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THE STRAIN OF THE HERD: RISK PERCEPTIONS, POLICY PREFERENCES, AND PARENTAL DECISION-MAKING FOR CHILDHOOD VACCINATION

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THE STRAIN OF THE HERD: RISK PERCEPTIONS, POLICY PREFERENCES, AND PARENTAL DECISION-MAKING FOR CHILDHOOD VACCINATION

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF POLITICAL SCIENCE

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Abstract

As the vaccine controversy continues to deepen in the United States, this dissertation research addresses how we can better understand and deal with this issue in respect to public policy in general and public health policy in particular. Based upon original data from a nationwide Internet survey of 1,213 adults conducted in 2010, this study scrutinizes ways in which individuals' values and beliefs, notably cultural predispositions, shape their differing opinions on the benefits and risks associated with childhood vaccinations and controversial vaccination policies, including mandatory vaccinations and religious/philosophical exemptions, and key related issues of governance. This study also attempts to explain how parents' subjective expected utility of vaccinations (derived from their perceptions of vaccine benefits and risks) and their beliefs regarding current vaccine policies actually translate into their vaccination-related behaviors in regards to the immunization of their own children.

The first empirical chapter (Chapter 3) explains how individuals' grid-group cultural orientations shape their perceptions regarding vaccine benefits and risks at both the societal and individual levels. As Mary Douglas and Aaron Wildavsky's cultural theory of risk perception (Douglas and Wildavsky, 1982) claims, empirical findings derived from robust regression analysis with heteroskedasticity consistent covariance estimation of errors and Bayesian posterior simulations reveal that those with a strong hierarch orientation tend to envision greater vaccination benefits and smaller risks, while those with a strong fatalist tendency are inclined to emphasize risks and downplay benefits. Situated between hierarchs and fatalists, egalitarians are prone to perceive greater benefits and smaller risks than individualists.

Knowing that the benefits and the risks of vaccinations are understood as a sociopolitical construct and a reflection of the competing values and beliefs of different members of society (notably manifested in the form of cultural predispositions), this dissertation research proceeds to examine whether people still hold similar (value motivated, rather than factual evidence based) reasoning patterns when they are involved in policy debates on vaccination. The second empirical chapter (Chapter 4) seeks to explain how individuals' fundamental values regarding a preferred social ordering shape their opinions on controversial vaccination policies and key related issues of governance. As Aaron Wildavsky's cultural theory of policy preference formation (Wildavsky, 1987) posits, empirical findings grounded on robust regression analysis with heteroskedasticity consistent error covariance estimation and Bayesian posterior simulations show that cultural biases have a significant impact on the formation of preferences toward various vaccination policies and governance issues. Hierarchs and egalitarians are more likely to be pro-vaccination, while individualists and (especially) fatalists tend to oppose this view. Hierarchs advocate mandatory vaccination, disapprove of religious and philosophical exemptions, and believe that the government, not parents, should control childhood immunizations. By contrast, fatalists are inclined to reject mandatory vaccination policy in favor of religious and philosophical exemptions and the role of parents in determining vaccination of children. Egalitarians' pro-vaccination inclination is relatively weaker and less consistent than hierarchs', while individualists' anti-vaccination leanings are overall less robust than those of fatalists.

Government health authorities can utilize knowledge concerning the way

individuals' cultural orientations shape vaccine benefit-risk perception and policy preference to improve risk communication between the government, experts, and the lay public and to encourage "desirable" (public health enhancing) changes in the general public's attitude toward vaccine risks and related policies. However, this assertion alone does not provide much assistance in terms of practical implications as to how an actual policy outcome can be realized through changes not only in individuals' attitudes and thoughts, but also in their behaviors. This line of thought led to the third empirical chapter (Chapter 5), which essentially examines how American parents' policy related beliefs (e.g., their perceptions of vaccine benefits and risks and related policy preferences) actually translate into their behaviors regarding child vaccinations. The results of an empirical analysis using nested dichotomies logistic regression reveal that parents who perceive high levels of societal and individual benefit from vaccination, a high (very favorable) benefit-risk ratio, and low levels of individual risk are more strongly motivated to have their own child (or children) receive all recommended vaccines. In addition, parents who more strongly support mandatory vaccination policy and are not in favor of religious and philosophical exemptions and parental decision-making rights regarding children's immunizations are more strongly motivated to have their own child(ren) receive all recommended vaccines.

The most important element of these findings is that the vaccine policy debate and related vaccination behaviors are not solely based upon efficacy in reduction of disease or the resulting societal benefits and costs. Rather, it actually gains considerable momentum from the clash of worldviews. An intrinsic value dimension, notably in the form of grid-group cultural orientation, is reflected in the way this debate

and related vaccination behaviors have come to stand in for an overarching contest among competing sets of societal norms.

Chapter 1. Introduction

A recent pertussis (or whooping cough) outbreak in California raises substantial and potentially dire public health implications for the US population. As of December 31, 2010, ten infants had died in that outbreak, and 9,273 whooping cough cases were confirmed (California Department of Public Health, 2011). If estimated unconfirmed cases are also considered, this outbreak is the largest in California in the past fifty years[1] (*The New York Times*, 2010). There are a number of plausible explanations for the resurgence of whooping cough, which was previously regarded as an eradicated disease in the United States. However, most experts argue that its resurgence was a direct result of the decreasing vaccination rate and subsequently weakening "herd immunity" among some communities and ethnic groups (Baker et al., 2010; Luman et al. 2005; Smith and Stevenson, 2008; Wooten, Luman and Baker, 2007). Furthermore, experts warn that if this trend toward reduced vaccination rates continues, additional diseases once believed to have been eliminated in the U.S. will also resurface.

Vaccinations involve benefit/risk tradeoffs at both the collective, societal level and for individuals. For society as a whole, vaccines prevent the spread of infectious diseases, while at the individual level, vaccines protect from potentially life-threatening illnesses. At the societal level, government health authorities face a dilemma in deciding between the importance of employing (potentially coercive) programs for safeguarding public health and that of allowing individuals to make their own choices about vaccinating themselves or their children. Individuals run a risk, however small, of experiencing side effects that can range from minor to life threatening. In deciding

[1] More recently, in late February of 2011, concerns about measles outbreaks in the US resulted from air-travel exposure of hundreds of travelers by an infected passenger who, apparently, had made the choice not to be vaccinated (*The Washington Post*, 2011).

whether to vaccinate, a stark trade-off is posed; each time an individual's (or parent's) concerns about side effects results in a decision not to vaccinate, they or their child remain vulnerable to preventable infectious diseases while simultaneously weakening the "herd immunity" of the overall population by increasing the number of potentially infectious carriers.

Improvement of public health by immunization through vaccinations has been a consistent policy in the US for decades. In the late 1950's and early 1960's, the federal government established a nationwide vaccination policy based upon the Vaccination Assistance Act (Calandrillo and Hall, 2004; Rein et al., 2006). Due to this act, by the late 1960s, several states established mandatory vaccination policies for children upon school entry against an array of infectious diseases, including measles, polio, diphtheria, pertussis, and tetanus. By the late 1970's, all fifty states had adopted this vaccination requirement. Currently, all states require vaccinations against measles, polio, rubella, and diphtheria. Vaccinations against other diseases are either required or recommended by the various state governments (Orenstein and Hinman, 1999; Ridgway, 1999). However, some vaccinations may result in adverse reactions. These reactions are generally minor and include temporary pain or swelling in the injection area (Salmon, Moulton and Halsey, 2004), but systemic symptoms such as fever, headaches, and vomiting may occur. Though extremely rare, and though a causal link has yet to be verified, severe allergic reactions resulting in brain damage have been reported in infants after receiving vaccines (Centers for Disease Control and Prevention, 2008). In order to address the possible relationship of these rare and scientifically unverified but potentially grave side effects of vaccines, the federal government established the

National Childhood Vaccine Injury Act in 1986. The National Childhood Vaccine Injury Program, based upon this act, provides compensation for injury or death resulting from an adverse reaction to a vaccination without requiring a confirmatory investigation of the responsible party, through a federal "no-fault" system (Barringer et al., 2008; Elliott, Narayan and Nasmith, 2008; Ridgway, 1999; Schwartz and Mahshigian, 1987; but see Widman and Hochberg, 2008). In addition to offering compensation, current public health policy also provides avenues for vaccine avoidance. Currently, all fifty states allow medical exemption from vaccinations for those children who can be expected to develop serious allergic reactions. Another forty-eight states, excluding Mississippi and West Virginia, allow for religious exemption from vaccination. In twenty states[2], a philosophical (non-religious belief) exemption is also permitted (Kasprak, 2004).

In sum, vaccine policy generally strives for near universal vaccinations to maintain herd immunity levels for the population at large, while at the same time providing the means to "opt out." From this array of different policy directions, the government's struggle between enforcement of vaccination requirements for the benefit of public health and provisions for individual rights based upon religious or philosophical convictions is evident. Proponents of mandatory vaccinations argue that the government should limit the scope of religious and philosophical exemptions (which, if widely exercised, will result in a declining vaccination rate) because in their view, the benefits of freedom from infectious diseases, both at the individual and societal level, far outweigh the costs of restricted parental choice or the physical risks posed by

[2] These states are Arizona, Arkansas, California, Colorado, Idaho, Louisiana, Maine, Michigan, Minnesota, Missouri, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, Texas, Utah, Vermont, Washington, and Wisconsin.

vaccinations. Therefore, proponents urge that exemptions be limited only to those based upon verified medical reasons (Salmon et al., 2005). By contrast, vaccination opponents argue that the focus should now be shifted to the risks of vaccinations because the threat of infectious diseases has been diminished in modern societies, and because individuals (and parents) should have the right to make decisions about vaccinations based upon their personal beliefs (Mariner, Annas and Glantz, 2005; *PBS Frontline*, 2010; Wallace, 2009; Woo et al., 2004).

In the face of the reemerging threat of preventable deadly diseases and in the midst of the vaccine risk controversy, it is of critical importance that we understand how individuals formulate their decision of whether or not to vaccinate. In so doing, this study seeks to answer the following questions: what explains the differences within the general public in (a) perceptions of vaccine benefits and risks, (b) related policy preferences, and (c) parental behavior with regard to vaccinating child(ren)? Based on theories regarding risk perceptions, formation of policy preferences, and how perceptions and preferences translate into behaviors, the three empirical chapters of this dissertation seek to answer these questions with a systemic approach. Chapter 2 discusses Mary Douglas and Aaron Wildavsky's cultural theory and related measures that provide the basis of theoretical and empirical analyses of this study. Then, the first empirical chapter (Chapter 3) examines how individuals' cultural predispositions influence their perceptions pertaining to vaccine benefits and risks at both the societal and individual levels; The second empirical chapter (Chapter 4) seeks to explain how individuals' fundamental values regarding a preferred social ordering shape their opinions on controversial vaccination policies and key related issues of governance;

The third empirical chapter (Chapter 5) essentially examines how American parents' policy related beliefs (e.g., their perceptions of vaccine benefits and risks and related policy preferences) actually translate into their behaviors regarding child vaccinations. Finally, Chapter 6 discusses the theoretical contributions of the research findings reported in the aforementioned three empirical chapters and concludes with a discussion on some practical implications for future policy directions for government health authorities. This chapter also discusses limitations of this research and suggests future research directions.

Chapter 2. Cultural Theory and Cultural Type

Much of the previous research examining the ways in which individuals' values and beliefs translate into benefit/risk perceptions, policy preferences and behaviors seeks to understand the hierarchically structured nature of personal values and beliefs (Rokeach 1973; Schwartz and Bilsky 1987; Schwartz 1992; Verplanken and Holland 2002; Jacoby 2006; but see Tetlock 1986; Nelson, Clawson, and Oxley 1997; Maio and Olson 1998). In the Advocacy Coalition Framework (ACF), for instance, Sabatier and Jenkins-Smith argue that a hierarchical belief system is grounded in an individual's enduring *deep core* beliefs, the "foundational normative and ontological axioms" regarding qualities of human nature, priority of ultimate values, and distributive justice (1993, 31). Deep core beliefs manifest themselves in *policy core* beliefs which are related to "fundamental policy positions concerning the basic strategies for achieving normative axioms of deep core," such as orientation on substantive policy conflicts (e.g., environmental protection versus economic development) (Sabatier and Jenkins-Smith 1993, 31; Jenkins-Smith, Mitchell, and Herron 2004; Sabatier and Weible 2007). Finally, *secondary aspects* are essentially associated with "instrumental decisions and information searches necessary to implement policy core" (Sabatier and Jenkins-Smith 1993, 31).

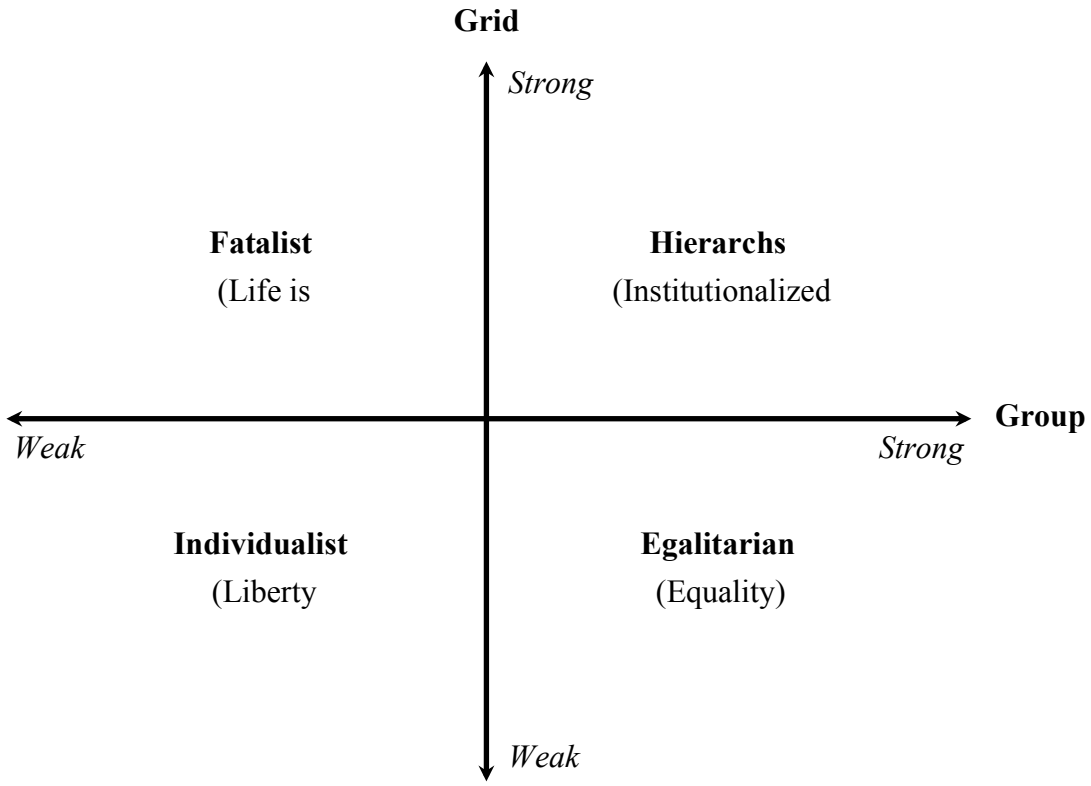
2.1. Grid-Group Cultural Theory Framework

Of particular interest among the various components of a personal belief system are grid-group cultural orientations (as deep core beliefs) that may have direct bearings on individuals' vaccine benefit/risk perceptions, vaccination policy preferences, and related behaviors. Cultural theory of risk perception and policy preference formation posits

that people form conceptions of societal danger and preferred policies in ways that will sustain their preferred "way of life" (Douglas and Wildavsky, 1982). Here, "culture" is defined by the manner in which an individual relates to society. Anthropologist Mary Douglas (1970) and political scientist Aaron Wildavsky (1987) argue that an individual's social relationships can be explained by two conceptual dimensions of sociality: group and grid. *Group* refers to the degree to which individuals' social relations are governed by group membership or "bounded units" within a society (Thompson, Ellis and Wildavsky 1990, 5). This dimension is related to the question of "Who am I?" in the context of society. One can answer this question of identity by observing that "individuals belong to a strong group, a collective, that makes decisions binding on all members or that their ties to others are weak in that their choices bind only themselves" (Wildavsky 1987, 6). *Grid* indicates to what degree individuals' social relationships are determined by "externally imposed prescriptions" such as rules or social norms (Thompson, Ellis and Wildavsky 1990, 5). This dimension is related to the question of "What shall I do?" in the context of socially constructed institutional coercion. One can answer this question of action by "responding that the individual is subject to many or few prescriptions, a free spirit or a spirit tightly constrained" (Wildavsky 1987, 6). So, the strength or weakness of "group boundaries" (*group*) and the number, nature, and diversity of the various "prescriptions" (*grid*) enacted upon individuals formulate their culture, i.e. "*shared values legitimating social practices*" (Wildavsky 1987, 6). Based upon these two dimensions of sociality are four different types of individuals holding distinctive cultural orientations: egalitarians, individualists,

hierarchs and fatalists (Dake, 1991; Jenkins-Smith and Smith, 1994; Rayner, 1992; Thompson, Ellis, and Wildavsky, 1990; Wildavsky and Dake, 1990).

Figure 1. Grid-Group Cultural Theory Framework



Hierarchs hold strong group and grid orientations and fear deviation from established rules and social disorder. Their morals center on institutionalized authority, and they justify inequality among the members of society based upon their beliefs that specialization and division of labor in a stratified society can enhance societal efficiency and effectiveness in comparison with any alternative social structure. Therefore, they confer much credit on experts' opinion. They tend to be loyal to the group with which they affiliate, and believe that individual members of society are supposed to sacrifice themselves for society as a whole. Meanwhile, *Egalitarians* possess strong group and weak grid orientations. Fairness and equality are their social norms of pursuit, and they

dislike any kind of social/institutional coercion or authority unless they are the product of consensus among the members of their own group. As sectarians, they tend to make substantial commitments to voluntary activities geared towards the reduction of various societal inequalities based on race, gender, income, and other types of social cleavages. Egalitarians often dislike big businesses, as they believe their commercial activities cause social inequality and legitimize unconstrained self-interest (Kahan, Braman, Gastil, Slovic and Mertz 2007, 469). Third are the *individualists*, who have weak group and grid orientations and do not consider themselves to be subject to control by others or existing institutional constraints. Their moral base is self-regulation, and they prefer contract-based social relations, which is the profound normative principle of the modern free market system. Individualists who care about individual freedom and liberty unmistakably dislike institutional coercion and government regulations based upon experts' opinions, and value the idea that individuals can freely compete with one another in order to achieve a desired goal, even when such competition results in apparent winners and losers and consequential inequality among the members of society. Finally, *Fatalists* retain weak group and strong grid orientations and choose to cope with erratic events in a random world, instead of trying to manage or learn from them. These are the people who are passively obedient to institutional coercion and think that they cannot do anything about what will happen to them. For this cultural type, life is just a matter of luck: fatalists usually do not want to engage in any kind of collective action, if possible.

Since its introduction in the seventies and eighties, the grid-group cultural theory has been proven to hold great ramifications in explaining a wide variety of policy

issues, including industry and economic development (Wildavsky, 1986), technology (Kahan et al., 2008), climate change (Jones, 2011), gun control (Kahan, Braman, and Gastil, 2006), and various risks (Jenkins-Smith and Smith 1994; Swedlow et al., 2009; Wildavksy and Dake, 1990). However, especially with regard to the empirical research following the introduction of cultural theory by Mary Douglas and Aaron Wildavsky, there is a critical methodological issue yet to be resolved: how can cultural type be identified? This is an important question to answer because cultural orientation measures that have been widely employed in the majority of empirical cultural theory works since Wildavsky and Dake (1990) hold some conceptual inconsistency with the theoretical postulations originally suggested by Douglas and Widavsky (Kahan, 2011). Scholars who follow Wildavsky and Dake's tradition of cultural orientation measures usually use several cultural orientation scales designed to measure individuals' orientations toward each of four different quadrants of cultural types. The problem is that it is possible that a survey respondent simultaneously scores high on multiple, competing cultural orientation measures, which should not be the case according to the original cultural theory that assumes that individuals hold one of four *mutually exclusive* cultural types. Though the traditional way of measuring individuals' cultural orientations has been very useful in explicating how individuals' cultural orientations, as more intrinsic values and beliefs within hierarchically structured belief systems, form their differing opinions on issues regarding various risks, related policies, and behaviors, in the following sections of this chapter, therefore, I discuss how to overcome such methodological limitations and seek to find an appropriate way of empirical identification of individuals' cultural type.

2.2. Identification of Cultural Type

The conventional approach to identify cultural type of individuals based on survey methods uses multiple survey questions designed to measure each individual respondent's propensity toward each of the four cultural types. Typically, survey respondents are asked to place themselves on a cultural orientation scale, and then their scores are aggregated (or averaged) to produce an index for each of the cultural types. Comparing these cultural orientation indices, the one that the respondent scores highest on is considered that respondent's cultural type.

Another way to identify an individual's cultural type that I am proposing here is to use *classification functions* derived from *linear discriminant analysis* using the aforementioned cultural orientation indices as predictors of an individual's membership in one of four mutually exclusive cultural types. In order to identify each individual's cultural type, a classification function that essentially shows a relationship between the cultural orientation indices and a cultural type is estimated for each cultural type: a total of four classification functions are estimated. Then, an individual respondent's four cultural orientation indices are inserted into each classification function to calculate a classification score for each cultural type. Each individual is assigned to the cultural type for which he or she has the highest classification score.

2.2.1. Survey Data

In order to evaluate and compare these two identification approaches more systemically, I use original data collected from nationwide Internet and telephone surveys of 2,718 American adults conducted in 2011. The University of Oklahoma Institutional Review Board approved the survey and overall research design for Human Research Participant

Protection. The Internet survey sample (a total of 2,125) was drawn from Survey Sampling International's (SSI) regular panel of approximately 400,000 Internet survey recruits whose demographic characteristics approximates national census characteristics. The telephone survey sample consisted of a total of 593 individual respondents who were selected using the Random Digit Dialing method. The average age (in years) of survey participants was 48.40. 52.2% of total survey respondents were female, approximately 82% were non-Hispanic whites, and 40.9% had a college degree. Survey participants' median annual household income was between $40,000 and $50,000.

