. Even simple increases in what citizens know about nuclear energy are likely to have a significant effect on clearing away mistaken beliefs which drive fears towards nuclear.

This thesis has shown, however, that education by itself may not be effective. After examining the interaction between egalitarian values and basic knowledge, it was observed that egalitarians continue to perceive heightened risk towards nuclear energy even if their basic knowledge increases. This means that simply presenting facts about the safety of nuclear may be ineffective at convincing

egalitarians that nuclear energy is not dangerous because some individuals may choose to retain facts only if those facts reflect or reinforce pre-existing worldviews. As a result, efforts to educate the public on nuclear energy may fail to resonate with those individuals whose egalitarian values bias interpretations of nuclear energy facts.

A more effective way of increasing the transmission of nuclear energy facts is to improve the way in which risk is communicated. One way to increase the effectiveness of educating the public about nuclear energy could be achieved by reducing cultural bias. As cultural theory suggests, egalitarians are not automatically swayed by expert opinion, nor are they anti-science as indicated by their risk perceptions towards vaccines and homeopathic medicine. Instead, egalitarians are receptive to trusted non-expert opinion. To address prohibitive egalitarian values which interfere with the transmission of nuclear energy facts, relying on trusted non-expert spokespersons could help with increasing the effectiveness of education efforts. For example, trusted public figures like Bill Gates, James Hanson, and Stewart Brand are more likely to change egalitarian attitudes towards nuclear than more official sources that simply present facts. The key point for this particular strategy is that the spokesperson is both trusted by egalitarians and perceives nuclear energy risk consistent with evidence from experts.

The above technique, using spokespersons to infuse cultural values with education, is only one of many techniques which could help improve communicating risk when bias clouds assessments. Other communication techniques, such as framing information designed to resonate with individuals whose values predispose them to mistake low-risk technology as high-risk, could also work on cases in which cultural values cause individuals to misfear. Applying cultural theory would aid with improving transmission of facts on controversial issues where culture biases interpretations of facts. For example, cultural theory suggests individualists trust their own judgment. Framing information about vaccines as a self-defence tool against disease, not as a government sponsored program, could change the way in which individualists think about vaccines and their attendant risks. Furthermore, successful strategies could be adopted and applied to other kinds of factors known to bias fair assessments, such as gender and political views. Therefore, investing in education and improving communication techniques could help ensure not just that a nuclear agenda becomes a viable option by helping the public to understand the safety of nuclear, but also that governments will develop strategies to better manage other topics of controversy.

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APPENDICES

APPENDIX A. RISK SCALES

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe nuclear energy poses to:

	1 No Risk At All	2 Very Slight Risk	3 Slight Risk	4 Moderate Risk	5 High Risk	6 Very High Risk	7 Extreme Risk
Society	○	○	○	○	○	○	○
The economy	○	○	○	○	○	○	○
Human health	○	○	○	○	○	○	○
The environment	○	○	○	○	○	○	○

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé à l'énergie nucléaire selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

	1 Aucun risque	2 Très faible risque	3 Faible risque	4 Risque modéré	5 Risque élevé	6 Un risque très élevé	7 Un risque extrême
La société	○	○	○	○	○	○	○
L'économie	○	○	○	○	○	○	○
La santé humaine	○	○	○	○	○	○	○
L'environnement	○	○	○	○	○	○	○

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe homeopathic (alternative) medicine poses to:

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé à la médecine homéopathique (ou alternative) selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe vaccines pose to:

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé aux vaccins selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe genetically modified organisms (GMOs) pose to:

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé aux organismes génétiquement modifiés (OGM) selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

APPENDIX B. CULTURAL COGNITION WORLDVIEW SCALE (MODIFIED SHORT FORM)

A. *Group* or *Individualism-Communitarianism* (reverse code "C" items)

People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

1. *IINTRSTS. The government interferes far too much in our everyday lives.*
2. *CHARM. Sometimes government needs to make laws that keep people from hurting themselves.*
3. *IPROTECT. It's not the government's business to try to protect people from themselves.*
4. *IPRIVACY. The government should stop telling people how to live their lives.*
5. *CPROTECT. The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.*
6. *CLIMCHOI. Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.*

Les gens dansnotresociété ne sont pas souventd'accord sur si on devraitintervenirdans la prise de décision de quelqu'und'autre. Indiquezvotreniveaud'accord avec chaquedéclaration. [Tout à fait endésaccord, Modérémentendésaccord, Plutôtendésaccord, Plutôtd'accord, Modérément D'accord, Tout à fait d'accord]

1. *IINTRSTS. Le gouvernements'ingère trop dansnos vies quotidiennes.*
2. *CHARM. Le gouvernementdoitparfoislégiférer pour empêcher les gens de se blesser.*
3. *IPROTECT. Le gouvernementn'a pas le droit d'essayer de protéger les gens contreeux-mêmes.*
4. *IPRIVACY. Le gouvernementdoitcesser de dire aux gens comment ilsdevraient vivre.*
5. *CPROTECT. Le gouvernementdevrait faire davantage pour faire advancer les objectifs de la société, mêmesicelasignifie limiter la liberté et les choix des individus.*
6. *CLIMCHOI. Le gouvernementdevrait imposer des limites sur les choix que les individuspeuventavoir de sortequ'ilsn'interfère pas avec ce qui estbien pour la société.*