2.2.2. Cultural Theory Measures

In order to identify an individual's cultural type, the questions presented in Table 1 were provided to the survey respondents. Survey respondents were asked to use drop-down boxes to assign a number from four (most agree) to one (least agree) for each statement corresponding to each of four cultural types. The survey questions were programed in such a way that the survey respondents could use a ranking number only once – they were forced to self-identify one unique cultural type with which they most associate– and they were supposed to assign a rank to each cultural type statement

Table 1. Cultural Type Measures

Cultural type	Measure
Hierarch	I am more comfortable when I know who is, and who is not, a part of my group, and loyalty to the group is important to me. I prefer to know who is in charge and to have clear rules and procedures; those who are in charge should punish those who break the rules. I like to have my responsibilities clearly defined, and I believe people should be rewarded based on the position they hold and their competence. Most of the time, I trust those with authority and expertise to do what is right for society. (1=Least Agree to 4=Most Agree)

Egalitarian	Much of society today is unfair and corrupt, and my most important contributions are made as a member of a group that promotes justice and equality. Within my group, everyone should play an equal role without differences in rank or authority. It is easy to lose track of what is important, so I have to keep a close eye on the actions of my group. It is not enough to provide equal opportunities; we also have to try to make outcomes more equal. (1=Least Agree to 4=Most Agree)
Individualist	Groups are not all that important to me. I prefer to make my own way in life without having to follow other peoples' rules. Rewards in life should be based on initiative, skill, and hard work, even if that results in inequality. I respect people based on what they do, not the positions or titles they hold. I like relationships that are based on negotiated "give and take," rather than on status. Everyone benefits when individuals are allowed to compete. (1=Least Agree to 4=Most Agree)
Fatalist	Life is unpredictable and I have little control. I have to live by lots of rules, but I don't get to make them. My fate in life is determined mostly by chance. I can't become a member of the groups that make most of the important decisions affecting me. Getting along in life is largely a matter of doing the best I can with what comes my way, so I focus on taking care of myself and the people closest to me. (1=Least Agree to 4=Most Agree)

before they advanced to the next statement.

Table 2 presents the distribution of self-identified cultural types of survey respondents. Out of 1,666 valid responses, 676 (40%) respondents self-identified that they are individualists, 376 (23%), hierarchs, 310 (19%), egalitarians, and the remaining 307 (18%), fatalists, respectively. In the following analysis, this self-identified cultural

Table 2. Frequency Table

Cultural type	Frequency	Percent
Hierarch	376	0.23
Egalitarian	310	0.19
Individualist	673	0.40
Fatalist	307	0.18
Total	1666	1.00

type will be used as a reference for evaluating and comparing the two aforementioned approaches used to identify the cultural types of each individual respondent (i.e., conventional approach and proposed approach using discriminant analysis).

Table 3 presents cultural orientation measures that have been most widely used in cultural theory research (e.g., Jenkins-Smith and Smith, 1994; Silva and Jenkins-Smith, 2007; Wildavsky and Dake, 1990). Using scales from twelve survey items on cultural orientations presented in Table 3, survey respondents were asked to rate the degree of their agreement with the given statements (related to cultural orientations) on a 7-point scale, with high scores meaning strong agreement. Then, I constructed four respective indices for egalitarianism, individualism, and hierarchism by taking the mean of the three respective survey items. Cronbach's Alpha scores, ranging from 0.68 to

Table 3. Cultural Orientation Measures

Cultural orientation	Measure
Hierarchism	The best way to get ahead in life is to work hard to do what you are told to do. (1=Strongly Disagree to 7=Strongly Agree)
	Even the disadvantaged should have to make their own way in the world. (1=Strongly Disagree to 7=Strongly Agree)
	Society would be much better off if we imposed strict and swift punishment on those who break the rules. (1=Strongly Disagree to 7=Strongly Agree)
Hierarchism index	Index of above three items (α=0.68)
Egalitarianism	What society needs is a fairness revolution to make the distribution of goods more equal. . (1=Strongly Disagree to 7=Strongly Agree)
	Society works best if power is shared equally. (1=Strongly Disagree to 7=Strongly Agree)
	No matter how hard we try, the course of our lives is largely determined by forces beyond our control. (1=Strongly Disagree to 7=Strongly Agree)
Egalitarianism index	Index of above three items (α=0.76)

Individualism	Even if some people are at a disadvantage, it is best for society to let people succeed or fail on their own. (1=Strongly Disagree to 7=Strongly Agree)
	Even the disadvantaged should have to make their own way in the world. (1=Strongly Disagree to 7=Strongly Agree)
	We are all better off when we compete as individuals. (1=Strongly Disagree to 7=Strongly Agree)
Individualism index	Index of above three items (α=0.68)
Fatalism	The most important things that take place in life happen by chance. (1=Strongly Disagree to 7=Strongly Agree)
	No matter how hard we try, the course of our lives is largely determined by forces beyond our control. (1=Strongly Disagree to 7=Strongly Agree)
	For the most part, succeeding in life is a matter of chance. (1=Strongly Disagree to 7=Strongly Agree)
Fatalism index	Index of above three items (α=0.75)

0.76, show that these items are fairly reliable in measuring each cultural orientation of interest.

As presented in Table 4, in order to evaluate the empirical validity of these cultural orientation measures, I checked the dimensionality of these measures by conducting factor analysis with varimax rotation, and found that these twelve cultural orientation items load neatly into four latent dimensions constructing the four mutually exclusive cultural orientations suggested in the cultural theory literature (Douglas 1970; Douglas and Wildavsky 1982; Thompson et al. 1990). The first three hierarchism items, for instance, are loaded high on Factor 4 (hierarchism dimension of cultural theory) with factor loadings ranging from 0.64 to 0.78, while showing low factor loadings in other remaining factors (ranging from 0.01 to 0.26). Measures for other cultural orientations show similar patterns. The three egalitarianism items are loaded high on Factor 3 (egalitarianism factors) and low on other remaining factors, the three

individualism items high on Factor 2 (individualism), and the fatalism items on Factor 1 (fatalism), respectively. These four extracted factors explain approximately 65% of overall variance in the data, while proportion of variance explained by each latent dimension varies from 15% to 18%. Eigenvalues for each extracted factor range from 1.178 (eigenvalue for Factor 4) to 2.934 (eigenvalue for Factor 1) while the eigenvalue of the fifth factor is 0.711, which shows that four-factor solution is most appropriate in this analysis.

Table 4. Rotated Factor Matrix

	Factor 1	Factor 2	Factor 3	Factor 4
Hierarchism item 1	0.06	0.26	0.10	**0.64**
Hierarchism item 2	0.19	0.01	0.02	**0.83**
Hierarchism item 3	0.04	0.13	0.08	**0.78**
Egalitarianism item 1	0.31	-0.26	**0.74**	0.17
Egalitarianism item 2	0.03	0.10	**0.84**	0.03
Egalitarianism item 3	0.30	-0.24	**0.73**	0.07
Individualism item 1	0.05	**0.79**	-0.14	0.15
Individualism item 2	0.05	**0.77**	0.06	0.16
Individualism item 3	0.07	**0.70**	-0.15	0.08
Fatalism item 1	**0.84**	0.11	0.16	0.04
Fatalism item 2	**0.68**	0.03	0.15	0.22
Fatalism item 3	**0.83**	0.07	0.14	0.05

	Factor 1	Factor 2	Factor 3	Factor 4
SS loadings	2.11	1.95	1.91	1.85
Proportion Var.	0.18	0.16	0.16	0.15
Cumulative Var.	0.18	0.34	0.50	0.65

Note: factor loadings greater than 0.6 are presented in a bold font.

Establishing two important tenants of a good measure, reliability and validity, some descriptive statistics of cultural orientation index (generated by taking a mean of related three cultural orientation measures for each of the four cultural types as discussed earlier) are examined. As presented in Table 5, no apparent statistical problems in distributional characteristics of these cultural orientation indices are found.

Generally, respondents' fatalist tendency is weaker than other cultural affinities by a very small margin. Among the remaining three cultural orientations, individuals' hierarchism and individualism is slightly stronger than their egalitarianism.

Table 5. Descriptive Statistics

Cultural orientation index	*n*	Mean	S.D.	Median	Min	Max
Hierarchism	1684	4.36	1.30	4.33	1	7
Egalitarianism	1691	4.16	1.47	4.00	1	7
Individualism	1691	4.42	1.27	4.33	1	7
Fatalism	1693	3.72	1.39	3.67	1	7

2.2.3. Results

Table 6 presents how many individuals' cultural types are predicted correctly when the conventional cultural type identification approach is employed. As discussed earlier, I compared four cultural orientation indices (hierarchism index, egalitarianism index, individualism index, and fatalism index as explained in Table 3) for each individual respondent, and assigned each person a dominant cultural type when he or she scored highest on that cultural orientation index among the four. After implementing listwise deletion of missing values in the data matrix used for this analysis, a total of 1,236 valid responses were recognized. Overall, when employing this conventional approach, out of these 1,236 individual respondents, 478 (38.9%) individuals' cultural types were predicted correctly. More specifically, there are 263 respondents who self-identified as hierarchs. Out of these 263 hierarchs, 100 (38.0%) individuals were correctly predicted as hierarchs when this conventional method was used. Similarly, 102 (44.9%) out of 227 self-identified egalitarians were predicted correctly, 236 (44.2%) out of 534 actual individualists, and 40 (18.9%) out of 212 actual fatalists, were predicted correctly.

Table 6. Cultural Type Predicted Using Conventional Method

		Actual cultural type			
		Hierarch	Egalitarian	Individualist	Fatalist
Predicted cultural type	Hierarch	**100(38.0)**	64(28.2)	135(25.3)	54(25.5)
	Egalitarian	73(27.8)	**102(44.9)**	121(22.7)	61(28.8)
	Individualist	74(28.1)	39(17.2)	**236(44.2)**	57(27.9)
	Fatalist	16(6.1)	22(9.7)	42(7.9)	**40(18.9)**
Total		263(100)	227(100)	534(100)	212(100)
Total number correct		478			
Total percent correct		38.9%			

Note: numbers represent frequency and numbers in parentheses shows column percentage.

Another way to predict individual respondents' cultural type is to utilize *classification functions* extracted from *linear discriminant analysis,* in which the aforementioned four cultural indices are used as predictors of individuals' cultural type. Following this approach, I estimated a classification equation[3] representing the relationship between predictor variables (four cultural orientation indices) and a particular cultural type. This resulted in four classification equations corresponding to four cultural types. Then, I inserted an individual respondent's four cultural orientation indices into each of these classification equations to calculate an individual's classification score for each cultural type. I determined each individual's cultural type for which she or he holds the highest classification score. Table 7 presents the results acquired from employing this approach of cultural type identification. Overall, 673 (43%) out of 1,565 total valid survey respondents' cultural types were predicted correctly. Out of 637 self-identified individualists, 539 (84.6 %) were predicted correctly, which is better than any other cultural type both in terms of number and

[3] The functional form of classification equation for *j*th cultural type (j = 1, 2, 3, 4) is $C_j = c_{j0} + c_{j1}X_1 + c_{j2}X_2 + c_{j3}X_3 + c_{j4}X_4$, where C_j is a score on the classification function for cultural type j, c_j is a classification function coefficient for cultural type j, and X is each cultural orientation index.

proportion in this analysis. For the remaining cultural types, 40 (11.2%) out of 356 actual hierarchs were predicted correctly, 72 (25.1%) out of 287 egalitarians, and 22 (7.7%) out of 285 actual fatalists, respectively.

Table 7. Cultural Type Predicted Using Discriminant Analysis

		Actual cultural type			
		Hierarch	Egalitarian	Individualist	Fatalist
Predicted cultural type	Hierarch	**40(11.2)**	31(10.8)	31(4.9)	25(8.8)
	Egalitarian	56(15.7)	**72(25.1)**	46(7.2)	47(16.5)
	Individualist	249(70.0)	165(57.5)	**539(84.6)**	191(67.0)
	Fatalist	11(3.1)	19(6.6)	21(3.3)	**22(7.7)**
Total		356(100)	287(100)	637(100)	285(100)
Total number correct		673			
Total percent correct		43.0%			

Note: numbers represent frequency and numbers in parentheses shows column percentage.

As shown in Table 8, when comparing the two approaches previously discussed, the proposed approach (based upon discriminant analysis) outperformed the conventional approach in terms of total number of correctly predicted cultural types and the overall proportion of correctly predicted vs. actual cultural types. These results, however, are attributed mostly to the fact that the proposed approach is better than the conventional approach in identifying individualists to a great degree. The proposed approach predicted 539 (or 84.6%) individualists (out of 627 actual individualists) correctly while the conventional method predicted only 236 (or 44.2%) individualists correctly. As for the other remaining cultural types, the conventional approach generally performed better than the proposed approaches both in terms of actual number of correctly predicted cultural types and the percentage of them vs. actual cultural types. Noteworthy is the differences between these two approaches in terms of overall number of valid responses. When applying the conventional approach, responses from

individuals who assigned the highest score to more than two cultural orientation indices at the same time were dropped off from the analysis because their cultural type is inconclusive.

Table 8. Comparisons of Different Approaches

Approach / Cultural type	Conventional approach	Proposed approach
Hierarch	100/263 (38.0)	40/356 (11.2)
Egalitarian	102/227 (44.9)	72/287 (25.1)
Individualist	236/534 (44.2)	539/637 (84.6)
Fatalist	40/212 (18.9)	22/285 (7.7)
Overall	478/1236 (38.9)	673/1565 (43.0)

Note: numbers read 'frequency of correctly predicted cultural type'/'frequency of actual cultural type.' Numbers in parentheses show percentile proportion of 'correctly predicted cultural type' to 'actual cultural type'.

2.3. Summary

This chapter introduces Douglas and Wildavsky's grid-group cultural theory, that essentially claims that individuals' intrinsic values and beliefs about preferred social organization and ordering influence their conceptions of benefits and risks and their attitudes towards policies and related behaviors. Acknowledging methodological shortcomings in the way in which theoretical cultural types (suggested in cultural theory) are operationalized in previous empirical studies, this chapter also seeks to assess and compare the conventional and new approaches for identifying individuals' cultural type through systemic analysis of original survey data collected in 2011. Theoretical claims suggested by cultural theory and proposed methods of individuals' cultural type

identification relying on discriminant analysis will be greatly utilized in the discussion in the following chapters (Chapters 3 and 4) of this dissertation research.

Chapter 3. Public Perceptions of Benefits and Risks of Childhood Vaccinations

When we visualize an individual's expected utility regarding childhood vaccination, two major dimensions should be considered: perceived benefits and perceived risks. Theoretically speaking, when a person expects greater benefits, fewer risks, and that overall, benefits will outweigh risks, he or she will have a high expected utility for vaccinations, whereas in the opposite scenario, the person will hold a low expected utility (Weber, Blais and Betz, 2002). Benefits and risks can be considered both at the collective and the individual level. From the public health perspective, expected benefits of vaccination include foremost the avoidance of an epidemic of preventable diseases. At the individual level, vaccinations benefit an infant or child with a healthier life by minimizing the risk of contracting such dangerous illnesses. For individuals, vaccines' risk lies in the possibility of grave side effects, while the collective wellbeing is threatened by the prospect that any given individual may suffer adverse reactions from mandatory childhood vaccinations. Individuals' expected utility of vaccination, however, naturally varies because of the considerable disparities in individuals' perceptions of vaccine benefits and risks. What accounts for such disparities? Major theoretical developments of benefit-risk perception in the past several decades[4] have shown that when an individual is unsure of the probability of certain consequences for a particular event, his or her benefit-risk assessment can be influenced by a number of factors including (a) technical estimation of "real" risk (e.g., Lichtenstein et al., 1978; Winterfeldt, John, and Borcherding, 1981), (b) cognitive heuristics and biases (Tversky and Kahneman, 1973; Tversky and Kahneman, 1974), (c) psychometric characteristics of risk (Fischhoff et al., 1978; Slovic, 1987) and (d) values and beliefs, notably cultural

[4] For a good empirical review of risk perception theories, see Slovic et al. (2000).

worldview (Douglas and Wildvsky 1982). Disparities within public benefit-risk perception on childhood vaccinations can be explained through these theoretical references. The primary concern in this chapter, however, is to examine how cultural worldview, a core value centered in an individual's belief system, impinges upon his or her comprehension of those benefits and risks related with vaccines.

3.1. Cultural Theory of Risk Perception

Cultural theory of risk perception posits that people form conceptions of societal danger in ways that will sustain their preferred "way of life" (Douglas and Wildavsky, 1982). The more a particular event threatens their ideal social ordering, the higher the level of risk people perceive from it, while the more it supports their way of life, the lower the level of risk they perceive[5] (e.g., Jenkins-Smith and Herron, 2009; Jenkins-Smith and Smith, 1994; Kahan et al., 2010; Lodge, Wegrich and McElroy, 2010; Silva and Jenkins-Smith, 2007; Thompson, Ellis and Wildavsky, 1990). Cultural theory posits two fundamental theoretical dimensions of sociality that are woven into social interactions: group and grid. The *Group* dimension represents the degree to which an individual's social relations are determined by "bounded units" or group identity, while *grid* denotes the extent to which an individual's social interactions are governed by

[5] There are an increasing number of approaches to cultural theory of risk perception. For instance, a group of scholars at the University of Oklahoma, lead by Hank Jenkins-Smith and Carol Silva, follows most closely with the original work of Douglas and Wildavsky (1982) and Wildavksy and Dake (1990), in which individual-level indicators of cultural orientation, as a core value of the individual belief system, are measured and used to predict risk perceptions, policy preferences and behaviors in various risk domains (e.g., Jenkins-Smith and Herron, 2009; Silva and Jenkins-Smith, 2007; Ripberger, Jenkins-Smith and Herron, 2011; Song, Jenkins-Smith and Silva, 2011 etc.). Another group of scholars from the Cultural Cognition Project at Yale University, headed by Dan Kahan, emphasizes the cognitive aspects of cultural orientation and focuses on how individuals' cultural biases work as a set of heuristics in the processing of information and in the course of risk-related reasoning (e.g., Kahan and Braman, 2006; Kahan, Braman, Cohen, Gastil and Slovic., 2010; Kahan, Braman, Slovic, and Gastil et. al., 2008 etc.).

"externally imposed prescription," such as rules, social coercion, or institutionalized authority (Thompson, Ellis and Wildavsky, 1990: 5). Based on these two theoretical dimensions, four distinctive prototypes of cultural orientations (favoring disparate sets of desirable social relationships) are proposed: hierarchism, egalitarianism, individualism, and fatalism (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990).

The hierarch orientation is grounded on an inclination for strong group attachment and numerous social rules that clearly define stratified roles within society, in the confidence that a strong central point of authority encourages a better off, more productive society through a clearly defined social division of labor based not on mass equality, but expertise and specialization (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). Likewise, it is reasonable to infer that when it comes to vaccinations, people with strong hierarchical tendencies would be expected to perceive substantial societal and individual benefits, and very small (or even negligible) risks, since most experts are in clear support of vaccinations as the most effective way to prevent the spread of infectious diseases and concur that these benefits overwhelm any minor risks. Accordingly, cultural theorists expect to find that the benefits of vaccines outweigh the risks to a greater degree in comparison with other cultural types. Furthermore, since hierarchs are as a rule more group-oriented, their interest in the collective benefits of vaccines will also tip the scales against the perceived individual-level risks.

Though those who hold strong egalitarian orientation also highly prize group identity and cohesion, they reject a stratified society controlled by institutions and rules

imposed by what they perceive as lofty expert opinion (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). Therefore, egalitarians' grid orientation is weak. Instead, their ideal societal structure would involve a network of generally equal social relationships with no infringing outside authority. Because of egalitarians' strong group orientation, individuals' personal preferences regarding vaccinations would be given less weight than the concern for endangered public health caused by failure or refusal to vaccinate. Therefore, strong egalitarians are expected to perceive higher levels of benefit for vaccinations and lower levels of risk, though to a lesser degree than hierarchs, because of their aversion to the imposition of expert opinion upon the wishes of a community.

People who most identify with the individualist orientation have both weak group and grid orientations, preferring a society centered on unfettered, self-regulated social relationships and a more competitive environment where equality is rooted in the ideal of equal opportunity (not in unconditional equal outcome); everyone has the same chance at achieving personal accomplishment through individual merit and exertion (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). They are prone to resist centralized, top-down authority and the imposition of expert opinion over individual preference. However, not unlike egalitarians, they are often conflicted about the merits, and drawbacks, of vaccinations. Individualists are much more prone than hierarchs or egalitarians to assign lower levels of benefit to vaccinations and higher levels of risk because of their aversion towards experts, but they will still be concerned with experts' opinions because of a fear that non-vaccinated individuals could force infectious diseases upon others; causing

another's health to suffer because of personal irresponsibility or preference undermines their centerpiece principle of individual self-determination[6].

Finally, people who most strongly identify as fatalists possess weak group orientations, avoiding social involvement and its constraints while exhibiting strong grid orientation and submission to socially imposed distinctions and the decisions of higher authorities (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). However, they perceive of life as a series of uncontrollable events, so of all cultural types, they are most likely to emphasize the risks of vaccinations over any benefits; becoming infected with a communicable disease is seen as an inevitable part of one's destiny or fortune. This discussion is summarized in Table 9.

Table 9. Cultural Type and Perception of Benefits and Risks of Vaccination

	Perceived benefits to the society as a whole	Perceived benefits to you and your family	Perceived risks to the society as a whole	Perceived risks to you and your family	Perceived benefit/risk ratio
Hierarch	High	High	Low	Low	High
Egalitarian	Moderately high	Moderately high	Moderately low	Moderately low	Moderately high
Individualist	Moderately low	Moderately low	Moderately high	Moderately high	Moderately low
Fatalist	Low	Low	High	High	Low

[6] The individualist concern is that personal choices not to vaccinate may result in an expensive externality (a spillover cost on others not privy to the decision). This is one of the few justifications among free-market thinkers for interventions in private decision-making.

3.2. Technocratic Disposition, Organic Culture, Trust, and Demographics

Though the focus of this discussion is on cultural theory, there are many competing (and complementary) theoretical traditions and hypotheses that can also be applied to explain benefit-risk perceptions of childhood vaccinations. As both rival explanations to cultural theory and controls in the statistical models that follow, a subset of the most promising alternative hypotheses is incorporated.

Among another components of a personal belief system that have a direct bearing upon the perception of vaccine benefits and risks is the "technocratic disposition" based upon scientific optimism (Silva and Jenkins-Smith, 2007). This is the conviction that the development of science and technology within a framework of the pursuit of "scientific (objective and value-neutral) truth" will benefit society by contributing to the common welfare, including through the advancement of vaccines. Intrinsic to this framework is the assumption that scientific experts will act for the greater good and not for their own material interests. Currently, the majority of experts assess vaccines' benefits as outweighing their risks. Therefore, those with a strong technocratic disposition will accept this judgment and consequently judge vaccinations as more beneficial than risky.

The set of values often dubbed "organic culture" is another aspect of the personal belief systems that may impact one's appraisal of the role of vaccinations in individual and public health (Ernst, 2001; Lehrke et al., 2001; Gellin, Maibach and Marcuse, 2000). As a subculture of post-materialism[7], this culture prioritizes personal

[7] Inglehart (1990: 66) posits that as a society's socioeconomic environment changes –improves– over time, individuals' value priorities shift from issues of physical sustenance and safety (materialism) to concerns related to quality of life (Post-materialism). Recent profusion of environmentalism, for instance, can be explained by this values shift.

wellbeing over material advancement and rejects the more mechanistic and synthetic approach to medicine and agriculture based upon modernism, namely methodological individualism. Instead, proponents of organic culture favor naturally created everyday products as well as treatments rooted in holistic and homeopathic approaches in the belief that the human body can heal itself. Accordingly, those possessing strong organic culture will be prone to sense higher levels of risk and lower levels of the benefit for vaccinations.

The personal level of trust in health care professionals such as doctors and nurses can also have a considerable impact on individual attitudes towards benefits and risks of vaccinations (Gust et al., 2004; McMurray, 2004; Flanagan-Klygis, Sharp and Frader, 2005). Health care professionals play an important role in directly providing information on childhood vaccinations to the general public. However, those who mistrust health care professionals are more likely to reject the information they provide or even purposefully adopt a directly opposing viewpoint. Considering that the majority of health care professionals affirm the overwhelming benefits of vaccines for individual infants and children and for overall public health, those who mistrust them are more likely to believe that the risks are high and the benefits low, as a result of their suspicions.

Demographic characteristics, including individuals' levels of "quality knowledge" or domestic composition (Meszaros et al., 1996; Asch et al., 1994), can also influence judgment regarding vaccinations. Quality knowledge may be defined as that which is accumulated based upon the solid scientific findings of experts and which reflects a recognized consensus within the scientific community. Considering that the

majority of experts, including pediatricians, have reached a strong consensus on the safety and effectiveness of vaccinations, those who possess higher levels of quality knowledge on vaccines are apt to see vaccination as more beneficial than dangerous. The risk (benefit) perception of parents of infants and young children who ought to be vaccinated would differ from that of people with no children or with adult children. Additionally, females may perceive higher levels of vaccine risk than do males because they are more risk-adverse within the male-dominated socioeconomic structure and possess biological differences that foster protective maternal instincts (Finucane, Slovic, Mertz, Flynn, et al. 2000; Flynn, Slovic, and Mertz, 1994; but see Palmer, 2003; Kahan et al., 2007). Other demographic characteristics such as age, race (Finucane, Slovic, Mertz, Flynn, et al. 2000; Flynn, Slovic, and Mertz, 1994; but see Palmer, 2003; Kahan et al., 2007), education, and income level also have an impact on benefit/risk assessment and act as a compounding factor with the other aforementioned characteristics (Timmermans et al., 2005). Overall, highly educated, wealthier non-Hispanic whites, for example, are more likely to have better access to quality knowledge, which may in turn lead them to perceive greater benefits from vaccinations in comparison with other groups (e.g., Baker et al. 2010; Luman et al. 2005; Smith and Stevenson 2008; Wooten, Luman and Baker 2007). Older people are generally more risk averse (e.g., Matthews and Moran, 1986) and may focus on the risks of vaccinations over any benefits.

While concentrating upon the role of cultural orientations in the formation of the general public's benefit-risk perception of child vaccinations, this research utilizes these controls to test the various hypotheses drawn from competing theoretical explanations.

3.3. Data, Variables, and Measures

3.3.1. Survey Data

A nationwide Internet survey focused on public perceptions of vaccination risks and policy preferences was conducted in early February 2010. Survey Sampling, Inc. (SSI), of Fairfield Connecticut, recruited the web survey respondents. SSI maintains a panel of approximately 400,000 willing Internet survey participants whose demographics are roughly proportional to national census characteristics. The sample was randomly drawn from the 400,000 census balanced panel. Each member of the sample received an email invitation to participate in the survey describing the general nature and subject matter of the study. As an incentive to participate, each respondent who completed the survey received a five-dollar stipend and was entered into a drawing for a larger cash award. A total of 1,213 respondents (who are adults, 18 years or older) voluntarily participated in the survey. On average, the survey participants were slightly over 45 years of age. Nearly 52% were female, 77% were non-Hispanic White, 45% had completed college, and their median annual household income fell between $40,000 and $50,000. Sixty-four percent of survey participants were parents; approximately half of those who were parents had children living at home. The survey included over 100 questions, requiring an average response time of 22 minutes. The questions focused on issues regarding vaccination practices, perceived benefits and risks of vaccinations, preferences for government vaccination policies, and acquisition of health information from the Internet. Each respondent also provided a range of background information such as age, education level, annual household income and gender. The University Institutional Review Board approved the survey and overall research design for Human

Research Participant Protection. All personal identifiers were eliminated from the data to protect the privacy of survey respondents.

3.3.2. Variables and Measures

Ordinary least square (OLS) regression with robust standard errors is employed to test the hypotheses discussed above. Dependent variables are related with individuals' perceptions of both vaccines' benefits and risks and the balance between them. The primary independent variables of interest are the individual's cultural worldviews, while control variables include individuals' beliefs and values (technocratic disposition and organic culture), level of trust for health care professionals, and the demographic characteristics addressed previously.

Table 10. Variables and Associated Models

<table>
<tr><td rowspan="7">Dependent variable</td><td rowspan="2">Perceived benefits</td><td>Perceived benefits to the society as a whole</td><td>Model 1</td></tr>
<tr><td>Perceived benefits to you and your family</td><td>Model 2</td></tr>
<tr><td rowspan="2">Perceived risks</td><td>Perceived risks to the society as a whole</td><td>Model 3</td></tr>
<tr><td>Perceived risks to you and your family</td><td>Model 4</td></tr>
<tr><td colspan="2">Balance between benefits and risks</td><td>Model 5</td></tr>
<tr><td rowspan="4">Independent variable</td><td rowspan="4">Cultural worldview</td><td>Hierarchism</td><td rowspan="14">Model 1, 2, 3, 4, and 5</td></tr>
<tr><td>Egalitarianism</td></tr>
<tr><td>Fatalism</td></tr>
<tr><td>Individualism</td></tr>
<tr><td rowspan="10">Control variable</td><td rowspan="2">Other beliefs and values</td><td>Technocratic disposition</td></tr>
<tr><td>Organic culture</td></tr>
<tr><td colspan="2">Trust</td></tr>
<tr><td rowspan="7">Demographic characteristics</td><td>Vaccine-related knowledge</td></tr>
<tr><td>Parental status</td></tr>
<tr><td>Age</td></tr>
<tr><td>Gender</td></tr>
<tr><td>Race</td></tr>
<tr><td>Education</td></tr>
<tr><td>Income</td></tr>
</table>

As shown in Table 11, perceived benefit and perceived risk at the individual and societal levels respectively, along with benefit-risk ratio, constitute the dependent variables. The variables related with perceived benefits and risks are graded on an 11-point scale; higher scores indicate that survey respondents perceive higher levels of benefits (or risks). On a 7-point Likert-type scale, a rating of under 4 for the variable of benefit-risk ratio indicates that survey respondents perceive that risks outweigh benefits, while a rating of 4 indicates that benefits and risks are equal, and a score from 5 to 7 indicates that benefits outweigh risks.

Table 11. Dependent Variables and Measures

Variable	Measure
Perceived benefits to the society as a whole	How much benefit do you think vaccinations provide to *society as a whole* by reducing sickness and preventing the spread of infectious diseases? (0=Not at all beneficial to 10=Extremely beneficial)
Perceived benefits to you and your family	How much benefit do you think vaccinations bring to *you and your family* in preventing infectious disease? (0=Not at all beneficial to 10=Extremely beneficial)
Perceived risks to the society as a whole	How much risk from *adverse health reactions* do you think vaccinations pose to *people and society as a whole*? (0=No risk to 10=Extreme risk)
Perceived risks to you and your family	How much risk from *adverse health reactions* do you think vaccinations pose to *you and your family*? (0=No risk to 10=Extreme risk)
Balance between benefits and risks	How do you rate the overall balance of the risks and benefits of required vaccinations for infants and children in the U.S.? (1=Risks far outweigh benefits to 4=Risks and benefits are equally balanced to 7=Benefits far outweigh risks)

Hierarchism, egalitarianism, fatalism, and individualism, the four cultural dispositions rooted in cultural theory, are the primary independent variables. Three cultural bias-related statements representing each disposition (for a total of twelve separate statements) were presented in random order within the survey. On a 7-point

Table 12. Independent Variables and Measures

Variable	Measure
Hierarchism	The best way to get ahead in life is to work hard and do what you are told to do. (1=Strongly disagree to 7=Strongly agree)
	Our society is in trouble because we don't obey those in authority. (1=Strongly disagree to 7=Strongly agree)
	Society would be much better off if we imposed strict and swift punishment on those who break the rules. (1=Strongly disagree to 7=Strongly agree)
Hierarchism index	Index of above three items (α=0.63)
Egalitarianism	What our society needs is a fairness revolution to make the distribution of goods more equal. (1=Strongly disagree to 7=Strongly agree)
	Society works best if power is shared equally. (1=Strongly disagree to 7=Strongly agree)
	It is our responsibility to reduce the differences in income between the rich and the poor. (1=Strongly disagree to 7=Strongly agree)
Egalitarianism index	Index of above three items (α=0.80)
Fatalism	Most of the important things that take place in life happen by random chance. (1=Strongly disagree to 7=Strongly agree)
	No matter how hard we try, the course of our lives is largely determined by forces beyond our control. (1=Strongly disagree to 7=Strongly agree)
	For the most part, succeeding in life is a matter of chance. (1=Strongly disagree to 7=Strongly agree)
Fatalism index	Index of above three items (α=0.77)
Individualism	Even if some people are at a disadvantage, it is best for society to let people succeed or fail on their own. (1=Strongly disagree to 7=Strongly agree)
	Even the disadvantaged should have to make their own way in the world. (1=Strongly disagree to 7=Strongly agree)
	We are all better off when we compete as individuals. (1=Strongly disagree to 7=Strongly agree)
Individualism index	Index of above three items (α=0.70)

ordinal scale ranging from 1 to 7, respondents rated their level of agreement with each statement. The index for each cultural bias is then calculated by taking the mean of each set of three representative statements. The question wording of these cultural measures is provided in Table 12. The indices were derived from previous research (Jenkins-Smith and Smith, 1994; Silva, Jenkins-Smith and Barke, 1997). Factor analysis demonstrates that these indicators are loaded on four unique underlying conceptual dimensions, one for each cultural disposition. Cronbach's alpha scores for scale reliability for the three measures constituting each cultural index were all in the acceptable range, from 0.63 to 0.80.

In order to more precisely evaluate the effects of the primary independent variables (i.e., cultural worldview) on the dependent variables, this analysis control the effect of other values and beliefs, trust of health care professionals, and demographic attributes. To create an index of technocratic disposition, the survey measure respondents' degree of agreement with five statements related to their trust for science in general and for dependence upon expert opinion for societal decision-making. For each statement, responses are graded on a 7-point scale, with higher scores exhibiting higher trust levels. The mean value of all five responses is then used as the technocratic disposition index. Likewise, the survey measure respondents' degree of agreement with three statements addressing organic culture and take a mean score for these three items as the organic culture index. Level of trust for health care professionals is measured on an 11-point scale (from 0 to 10) with higher scores demonstrating greater trust. Finally, this analysis controls demographic variables that could impact personal opinion on vaccinations. In order to create an index representing individuals' level of knowledge,

the survey posed six basic yes-no questions related to vaccine issues. The number of correct answers per individual can range from 0 to 6, with higher scores indicating greater knowledge. Parental status categorizes those who have at least one child under age eighteen, who are parents but do not have any children under age eighteen, and those without children. Respondents are coded 1 for male in gender and for non-Hispanic white in race. Levels of education and household income are measured on 7-point and 21-point scales

Table 13. Control Variables and Measures

Variable	Measure
Technocratic disposition	Technically trained experts, not the public, should make decisions about the applications of advanced technologies in society, such as new mandatory vaccines, use of genetically engineered foods, or reliance on nuclear energy. (1=Strongly disagree to 7=Strongly agree)
	Technology can solve almost all of society's problems. (1=Strongly disagree to 7=Strongly agree)
	The scientific process is the only valid and reliable way to understand nature. (1=Strongly disagree to 7=Strongly agree)
	Those who are better informed should have more influence in policy making. (1=Strongly disagree to 7=Strongly agree)
	Technical issues are so complex that most people cannot contribute to reasonable policy choices. (1=Strongly disagree to 7=Strongly agree)
Technocratic disposition index	Index of above five items (α=0.74)
Organic culture	Man-made toxins are much more dangerous than those toxins found in nature. (1=Strongly disagree to 7=Strongly agree)
	It is almost always better to try natural or homeopathic remedies first. (1=Strongly disagree to 7=Strongly agree)
	In general, organic fruits and vegetables are healthier for you than non-organic ones. (1=Strongly disagree to 7=Strongly agree)
Organic culture index	Index of above three items (α=0.64)

Trust	How trustworthy is information about health issues from health care professionals? (0=Not at all trustworthy to 10=Completely trustworthy)
Vaccine-related knowledge	Even with mandatory vaccine programs, infectious diseases including measles, whooping cough and chickenpox, still occur in small numbers in the United States. (0=No; 1=Yes)
	Vaccines typically cause many harmful side effects, illnesses, and even death. (0=No; 1=Yes)
	Infants have natural immunity for most infectious diseases. (0=No; 1=Yes)
	Getting vaccinated will substantially reduce the likelihood of getting the disease, but it will not eliminate the chance of getting it completely. (0=No; 1=Yes)
	Most health officials recommend that infants and children receive multiple vaccinations for different diseases at the same time. (0=No; 1=Yes)
	Diseases had already begun to disappear before vaccines were introduced, because of better hygiene and sanitation. (0=No; 1=Yes)
Knowledge index	Index of above six items (A total number of correct answers)
Parent with children under 18	1=Parent who has at least one child under 18
Parent with children over 18	1=Parent who does not have any children under 18
Age	Age on last birthday
Gender	1=Male
Race	1=White, Not Hispanic
Education	The highest level of education completed (1=Elementary or some high school to 7=Doctorate (of any type))
Income	Total estimated annual income (1=0-$10,000 to 21=$200,000 or more)

respectively, with higher scores indicating higher levels. The question wording of the control items is shown in Table 13. Cronbach's alpha scores for five technocratic disposition items and for three organic culture items were 0.74 and 0.64, respectively.

Table 14 displays the descriptive statistics. No problematic areas are apparent in distribution, range, and central tendency measures. The distribution of income variable is slightly right-skewed; however, this characteristic is not unusual. In general,

respondents believe that vaccines provide great benefits, both for society and for their own families, and perceive relatively minor societal and personal risks. Turning to the four cultural biases, respondents are less inclined towards fatalism than they are hierarchism, egalitarianism, and individualism. Additionally, respondents possess a relatively high level of vaccine-related knowledge, moderate levels of technocratic disposition and organic culture, and relatively strong trust for advice given by health care professionals.

Table 14. Descriptive Statistics

Variable	*n*	Mean	S.D.	Min	Max
Perceived benefits to the society as a whole	1212	7.8	2.0	0	10
Perceived benefits to you and your family	1194	7.5	2.3	0	10
Perceived risks to the society as a whole	1206	4.6	2.5	0	10
Perceived risks to you and your family	1209	4.1	2.6	0	10
Balance between benefits and risks	1205	5.2	1.5	1	7
Hierarchism index	1196	4.5	1.3	1	7
Egalitarianism index	1199	4.2	1.6	1	7
Individualism index	1195	4.4	1.3	1	7
Fatalism index	1198	3.6	1.5	1	7
Technocratic disposition index	1184	4.0	1.1	1	7
Organic culture index	1196	4.5	1.3	1	7
Trust	1196	7.2	2.0	0	10
Knowledge index	1194	4.4	1.2	0	6
Age	1212	45.2	15.8	18	88
Education	1194	3.5	1.3	1	7
Income	1198	6.1	4.3	1	21

As shown in the following table (Table 15), the number of respondents who are parents of children under age eighteen is 318, while 388 have children over eighteen, comprising 31.7% and 32.3% respectively of total valid responses.

Table 15. Frequency Table

Variable	*n*	Category 1	Category 2
Parent with children over 18	1201	No (68.3%)	Yes (31.7%)
Parent with children under 18	1201	No (67.7%)	Yes (32.3%)
Gender	1201	Female (51.9%)	Male (48.1%)
Race	1207	Non-White (23.0%)	White, Not Hispanic (77.0%)

3.4. Empirical Findings

OLS regression results with robust standard errors are displayed in the following table. The procedures for heteroskedasticity consistent covariance estimation as suggested by White (1980) were applied to address the problem of the heteroskedastic error distribution in statistical inference based on the results acquired from the fitted regression models, and used the results to make adjustments to the standard errors of regression coefficients derived from the OLS estimation in order to improve the statistical inference.

As presented in Table 16, even when controlling for the effects of other variables, cultural biases consistently influence benefit-risk perceptions of childhood vaccinations[8]. As hypothesized, even after controlling for the impacts of individuals' technocratic disposition, organic culture, trust, and demographic characteristics, the results show that a stronger hierarch orientation translates into perceptions of greater

[8] A series of nested *F*-tests was conducted to examine the marginal contribution of a group of cultural orientation variables (i.e., hierarchism, egalitarianism, individualism and fatalism) in explaining dependent variables in all models, considering that all other control variables (based on alternative theoretical claims) are already in the models and that they collectively explain the dependent variables with statistical significance. These results showed that the marginal contribution of cultural orientation measures were statistically significant at the level of $p < 0.001$ in all models.

Table 16. OLS Regression Results

	Dependent variable				
	Perceived benefits to the society as a whole	Perceived benefits to you and your family	Perceived risks to the society as a whole	Perceived risks to you and your family	Balance between benefits and risks
Parameters	Model 1	Model 2	Model 3	Model 4	Model 5
Hierarchism	0.187***	0.269***	0.016	-0.015	0.109***
	(0.052)	(0.066)	(0.066)	(0.072)	(0.039)
Egalitarianism	0.103**	0.079	-0.097*	-0.024	0.066**
	(0.046)	(0.058)	(0.059)	(0.058)	(0.034)
Individualism	-0.051	-0.109*	0.098*	0.177***	-0.059*
	(0.051)	(0.061)	(0.063)	(0.068)	(0.038)
Fatalism	-0.174***	-0.137**	0.377***	0.345***	-0.173***
	(0.049)	(0.059)	(0.060)	(0.062)	(0.038)
Technocratic disposition	0.279***	0.369***	-0.140*	-0.258***	0.297***
	(0.079)	(0.083)	(0.082)	(0.089)	(0.053)
Organic culture	-0.174***	-0.198***	0.461***	0.388***	-0.221***
	(0.053)	(0.066)	(0.060)	(0.060)	(0.036)
Trust	0.254***	0.228***	-0.144***	-0.082**	0.141***
	(0.031)	(0.038)	(0.042)	(0.041)	(0.024)
Knowledge	0.277***	0.258***	-0.326***	-0.430***	0.203***
	(0.050)	(0.061)	(0.064)	(0.066)	(0.035)
Parent with children over 18 (1=Yes)	0.173	0.303	0.246	0.044	0.269**
	(0.172)	(0.217)	(0.202)	(0.222)	(0.119)
Parent with children under 18 (1=Yes)	0.328**	0.432***	0.136	0.304*	0.029
	(0.137)	(0.162)	(0.168)	(0.181)	(0.101)
Age	0.009*	0.010*	-0.025***	-0.019***	0.003
	(0.009)	(0.006)	(0.006)	(0.006)	(0.004)
Gender (1=Male)	-0.212*	-0.209	0.008	-0.002	-0.112
	(0.111)	(0.134)	(0.141)	(0.148)	(0.081)
Race (1=White, not Hispanic)	0.111	-0.143	-0.237	-0.241	0.015
	(0.142)	(0.157)	(0.179)	(0.186)	(0.094)
Education	0.134***	0.194***	-0.044	-0.031	0.049
	(0.043)	(0.053)	(0.059)	(0.061)	(0.036)
Income	0.025*	0.018	-0.015	-0.012	0.020*
	(0.014)	(0.017)	(0.019)	(0.019)	(0.011)
Intercept	2.876***	2.298***	5.536***	5.074***	2.785***
	(0.520)	(0.609)	(0.663)	(0.715)	(0.384)
F	20.59***	15.52***	20.66***	17.71***	19.77***
Adjusted R^2	0.22	0.17	0.22	0.19	0.21
Degree of freedom	1039	1024	1034	1039	1037

*p<0.10. **p<0.05. ***p<0.01. (Robust standard errors in parentheses)

benefits from vaccinations for society and individuals (Model 1 and 2). Furthermore, those with strong hierarchical culture are more likely to perceive vaccinations' benefits to far outweigh their risks (Model 5). Meanwhile, hierarchism does not have

statistically significant impacts on the perceptions of risks (Model 3 and 4). Secondly, the egalitarian bias has a comparatively weaker and less reliable impact on benefit-risk perceptions, confirming this study's earlier conjecture. Strong egalitarians tend to perceive high levels of collective benefit and low levels of collective risk for vaccination (Model 1 and 3) and are prone to think that any risks from vaccination are overshadowed by the benefits (Model 5). The egalitarian bias, however, fails to explain individual-level benefit and risk of vaccination with any statistical significance (Model 2 and 4). Furthermore, the individualist cultural bias also has a modest and somewhat fickle impact upon respondents' perceptions of vaccinations' benefits and risks. In general, strong individualists are likely to imagine low levels of individual benefit (Model 2) and high levels of risks regarding vaccinations (Model 3 and 4). Additionally, those who possess strong individualist orientation are less likely to believe that the benefits are generally greater than the risks (Model 5). However, individualism is not associated with perceived vaccine benefits at the societal level (Model 1) with any statistical significance. The fourth and final cultural bias, fatalism, represents the most cohesive influence on vaccination benefit-risk perception. Archetypical fatalists tend to emphasize the risks (Model 3 and 4), downplay vaccine benefits (Model 1 and 2), and are overall less likely to think the benefits are greater than risks (Model 5).

Of note are several effects brought about by the control variables. In general, individuals' value and belief systems, trust, and some demographic characteristics also influence perceptions of the benefits and the risks of vaccinations in a very consistent manner. Individuals characterized by a strong technocratic disposition, weak organic culture, greater trust for health care professionals, and greater vaccine-related

knowledge perceive higher levels of benefits and lower levels of risks from vaccinations at both societal and individual level. In addition, they are more prone to believe that the benefits are greater than the risks.

The analysis now turns to a prediction of the distributions of perceived benefits and risks of vaccinations by prototypical cultural type. Based upon the statistical simulation technique suggested by King, Tomz, and Wittenberg[9] (2000), this research takes the following analytic steps to calculate predicted distribution of perceived vaccination benefits and risks. First, OLS regression models are estimated using the sample from the previous regression analysis applied for the hypothesis test. In this parsimonious model, the same dependent variables employed previously (i.e., perceived vaccine benefits and risks at both societal and individual levels and their tradeoff) were used, but just four cultural measures (i.e., hierarchism, egalitarianism, individualism, and fatalism) served as explanatory variables. This parsimonious model was utilized mainly because this analysis focuses on the predictions based on the estimated effects of primary explanatory variables (i.e., hierarchism, egalitarianism, individualism and fatalism) on dependent variables (i.e., perceived benefits and risks of vaccinations) rather than on the hypothesis test. Statistical verification of such effects was already accomplished through the previous regression analysis in which major control variables (derived from competing theoretical claims) were included. Table 17 displays the results of this simpler regression analysis.

[9] Because of the finite nature of the sample, King, Tomz, and Wittenberg (2000) argue that parameter estimates from a regression model (e.g., regression coefficients) fit to the sample can never be absolutely certain. Many probable sets of parameters can be drawn from their posterior or sampling distribution to address this uncertainty more directly. For a more effective representation of the original regression results, these simulated results can be displayed graphically or employed for further analysis.