B. *Grid* or *Hierarchy-Egalitarianism* (reverse code "E" items)

People in our society often disagree about issues of equality and discrimination. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

1. *HEQUAL. We have gone too far in pushing equal rights in this country.*
2. *EWEALTH. Our society would be better off if the distribution of wealth was more equal.*
3. *ERADEQ. We need to dramatically reduce inequalities between the rich and the poor, whites and visible minorities[9] [people of color], and men and women.*
4. *EDISCRIM. Discrimination against minorities is still a very serious problem in our society.*
5. *HREVDIS2. It seems like ethnic minorities [blacks], women, homosexuals and other groups don't want equal rights, they want special rights just for them.*
6. *HFEMININ. Society as a whole has become too soft and feminine*

Les gens dansnotresociété ne sont pas souventd'accord sur les problèmesd'égalité et de discrimination. Indiquezvotreniveaud'accord avec chaquedéclaration. [Tout à fait endésaccord, Modérémentendésaccord, Plutôtendésaccord, Plutôtd'accord, Modérément D'accord, Tout à fait d'accord]

1. *HEQUAL. Nous sommesallés trop loin dans la promotion l'égalité des droitsdansce pays.*
2. *EWEALTH. Notre sociétéseraitmeilleuresi la répartition de la richessea été plus égale.*
3. *ERADEQ. Nous avonsbesoin de réduireconsidérablement les inégalités entre les riches et les pauvres, les blancs et les minoritésvisibles, et les hommes et les femmes.*
4. *EDISCRIM. La discrimination contre les minoritésvisiblesreste encore un problèmetrès gravedansnotresociété.*
5. *HREVDIS2. Il semble que les minoritésethniques, les femmes, les homosexuels et les autresgroupes ne veulent pasl'égalité des droits, maisveulentplutôt des droits spéciauxjuste pour eux.*
6. *HFEMININ. La société,dans son ensemble, estdevenue trop douce et féminine*

[9] Underlined text denotes language used in this study's scale items, subsequent square brackets denotes language used in the CCT short-form worldview scale.

APPENDIX C. BASIC NUCLEAR ENERGY KNOWLEDGE QUESTIONS

True or false: There have been no nuclear accidents with environmental or health consequences in over 40 years of operations in Canada.

- ❍ **True**
- ❍ False

Vraiou faux: Il n'y a pas eud'accidents nucléaires avec des conséquences environnementales ou de santédepuis 40 ans au Canada.

- ❍ **Vrai**
- ❍ Faux

True or false: Nuclear power provided electricity in Canada last year.

- ❍ **True**
- ❍ False

Vrai ou faux: L'énergie nucléaire a fourni de l'électricité pour le Canada l'année dernière.

- ❍ **Vrai**
- ❍ Faux

True or false: Potentially harmful radiation is a man-made substance that only comes from sources such as nuclear power facilities and X-ray machines.

- ❍ True
- ❍ **False**

Vrai ou faux : Le rayonnement potentiellement nocif est provoqué par l'homme et ne vient que des sources telles que les centrales nucléaires et les appareils à rayons X.

- ❍ Vrai
- ❍ **Faux**

APPENDIX D. DEMOGRAPHICS

QRegion In what Canadian province or territory do you currently reside?

- ❍ Alberta
- ❍ British Columbia
- ❍ Manitoba
- ❍ New Brunswick
- ❍ Newfoundland & Labrador
- ❍ Nova Scotia
- ❍ Northwest Territories
- ❍ Nunavut
- ❍ Ontario
- ❍ Prince Edward Island
- ❍ Quebec
- ❍ Saskatchewan
- ❍ Yukon

QRégion Dans quelle province ou territoire canadienne habitez-vous ?

- ❍ Alberta
- ❍ Colombie-Britannique
- ❍ Île-du-Prince-Édouard
- ❍ Manitoba
- ❍ Nouveau-Brunswick
- ❍ Nouvelle-Écosse
- ❍ Nunavut
- ❍ Ontario
- ❍ Québec
- ❍ Saskatchewan
- ❍ Terre-Neuve-et-Labrador
- ❍ Territoires du Nord-Ouest
- ❍ Yukon

QAGE What is your age?

- ❍ 18-24 years old
- ❍ 25-34 years old
- ❍ 35-44 years old
- ❍ 45-54 years old
- ❍ 55-64 years old
- ❍ 65 years or older

QÂGE Quel âge avez-vous ?

- ❍ 18 à 24 ans
- ❍ 25 à 34 ans
- ❍ 35 à 44 ans
- ❍ 45 à 54 ans
- ❍ 55 à 64 ans
- ❍ 65 ans ou plus âgé(e)

QINC What was your total income in 2014?