Table 17. OLS Regression Results used for Posterior Simulation

	Dependent variable				
	Perceived benefits to the society as a whole	Perceived benefits to you and your family	Perceived risks to the society as a whole	Perceived risks to you and your family	Balance between benefits and risks
Parameters	Model 6	Model 7	Model 8	Model 9	Model 10
Hierarchism	0.323***	0.402***	-0.089	-0.106	0.203***
	(0.052)	(0.061)	(0.063)	(0.067)	(0.038)
Egalitarianism	0.125***	0.098**	0.032	0.087	0.082***
	(0.042)	(0.049)	(0.051)	(0.054)	(0.031)
Individualism	0.002	-0.055	0.099*	0.177***	-0.011
	(0.047)	(0.056)	(0.058)	(0.061)	(0.035)
Fatalism	-0.278***	-0.204**	0.510***	0.445***	-0.231***
	(0.045)	(0.053)	(0.055)	(0.058)	(0.033)
Intercept	6.863***	6.259***	2.601***	1.792***	4.849***
	(0.278)	(0.328)	(0.341)	(0.358)	(0.205)
F	17.77***	14.17***	30.61***	26.21***	16.77***
Adjusted R^2	0.05	0.04	0.09	0.08	0.05
Degree of freedom	1156	1139	1150	1154	1152

*p<0.10. **p<0.05. ***p<0.01. (Standard errors in parentheses)

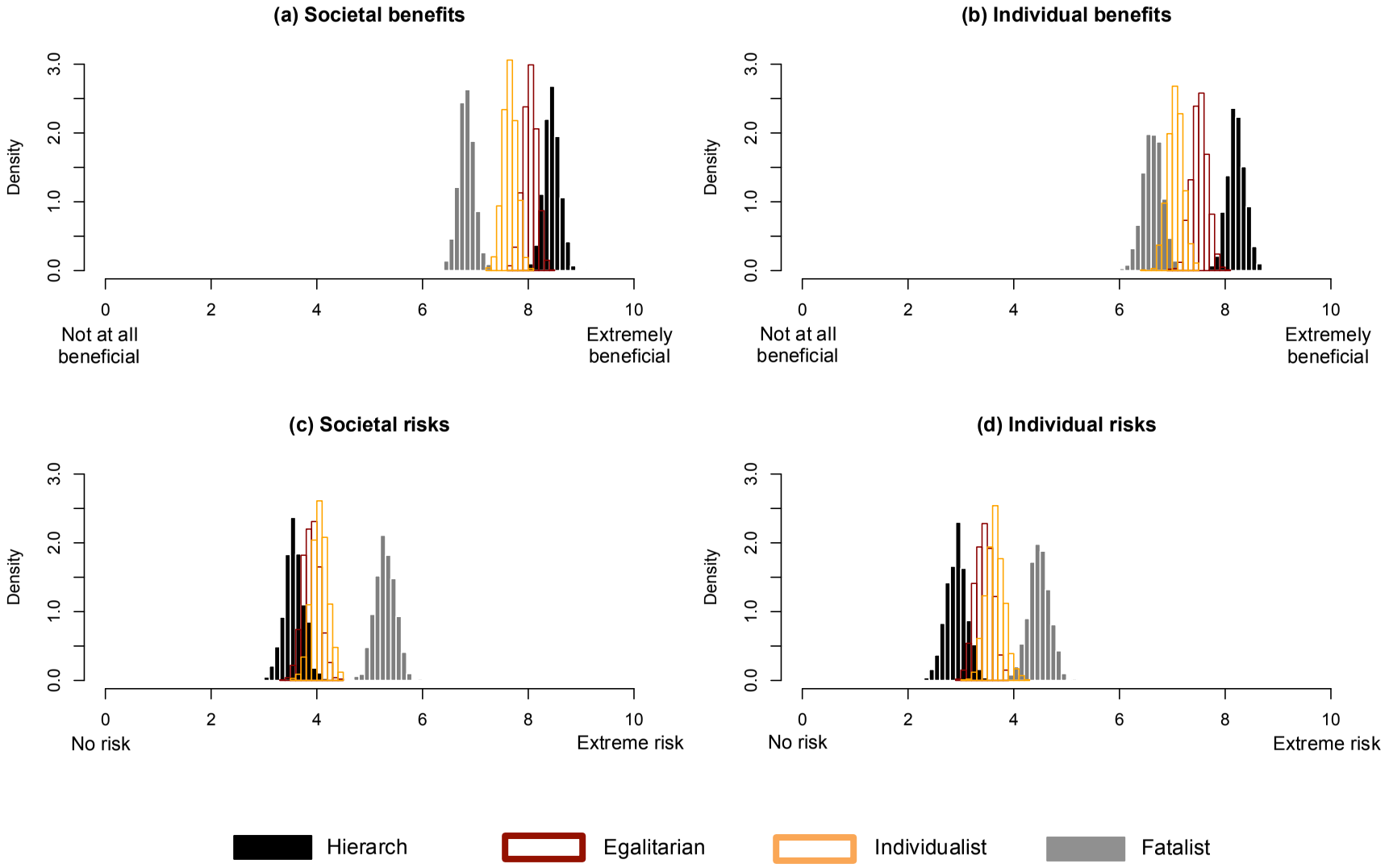
Second, iterative simulation (1,000 times) suggested by Gelman and Hill[10] (2007) based upon the estimated parameters and variance-covariance matrix of these parameters acquired from the first step of the analysis is utilized. One thousand different vectors of estimated regression coefficients (including coefficient for intercept term) for each model were obtained using this iterative simulation. Third, an individual respondent's cultural type is identified using *classification equation* estimated from *discriminant analysis* of data collected from 2011 survey data, as suggested in Chapter 2. This classification equation essentially explains the functional relationships between the four

[10] The following computational steps were taken for this posterior simulation (Gelman and Hill 2007: 143): First, the vector $\hat{\beta}$ of estimated parameters, the variance-covariance matrix of parameter estimates, V_β, and the residual variance $\hat{\sigma}^2$ were computed by using classical regression of *n* observations on *k* predictors. Second, random simulations of the coefficient vector β and the residual standard deviation σ were conducted. For each simulation draw, (a) this analysis simulated $\sigma = \hat{\sigma}\sqrt{(n-k)/X}$, where *X* is a random draw from the χ^2 distribution with $n-k$ degrees of freedom and (b) given the random draw of σ, this analysis simulated β from a multivariate normal distribution with mean $\hat{\beta}$ and variance matrix $\sigma^2 V_\beta$.

cultural orientation measures (i.e., cultural orientation indices) and self identified cultural type found in the 2011 survey sample and can be applied to identify cultural type of an individual when each individual's cultural orientation measures are available. Lastly, in order to obtain a distribution of predicted perceived benefits and risks for the four respective cultural types, I entered the cultural measure values for each prototypical cultural type (determined in the previous step) into each of the 1,000 different simulated regression equations.

The results of the analysis explaining predicted perceived benefits and risks of vaccinations are displayed in Figure 2. Representing the distribution of predicted perceived societal and individual benefits of vaccination are panels (a) and (b) respectively. Panel (c) shows predicted perceived societal risk of vaccination and panel (d), individual risk. *Hierarch* is indicated by the solid black histogram, white outlined in dark gray represents *egalitarian*, white outlined in light gray represents *individualist*, and solid gray represents *fatalist,* as designated in the legend. While the horizontal axis represents the degree of perceived benefits (or risks) of vaccination, the vertical axis of the histograms shows the density function of the distribution. As shown in the panels of Figure 2, the greatest contrast in vaccine benefit- risk perception lies between hierarchs and fatalists (their histograms show no overlap in the distribution of predicted benefit-risk perceptions). In comparison with other cultural types, hierarchs, as predicted, egalitarians perceive greater vaccine benefits and fewer risks than do individualists, while their distributions of predicted perceptions of vaccine risks significantly overlap. Though there are the aforementioned differences among the different cultural types' predicted perceptions of vaccine benefits, all cultural types' measures plainly fall above

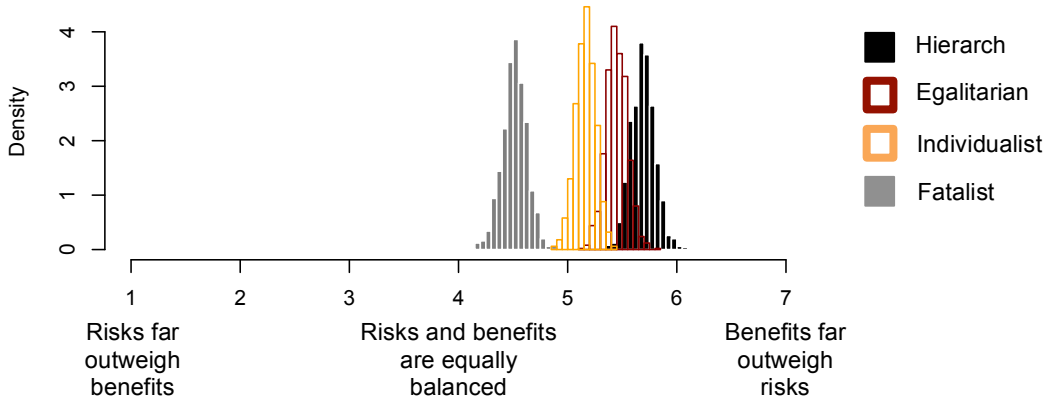
Figure 2. Perceived Benefits and Risks of Vaccination



the midscale. However, for predicted vaccine risk, fatalists rate either above or around the midscale for predicted vaccine risks, revealing a marked contrast in opinion (that vaccination can be dangerous) from other cultural types, indicating that it is the perception of risk rather than benefit that is fueling controversy within the societal vaccine dialogue, as people with different cultural orientations express clashing viewpoints on vaccine risk. Furthermore, while people generally perceive the societal benefits of vaccination use as slightly greater than individual benefits, they likewise feel that the risk posed to individuals is greater than societal risk.

Figure 3 shows the distribution of predicted perceptions of the balance between vaccination benefits and risks. For all four cultural types, there is a clear perception of benefits as greater than risks (falling above the mid scale). In reality, however, this does not mean that individuals of different cultural types will easily come to an agreement about the actual efficacy of vaccinations. Hierarchs' assessment of the benefit-risk ratio of vaccination is much greater than fatalists' and this perceptual difference is the heart of the vaccine controversy.

Figure 3. Predicted Balance between Vaccine Benefits and Risks by Cultural Type



3.5. Summary

This chapter seeks to explain the variations in perceived benefits and risks of vaccinations among the general public. As cultural theory (Douglas and Wildavsky, 1982) claims, the results of the analysis suggest that cultural predispositions significantly influence individuals' perceptions pertaining to vaccine benefits and risks at both societal and individual levels. Those with a strong hierarch orientation tend to envision greater benefits and lesser risk and conceive of a relatively high ratio of benefit to risk when compared to other cultural types. By contrast, those with a strong fatalist tendency are inclined to emphasize risks and downplay benefits while conceiving of a low vaccination benefit-risk ratio. Situated between hierarchs and fatalists, egalitarians are prone to perceive greater benefits, smaller risks and a higher benefit-risk ratio than individualists.

Chapter 4. Understanding Preferences For Childhood Vaccination Policy

Acknowledging that public perception of vaccine benefits and risks can be understood as a sociopolitical surrogate for the justification of competing cultural dispositions aimed at desirable social relations among the members of society, this chapter proceeds to investigate whether average citizens have analogous patterns of rationalization when they are involved in vaccine policy debates. This chapter elucidates how individuals' deep core values concerning a desirable social ordering impact the formation of their preferences toward controversial vaccination policies and key related issues of governance.

4.1. Cultural Theory of Policy Preference Formation

From a neoinstitutionalist perspective, the most important factors influencing individual policy preference involve personal values and beliefs (Peters, 2005; Sabatier and Jenkins-Smith, 1993; Wildavsky, 1987). Because public policy is considered to be an institution designed to resolve a particular social problem, and because public policy based upon due process and social consensus is understood as a norm and rule that defines social relationships, one's preference for a particular public policy is derived not from a simple benefit-cost calculation, but rather from individual evaluation of the nature of influence a given policy, rule, or norm has upon a preferred "way of life" (e.g., Jenkins-Smith and Herron, 2009; Jenkins-Smith and Smith, 1994; Kahan et al., 2010; Lodge, Wegrich and McElroy, 2010; Schwarz and Thompson, 1990; Silva and Jenkins-Smith, 2007; Thompson, Ellis and Wildavsky, 1990). Cultural theory seeks to characterize the scope and nature of preferred ways of life based on different orientations for social relationships based upon two dimensions: *group* and *grid*

(Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). Group refers to what degree individuals are incorporated into "bounded units" within a society and grid indicates to what degree individuals' social relationships are determined by "externally imposed prescriptions" (Thompson, Ellis and Wildavsky, 1990: 5). Based upon these two dimensions are four different types of cultural orientation: hierarchism, egalitarianism, individualism, and fatalism.

The hierarch orientation is rooted in a preference for strong group attachment and numerous social prescriptions that clearly define roles in society. This cultural bias emphasizes authority in the belief that social division of labor based upon specialization and expertise (rather than upon equality among the members of society) contributes to the wellbeing of society as a whole (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). Considering that most experts assert that vaccinations are the most effective way to improve public health through prevention of diseases and that the health risks when weighed against the benefits are negligible, it can be conjectured that those with strong hierarchical tendencies will favor a mandatory vaccination policy. This policy preference is also attributed to the fact that the mandatory vaccination policy is characterized as government prescription emphasizing collective benefits over individual risk. With the same reasoning, those with a strong hierarch bias will tend to reject the various exemption policies. That is, hierarchs are expected to oppose such policies because they are seen to resist expert opinion, focus on individual concerns rather than societal benefits, and are based upon "exceptional" cases which encourage defection from the existing institutional order (of mandatory vaccination policy). From the perspective of risk governance, which is

related to the broader framework of policy decision-making, group-oriented hierarchs will tend to believe that eradication and elimination of infectious diseases is the responsibility of the community and not of individuals. Therefore, hierarchs will believe that the government, not children's parents, should be the chief decision maker regarding childhood immunizations.

The egalitarian orientation, like that of hierarchs, is based upon strong group affinities. However, its grid orientation is weak; egalitarians do not desire social relationships depending upon stratified institutions or the rules imposed by expert "outsiders" (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). That is, egalitarians prefer equal social relationships and dislike institutional infringement and authority imposed from outside the group. A robust sense of group orientation makes egalitarians more concerned about societal risk posed by jeopardizing public health through decreased herd immunity than about infringement upon individuals' choice not to be vaccinated. Because they are most concerned with societal-level wellbeing, they will tend to support government-mandated vaccination policies. However, egalitarians are likely to support such policies to a lesser degree than hierarchs due to their aversion to coercion by concentrated authority based on expert (rather than community) consensus. This cultural characteristic will also have an impact on various vaccine exemption policies; considering that exemption policies focus more on individual rather than collective benefits, like hierarchs, egalitarians will oppose them, but to a lesser degree, due to their skepticism concerning policies based on centralized institutional controls rather than community consensus. Group-oriented egalitarians will be prone to think that the

elimination and eradication of infectious diseases is a societal, not an individual, responsibility. Accordingly, they will tend to believe that the government, not parents, should be the ultimate decision makers with regard to immunization of children. However, egalitarians know that emphasizing the role of government in the immunization of children also means the institutionalization of mandatory vaccination, which lessens their level of agreement with this reinforcement of governmental authority in comparison with hierarchs.

The individualist orientation can be characterized as having both weak group and grid orientations. Individualists prefer *laissez faire*, contract-based social interactions based upon self-regulation and competitiveness rooted in equal opportunity (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). They dislike authority, external prescription, and the idea of equity based on equal outcomes rather than individual merit and effort. With respect to mandatory vaccine policies, individualists (like egalitarians) are likely to be conflicted. Individualists may tend to oppose mandatory vaccination policies because they rely on institutional prescription and coercion. At the same time, individualists will be sympathetic with these policies because they do not want non-vaccinated individuals to impose disease on others against their will; contracting a contagious disease due to the negligence or choice of others violates individualists' preferences for individual autonomy. Nevertheless, individualists are likely to support vaccination exemptions because they oppose imposition of choice on private individuals by governments. They will tend to believe that the elimination of infectious diseases is, in the end, an

individual problem. Therefore, in their view, children's parents should make the key decisions regarding their immunization, not the government.

Based upon a weak group orientation coupled with a perception of capriciously imposed constraints, fatalists lean toward nonparticipation in social relationships and (where possible) seek to avoid the requirements imposed by society (Douglas, 1970; Thompson, Ellis and Wildavsky, 1990; Wildavsky, 1987; Wildavsky and Dake, 1990). Fatalists perceive ubiquitous societal rules and distinctions, exhibiting strong grid orientation, while simultaneously perceiving life's events as chiefly random and uncontrollable. By implication, fatalists would tend to believe that becoming infected with communicable diseases is part of one's destiny or luck, and therefore will be skeptical of the mandatory vaccine policies designed to prevent such diseases. Given that life is largely governed by random events, fatalists are also likely to view the potential risks of vaccines as being as great as the benefits. Because they are likely to be skeptical of vaccine benefits and concerned about the risks, they will tend to support various vaccination exemption policies that would free them from responsibility for vaccinating themselves and their children. This type of cultural orientation will urge

Table 18. Cultural Type and Preferences for Childhood Vaccination Policy

	Mandatory vaccination	Religious exemption	Philosophical exemption	Parent should decide?
Hierarch	Strongly support	Strongly oppose	Strongly oppose	Strongly disagree
Egalitarian	Conflictingly support	Conflictingly oppose	Conflictingly oppose	Conflictingly disagree
Individualist	Conflictingly oppose	Conflictingly support	Conflictingly support	Conflictingly agree
Fatalist	Strongly oppose	Strongly support	Strongly support	Strongly agree

people to think that efforts to eliminate infectious diseases are (at best) left to the individual, rather than depending on a (probably ineffectual) societal mandate. For fatalists, parents, not the government, should be the chief decision makers regarding children's vaccinations. This discussion is summarized in Table 18.

4.2. Organic Culture, Ideology, Religion, and Demographics

Grid/group orientations are not expected to operate in isolation, and there are a number of competing (or complementary) conjectures regarding the sources of vaccine policy preferences. This study includes a subset of those that are most promising, both as rival explanations to cultural theory and as controls in the models that follow. The post-materialistic "organic" subculture promotes personal wellbeing, favoring naturally based remedies and holistic, homeopathic treatments (in the belief that the human body can heal itself) over mechanized, mass-produced, and synthetically derived modern medicine based upon methodological individualism. Therefore, strong adherents to organic culture are expected generally to dislike vaccinations (Ernst, 2001; Gellin, Maibach and Marcuse, 2000; Lehrke et al., 2001), oppose mandatory vaccinations, and support exemption policies, reducing the problem of dealing with infectious diseases to the individual (or local community) level and delegating parents as the chief decision makers for their children's vaccinations. Political ideologies are also expected to influence policy preferences over a wide range of policies (Fiorino, 1989; Rothman and Lichter, 1987; Plutzer, Maney and O'Connor, 1998). Those who are politically conservative generally tend to dislike expansive government that infringes on individual liberties. Therefore, with regard to vaccination policies, conservatives are more likely than liberals to oppose mandatory vaccine policy, which is based upon government

enforcement, and are also more prone to support various exemption policies and to believe that parents should decide whether their children should be given immunizations. Beyond political ideologies, it is also expected that those for whom religion is very important in their personal lives will tend to oppose mandatory vaccination policies, support exemptions (especially those which are religiously or philosophically based) and believe that parents should be the sole decision makers for childhood vaccinations.

Demographic characteristics, including vaccine related knowledge level and domestic composition, can also influence policy preferences regarding vaccinations. Considering the fact that the majority of scientists champion the effectiveness of vaccinations and have verified very few cases of severe adverse reactions, those who are more knowledgeable about the scientific consensus regarding vaccines are likely to support mandatory vaccination policy, oppose exemptions, and favor the government's role in managing childhood vaccinations. Domestic composition also helps form policy preference. For instance, the benefit/risk perceptions (and therefore, policy preference) of parents of infants and young children who are the targets of mandatory vaccine programs may differ from those of people with no children or with adult children. Additionally, females, who tend to be more risk-adverse than men across a wide array of hazards, may generally perceive higher levels of vaccine risk than do males (Barke, Jenkins-Smith and Slovic, 1993). Therefore, parents with infants or young children and females may be more likely to oppose mandatory vaccination policy, support exemptions, and prefer to make their own decisions regarding immunization of any children in their care. Other demographic characteristics such as age, race, education,

and income level may also have an impact on vaccination policy preferences and interact with the other aforementioned characteristics (Timmermans et al., 2005). Prior research has found that on average, highly educated, older, and wealthier non-Hispanic whites are more likely to be more knowledgeable, which may in turn lead them to support mandatory vaccination policy and to dislike exemptions (e.g., Baker et al., 2010; Luman et al., 2005; Smith and Stevenson, 2008; Wooten, Luman and Baker, 2007).

Utilizing these rival explanations and controls, this research tests hypotheses drawn from a variety of theoretical explanations for policy preferences toward childhood vaccination policy and the factors that impinge upon the formation of such preferences. However, the primary focus is on how the general public's cultural biases shape their vaccination policy preferences.

4.3. Data, Variables, and Measures

4.3.1. Survey Data

A February 2010 nationwide Internet survey involving respondents recruited by Survey Sampling International (SSI) was conducted to measure public perceptions of vaccination risks and policy preferences. The sample for this study was drawn from SSI's regular panel of approximately 400,000 Internet survey recruits (whose demographics reflect national census characteristics). A total of 1,213 volunteers aged 18 and older accepted an e-mail invitation describing the study, received five dollars in compensation, and were entered into a larger cash drawing. Each respondent provided a range of background information including age, gender, education level, and household income, revealing that the average age of survey participants was slightly over 45. Nearly 52% of respondents were female, 77% were non-Hispanic whites, and

45% had a college degree. Participants' median annual household income was between $40,000 and $50,000. Of the 64% of participants who were parents, roughly half had children living at home. The survey encompassed over 100 questions focused on issues regarding vaccination practices, perceived benefits and risks of vaccinations, preferences for government vaccination policies, and acquisition of health information from the Internet, with an average response time of 22 minutes. The University of Oklahoma Institutional Review Board approved the survey and overall research design for Human Research Participant Protection.

4.3.2. Variables and Measures

This study employed ordinary least squares (OLS) regression with robust standard

Table 19. Variables and Associated Models

<table>
<tr><td rowspan="4">Dependent variable</td><td colspan="2">Preference toward mandatory vaccination policy</td><td>Model 1</td></tr>
<tr><td colspan="2">Preference toward religious exemption policy</td><td>Model 2</td></tr>
<tr><td colspan="2">Preference toward philosophical exemption policy</td><td>Model 3</td></tr>
<tr><td colspan="2">Parents, not government, as chief immunization decision makers</td><td>Model 4</td></tr>
<tr><td rowspan="4">Independent variable</td><td rowspan="4">Cultural worldview</td><td>Hierarchism</td><td rowspan="13">Model 1, 2, 3 and 4</td></tr>
<tr><td>Egalitarianism</td></tr>
<tr><td>Fatalism</td></tr>
<tr><td>Individualism</td></tr>
<tr><td rowspan="9">Control variable</td><td rowspan="3">Beliefs and values</td><td>Organic culture</td></tr>
<tr><td>Political ideology</td></tr>
<tr><td>Personal Importance of religious faith</td></tr>
<tr><td rowspan="6">Demographic characteristics</td><td>Vaccine-related knowledge</td></tr>
<tr><td>Parent</td></tr>
<tr><td>Age</td></tr>
<tr><td>Gender</td></tr>
<tr><td>Race</td></tr>
<tr><td>Education</td></tr>
<tr><td>Income</td></tr>
</table>

errors to test the hypotheses developed in previous sections of this paper. The variables used in the model estimations are listed in Table 19.