- ❍ Less than $25,000
- ❍ $25,000 to less than $50,000
- ❍ $50,000 to less than $75,000
- ❍ $75,000 to less than $100,000
- ❍ $100,000 to less than $125,000
- ❍ $125,000 to less than $150,000
- ❍ $150,000 to less than $175,000
- ❍ $175,000 or more
- ❍ Prefer not to say

QINC Qu'est-ce qui était votre revenu total pour l'année 2014 ?

- ❍ Moins de 25 000 $
- ❍ 25 000 $ à moins de 50 000 $
- ❍ 50 000 $ à moins de 75 000 $
- ❍ 75 000 $ à moins de 100 000 $
- ❍ 100 000 $ à moins de 125 000 $
- ❍ 125 000 $ à moins de 150 000 $
- ❍ 150 000 $ à moins de 175 000 $
- ❍ 175 000 $ ou plus
- ❍ Je préfère ne pas dire

QEDU What is the highest degree or level of school you have completed? If currently enrolled, highest degree received.

- ❍ Some high school, no diploma
- ❍ High school graduate, diploma or the equivalent (for example: GED)
- ❍ Some college credit, no degree
- ❍ Trade/technical/vocational training
- ❍ Associate degree
- ❍ Bachelor's degree
- ❍ Master's degree
- ❍ Professional degree
- ❍ Doctorate degree

QÉDU Quel est le plus haut niveau de formation scolaire que vous avez complétée ?

- ❍ J'ai assisté au secondaire, mais je n'ai pas obtenu mon diplôme d'études secondaires
- ❍ J'ai obtenu mon diplôme d'études secondaires ou j'ai passé l'examen du GED (ou quelque chose d'équivalent)
- ❍ J'ai assisté à l'université, mais je ne détiens pas un diplôme universitaire
- ❍ J'ai reçu la formation professionnelle
- ❍ J'ai obtenu un diplôme d'associé en quelque chose
- ❍ J'ai obtenu un baccalauréat
- ❍ J'ai obtenu une maîtrise
- ❍ J'ai obtenu un diplôme professionnel
- ❍ J'ai obtenu un doctorat

QGEN Please specify your gender.

- ❍ Male
- ❍ Female
- ❍ Other

QGEN Veuillez indiquer votre sexe.

- ❍ Masculin
- ❍ Féminin
- ❍ Autre

QELE If the Federal election were held today, which party would you vote for?

- ❍ Conservative
- ❍ Liberal
- ❍ New Democratic Party
- ❍ Green
- ❍ Other
- ❍ Don't know / Prefer not to say

QÉLE Si les élections fédérales avaient lieu aujourd'hui, quel parti politique voteriez-vous ?

- ❍ Parti conservateur du Canada
- ❍ Parti libéral du Canada
- ❍ Nouveau Parti démocratique
- ❍ Le Parti Vert du Canada
- ❍ Autre
- ❍ Je ne sais pas / Je préfère ne pas dire

APPENDIX E. SURVEY RECRUITMENT EMAIL

Dear member of the Probit research panel,

We are inviting you to participate in a study about how Canadians view scientific technologies. Your responses will help inform research that looks at ways to improve communicating science with citizens.

Please rest assured that this is voluntary and your answers are completely confidential (this means that no individual will be associated with the survey's results - rather, all of the results will be combined to protect the confidentiality of each respondent).

The researchers at the University of Saskatchewan would like to thank you for your interest in their research and your participation.

Probit, Inc.

Madame, Monsieur,

Nous vous invitons de participer à une étude à propos de comment les Canadiens comprennent la technologie scientifique. Vos réponses nous aideront à rechercher de meilleurs procédés de communiquer les sciences avec les citoyens

Soyez assuré(e) que ceci n'est pas obligatoire et que vos réponses seront complètement confidentielles (c'est-à-dire aucun individu ne sera associé aux résultats du sondage – tous les résultats seront plutôt combinés afin de protéger la confidentialité de chaque participant).

Les chercheurs à l'Université de Saskatchewan voudrions vous remercier de leur avoir montré votre intérêt pour leur recherche et d'avoir participé à l'étude.

Veuillez recevoir, Madame, Monsieur, nos salutations distinguées.

Probit, Inc.

APPENDIX F. SURVEY (WAVE 1)

Consent Form

We are researchers at the Johnson-Shoyama Graduate School of Public Policy, located at the University of Saskatchewan campus, who have an interest in science and innovation policy. The study in which you are invited to participate is identifying and better understanding how Canadians view scientific technologies. Your responses will help inform research that looks at ways to improve communicating science with citizens.

The study will involve completion of two online questionnaires, set one week apart. In this part (1 of 2) you will be asked for your opinions on social issues and technologies, and will be asked to answer demographic questions. One week from now, the next part (2 of 2) will ask you to read and respond to a brief article about a scientific technology and answer some questions. These questionnaires should each take approximately 10 minutes, 20 minutes total. Those who complete both tasks will have a chance to win one of four $50 gift cards. Upon completion of the second part, participants will receive a debriefing form describing what the study is about.