The major dependent variables are the preferences for the existing government vaccine policies: mandatory vaccine policy and religious and philosophical exemption policies. For a given vaccination policy, each respondent's preference is measured on a 7-point ordinal scale ranging from 1 (strongly oppose) to 7 (strongly support). In addition, dependent variables also include the general public's preference for the intrinsic governance framework bearing on vaccine policies, such as whether parents or the government should make decisions about immunization of children. The respondents were asked to rate their level of agreement (or disagreement) with the relevant statement on a 7-point ordinal measure ranging from 1 (strongly disagree) to 7 (strongly agree). The question wording used for measuring these policy preferences is shown in Table 20.

Table 20. Dependent Variables and Measures

Variable	Measure
Preference toward mandatory vaccination policy	How do you feel about vaccine requirements for school entry? (1=Strongly oppose to 7=Strongly support)
Preference toward religious exemption policy	How do you feel about religious exemptions from vaccine requirements? (1=Strongly oppose to 7=Strongly support)
Preference toward philosophical exemption policy	How do you feel about exemptions from vaccine requirements based on the parents' philosophy or beliefs? (1=Strongly oppose to 7=Strongly support)
Parents, not government, as chief immunization decision makers	Parents, not the government, should make decisions about immunizing their children. (1=Strongly disagree to 7=Strongly agree)

The primary independent variables include the four cultural dispositions based upon cultural theory: hierarchism, egalitarianism, fatalism, and individualism. Three cultural

bias-related survey questions were asked for each bias (provided in random order), for a

Table 21. Independent Variables and Measures

Variable	Measure
Hierarchism	The best way to get ahead in life is to work hard and do what you are told to do. (1=Strongly disagree to 7=Strongly agree)
	Our society is in trouble because we don't obey those in authority. (1=Strongly disagree to 7=Strongly agree)
	Society would be much better off if we imposed strict and swift punishment on those who break the rules. (1=Strongly disagree to 7=Strongly agree)
Hierarchism index	Index of above three items (α=0.63)
Egalitarianism	What our society needs is a fairness revolution to make the distribution of goods more equal. (1=Strongly disagree to 7=Strongly agree)
	Society works best if power is shared equally. (1=Strongly disagree to 7=Strongly agree)
	It is our responsibility to reduce the differences in income between the rich and the poor. (1=Strongly disagree to 7=Strongly agree)
Egalitarianism index	Index of above three items (α=0.80)
Individualism	Even if some people are at a disadvantage, it is best for society to let people succeed or fail on their own. (1=Strongly disagree to 7=Strongly agree)
	Even the disadvantaged should have to make their own way in the world. (1=Strongly disagree to 7=Strongly agree)
	We are all better off when we compete as individuals. (1=Strongly disagree to 7=Strongly agree)
Individualism index	Index of above three items (α=0.70)
Fatalism	Most of the important things that take place in life happen by random chance. (1=Strongly disagree to 7=Strongly agree)
	No matter how hard we try, the course of our lives is largely determined by forces beyond our control. (1=Strongly disagree to 7=Strongly agree)
	For the most part, succeeding in life is a matter of chance. (1=Strongly disagree to 7=Strongly agree)
Fatalism index	Index of above three items (α=0.77)

total of twelve questions. Respondents rated the degree of agreement with each statement on a 7-point ordinal scale ranging from 1 to 7. The index for each cultural bias is calculated by taking the mean of each set of three related survey items. The question wording of these variables is presented in Table 21. The indices were based on prior research (Jenkins-Smith and Smith, 1994; Silva, Jenkins-Smith and Barke, 1997). Factor analysis of the indicators demonstrates that they load on four unique factors, one for each cultural disposition. Alpha scalability scores for the three measures were all in the acceptable range, with scores from 0.63 to 0.80.

Control and rival explanatory variables include other values and beliefs that have an impact on policy preference as described above. To create an index of organic culture, the survey measures respondents' degree of agreement with three relevant statements, grading their responses to each on a 7-point scale, with higher scores representing greater agreement. The mean value of all three responses is then used as the organic culture index.[11] Political ideology is measured on a 7-point scale (from 1 to 7) with lower scores exhibiting stronger liberalism and higher scores demonstrating stronger conservatism. Personal importance of religious faith was measured on an 11-point ordinal scale ranging from 0 to 10, with higher scores indicating that respondents consider religion more important in their lives. In order to create an index that measures individuals' knowledge levels regarding vaccinations, the survey posed six basic vaccine related yes-no questions. Individuals are given one point for each correct answer and a final score from 0 to 6, with higher scores indicating greater knowledge (as a higher number of the six questions was answered correctly). Finally, this analysis

[11] The Alpha score for the organic culture scale is 0.64.

Table 22. Control Variables and Measures

Variable	Measure
Organic culture	Man-made toxins are much more dangerous than those toxins found in nature. (1=Strongly disagree to 7=Strongly agree)
	It is almost always better to try natural or homeopathic remedies first. (1=Strongly disagree to 7=Strongly agree)
	In general, organic fruits and vegetables are healthier for you than non-organic ones. (1=Strongly disagree to 7=Strongly agree)
Organic culture index	Index of above three items (α=0.64)
Political ideology	Which of the following categories best describes your views? (1=Strongly liberal to 4=Middle of the road to 7=Strongly conservative)
Personal importance of religious faith	How important is religious faith in your life? (0=Not at all important to 10=Extremely important)
Vaccine-related knowledge	Even with mandatory vaccine programs, infectious diseases including measles, whooping cough and chickenpox, still occur in small numbers in the United States. (0=No; 1=Yes)
	Vaccines typically cause many harmful side effects, illnesses, and even death. (0=No; 1=Yes)
	Infants have natural immunity for most infectious diseases. (0=No; 1=Yes)
	Getting vaccinated will substantially reduce the likelihood of getting the disease, but it will not eliminate the chance of getting it completely. (0=No; 1=Yes)
	Most health officials recommend that infants and children receive multiple vaccinations for different diseases at the same time. (0=No; 1=Yes)
	Diseases had already begun to disappear before vaccines were introduced, because of better hygiene and sanitation. (0=No; 1=Yes)
Knowledge index	Index of above six items (A total number of correct answers)
Parent with children over 18	1=Parent who does not have any child under 18
Parent with children under 18	1=Parent who has at least one child under 18
Age	Age on last birthday
Gender	1=Male
Race	1=White, Not Hispanic

Education	The highest level of education completed (1=Elementary or some high school to 7=Doctorate (of any type))
Income	Total estimated annual income (1=0-$10,000 to 21=$200,000 or more)

controls demographic variables that could impact personal opinion on vaccination policies. Parental status identifies parents of children under age eighteen, of children eighteen and older, and non-parents. In the categories of gender and race, respondents are coded 1 for male and for non-Hispanic white. Levels of education and household income are measured on 7-point and 21-point rising scales, respectively. The question wordings for the control items are shown in Table 22.

As shown in Table 23, distribution, range, and central tendency measures reveal no apparent statistical problems. In general, respondents prefer mandatory vaccination

Table 23. Descriptive Statistics

Variable	*n*	Mean	S.D.	Min	Max
Preference toward mandatory vaccination policy	1203	5.5	1.6	1	7
Preference toward religious exemption policy	1201	3.5	2	1	7
Preference toward philosophical exemption policy	1205	3.3	1.9	1	7
Parents as chief immunization decision makers	1208	4.4	1.9	1	7
Hierarchism index	1196	4.5	1.3	1	7
Egalitarianism index	1199	4.2	1.6	1	7
Individualism index	1195	4.4	1.3	1	7
Fatalism index	1198	3.6	1.5	1	7
Organic culture index	1196	4.5	1.3	1	7
Political ideology	1203	4.1	1.6	1	7
Personal importance of religious faith	1209	6.5	3.4	0	10
Knowledge index	1194	4.4	1.2	0	6
Age	1212	45.2	15.8	18	88
Education	1194	3.5	1.3	1	7
Income	1198	6.1	4.3	1	21

policy to various exemption policies. When they were asked who should decide about immunizing children many people felt that parents rather than the government should have the final say. In terms of cultural biases, respondents are more inclined toward

hierarchism, egalitarianism, and individualism than they are toward fatalism. Respondents exhibit a modest level of affinity with "organic culture" and a normal distribution over the range of political ideologies. Overall, respondents indicate that religious faith is relatively important in their lives and possess moderately high levels of vaccine related knowledge as measured on the index. The distribution of the income variable displays the typical characteristic of being skewed to the right.

The frequencies of the categorical variables are shown in Table 24. While 381 participants (31.7% of total valid responses) are parents who do not have any child under eighteen, 388 participants (32.3% of total valid responses) are parents who have at least one child under eighteen.

Table 24. Frequency Table

Variable	*n*	Category 1	Category 2
Parent with children over 18	1201	No (68.3%)	Yes (31.7%)
Parent with children under 18	1201	No (67.7%)	Yes (32.3%)
Gender	1201	Female (51.9%)	Male (48.1%)
Race	1207	Non-White (23.0%)	White, Not Hispanic (77.0%)

4.4. Empirical Findings

Table 25 displays the OLS regression results with robust standard errors. In order to tackle the problem of the heteroskedastic error distribution in statistical inference based on the results acquired from the fitted regression models, this analysis applied the procedures for heteroskedasticity consistent covariance estimation suggested by White (1980) and used the results to make adjustments to the standard errors of regression

Table 25. OLS Regression Results

	Dependent variable			
	Preference toward mandatory vaccination policy	Preference toward religious exemption policy	Preference toward philosophical exemption policy	Parents, not government, as chief immunization decision makers
Parameters	Model 1	Model 2	Model 3	Model 4
Hierarchism	0.272***	-0.238***	-0.258***	-0.209***
	(0.044)	(0.055)	(0.060)	(0.057)
Egalitarianism	0.137***	-0.110**	-0.062	-0.024
	(0.039)	(0.048)	(0.047)	(0.047)
Individualism	0.034	0.162***	0.205***	0.253***
	(0.041)	(0.051)	(0.055)	(0.050)
Fatalism	-0.101***	0.195***	0.194***	0.175***
	(0.038)	(0.048)	(0.049)	(0.048)
Organic culture	-0.166***	0.234***	0.236***	0.185***
	(0.040)	(0.050)	(0.048)	(0.048)
Political ideology	-0.070**	0.048	0.039	0.100**
	(0.034)	(0.043)	(0.041)	(0.041)
Personal importance of religious faith	0.005	0.135***	0.090***	0.091***
	(0.014)	(0.018)	(0.018)	(0.018)
Knowledge	0.173***	-0.190***	-0.219***	-0.152***
	(0.040)	(0.048)	(0.047)	(0.046)
Parent with children over 18 (1=Yes)	0.088	-0.058	-0.005	0.076
	(0.133)	(0.171)	(0.160)	(0.168)
Parent with children under 18 (1=Yes)	0.055	-0.025	0.128	0.256*
	(0.115)	(0.140)	(0.139)	(0.134)
Age	0.009**	-0.026***	-0.023***	-0.018***
	(0.004)	(0.005)	(0.005)	(0.005)
Gender (1=Male)	-0.150*	-0.049	-0.005	0.040
	(0.090)	(0.113)	(0.111)	(0.109)
Race (1=White, not Hispanic)	-0.071	0.402***	0.337**	0.461***
	(0.117)	(0.141)	(0.139)	(0.134)
Education	0.058*	0.018	-0.050	-0.132***
	(0.035)	(0.048)	(0.048)	(0.046)
Income	0.018	-0.018	-0.011	-0.003
	(0.011)	(0.014)	(0.014)	(0.015)
Intercept	3.584***	3.199***	3.297***	3.376***
	(0.430)	(0.533)	(0.535)	(0.545)
F	10.01***	15.48***	15.94***	14.84***
Adjusted R^2	0.112	0.169	0.173	0.162
Degree of freedom	1054	1053	1056	1058

*p<0.10. **p<0.05. ***p<0.01. (Robust standard errors in parentheses)

coefficients derived from the OLS estimation in order to improve the statistical inference. The results show that cultural biases systematically influence vaccine policy preferences even when controlling for the effects of other variables on the dependent variable. First, as hypothesized earlier, those with strong hierarchical culture tend to support mandatory vaccine policy (Model 1), oppose various exemption policies (Model 2 and 3), and find that the government, not parents, should determine childhood vaccinations (Model 4). Second, as conjectured, egalitarian bias has a comparatively weaker and less consistent impact on vaccine related policy preferences. Those who have a strong egalitarian bias tend to support mandatory vaccine policy (Model 1) and oppose religious exemption policy (Model 2). However, egalitarianism has no statistically significant impact on any other policy preferences (Model 3 and 4). Third, the individualist cultural bias has an inconsistent impact on vaccination policy preferences. Strong individualists are more likely to support various vaccine exemption policies (Model 2 and 3) and agree that parents, not the government, should decide on children's vaccinations (Model 4). However, individualism has no statistically significant impact on other policy preference (Model 1). Finally, the fatalist bias exhibits a consistent influence on various vaccine-related policy preferences. As expected, strong fatalists tend to oppose mandatory vaccination policies (Model 1), support various exemption policies (Model 2 and 3), and believe that parents should decide if their children are immunized (Model 4).

The effects of several control variables on the policy preferences are noteworthy. In general, those who are characterized by a strong organic culture, who

are politically conservative[12], who hold strong religious beliefs[13], or who are non-Hispanic white, older, or who are less knowledgeable about immunizations are more reluctant to support mandatory vaccination policy (Model 1), tend to favor vaccine exemption policies (Model 2 and 3), believe that parents, not government, should chiefly decide about immunization of children (Model 4).

The next analysis involves a prediction of the distributions of vaccine policy preferences according to prototypical cultural type utilizing the fitted regression model and technique of statistical simulations suggested by King, Tomz, and Wittenberg (2000). Based upon this approach, this research took the following analytic steps to acquire predicted distribution of various vaccine policy preferences for each of the four cultural types in this paper. First, OLS regression models were fitted to the sample used for previous regression analysis for the hypothesis test. This regression analysis used the same dependent variables employed in the previous models (i.e., preferences for various vaccination policies), but used only the four cultural measures (i.e., hierarchism, egalitarianism, individualism, and fatalism) as explanatory variables. A simplified model mainly because the focus of this analysis does not lie in the hypothesis test (which was the focus of previous regression analysis) but in the predictions based on the estimated effects of primary independent variables (i.e., cultural measures) on dependent variables (i.e., vaccine policy preferences) which were statistically verified in the previous regression analysis that also contained control variables derived from other major competing theoretical claims. In addition, hypothesis tests involved in previous regressions showed that many of the estimated regression coefficients for the control

[12] The effect of support for vaccine exemption policies based upon religion or philosophical belief is not statistically significant.
[13] Their propensity to support mandatory vaccination policy is not statistically significant.

variables are not statistically significantly different from zero, which was another reason to discard these variables in this regression analysis for the prediction. The results of this regression analysis are shown in Table 26. Second, based upon the estimated parameters and variance-covariance matrix[14] of these parameters acquired from the first

Table 26. OLS Regression Results used for Posterior Simulation

	Dependent variable			
	Preference toward mandatory vaccination policy	Preference toward religious exemption policy	Preference toward philosophical exemption policy	Parents, not government, as chief immunization decision makers
Parameters	Model 5	Model 6	Model 7	Model 8
Hierarchism	0.264***	-0.174***	-0.210***	-0.141**
	(0.041)	(0.053)	(0.050)	(0.050)
Egalitarianism	0.097***	-0.029	0.011	0.010
	(0.033)	(0.043)	(0.041)	(0.040)
Individualism	0.015	0.166***	0.204***	0.250***
	(0.037)	(0.048)	(0.046)	(0.046)
Fatalism	-0.171***	0.233***	0.266***	0.229***
	(0.035)	(0.046)	(0.044)	(0.043)
Intercept	4.504***	2.827***	2.395***	3.098***
	(0.219)	(0.284)	(0.271)	(0.268)
F	16.85***	11.38***	17.94***	18.120***
Adjusted R^2	0.052	0.035	0.055	0.056
Degree of freedom	1149	1148	1151	1154

**p<0.05. ***p<0.01. (Standard errors in parentheses)

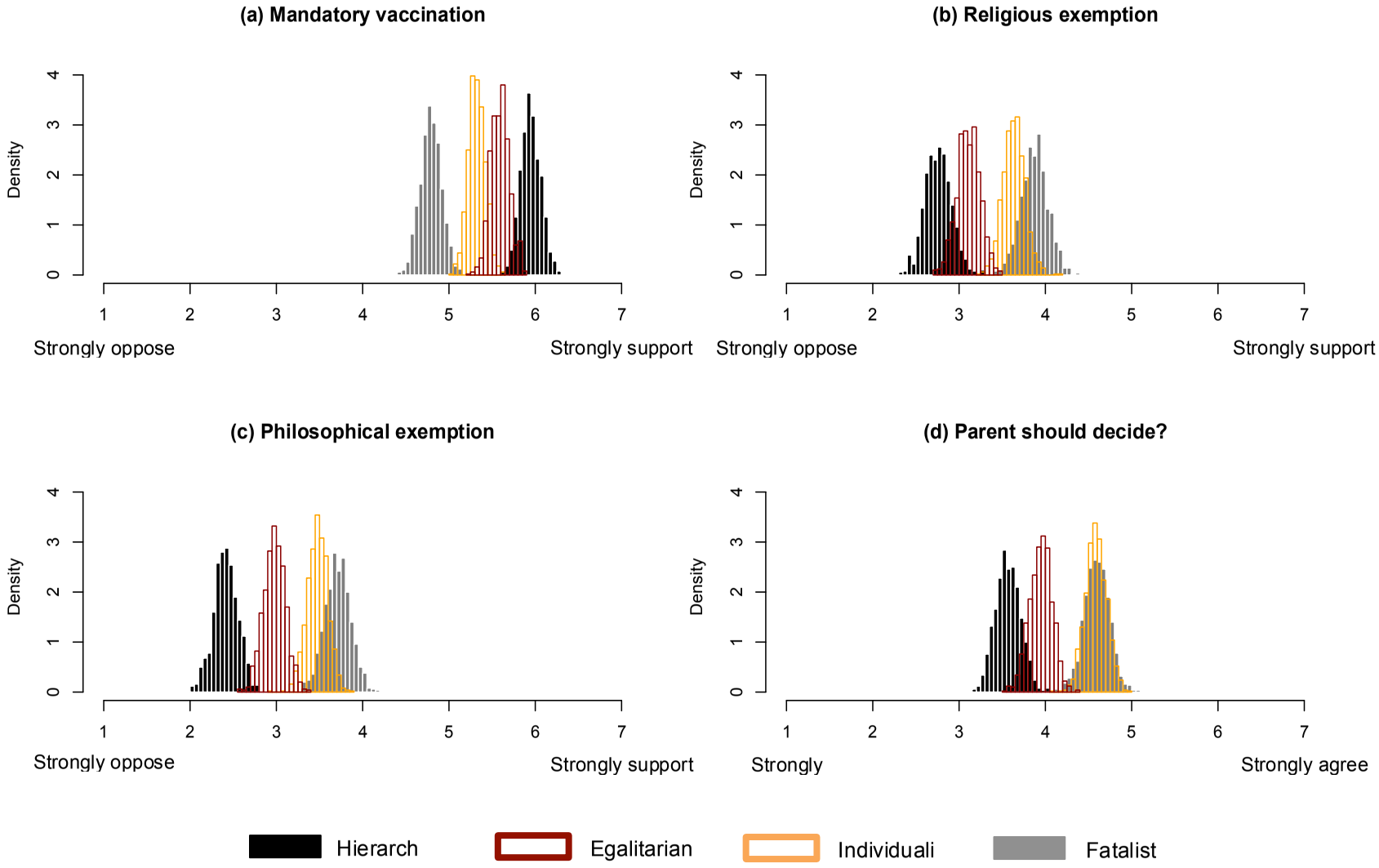
step of the analysis, this analysis ran iterative simulation (1,000 times) suggested by Gelman and Hill (2007). From this iterative simulation, 1,000 different vectors of estimated regression coefficients (including coefficient for intercept term) for each model were obtained. Third, this analysis determined each individual's cultural type by applying *classification equation* (estimated from *discriminant analysis* of 2011 survey

[14] This analysis uses variance-covariance matrix of estimated parameters derived from OLS regression rather than the one adjusted to heteroskedastic distribution of errors, which was used for statistical inference in the original multivariate model, because no heteroskedasticity problem was found in this simplified regression model.

data) to predict cultural type using individuals' cultural orientation indices derived from 2010 survey data, as proposed in Chapter 2. As this classification equation basically explains how four cultural orientation measures predict each cultural type, we can predict cultural type of any sample when we have cultural orientation measures of that sample. Finally, the cultural measure values for each prototypical cultural type determined in the previous step were entered in each of the 1,000 different simulated regression equations in order to obtain a distribution of predicted preferences for each of the four cultural types for the respective childhood vaccination policies.

Figure 4 displays the results of this analysis highlighting the four most contested childhood vaccination policy issues. Panel (a) shows distribution of predicted policy preferences for mandatory vaccinations, while panels (b), (c), and (d) show predicted policy preferences for religious exemption, philosophical exemption, and opinion on parental decision-making power regarding vaccinations, respectively. As shown in the legend, the solid black histogram represents hierarch, white outlined in dark gray represents egalitarian, white outlined in light gray represents individualist, and solid gray represents fatalist. The vertical axis of the histograms shows the density function of the distribution, while the horizontal axis represents either the degree of support for, or level of agreement with, the given policy issue. Overall, the panels in Figure 4 reveal that hierarchs and fatalists are the two cultural types exhibiting the sharpest contrast in policy preference (histograms show no overlap in the distribution of predicted policy preferences for these two prototypes). As expected, hierarchs are typically in support of mandatory vaccination, oppose religious and philosophical

Figure 4. Vaccination Policy Preference by Cultural Type



exemption, and feel that government should preside over vaccination-related decisions. Fatalists strike a bold contrast in their opposition to mandatory vaccination policy and support for religious and philosophical exemptions. In addition, they are much more likely to support the role of parents in deciding on vaccinations. In general, the divergence in policy position between the two groups is driven by hierarchs, who are, for instance, clearly and strongly in support of mandatory vaccine policy, and oppose religious and philosophical exemptions, whereas fatalists neither strongly oppose (or support) mandatory vaccinations nor are in clear support of (or opposition to) exemptions based on religious and philosophical beliefs. Instead, fatalists' opinions on both issues tend to fall closer to the scale midpoint, reflecting both less support for mandatory vaccination positions and a less decisive position overall. Falling between hierarchs and fatalists, egalitarian support for vaccinations is essentially stronger than individualists', while the two exhibit notable overlap in their distribution of predicted preferences toward mandatory vaccination.

4.5. Summary

This chapter seeks to explain varying public opinions in the vaccine policy subsystem of the United States, where conflicting principles coexist within the same policy. Consistent with the argument of cultural theory (Douglas and Wildavsky, 1982), it is found that cultural biases have significant impacts on the formation of preferences toward vaccination policies. Hierarchs and egalitarians are more likely to be pro-vaccination, while individualists and (especially) fatalists tend to oppose this view. Hierarchs advocate mandatory vaccination, disapprove of religious and philosophical exemptions, and believe that government, not parents, should preside over childhood

immunizations. By contrast, fatalists are inclined to negate mandatory vaccination policy and uphold religious and philosophical exemptions and the role of parents in determining vaccination of children. Egalitarians' pro-vaccination inclination is relatively weaker and less consistent than hierarchs', while individualists' anti-vaccination leanings are overall less robust than those of fatalists.

Chapter 5. Parents' Behavioral Decisions On Childhood Vaccinations

Previous chapters have found that individuals' morally based preferences for what they perceive as an ideal social order shape their benefit-risk perceptions regarding vaccinations and are reflected in their policy judgments. The practical implications of such findings are manifold. Government health authorities can utilize knowledge concerning the way individuals' cultural orientations shape vaccine benefit-risk perception and policy preference to improve risk communication between the government, experts, and average people (Kahan, Jenkins-Smith and Braman. 2011**)**. This goal is best carried out by adopting communication strategies based on *identity confirmation* (Cohen, Aronson and Steele, 2000), *pluralistic advocacy* (Earle and Cvetkovich, 1995), and *narrative framing* (Jones and McBeth, 2010; Shanahan, Jones and McBeth, 2011) and fostering "desirable" changes to public opinions on the issue.

To pinpoint the practical limitations of these findings, we must first consider whether such "desirable" changes in general public attitude toward vaccine benefits and risks and related policies can actually directly translate into individual behavioral changes with regard to vaccinations. Considerable previous research in public policy does not explicitly address the translation of such beliefs into behavior. Instead, the focus remains on examining what shapes such beliefs (e.g., vaccine benefits and risks and policy preferences), with the assumption that those beliefs automatically translate into individuals' behaviors. Though this assumption is not incorrect, it does not provide much assistance in terms of the practical implications as to how an actual policy outcome can be realized through changes not only in individuals' attitudes and thoughts, but also in their behavior. This chapter focuses upon an empirical test of this very

assumption: In the context of childhood vaccination policy, how do individuals' policy related beliefs (e.g., perceptions of vaccine benefits and risks and attitudes toward existing vaccine policies) actually translate into their behaviors, and what factors mediate such translations?

5.1. Health Behavior Theories?

Public health scholars have developed individual level health behavior theories for several decades. Major theoretical models of individual health-related behavior, such as the Health Belief Model (HBM, Becker, 1974; Janz and Becker, 1984; Kirscht, 1988), Protection Motivation Theory (PMT, Maddux and Rogers, 1983; Prentice-Dunn and Rogers, 1986; Rogers, 1983), Subjective Expected Utility Theory (SEUT, Edwards, 1954; Ronis, 1992; Sutton, 1982) and Theory of Reasoned Action (TRA, Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) address individuals' behavior as motivated by their own reasoning, which in turn is composed mainly of two components: value and expectation (Weinstein 1993). The theoretical root of this claim is the *value-expectancy theory* (Fishbein, 1967; Fishbein, 1968). Cognitive psychologists argue that individual behavior is a "function of the subjective *value* of an outcome and of the subjective probability, or *expectation,* that a particular action will achieve that outcome" (Champion and Skinner, 2008: 46). The emphasis of this theoretical tradition lies in the influence of individuals' mental processes (e.g., "thinking, reasoning, hypothesizing, and expecting" (Champion and Skinner, 2008: 46)) on their action; *reinforcements* are considered to operate by mediating expectations about the situation rather than having direct bearings on behavior. When applied to the issue of public health, the aforementioned theoretical models of individual health related behavior generally

assume that "anticipation of a negative health outcome and the desire to avoid this outcome or reduce its impact creates motivation for self-protection" (Weinstein, 1993: 324-325). Individuals' behaviors (their efforts to improve their own health) fall under the influence of the subjective value they assign to the "expected *aversiveness*" of the outcome (Weinstein, 1993: 325). In the HBM and PMT, this is framed as *perceived severity* of health consequences, in SEUP as negative *utility*, and in the TRA as negative *evaluation*. In all models, the impact of the perception of an adverse outcome on motivated behavior is in turn affected by its perceived probability, which is known as *perceived vulnerability* or *perceived susceptibility* in the HBM and PMT, *subjective probability* in SEUT, and as *expectancy* in the TRA. If there is an expectation that a certain action can reduce "the likelihood or severity of harm," then there is naturally also motivation to take that action. Thus, expected benefit is the belief about the extent an action can actually mitigate the severity and likelihood of the undesirable health outcome.

How can we apply these theoretical configurations[15] in explicating parents' behaviors regarding childhood vaccinations? When an individual parent perceives high levels of risk from disease infection (i.e., believes that the severity and probability of disease infection is high), he or she will be more motivated to have his or her children vaccinated, and the expected benefit from such a behavioral decision is the mitigation of the risk of disease infection (both in terms of severity and probability) posed to the child by taking such preventive measures. The real focus of the discussion of this research,

[15] Certainly, such simplified descriptions do not fully encapsulate all the complexities of these theoretical models, but this study seeks a broader conceptual discussion than already found in the existing theoretical literature. For a more detailed comparative review of the theories, see Weinstein (1993).

however, is how to address the risks derived from vaccination *per se*. Vaccinating can be thought of as an action motivated by the belief that it can generate benefits, to the extent that it mitigates the risks posed by disease infection at the individual level and secures herd immunity at the collective level. At the same time, we cannot ignore that such an action can also generate harmful consequences if side effects occur. If we assume that all members of society equally perceive the same level of benefit from vaccination (i.e., benefits gained from avoiding potential disease infection), then the motivation of vaccine related behavior (and the force behind individual variation in that behavior) is dependent upon individuals' perception of risk; when people perceive higher levels of (individual and societal) risks (in terms of severity and probability of vaccine side effects), then expected benefits derived from avoiding vaccinations strongly motivate them to "opt out" from vaccination for their own children. Meanwhile, if we assume that members of society all perceive roughly the same levels of risk from vaccinations, then perceived (individual and societal) benefits from vaccinations can influence individuals' vaccination behavior as a motivation factor. Furthermore, parents' mental comparison between these two important aspects of vaccinations (i.e., risks and benefits), not just an independent consideration of each dimension, will motivate vaccination-related behavior such that the more parents believe vaccine benefits outweigh the risks, the more likely they are to actually vaccinate their children.

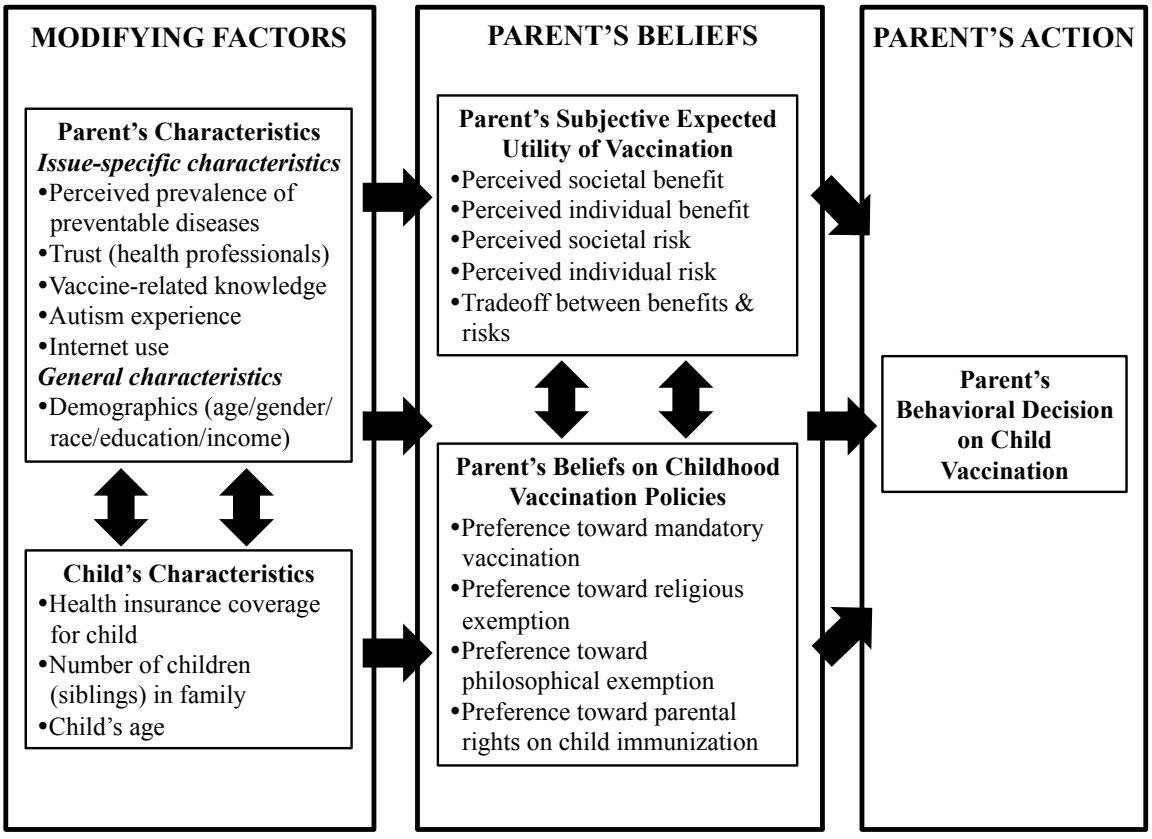
More importantly, most of the aforementioned individual level health related behavior theories have neglected the idea that "related policies" can function as institutional constraints on individual behaviors; this is not strange, however. Not all

individual-level health related behaviors are actually constrained by government policy (e.g., consuming lots of sugary foods after an individual has been diagnosed with diabetes). However, the TRA differs from other preceding models by explicitly incorporating social influence. It does this by examining how much members of society desire to see an individual follow a shared set of social norms and mores by taking a particular action, and how much the individual feels compelled by their instructions. While this theory does not explicitly consider the importance of government policy in shaping individuals' behavior, it provides some theoretical basis (particularly from a neoinstitutionalist perspective, which considers institutions as part of the norms and beliefs shared by members of a society (e.g., Peters, 2005; Sabatier and Jenkins-Smith, 1993; Wildavsky, 1987)) for directly scrutinizing the influence of government policy vis-à-vis individuals' vaccination related behavioral decisions. Public policy is often linked with the goals of social change, sharing the aim to resolve a particular social problem. Social change is possible only when accompanied by changes in individual behaviors (Coombs, 1980). This does not necessarily mean that government policy dictates individuals' behaviors, but it can function as an institutional constraint. Therefore, individual preferences (e.g., support or opposition) toward existing policies can be an important part of motivation, which sets the course for behavior. In the case of childhood vaccination, the United States' current policies (e.g., both mandatory policy and various exemptions) simultaneously allow for a variety of individual behaviors. Under such an arrangement, it is plausible to argue that the degree to which vaccination policies (as institutional constraints) affect individual behavior depends on what preferences the same individual has toward such policies.

5.2. Analytical Framework and Hypotheses

The proposed analytical framework of this research is presented in Figure 5. As the previous theoretical arguments imply, parents' behavior in relation to childhood vaccinations is motivated by subjective expected utility of vaccination and preferences towards existing government vaccine policy. The parent's and child's demographic and

Figure 5. Analytical Framework



vaccination-related characteristics influence these dynamics both directly and indirectly. That is, such factors may have a direct impact on a parent's behavioral decisions about vaccination, or indirectly impact them by impinging upon subjective expected utility and policy preferences, which in turn influence his or her behaviors.

More specifically, subjective expected utility of vaccination explores the benefits and risks at both societal and individual levels, and their tradeoffs. It is conjectured that when individual parents perceive greater benefits, low risks, and a high benefit-risk ratio, they will be more likely to take their children to receive all government recommended vaccinations. Meanwhile, parents' preferences (support or opposition) toward existing vaccination policies and related key issues of governance will influence their vaccination related behaviors. It is expected that when parents strongly support mandatory vaccinations, clearly oppose religious and philosophical exemption policies, and believe that the government, not parents, should be the chief decision maker when it comes to childhood immunizations, they will be more likely to have their children vaccinated.

Other factors may also influence a parent's behavioral decisions regarding his or her children, including individual demographic characteristics and the perceived prevalence of preventable diseases. Parents who believe that the world has become "much safer" and healthier (less risky) in regards to the threat of certain preventable infectious diseases will be less likely to vaccinate their children (Calandrillo, 2004; Wolfe and Sharp, 2002). Parents who distrust health care professionals (who are frequently tasked with the important role of transmitting vital public health information to the general public) will be strongly influenced by such misgivings when judging the benefits and risks of vaccinations (Gust et al., 2004; McMurray, 2004; Flanagan-Klygis, Sharp and Frader, 2005). Perhaps not surprisingly, distrustful parents are less likely to support mandatory vaccination policy and vaccinate their own children. This is likely because the majority of health care experts strongly advocate for the considerable

benefits of vaccinations for infants, children, and public health. An individual assessment of the benefits and risks of vaccination and related policies can be influenced by his or her *affect*[16] towards vaccines, and this can impact behavioral decisions regarding vaccinations. The evolving controversy over a potential vaccine-autism link provides a prime example. A few members of the scientific community have published studies claiming that thimerosal, a preservative found in vaccines, can result in both neurological damage and autism in infants and children (e.g., Stratton, Gable and Shetty 2001; Wakefield et al. 1998; Wakefield and Montgomery 2000). However, the current consensus among most experts is that this claim is erroneous (e.g., Dales, Hammer and Smith 2001; Kaye, Melero-Montes and Jick 2001; Taylor et al. 1999). A recent federal vaccine court decision added fuel to the vaccine-autism link controversy when it was found that vaccines did not cause Hannah Polling's autism, but that receiving vaccinations "resulted" in a grave reaction caused by an as-yet unknown mitochondrial disorder (Attkisson, 2010), after which the government compensated the Polling family with $1.5 million and $500,000 for each following year for the duration of the child's lifetime. Along with absorbing controversial information, parents with family and friends who have autism or Asperger's syndrome are more likely to view vaccines in a negative light. Though any link between vaccines and autism is as yet unproven, such "false" information is quickly and easily disseminated through the Internet (Clements et al., 1999), particularly to frequent web users. This in turn will serve to reinforce unfavorable notions about mandatory vaccinations and encourage a

[16] Slovic et al. (2004: 2-3) define *affect* as "the specific quality of "goodness" or "badness" (1) experienced as a feeling state (with or without consciousness) and (2) demarcating a positive or negative quality of a stimulus." For more details, see Finucane et al. (2000), Slovic et al. (2004), or Slovic et al. (2007).

like-minded parent to avoid vaccination for his or her child. Since the great majority of scientists currently uphold vaccinations as a means of effective and safe disease prevention for infants and children, those who have absorbed more vaccine related knowledge from mainstream scientific sources are more likely to see vaccinations as beneficial and support government operated mandatory vaccination programs.

Meanwhile, parents' general demographic characteristics, such as age, race, gender, education, and income level also have an impact on an individual's benefit-risk assessment of vaccinations and impinge upon the other previously mentioned factors (Timmermans et al., 2005). Due in part to vestiges of male social and economic domination in the structure of contemporary society, and also to biological differences that foster more protective and cautious reactions overall, females are generally more likely than males to think that vaccinations are risky (Finucane, Slovic, Mertz, Flynn, et al. 2000; Flynn, Slovic, and Mertz, 1994; but see Palmer, 2003; Kahan et al., 2007). Non-Hispanic whites with both higher education and income levels are more privy to quality knowledge regarding vaccinations. Therefore, this demographic group may be led to conclude that vaccinations are more beneficial than other groups would believe (e.g., Baker et al. 2010; Luman et al. 2005; Smith and Stevenson 2008; Wooten, Luman and Baker 2007). Finally, as people often become more risk averse as they age, the elder members of the population may emphasize the risks of vaccinations over benefits.

Demographic characteristics of a child, such as his or her age, whether the child is covered by health insurance, and how many siblings the child has, will also be examined as control variables. One can expect that parents are more likely to vaccinate their child when the child is young, has health insurance, and has fewer siblings.

5.3. Data, Variables, and Methods

5.3.1. Survey Data

Data for this study comes from a nationwide Internet survey conducted in early February 2010, which examines public perceptions of vaccine risks and individual policy preferences. Participants were randomly selected and recruited via e-mail notification from the Survey Sampling, Inc. (SSI) panel of roughly 400,000 volunteer online survey participants who reflect national census demographics, for a total number of 1,213 volunteers (all adults above age 18). Each participant was awarded five dollars for completing the roughly 22-minute, 100 question survey and given a chance to win a cash prize drawing. The average age of the survey participants was slightly over 45 years, while 52% of them were female, 77% non-Hispanic white, and 45% had a college degree. The median household income fell between $40,000 and $50,000. Approximately half of the 64% of survey respondents who indicated they were parents had small children at home. It is upon this subsample of parents (who had at least one child under age 18), and their children, that this research is focused. Participants answered a variety of questions centered on vaccine practices, perceived benefits and risks of vaccinations, preference for government vaccination policy, and personal experience with accessing vaccine related information on the Internet. Additionally, each respondent provided basic personal demographic information, including age, gender, level of education, and household income. The University Institutional Review Board approved the survey structure as part of Human Research Participant Protection.

5.3.2. Variables and Measures

As shown in Table 27, the dependent variable in this study is linked with whether, and how, the parent (survey respondent) vaccinated his or her child. This is categorized where 0, 1, and 2 mean that a child received no, some, or all of the recommended vaccinations respectively.

Table 27. Dependent Variable and Measures

Variable	Measure
Vaccination	To the best of your knowledge, have your children received all, some or none of the recommended vaccines? (0=Child received no vaccines; 1=Child received some vaccines; 2=Child received all vaccines)

As presented in Table 28, the parent's individual assessment of his or her perceived benefits and risks at both the societal and individual levels and of the benefit-risk ratio for vaccinations make up the first five primary independent variables. Variables representing benefits and risks of vaccinations, respectively, are gauged on an 11-point scale, with larger numbers representing higher levels of perceived benefit or risk. To measure the perceived benefit-risk ratio for each parent (survey participant), a 7-point ordinal scale is used, with a score under 4 indicating that a parent believes risks outweigh benefits, while a score of 4 stands for an equal balance between benefit and risk, and a score of 5 to 7 represents a parent who feels that benefits are greater than risks. Other primary variables are individuals' preferences for existing government vaccination policies (mandatory policies and religious and philosophical exemption policies). For each policy, parents' preferences are measured on a 7-point scale ranging from 1 (strongly oppose) to 7 (strongly support). Additionally, these independent variables also incorporate questions designed to gauge all respondents' opinions on the

Table 28. Primary Independent Variables and Measures

(a) Parent's Subjective Expected Utility of Vaccination

Variable	Measure
Perceived benefits to the society as a whole	How much benefit do you think vaccinations provide to *society as a whole* by reducing sickness and preventing the spread of infectious diseases? (0=Not at all beneficial to 10=Extremely beneficial)
Perceived benefits to you and your family	How much benefit do you think vaccinations bring to *you and your family* in preventing infectious disease? (0=Not at all beneficial to 10=Extremely beneficial)
Perceived risks to the society as a whole	How much risk from *adverse health reactions* do you think vaccinations pose to *people and society as a whole*? (0=No risk to 10=Extreme risk)
Perceived risks to you and your family	How much risk from *adverse health reactions* do you think vaccinations pose to *you and your family*? (0=No risk to 10=Extreme risk)
Balance between benefits and risks	How do you rate the overall balance of the risks and benefits of required vaccinations for infants and children in the U.S.? (1=Risks far outweigh benefits to 4=Risks and benefits are equally balanced to 7=Benefits far outweigh risks)

(b) Vaccine Policy Preferences

Variable	Measure
Preference toward mandatory vaccination policy	How do you feel about vaccine requirements for school entry? (1=Strongly oppose to 7=Strongly support)
Preference toward religious exemption policy	How do you feel about religious exemptions from vaccine requirements? (1=Strongly oppose to 7=Strongly support)
Preference toward philosophical exemption policy	How do you feel about exemptions from vaccine requirements based on the parents' philosophy or beliefs? (1=Strongly oppose to 7=Strongly support)
Parents, not government, as chief immunization decision makers	Parents, not the government, should make decisions about immunizing their children. (1=Strongly disagree to 7=Strongly agree)

ideal role of government in dealing with this issue. For example, parents were asked about the degree to which they agree with a set of statements that the parents, not

government, should make decisions about the immunization of children. Respondents rated each relevant statement on a 7-point scale, with 1 representing "strongly disagree" and 7 representing "strongly agree."

Control variables and measures are presented in Table 29. Parents were asked about their perceptions of the prevalence of ten different infectious diseases: *measles, smallpox, hepatitis B, mumps, pertussis (whooping cough), tuberculosis, H1N1 flu (swine flu), varicella (chickenpox),* and *influenza (seasonal flu).* For each disease, they rated -1, 0 and 1 if they believed the disease is occurring *less frequently, about the same,* and *more frequently*, respectively, than it did fifty years ago. These scores were then summed up to generate an additive index representing each parent's perceptions on current disease prevalence. The results from the questions about disease prevalence make up the first control variable in this analysis. As a second control variable, respondents had to measure their own level of trust for health care professionals on an 11-point scale (from 0 to 10), with higher scores demonstrating greater trust. Third, individuals' vaccine-related knowledge was taken into account through the creation of a representative index based upon six basic yes-no questions about vaccinations. An individual's score could range from 0 to 6, depending upon the number of questions they answered correctly. If a parent has a child, other family members, or friends who have been diagnosed with autism or Asperger's syndrome, they were coded as 1, and 0 if they did not. A parent who responded that he or she uses the Internet several times a day was coded with 1, and with a 0 otherwise. Male parents were coded 1 in gender, as were non- Hispanic whites in race. Education level and household income were measured on 7-point and 21-point scales, respectively, with high scores indicating high

Table 29. Control Variables and Measures

Variable	Measure
Perceived prevalence of disease	In your view, is *measles* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *smallpox* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *hepatitis B* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *mumps* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *pertussis (Whooping Cough)* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *tuberculosis* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *H1N1 flu (swine flu)* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *poliomyelitis (polio)* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *varicella (chickenpox)* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
	In your view, is *influenza (seasonal flu)* occurring *less frequently*, *about the same*, or *more frequently* than it did 50 years ago? (-1=Less frequently; 0=About the same; 1=More frequently)
Perceived disease prevalence index	Additive index of above ten items

Trust	How trustworthy is information about health issues from health care professionals? (0=Not at all trustworthy to 10=Completely trustworthy)
Vaccine-related knowledge	Even with mandatory vaccine programs, infectious diseases including measles, whooping cough and chickenpox, still occur in small numbers in the United States. (0=No; 1=Yes)
	Vaccines typically cause many harmful side effects, illnesses, and even death. (0=No; 1=Yes)
	Infants have natural immunity for most infectious diseases. (0=No; 1=Yes)
	Getting vaccinated will substantially reduce the likelihood of getting the disease, but it will not eliminate the chance of getting it completely. (0=No; 1=Yes)
	Most health officials recommend that infants and children receive multiple vaccinations for different diseases at the same time. (0=No; 1=Yes)
	Diseases had already begun to disappear before vaccines were introduced, because of better hygiene and sanitation. (0=No; 1=Yes)
Knowledge index	Index of above six items (A total number of correct answers)
Experience with autism or Asperger's syndrome	Do you have family members or friends (or their children) that have been diagnosed with autism or with Asperger's syndrome? (0=No; 1=Yes)
Frequency of Web use	1=Several times almost every day
Age	Age in years
Gender	1=Male
Race	1=White, Not Hispanic
Education	The highest level of education completed (1=Elementary or some high school to 7=Doctorate (of any type))
Income	Total estimated annual income (1=0-$10,000 to 21=$200,000 or more)
Health insurance coverage for child	1=Yes
Number of children (siblings) in family	Number of children in a family
Child's age	Child's age in years

levels of education and income. Each child reported by the parent as not covered by health insurance was coded 0, and a 1 indicates an insured child. The number of

children in a family and the age of each child were also included as control variables.