Participation in this survey is voluntary and you can decide not to participate at any time and without penalty of any sort by closing your browser. Survey responses will remain anonymous. Since the survey responses will be anonymous, once it is submitted it cannot be removed. There are no known or anticipated risks associated to participation in this study; however, as with any online related activity there is always some risk of a breach of confidentiality. Your IP address will be automatically collected by our survey software, but will be removed from the final dataset prior to analysis.

This survey is hosted by Qualtrics, a company located in the USA and subject to US laws and whose servers are located outside of Canada. The privacy of the information you provide is subject to the laws of those other jurisdictions. By participating in this survey you acknowledge and agree that your responses will be stored and accessed outside of Canada and may or may not receive the same level of privacy protection. The privacy policy for the web survey company can be found at the following link: http://www.qualtrics.com/privacy-statement.

All information that you provide is considered completely confidential, indeed your name will not be included, or in any other way associated, with the data collected in the study. Furthermore, because the interest of this study is in the average responses of the entire group of participants, you will not be identified individually in any way in any written reports of this research. Electronic data will be stored on secure University of Saskatchewan servers and deleted after six years.

This research project has been approved by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to the Board through the Research Ethics Office ethics.office@usask.ca 306-966-2975. Out of town participants may call toll free 888-966-2975. If you have any questions regarding the study you can contact either the principal investigator Michael Atkinson michael.atkinson@usask.ca 306-966-8451 or collaborator Tyler Koebel tyk854@mail.usask.ca 403-330-6388.

By selecting 'I agree to participate', you are indicating that you understand the above conditions of participation in this study, and that by completing and submitting this questionnaire your free and informed consent is implied.

I agree to participate ○ I don't agree to participate ○

Formulaire de consentement

Nous sommes chercheurs à l'École supérieure de politique publique Johnson Shoyoma, ce qui se situe sur le campus de l'Université de Saskatchewan. Les sciences et la politique d'innovation nous passionnent. L'étude à laquelle nous vous invitons à participer concerne les meilleures méthodes d'identifier et comprendre comment les canadiens perçoivent les technologies scientifiques. Vos réponses nous aideront à rechercher de meilleurs procédés de communiquer les sciences avec les citoyens.

L'étude exige la complétion de deux questionnaires en ligne qui auront lieu à une semaine d'intervalle. Dans cette partie (1 de 2), vous répondrez aux questions démographiques et aux questions concernant la technologie et des problèmes sociaux. Une semaine d'aujourd'hui, vous participerez à la deuxième partie (2 de 2), ce qui vous demandera de répondre à un bref article d'une technologie scientifique. Chaque questionnaire prendra environ 10 minutes pour compléter, c'est-à-dire 20 minutes au total. Ceux qui complètent les deux tâches auront la chance de gagner une carte-cadeau Visa d'une valeur totalisant 50 $. Il y aura quatre gagneurs ou gagneuses. Après avoir complété la deuxième partie, les participants recevront un rapport de suivi qui décrit l'étude.

Vous n'êtes pas obligé de participer à ce sondage, alors si vous décidez de n'y plus participer, vous pouvez, sans pénalité, fermer votre navigateur Internet. Les réponses de sondage restent anonymes, donc après les avoir soumises, vous ne pourrez pas les changer. Il n'y a aucun risque connu associé à la participation de cette étude ; néanmoins, comme toutes les activités en ligne, il y a toujours un peu de risque à l'égard de la violation de la confidentialité. Votre adresse IP sera automatiquement collectée par notre logiciel de sondage; cependant, votre adresse IP sera retirée de notre collection finale des données avant qu'on commence l'analyse.