In terms of distribution, range, and central tendency measures, no problematic areas are evident as presented in Table 30. Though the distribution of income variable is slightly right-skewed, this is not an unusual phenomenon. In general, the data shows that parents believe that vaccinations are beneficial both for society and personally (for their own children), and perceive few societal and individual risks. As a group, parents prefer mandatory vaccination policies to any exemptions, but also feel that parents, not the government, should have control of their own child's immunizations. In terms of the prevalence of the ten listed infectious diseases, respondents felt that those diseases are less prevalent today than fifty years ago, while they exhibited a relatively high level of vaccine related knowledge. The parents also demonstrated a robust level of trust in

Table 30. Descriptive Statistics

Variable	*n*	Mean	S.D.	Min	Max
Perceived benefits to society as a whole	731	8.02	1.87	0	10
Perceived benefits to you and your family	721	7.78	2.15	0	10
Perceived risks to society as a whole	731	5.04	2.51	0	10
Perceived risks to you and your family	728	4.64	2.70	0	10
Balance between benefits and risks	729	5.21	1.48	1	7
Preference toward mandatory vaccination policy	729	5.51	1.61	1	7
Preference toward religious exemption policy	718	3.85	2.08	1	7
Preference toward philosophical exemption policy	727	3.71	2.04	1	7
Parents as chief immunization decision makers	725	4.82	1.90	1	7
Perceived prevalence of disease	695	-3.75	4.08	-10	10
Trust	723	7.47	2.01	0	10
Knowledge	722	4.35	1.26	1	6
Age	731	37.24	9.29	19	75
Income	721	6.91	4.61	1	21
Education	724	3.63	1.38	1	7
Number of children (siblings) in family	731	2.35	1.10	1	6
Child's age	713	9.10	5.16	0	27

health care professionals' opinions. The mean age of surveyed parents of minors was 37.24, and 52% of children had parents who had a college degree. The median family

income fell on the range between $50,000 and $60,000. Average number of children in a family was 2.35 and average child's age was 9.1 years.

As shown in Table 31, out of 696 valid responses, 18% of children had parents whose family members or friends (or their children) had been diagnosed with Autism or Asperger's syndrome. Out of 729 valid responses, 73% of children had parents who use the Internet very frequently (several times almost every day), while out of 719 valid responses, 93% of children were reported to have health insurance coverage. About 59% (out of 729 valid responses) of children had a responding parent who was female, while 72% (our of 728 valid responses) had a parent who was non-Hispanic white.

Table 31. Frequency Table

Variable	*n*	Category 1	Category 2	Category 3
Vaccination	718	No (6%)	Some (18%)	All (76 %)
Experience with autism or Asperger's syndrome	696	No (82%)	Yes (18%)	NA
Frequency of Web use	729	Low (27%)	High (73%)	NA
Gender	729	Female (59%)	Male (41%)	NA
Race	728	Non-White (28%)	White (72%)	NA
Health insurance coverage for child	719	No (7%)	Yes (93%)	NA

5.3.3. Methods

The dependent variable is polytomous with three categories representing ordered progress toward full vaccination. This variable is coded 0 when a child received *no* recommended vaccines, and 1 or 2 when a child received *some* or *all* recommended vaccines, respectively. This analysis fits separate binary logistic regression models to each of a set of dichotomies derived from this trichotomy in order to calculate

unconditional fitted probability of each category of the dependent variable in response to changes in primary independent variables (e.g., parent's subjective expected utility of vaccination and related policy preferences) (Fox, 2008; Greene 2002). In doing so, the following steps are taken.

First, the first set of binary partitions of the categories of aforementioned trichotomous dependent variable is generated and coded 0 when a child received *no* recommended vaccines and 1 when a child received *any* recommended vaccines (i.e., when a child received either *some* or *all* recommended vaccines). Then, a binary logistic regression model is fitted to estimate the conditional probabilities of a child receiving *any* recommended vaccines corresponding to the changes in the primary explanatory variables. Next, the second set of binary partitions of the second category (representing child receiving *any* recommended vaccines) of the dichotomous dependent variable acquired from the first step of analysis is produced and coded 0 when a child received *some* recommended vaccines and 1 when a child received *all* recommended vaccines, while the first category (representing child receiving *no* recommended vaccines) is *undefined*. Then, a logistic regression model is fitted to predict the conditional probabilities of a child receiving *all* recommended vaccines of this dichotomous dependent variable in response to changes in the primary independent variables. Third, using the conditional fitted probabilities acquired from previous two analytic steps, the unconditional fitted probabilities of each category of the original trichotomous dependent variable are calculated. In a given set of independent variables used in the model estimations, (a) the probability of child receiving *all* recommended vaccines is calculated by multiplying the conditional probability of child receiving *any*

recommended vaccines (acquired from the first analytical step) by the conditional probability of child receiving *all* recommended vaccines (acquired from the second analytical step), (b) the probability of child receiving *some* recommended vaccines is calculated by multiplying the conditional probability of child receiving *any* recommended vaccines (acquired from the first analytical step) by the conditional probability of child receiving *all* recommended vaccines (acquired from the second analytical step) subtracted from 1, and (c) the probability of child receiving *no* recommended vaccines is calculated by subtracting the probability of child receiving *any* recommended vaccines (acquired from the first analytical step) from 1.

More precisely, let $P(Y_i = all)$ denote unconditional fitted probability of child *i* receiving *all* recommended vaccines, $P(Y_i = some)$, unconditional fitted probability of child *i* receiving *some* recommended vaccines, and $P(Y_i = no)$, unconditional fitted probability of child *i* receiving *no* recommended vaccines, respectively, for $i = 1, 2, 3, \ldots, n$. Based on the logistic regression model fitted in the *first* step of analysis, $\boldsymbol{l}_1 = \mathbf{X}\mathbf{b}_1 + \mathbf{e}_1$, where $\boldsymbol{l}_1$ is an $n \times 1$ vector of estimated *logit*s (the log of the odds ratio), $\mathbf{X}$ is an $n \times k$ data matrix, $\mathbf{b}_1$ is a $k \times 1$ vector of maximum likelihood estimates of the model parameters, and $\mathbf{e}_1$ is an $n \times 1$ vector of residuals, the conditional fitted probability of child *i* receiving *any* recommended vaccines with a given set of independent variables is represented by $P(Y_i = any|\mathbf{x}_i) = P(Y_i = some \text{ or } all|\mathbf{x}_i) = 1/(1 + \exp[-\mathbf{x}_i'\mathbf{b}_1])$, where $\mathbf{x}_i'$ is the *i*th row of the data matrix $\mathbf{X}$. Likewise, based on the logistic regression model fitted in the *second* step of analysis where the category representing child receiving *no* vaccine is treated as *undefined*, $\boldsymbol{l}_2 = \mathbf{X}\mathbf{b}_2 + \mathbf{e}_2$, where $\boldsymbol{l}_2$ is an $n \times 1$ vector of estimated *logit*s, $\mathbf{X}$ is an $n \times k$ data matrix, $\mathbf{b}_2$ is a $k \times 1$ vector of

maximum likelihood estimates of the model parameters, and $\mathbf{e}_2$ is an $n \times 1$ vector of residuals, the conditional fitted probability of child *i* receiving *all* recommended vaccines with a given set of independent variables is given by $P(Y_i = all|\mathbf{x}_i) = 1/(1 + \exp[-\mathbf{x'}_i\mathbf{b}_2])$. Because the nested dichotomies (derived from Y) used in the first and the second analytic steps are independent[17], $P(Y_i = all) = P(Y_i = any|\mathbf{x}_i) \cdot P(Y_i = all|\mathbf{x}_i)$, $P(Y_i = some) = P(Y_i = any|\mathbf{x}_i) \cdot \big(1 - P(Y_i = all|\mathbf{x}_i)\big)$, and $P(Y_i = no) = 1 - P(Y_i = all|\mathbf{x}_i)$.

5.4. Empirical Findings

As displayed in Table 32, logistic regression results show how parents' subjective expected utility of vaccination influenced their behavioral decisions regarding whether

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[17] Suppose Y_i is trichotomous variable, coded 0, 1, and 2 when the *i*th child (i = 1, 2, 3, …, n) received *no*, *some*, or *all* recommended vaccines, respectively. Suppose V_{i0}, V_{i1}, and V_{i2} are dummy variables representing whether Y_i is 0, 1, and 2, respectively. For instance, $V_{i0} = 1$ when $Y_i = 0$, and 0 otherwise. Likewise, $V_{i1} = 1$ when $Y_i = 1$, and 0 otherwise. Let Y_i' denote a dummy variable generated for the *first* analytic step and coded 1 when $Y_i = 1\ or\ 2$, and 0 when $Y_i = 0$. Let Y_i'' indicate a dummy variable produced for the *second* analytic step and coded 1 when $Y_i = 2$ and 0 when $Y_i = 1$, while *undefined* when $Y_i = 0$.

The probability distribution of Y_i' is given by

$$p(y_i') = (\pi_{i1} + \pi_{i2})^{y_i'} \cdot \pi_{i0}^{1-y_i'} = (\pi_{i1} + \pi_{i2})^{v_{i1}+v_{i2}} \cdot \pi_{i0}^{v_{i0}} \quad (1)$$
$$\text{where } \pi_{ij} = P(Y_i = j) \text{ for } j = 0, 1, 2.$$

The probability distribution of Y_i'' is given by

$$\begin{aligned} p(y_i'') &= [P(Y_i'' = 1)]^{y_i''} \cdot [P(Y_i'' = 0)]^{1-y_i''} \quad (2) \\ &= [P(Y_i = 2|Y_i \neq 0)]^{y_i''} \cdot [P(Y_i = 1|Y_i \neq 0)]^{1-y_i''} \\ &= \left(\frac{\pi_{i2}}{\pi_{i1}+\pi_{i2}}\right)^{y_i''} \cdot \left(\frac{\pi_{i1}}{\pi_{i1}+\pi_{i2}}\right)^{1-y_i''} \\ &= \left(\frac{\pi_{i2}}{\pi_{i1}+\pi_{i2}}\right)^{v_{i2}} \cdot \left(\frac{\pi_{i1}}{\pi_{i1}+\pi_{i2}}\right)^{v_{i1}} \end{aligned}$$

Multiplying Equation (1) by Equation (2) produces

$$p(y_i') \cdot p(y_i'') = \pi_{i0}^{v_{i0}} \cdot \pi_{i1}^{v_{i1}} \cdot \pi_{i2}^{v_{i2}} = p(y_i)$$

Thus, nested dichotomies derived from the trichotomous dependent variable used for the analysis are independent.

Table 32. Logistic Regression Results: Effect of Parents' Subjective Expected Utility of Vaccination on the Likelihood of Their Child Receiving *NO* or *ANY* Recommended Vaccines

	Dependent variable Vaccination (0=No; 1=Yes)				
Parameters	Model 1	Model 2	Model 3	Model 4	Model 5
Perceived benefits to society as a whole	0.417*** (0.111)	-	-	-	-
Perceived benefits to you and your family	-	0.208** (0.095)	-	-	-
Perceived risks to society as a whole	-	-	-0.074 (0.093)	-	-
Perceived risks to you and your family	-	-	-	-0.262*** (0.086)	-
Balance between benefits and risks	-	-	-	-	0.274* (0.141)
Perceived prevalence of disease	-0.092 (0.059)	-0.085 (0.057)	-0.102* (0.052)	-0.073 (0.053)	-0.094* (0.055)
Trust	0.071 (0.112)	0.134 (0.110)	0.222** (0.101)	0.225** (0.104)	0.179* (0.104)
Knowledge	0.033 (0.201)	0.028 (0.205)	0.119 (0.193)	0.037 (0.200)	0.120 (0.197)
Experience with Autism or Asperger's syndrome (1=Yes)	2.484** (1.087)	2.280** (1.062)	2.537** (1.083)	2.732** (1.097)	2.367** (1.066)
Frequency of Web use (1=High)	0.594 (0.484)	0.434 (0.495)	0.661 (0.478)	0.708 (0.479)	0.753 (0.468)
Age	0.003 (0.030)	0.001 (0.029)	0.001 (0.028)	-0.010 (0.027)	0.001 (0.029)
Gender (1=Male)	-0.015 (0.464)	-0.511 (0.466)	-0.483 (0.434)	-0.652 (0.457)	-0.347 (0.440)
Race (1=White, not Hispanic)	1.773*** (0.490)	1.716*** (0.490)	1.534*** (0.455)	1.670*** (0.467)	1.669*** (0.470)
Income	-0.092 (0.062)	-0.082 (0.061)	-0.060 (0.063)	-0.049 (0.064)	-0.084 (0.061)
Education	-0.063 (0.239)	0.040 (0.237)	0.003 (0.234)	-0.022 (0.236)	0.025 (0.232)
Health insurance coverage for child (1=Yes)	2.029*** (0.650)	2.136*** (0.616)	1.985*** (0.627)	2.070*** (0.661)	1.913*** (0.624)
Number of children (siblings) in family	-0.571*** (0.190)	-0.565*** (0.193)	-0.584*** (0.186)	-0.535*** (0.193)	-0.577*** (0.191)
Child's age	-0.043 (0.049)	-0.033 (0.049)	-0.020 (0.047)	-0.037 (0.048)	-0.024 (0.047)
Intercept	-1.708 (1.585)	-0.716 (1.578)	0.033 (1.561)	1.784 (1.711)	-1.393 (1.534)
Degree of freedom	596	586	596	595	596
Residual deviance	168.91	171.72	182.70	173.02	179.62
AIC	198.91	201.72	212.70	203.02	209.62

*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$. (Standard errors in parentheses)

they decided their child receive *no* recommended vaccines or *any* recommended vaccines. As hypothesized earlier, other conditions being equal, those who perceive

vaccines as highly beneficial at both the societal and individual levels (Model 1 and 2), who feel that vaccines pose low levels of individual risk (Model 4), and who believe that vaccine benefits far outweigh risks (Model 5) are more likely to vaccinate their child with statistical significance. However, parents' perception of societal risks of vaccinations does not influence the likelihood of their own child's vaccination with any statistical significance (Model 3). The influence of control variables based on competing (and complementary) theoretical claims is noteworthy. In all models, those who have family members or acquaintances who have been diagnosed with autism or Asperger's syndrome, who are non-Hispanic white, have fewer children, and whose child or children are covered with health insurance, are more likely to decide that their child should receive *some* or *all* recommended vaccines.

In Table 33, logistic regression results show how parents' subjective expected utility of vaccination influences their behavioral decisions regarding whether their child ultimately received *some* or *all* recommended vaccines. As hypothesized earlier, other conditions being equal, those who perceive high levels of vaccine benefit at both the societal and individual levels (Model 6 and 7), who perceive low levels of individual risk (Model 9), and who believe that vaccines' benefits far outweigh risks (Model 10) are more likely to vaccinate their child with statistical significance. However, once more, parents' perception of risk to society posed by vaccinations does not influence the likelihood of their own child's vaccination with any statistical significance. The influence of control variables based on competing (and complementary) theoretical claims is noteworthy. Those who personally know someone diagnosed with autism or Asperger's syndrome (Model 6-10), who are white (Model 6, 8, 9 and 10), and whose

Table 33. Logistic Regression Results: Effect of Parents' Subjective Expected Utility of Vaccination on the Likelihood of Their Child Receiving *SOME* or *ALL* Recommended Vaccines

	Dependent variable Vaccination (0=Some; 1=All)				
Parameters	Model 6	Model 7	Model 8	Model 9	Model 10
Perceived benefits to society as a whole	0.306*** (0.067)	-	-	-	-
Perceived benefits to you and your family	-	0.334*** (0.055)	-	-	-
Perceived risks to society as a whole	-	-	-0.063 (0.048)	-	-
Perceived risks to you and your family	-	-	-	-0.120** (0.049)	-
Balance between benefits and risks	-	-	-	-	0.410*** (0.079)
Perceived prevalence of disease	-0.033 (0.030)	-0.045 (0.032)	-0.024 (0.029)	-0.016 (0.030)	-0.031 (0.030)
Trust	0.065 (0.063)	0.065 (0.065)	0.121** (0.058)	0.134** (0.059)	0.075 (0.062)
Knowledge	0.045 (0.102)	0.034 (0.103)	0.147 (0.098)	0.077 (0.103)	0.123 (0.100)
Experience with Autism or Asperger's syndrome (1=Yes)	-0.782*** (0.274)	-0.718** (0.280)	-0.724*** (0.271)	-0.730*** (0.271)	-0.769*** (0.274)
Frequency of Web use (1=High)	-0.204 (0.284)	-0.228 (0.290)	-0.125 (0.278)	-0.110 (0.279)	-0.047 (0.283)
Age	0.015 (0.016)	0.014 (0.016)	0.015 (0.015)	0.014 (0.015)	0.018 (0.016)
Gender (1=Male)	-0.342 (0.249)	-0.371 (0.256)	-0.377 (0.241)	-0.384 (0.242)	-0.418** (0.247)
Race (1=White, not Hispanic)	-0.573** (0.304)	-0.495 (0.313)	-0.619** (0.294)	-0.604** (0.297)	-0.610** (0.303)
Income	-0.028 (0.034)	-0.029 (0.035)	-0.017 (0.033)	-0.016 (0.033)	-0.016 (0.034)
Education	0.121 (0.116)	0.140 (0.118)	0.167 (0.111)	0.173 (0.113)	0.114 (0.116)
Health insurance coverage for child (1=Yes)	0.912** (0.455)	0.688 (0.472)	0.947*** (0.436)	0.952** (0.444)	0.861** (0.460)
Number of children (siblings) in family	0.127 (0.121)	0.140 (0.126)	0.148 (0.121)	0.156 (0.121)	0.155 (0.125)
Child's age	0.034 (0.028)	0.036 (0.029)	0.029 (0.027)	0.025 (0.027)	0.032 (0.028)
Intercept	-2.973*** (0.972)	-2.957*** (0.980)	-1.409 (0.982)	-0.905 (1.003)	-3.222 (0.973)
Degree of freedom	561	554	561	560	561
Residual deviance	482.75	462.26	502.49	497.26	476.86
AIC	512.75	492.26	532.49	527.26	506.86

**$p < 0.05$. ***$p < 0.01$. (Standard errors in parentheses)

child is covered by health insurance (Model 6, 8, 9 and 10) are more likely to have their child receive all recommended vaccines, compared with those who do not have any autism experience, are non-white, and whose children do not have healthcare coverage. Because the dichotomies derived from the original trichotomous dependent variable (related to childhood vaccination) are independent[18], the results of model estimations for these dichotomies (presented in Table 32 and 33) can be combined for statistical inferences for the original trichotomous dependent variable. The following analysis of the deviance table (Table 34) presents the combined (summed) results of corresponding likelihood ratio χ^2 statistics across two analyses of deviance tables derived from the results of previous logit analyses shown in Table 32 and 33, and the results of likelihood ratio tests to examine the statistical significance of the effects of each independent variable on the aforementioned trichotomous dependent variable. As hypothesized earlier, the effects of parents' perceptions of societal and individual vaccine benefits (combined results from Models 1 and 6 and from Models 2 and 7), individual vaccine risk (combined results from Models 4 and 9), and balance between vaccine benefits and risks (combined results from Models 5 and 10) on their behavioral decisions regarding child vaccinations are all statistically significant. However, parents' perception of the societal-level risks of vaccinations does not reveal any statistically significant influence on their behavior regarding vaccinating their own children (combined results from Model 3 and 8). Yet again, control variables demonstrate a notable influence. Parents' experience with autism or Asperger's syndrome, their race, health insurance coverage

[18] See footnote 17 for a more detailed explanation.

of child, and number of children (siblings) in family are statistically significantly related to their behavior regarding child vaccinations in all combined model results.