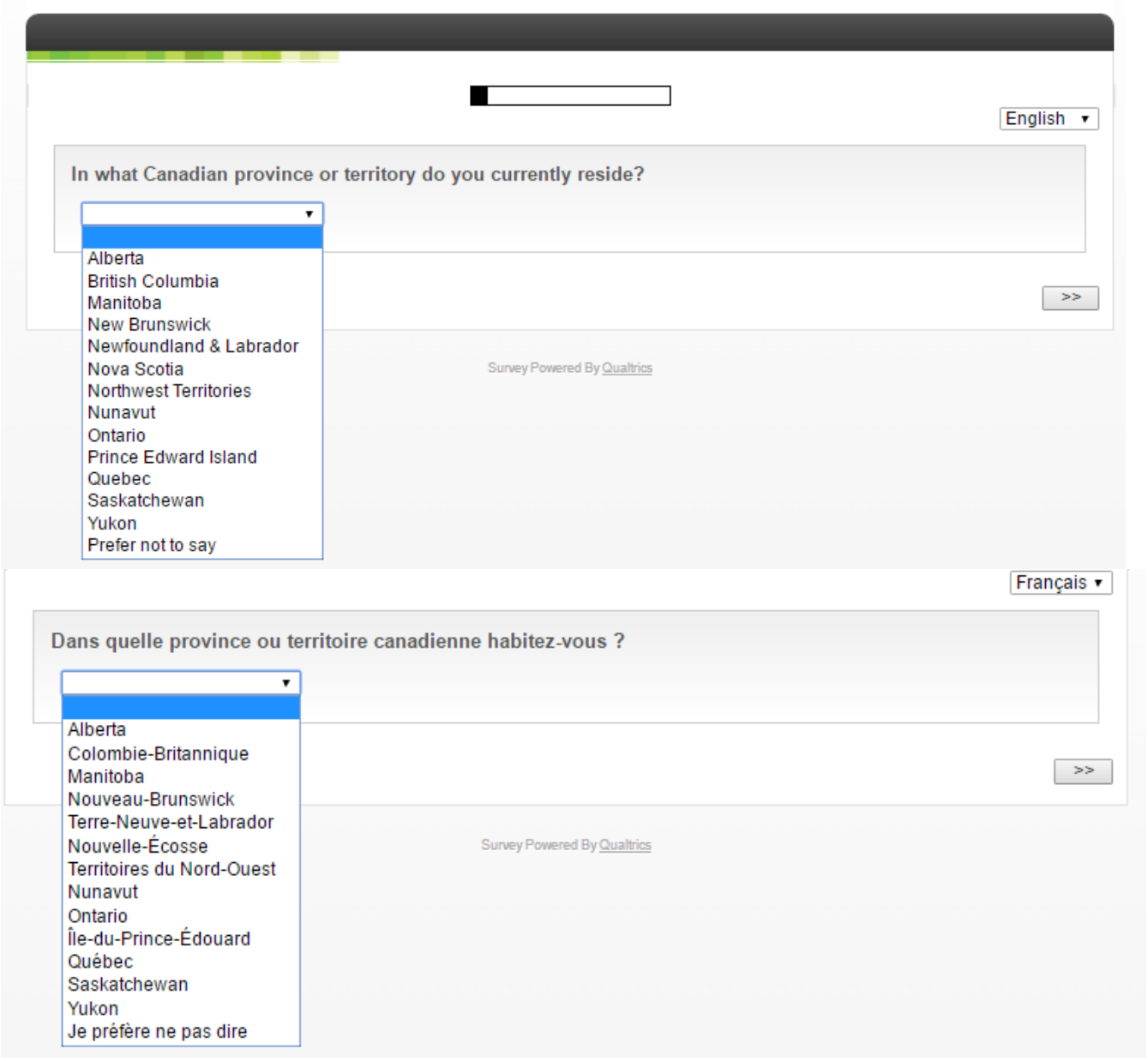
Ce sondage est hébergé par Qualtrics, ce qui est une entreprise qui se trouve aux États-Unis et qui est donc soumise à la loi américaine. Puisque ses serveurs se situent hors du Canada, l'information que vous fournissez seront soumise aux lois sur la protection de la vie privée de l'autre pays. En participant à ce sondage, vous acceptez que l'enregistrement de vos réponses et l'accès à elles auront lieu hors du Canada, et qu'il se peut qu'il y ait des différences entre les deux pays en ce qui concerne les lois sur la protection de la vie privée. La politique de respect de la vie privée de Qualtrics peut être trouvée au lien suivant : http://www.qualtrics.com/privacy-statement.

Toute l'information que vous fournissez est considérée complètement confidentielle. Votre prénom ne sera pas associé à la collection des données de cette étude. De plus, vous ne serez pas identifié(e) dans les rapports imprimés de cette étude puisque l'objectif de notre recherche est de découvrir les réponses moyennes de tous les participants. Les données électroniques seront enregistrées sur les serveurs protégés de l'Université de Saskatchewan et elles seront toutes supprimées dans six ans.

Ce projet de recherche a été approuvé par le Conseil d'éthique de la recherche comportementale de l'Université de Saskatchewan. Si vous avez des questions de vos droits comme un participant de cette étude, vous pouvez contacter le Conseil par le Bureau d'éthique de la recherche ethics.office@usask.ca 306 966-2975. Si vous êtes à l'extérieur de la ville, vous pouvez appeler ce numéro sans frais 888 966-2975. Si vous avez des questions de cette étude, vous pouvez contacter le chercheur principal Michael Atkinson michael.atkinson@usask.ca 306-966-8451 ou le collaborateur Tyler Koebel tyk854@mail.usask.ca 403 330-6388.

En sélectionnant « Je veux participer », vous nous indiquez que vous comprenez les conditions ci-dessus de la participation de cette étude. En soumettant ce questionnaire, votre consentement libre et éclairé est impliqué.

Je veux participer ○ Je ne veux pas participer ○


English
In what Canadian province or territory do you currently reside?
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland & Labrador
Nova Scotia
Northwest Territories
Nunavut
Ontario
Prince Edward Island
Quebec
Saskatchewan
Yukon
Prefer not to say
>>
Survey Powered By Qualtrics
Français
Dans quelle province ou territoire canadienne habitez-vous ?
Alberta
Colombie-Britannique
Manitoba
Nouveau-Brunswick
Terre-Neuve-et-Labrador
Nouvelle-Écosse
Territoires du Nord-Ouest
Nunavut
Ontario
Île-du-Prince-Édouard
Québec
Saskatchewan
Yukon
Je préfère ne pas dire
>>
Survey Powered By Qualtrics

English

People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly do you agree or disagree with each of these statements?

	Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree
It's not the government's business to try to protect people from themselves.	○	○	○	○	○	○
The government should stop telling people how to live their lives.	○	○	○	○	○	○
The government interferes far too much in our everyday lives.	○	○	○	○	○	○
Sometimes government needs to make laws that keep people from hurting themselves.	○	○	○	○	○	○
The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.	○	○	○	○	○	○
Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.	○	○	○	○	○	○

>>

Français

Les gens dansnotresociété ne sont pas souventd'accord sur si on devraitintervenirdans la prise de décision de quelqu'und'autre. Indiquezvotreniveaud'accord avec chaquedéclaration.

	Tout à fait d'accord	Modérément D'accord	Plutôt D'accord	Plutôt En Désaccord	Modérément Désaccord	Tout à fait endésaccord
Le gouvernementn'a pas le droit d'essayer de protéger les gens contreeux-mêmes.	○	○	○	○	○	○
Le gouvernementdoitparfoislégiférer pour empêcher les gens de se blesser.	○	○	○	○	○	○
Le gouvernements'ingère trop dansnos vies quotidiennes.	○	○	○	○	○	○
Le gouvernementdevrait faire davantage pour faire advancer les objectifs de la société, mêmesicelasignifie limiter la liberté et les choix des individus.	○	○	○	○	○	○
Le gouvernementdoitcesser de dire aux gens comment ilsdevraient vivre.	○	○	○	○	○	○
Le gouvernementdevrait imposer des limites sur les choix que les individuspeuventavoir de sortequ'ilsn'interfère pas avec ce qui estbien pour la société.	○	○	○	○	○	○

>>

English ▾

People in our society often disagree about issues of equality and discrimination. How strongly do you agree or disagree with each of these statements?

	Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree
Society as a whole has become too soft and feminine.	○	○	○	○	○	○
We need to dramatically reduce inequalities between the rich and the poor, whites and visible minorities, and men and women.	○	○	○	○	○	○
It seems like ethnic minorities, women, homosexuals, and other groups don't want equal rights, they want special rights just for them.	○	○	○	○	○	○
Our society would be better off if the distribution of wealth was more equal.	○	○	○	○	○	○
Discrimination against minorities is still a very serious problem in our society.	○	○	○	○	○	○
We have gone too far in pushing equal rights in this country.	○	○	○	○	○	○

>>

Français ▾

Les gens dansnotresociété ne sont pas souventd'accord sur les problèmesd'égalité et de discrimination. Indiquezvotreniveaud'accord avec chaquedéclaration.

	Tout à fait d'accord	Modérément D'accord	Plutôt D'accord	Plutôt En Désaccord	Modérément Désaccord	Tout à fait endésaccord
Nous sommesallés trop loin dans la promotion l'égalité des droitsdansce pays.	○	○	○	○	○	○
La société,dans son ensemble, estdevenue trop douce et féminine.	○	○	○	○	○	○
La discrimination contre les minoritésvisiblesreste encore un problèmetrès gravedansnotresociété.	○	○	○	○	○	○
Il semble que les minoritésethniques, les femmes, les homosexuels et les autresgroupes ne veulent pasl'égalité des droits, maisveulentplutôt des droits spéciauxjuste pour eux.	○	○	○	○	○	○
Notre sociétéseraitmeilleuresi la répartition de la richessea été plus égale.	○	○	○	○	○	○
Nous avonsbesoin de réduireconsidérablement les inégalités entre les riches et les pauvres, les blancs et les minoritésvisibles, et les hommes et les femmes.	○	○	○	○	○	○

>>

English

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe vaccines pose to:

	1 No Risk At All	2 Very Slight Risk	3 Slight Risk	4 Moderate Risk	5 High Risk	6 Very High Risk	7 Extreme Risk
Society	○	○	○	○	○	○	○
The environment	○	○	○	○	○	○	○
Human health	○	○	○	○	○	○	○
The economy	○	○	○	○	○	○	○

>>

Français

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé aux vaccins selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

	1 Aucun risque	2 Très faible isque	3 Faible risque	4 Risque modéré	5 Risque élevé	6 Un risque très élevé	7 Un risque extrême
La société	○	○	○	○	○	○	○
La santé humaine	○	○	○	○	○	○	○
L'environnement	○	○	○	○	○	○	○
L'économie	○	○	○	○	○	○	○

>>

English

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe homeopathic (alternative) medicine poses to:

	1 No Risk At All	2 Very Slight Risk	3 Slight Risk	4 Moderate Risk	5 High Risk	6 Very High Risk	7 Extreme Risk
Society							
Human health							
The economy							
The environment							

>>

Français

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé à la médecine homéopathique (ou alternative) selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

	1 Aucun risque	2 Très faible risque	3 Faible risque	4 Risque modéré	5 Risque élevé	6 Un risque très élevé	7 Un risque extrême
L'environnement							
L'économie							
La santé humaine							
La société							

>>

English

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe genetically modified organisms (GMOs) pose to:

	1 No Risk At All	2 Very Slight Risk	3 Slight Risk	4 Moderate Risk	5 High Risk	6 Very High Risk	7 Extreme Risk
The environment							
Human health							
The economy							
Society							

>>

Français

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé aux organismes génétiquement modifiés (OGM) selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

	1 Aucun risque	2 Très faible risque	3 Faible risque	4 Risque modéré	5 Risque élevé	6 Un risque très élevé	7 Un risque extrême
L'économie							
La santé humaine							
L'environnement							
La société							

>>

English

People in our society often disagree about issues of technological risk. Using a scale of 1 (no risk at all) to 7 (extreme risk), please rate how much risk you believe nuclear energy poses to:

	1 No Risk At All	2 Very Slight Risk	3 Slight Risk	4 Moderate Risk	5 High Risk	6 Very High Risk	7 Extreme Risk
The environment							
Human health							
Society							
The economy							

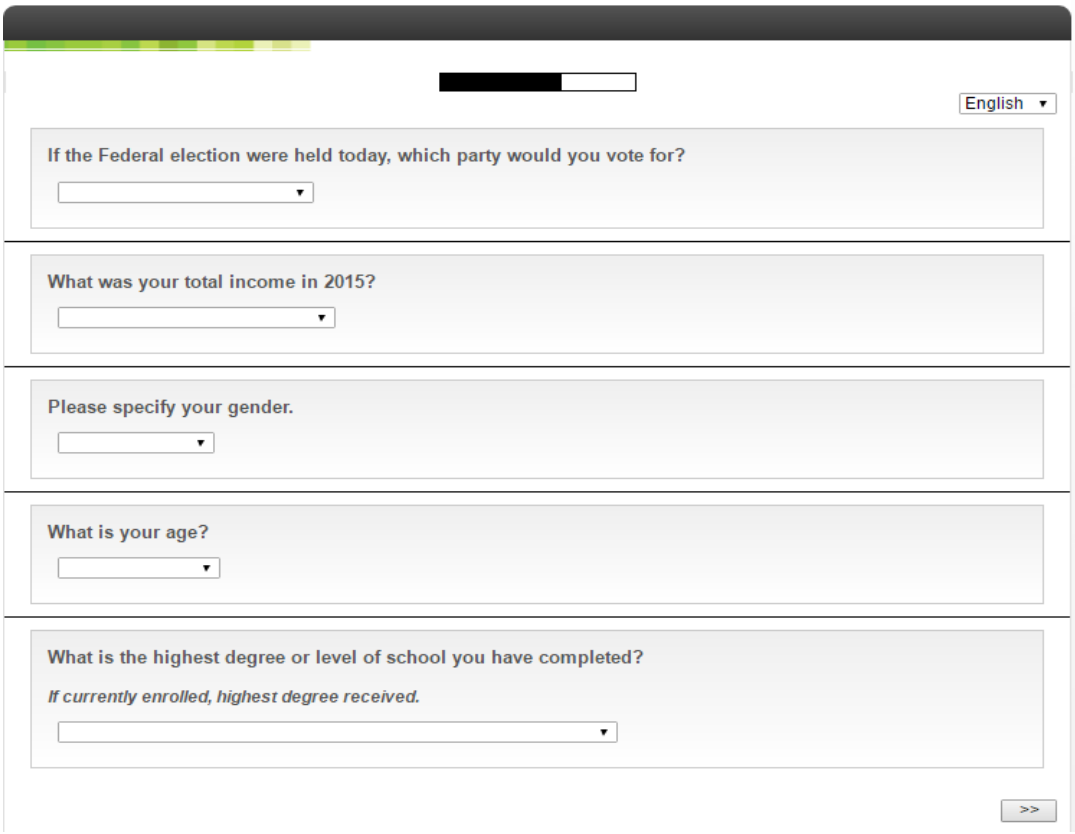
>>

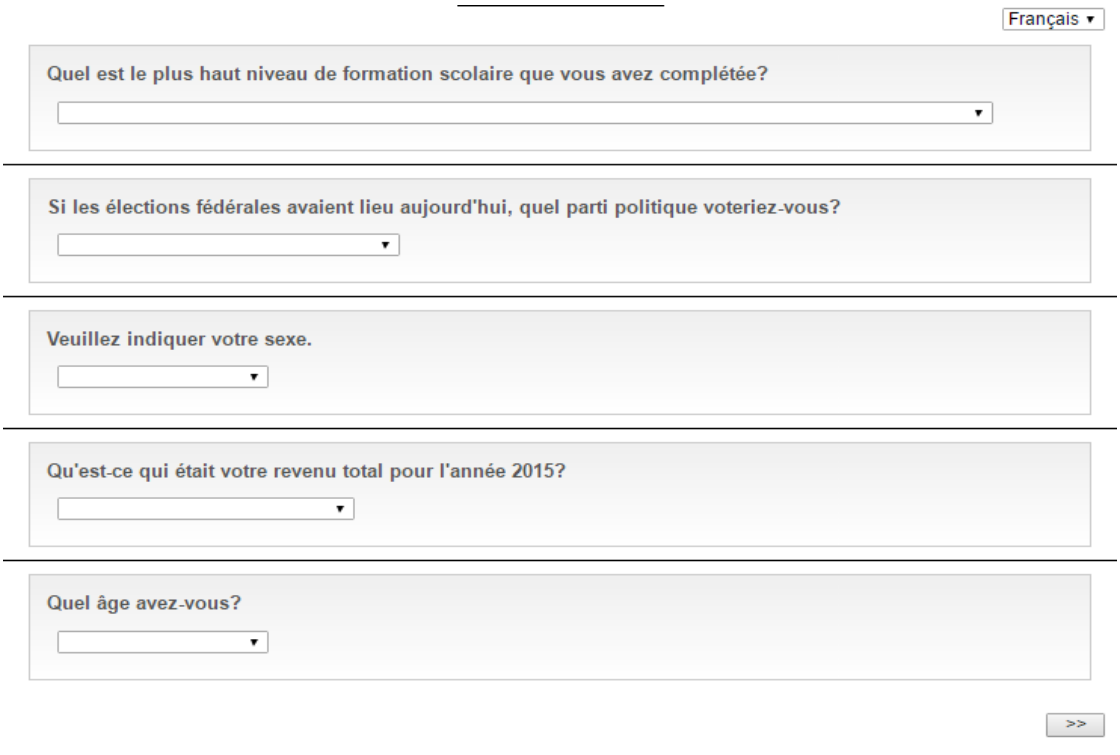
Français

Souvent, les gens dans notre société sont en désaccord sur le sujet du risque technologique. Veuillez indiquer le niveau de risque associé à l'énergie nucléaire selon une échelle de 1 (aucun risque) à 7 (un risque extrême):

	1 Aucun risque	2 Très faible risque	3 Faible risque	4 Risque modéré	5 Risque élevé	6 Un risque très élevé	7 Un risque extrême
L'économie							
La société							
La santé humaine							
L'environnement							

>>


English
If the Federal election were held today, which party would you vote for?
What was your total income in 2015?
Please specify your gender.
What is your age?
What is the highest degree or level of school you have completed?
If currently enrolled, highest degree received.
>>


Français
Quel est le plus haut niveau de formation scolaire que vous avez complétée?
Si les élections fédérales avaient lieu aujourd'hui, quel parti politique voteriez-vous?
Veuillez indiquer votre sexe.
Qu'est-ce qui était votre revenu total pour l'année 2015?
Quel âge avez-vous?
>>

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Debriefing Form
Thanks for taking the time to participate in part 1 of 2 of our study! Research like this depends on participation by individuals like yourself. We are very grateful for your help and will contact you again in approximately one week for part 2 of our study.

If you have any questions about this study or if you would like to receive a summary of the results when they become available, please contact either the principal investigator Michael Atkinson michael.atkinson@usask.ca 306-966-8451 or collaborator Tyler Koebel tyk854@mail.usask.ca 403-330-6388.

We would like to remind you that all information that you have provided is considered confidential, your name will not be included or in any other way associated with the data collected in the study. Furthermore, because the interest of this study is in the average responses of the entire group of participants, you will not be identified individually in any way in any written reports of this research. Electronic data will be stored on secure University of Saskatchewan servers and deleted after six years.

This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca 306-966-2975. Out of town participants may call toll free 888-966-2975.

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Rapport de suivi
Merci d'avoir participé à la première de deux parties de notre étude! La recherche comme celle-ci dépend de la participation des individus comme vous. Nous sommes reconnaissants d'avoir reçu votre aide. Nous vous contacterons encore une semaine d'aujourd'hui pour la deuxième partie de notre étude.

Si vous avez des questions concernant cette étude ou si vous voudriez recevoir un résumé des résultats quand ils deviennent disponibles, veuillez contacter le chercheur principal Michael Atkinson michael.atkinson@usask.ca 306 966-8451 ou le collaborateur Tyler Koebel tyk854@mail.usask.ca 403 330-6388.

Nous voudrions vous rappeler que toute l'information que vous nous avez fournie est considérée confidentielle. Votre prénom ne sera pas associé à la collection finale des données de cette étude. De plus, vous ne serez pas identifié(e) dans les rapports imprimés de cette étude puisque l'objectif de notre recherche est de découvrir les réponses moyennes de tous les participants. Les données électroniques seront enregistrées sur les serveurs protégés de l'Université de Saskatchewan et elles seront toutes supprimées dans six ans.

Ce projet de recherche a été approuvé par le Conseil d'éthique de la recherche comportementale de l'Université de Saskatchewan. Si vous avez des questions de vos droits comme un participant de cette étude, vous pouvez contacter le Conseil par le Bureau d'éthique de la recherche ethics.office@usask.ca 306 966-2975. Si vous êtes à l'extérieur de la ville, vous pouvez appeler ce numéro sans frais 888 966-2975. Si vous avez des questions de cette étude, vous pouvez contacter le chercheur principal Michael Atkinson michael.atkinson@usask.ca 306-966-8451 ou le collaborateur Tyler Koebel tyk854@mail.usask.ca 403 330-6388.

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