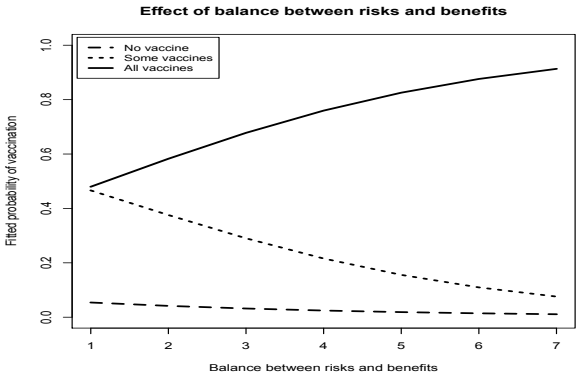
Table 34. Analysis of Deviance: Effect of Parents' Subjective Expected Utility of Vaccination on the Likelihood of Their Child Receiving *NO*, *SOME*, or *ALL* Recommended Vaccines

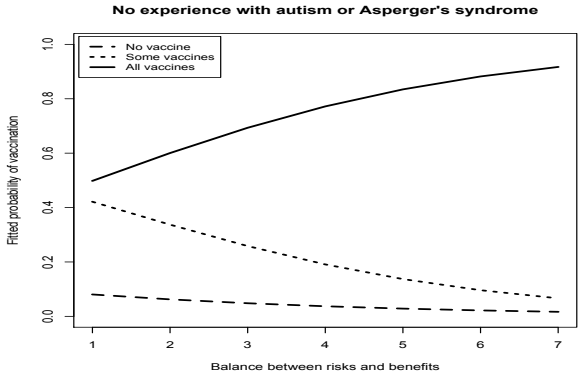
Parameters	*Dependent variable* Vaccination (0=None; 1=Some; 2=All) *Combined results from* Model 1 and 6	Model 2 and 7	Model 3 and 8	Model 4 and 9	Model 5 and 10
Perceived benefits to society as a whole	35.86***	-	-	-	-
Perceived benefits to you and your family	-	43.77***	-	-	-
Perceived risks to society as a whole	-	-	2.32	-	-
Perceived risks to you and your family	-	-	-	16.46***	-
Balance between benefits and risks	-	-	-	-	31.04***
Perceived prevalence of disease	3.56	4.13	4.43	2.19	3.86
Trust	1.45	2.44	9.08**	10.03***	4.37
Knowledge	0.22	0.12	2.64	0.58	1.96
Experience with Autism (1=Yes)	17.44***	14.74***	17.37***	18.85***	16.73***
Frequency of Web use (1=High)	2.01	1.39	2.07	2.29	2.57
Age	0.96	0.82	1.01	1.04	1.30
Gender (1=Male)	1.89	3.33	3.70	4.59	3.49
Race (1=White, not Hispanic)	17.99***	15.78***	16.64***	18.15***	17.82***
Income	2.87	2.48	1.03	0.82	2.09
Education	1.18	1.46	2.29	2.42	1.01
Health insurance coverage for child (1=Yes)	12.83***	13.20***	13.69***	13.24***	12.25***
Number of children (siblings) in family	9.93***	9.60***	11.19***	9.31***	10.51***
Child's age	2.33	2.05	1.32	1.43	1.56

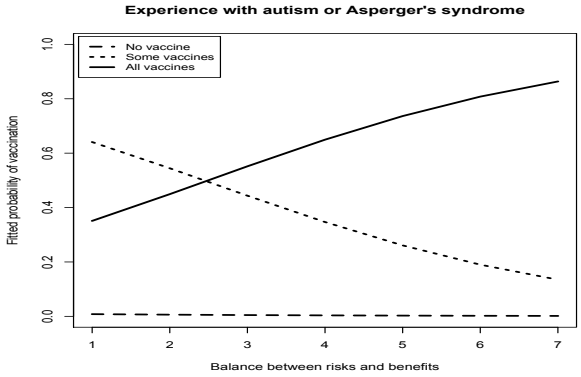
$^{**}p < 0.05$. $^{***}p < 0.01$. (*Note: Numbers presented in the table are likelihood ratio χ^2 statistics and the degrees of freedom for each variable in the likelihood test is 2.*)

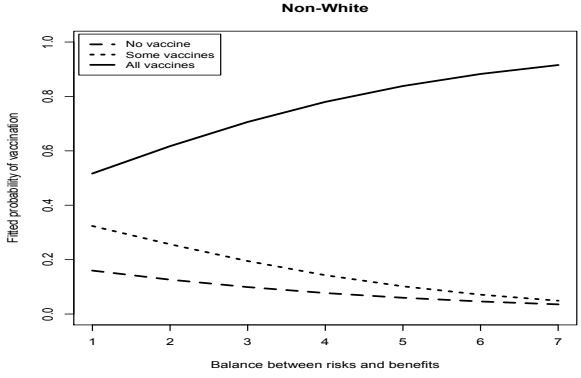
These results are graphically presented in Figure 6. This figure demonstrates how parents' perception of the benefit-risk ratio of vaccination influences their behavioral decisions with regard to vaccinating their children. The vertical axis represents predicted fitted probability of vaccination, while the horizontal axis shows parents' perception of the balance between vaccination benefits and risks, on a 7 point rising scale from 1 (risks far outweigh benefits) to 7 (benefits far outweigh risks). The dashed line shows the probability that a parent's child receives *no* recommended

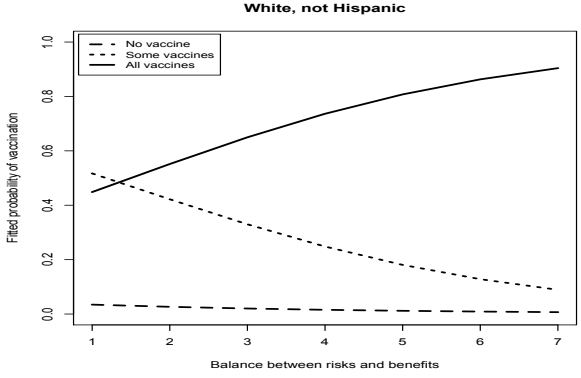
Figure 6. Effect of Vaccine Benefit-Risk Perception on Predicted Probability of Vaccination

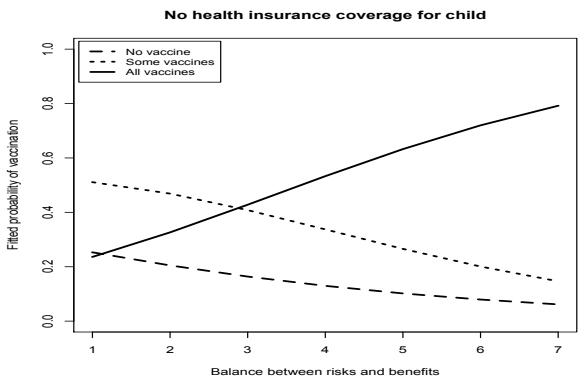


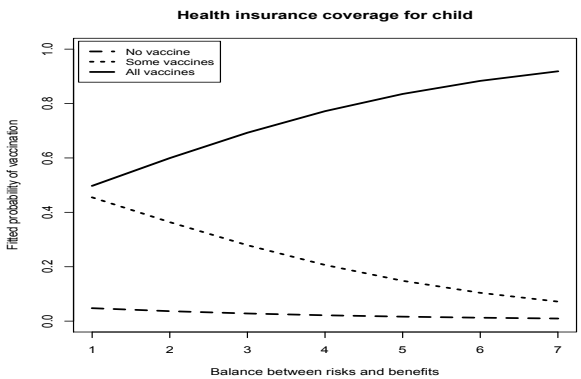












vaccines, the short dashed line, the probability a parent's child receives *some* recommended vaccines, and the solid line represents the probability that a parent's child receives *all* recommended vaccines. Parents who strongly believe that vaccine benefits are far greater than the risks are more likely to have children who received *all* recommended vaccines and less likely to have children with *some* or *no* vaccines (first row). The patterns of these relationships hold for parents who have different socio-demographic characteristics, but in general, those without experience with autism (second row), who are non-white (third row), and whose child has health insurance coverage (fourth row) are more likely to have taken their children for *all* recommended vaccines, and less likely to decide that their child have *some* or *no* recommended vaccines in comparison with those who have autism experience, who are white, and whose child does not have health insurance coverage.

In Table 35, the logistic regression results show how parents' beliefs about childhood vaccination policies influence their behavioral decisions regarding whether their child receives *no* or *any* recommended vaccines. As hypothesized earlier, *ceteris peribus*, those who support mandatory vaccinations (Model 11), oppose philosophical exemptions (Model 13), and disagree that parents (not government) should be the chief decision makers in immunizing children (Model 14) are more likely to vaccinate their child with statistical significance. However, parents' opinions on religious exemption policy do not influence the likelihood of their own child's vaccination with statistical significance (Model 12). Among the control variables that show the most consistent influence on the dependent variables are parent's experience with autism and Asperger's syndrome, race, health insurance coverage for child and the number of

Table 35. Logistic Regression Results: Effect of Parents' Vaccine Policy Beliefs on the Likelihood of Their Child Receiving *NO* or *ANY* Recommended Vaccines

	Dependent variable Vaccination (0=No; 1=Yes)			
Parameters	Model 11	Model 12	Model 13	Model 14
Preference toward mandatory vaccination policy	0.457*** (0.130)	-	-	-
Preference toward religious exemption policy	-	-0.161 (0.125)	-	-
Preference toward philosophical exemption policy	-	-	-0.311*** (0.119)	-
Parents, not government, as chief immunization decision makers	-	-	-	-0.296** (0.138)
Perceived prevalence of disease	-0.131** (0.056)	-0.116** (0.052)	-0.122** (0.053)	-0.082 (0.054)
Trust	0.174 (0.108)	0.212** (0.103)	0.219** (0.103)	0.206** (0.102)
Knowledge	0.097 (0.198)	0.047 (0.200)	-0.030 (0.206)	0.115 (0.191)
Experience with Autism or Asperger's syndrome (1=Yes)	2.432** (1.063)	2.391** (1.085)	2.712** (1.127)	2.623** (1.081)
Frequency of Web use (1=High)	0.577 (0.478)	0.703 (0.477)	0.758 (0.485)	1.007** (0.481)
Age	0.015 (0.030)	0.001 (0.028)	0.002 (0.028)	-0.010 (0.029)
Gender (1=Male)	-0.172 (0.448)	-0.533 (0.440)	-0.768* (0.462)	-0.586 (0.445)
Race (1=White, not Hispanic)	1.833*** (0.491)	1.613*** (0.465)	1.566*** (0.477)	1.661*** (0.459)
Income	-0.073 (0.062)	-0.064 (0.061)	-0.059 (0.061)	-0.065 (0.060)
Education	-0.073 (0.243)	0.050 (0.234)	0.025 (0.234)	-0.017 (0.230)
Health insurance coverage for child (1=Yes)	2.028*** (0.629)	1.831*** (0.645)	1.694** (0.671)	1.859*** (0.633)
Number of children (siblings) in family	-0.572*** (0.193)	-0.518*** (0.192)	-0.556*** (0.194)	-0.588*** (0.201)
Child's age	-0.049 (0.049)	-0.016 (0.047)	-0.016 (0.047)	-0.021 (0.048)
Intercept	-2.477 (1.612)	0.369 (1.608)	1.590 (1.681)	1.745 (1.744)
Degree of freedom	596	587	594	592
Residual deviance	170.97	180.54	175.39	176.09
AIC	200.97	210.54	205.39	206.09

*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$. (Standard errors in parentheses)

children in family. Those who have acquaintances diagnosed with autism or Asperger's syndrome, who are white, who have fewer children, and whose child is covered with health insurance are more likely (with statistical significance) to have their child receive

some or all recommended vaccines with statistical significance in all models than those who do not have autism experience, who are not white, who have more children, and whose child is not covered with health insurance.

Table 36. Logistic Regression Results: Effect of Parents' Vaccine Policy Beliefs on Their Child Receiving *SOME* or *ALL* Recommended Vaccines

	Dependent variable Vaccination (0=Some; 1=All)			
Parameters	Model 15	Model 16	Model 17	Model 18
Preference toward mandatory vaccination policy	0.473*** (0.074)	-	-	-
Preference toward religious exemption policy	-	-0.189*** (0.061)	-	-
Preference toward philosophical exemption policy	-	-	-0.194*** (0.061)	-
Parents, not government, as chief immunization decision makers	-	-	-	-0.109 (0.068)
Perceived prevalence of disease	-0.063** (0.031)	-0.034 (0.030)	-0.027 (0.030)	-0.029 (0.029)
Trust	0.062 (0.064)	0.132** (0.060)	0.133** (0.059)	0.126** (0.058)
Knowledge	0.068 (0.101)	0.130 (0.100)	0.091 (0.100)	0.153 (0.095)
Experience with Autism or Asperger's syndrome (1=Yes)	-0.772*** (0.279)	-0.802*** (0.277)	-0.773*** (0.274)	-0.713*** (0.271)
Frequency of Web use (1=High)	-0.136 (0.289)	-0.219 (0.287)	-0.137 (0.285)	-0.136 (0.278)
Age	0.008 (0.016)	0.007 (0.016)	0.013 (0.015)	0.014 (0.015)
Gender (1=Male)	-0.394 (0.255)	-0.496** (0.248)	-0.522** (0.247)	-0.418* (0.242)
Race (1=White, not Hispanic)	-0.387 (0.311)	-0.546* (0.301)	-0.510* (0.298)	-0.540* (0.297)
Income	-0.020 (0.035)	-0.006 (0.034)	-0.022 (0.034)	-0.008 (0.033)
Education	0.126 (0.119)	0.214* (0.115)	0.223* (0.118)	0.155 (0.113)
Health insurance coverage for child (1=Yes)	1.037** (0.462)	0.756* (0.456)	0.862* (0.449)	0.895** (0.436)
Number of children (siblings) in family	0.151 (0.126)	0.194 (0.124)	0.177 (0.123)	0.163 (0.122)
Child's age	0.031 (0.028)	0.048* (0.028)	0.035 (0.027)	0.030 (0.027)
Intercept	-3.359*** (0.987)	-0.919 (0.984)	-0.912 (0.982)	-1.253 (0.989)
Degree of freedom	561	552	559	557
Residual deviance	460.69	480.70	487.90	500.86
AIC	490.69	510.70	517.90	530.86

*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$. (Standard errors in parentheses)

As displayed in Table 36, logistic regression results show how parents' opinions on childhood vaccination policies influence their behavioral decisions regarding whether their children ultimately receive *some* or *all* recommended vaccines. As hypothesized, *ceteris paribus*, those who support mandatory vaccinations (Model 15) and oppose religious exemptions (Model 16) and philosophical exemptions (Model 17) are more likely to have a child who has received all recommended vaccines with statistical significance. However, parents' support of strong parental decision-making rights on the matter of immunization does not influence the likelihood of their own children receiving *all* recommended vaccines with any statistical significance (Model 18). In terms of control variables, those who have acquaintances diagnosed with autism or Asperger's syndrome (Model 15-18), who are white (Model 16-18), and whose child is covered with health insurance (Model 15-18) are more likely to have their child receive all recommended vaccines with statistical significance than those who do not have autism experience, who are non-white, and who do not have health insurance coverage for their child.

The following (Table 37) presents the combined (summed) results of corresponding likelihood ratio χ^2 statistics across two analyses of deviance tables derived from the results of previous logit analyses shown in Table 35 and 36, and the results of likelihood ratio tests to examine the statistical significance of the effects of each independent variable on the aforementioned trichotomous dependent variable related to child vaccination. As this study hypothesized, effects of parents' policy beliefs on mandatory vaccination (combined results from Model 11 and 15), religious exemptions (combined results from Model 12 and 16), philosophical exemptions

(combined results from Model 13 and 17), and the emphasis on parental rights in immunizing their child (combined results from Model 14 and 18) are all statistically significantly related to the trichotomous dependent variable of child vaccination. Control variables also exhibit statistical significance. Parents' experience with autism or Asperger's syndrome, their race, health insurance coverage of child, and number of children in family are statistically significantly related to their behavior regarding child vaccinations in all combined model results.

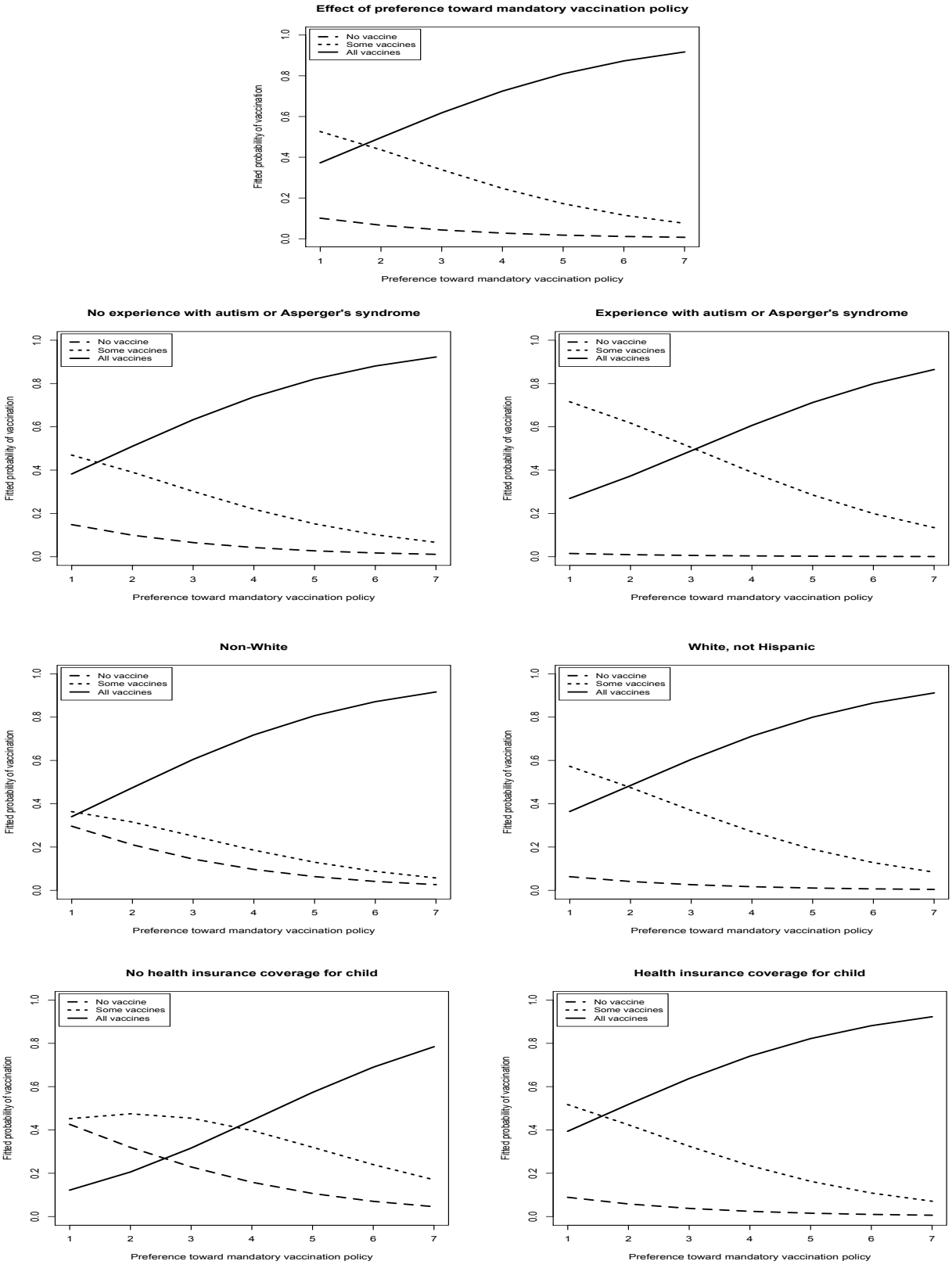
Table 37. Analysis of Deviance: Effects of Parents' Vaccine Policy Beliefs on the Likelihood of Their Child Receiving *NO*, *SOME*, or *ALL* Recommended Vaccines

	Dependent variable Vaccination (0=None; 1=Some; 2=All)			
	Combined results from			
Parameters	Model 11 and 15	Model 12 and 16	Model 13 and 17	Model 14 and 18
Preference toward mandatory vaccination policy	55.85***	-	-	-
Preference toward religious exemption policy	-	11.63***	-	-
Preference toward philosophical exemption policy	-	-	17.66***	-
Parents as chief immunization decision makers	-	-	-	7.79**
Perceived prevalence of disease	9.29***	6.12**	5.91*	3.27
Trust	3.51	9.20**	9.63***	8.75**
Knowledge	0.70	1.76	0.86	2.96
Experience with Autism (1=Yes)	17.25***	16.99***	18.76***	18.01***
Frequency of Web use (1=High)	1.66	2.72	2.64	4.50
Age	0.52	0.19	0.75	0.99
Gender (1=Male)	2.56	5.50*	7.33**	4.76*
Race (1=White, not Hispanic)	16.72***	16.17***	14.41***	17.28***
Income	1.71	1.13	1.35	1.22
Education	1.23	3.59	3.72	1.91
Health insurance coverage for child (1=Yes)	14.37***	10.41***	9.46***	12.12***
Number of children (siblings) in family	10.04***	9.61***	10.21***	10.25***
Child's age	2.18	3.10	1.78	1.41

*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$. (*Note: Numbers presented in the table are likelihood ratio χ^2 statistics and the degrees of freedom for each variable in the likelihood test is 2.*)

Figure 7 shows how parents' beliefs on vaccination policies influence their behavioral decisions with regard to the vaccination of their child. The vertical axis represents predicted fitted probability of vaccination, while the horizontal axis shows parent's degree of support for mandatory vaccination policy represented on a 7 point

Figure 7. Effect of Mandatory Vaccine Policy Preference on Predicted Probability of Vaccination



rising scale from 1 (strongly oppose) to 7 (strongly support). The dashed line indicates the probability that a survey respondent's child receives *no* recommended vaccines. The short dashed line shows the probability that a child received *some* recommended vaccines, and the solid line represents the probability of a child receiving *all* recommended vaccines.

Children of parents who strongly support mandatory vaccination policy are more likely to receive *all* recommended vaccines, and less likely to receive only *some* or *no* vaccines (first row). The patterns of these relationships hold for parents who have different socio-demographic characteristics; however, overall, those without autism experience (second row) and whose children have health insurance coverage (fourth row) are more likely to have taken their children for *all* recommended vaccines and less likely to have had their children take only *some* or *no* recommended vaccines than those who have experienced autism and whose children have no health insurance. However, there are no discernable differences in the patterns of these relationships between parents who are white and who are not (third row).

5.5. Summary

Acknowledging growing concerns for public health, along with the reemergence of infectious diseases such as pertussis and measles in certain communities in the United States, this chapter mainly seeks to answer how American parents' policy related beliefs translate into their behavior regarding child vaccinations. Clearly, parents' beliefs regarding vaccine benefits and risks and their opinions on vaccination policies directly translate into their child vaccination related behavior in most cases. Parents who perceive high levels of societal and individual benefits from vaccination, a high (very

favorable) benefit-risk ratio, and low levels of individual risk are more strongly motivated to have their child (or children) receive all recommended vaccines, whereas those who perceive low levels of societal and individual vaccination benefits, a low (very unfavorable) benefit-risk ratio, and high levels of individual risk are less motivated to vaccinate their child with all recommended vaccinations. In addition, parents who more strongly support mandatory vaccination policy and feel less support for religious and philosophical exemptions and parental decision-making rights regarding the immunization of children are more strongly motivated to have their own child receive all the recommended vaccines. Meanwhile, those who support mandatory vaccinations less and various exemptions and parental decision making rights more, are less motivated to have their child receive all recommended vaccines. This chapter also found that other modifying factors, such as a parent's autism related experience, parent's race, and health insurance coverage for his or her child also influence such belief-behavior relationships. For instance, while parents' perception of a high benefit-risk ratio of vaccination and their support for mandatory vaccination policy are positively associated with the likelihood of a child taking all recommended vaccines, parents who personally experienced or encountered autism or Asperger's syndrome, who are non-Hispanic white, and whose child does not have any health insurance coverage are less likely to have their child receive all recommended vaccinations in comparison with those who did not experience autism and Asperger's syndrome, who are not white[19], and whose child has health insurance coverage. Additionally, when a child has more siblings, the parent is less likely to vaccinate him or her.

[19] There is no statistically significant difference between white parents and non-white parents in terms of the positive relationship between their support for mandatory vaccination and the

Chapter 6. Conclusion

As the vaccine controversy continues to deepen in the United States, this dissertation research addresses how we can better understand and deal with this issue in respect to public policy in general and public health policy in particular. Based upon original data from a nationwide Internet survey of 1,213 adults conducted in 2010, this study scrutinizes ways in which individuals' values and beliefs, notably cultural predispositions, shape their differing opinions on the benefits and risks associated with childhood vaccinations and controversial vaccination policies, including mandatory vaccinations and religious/philosophical exemptions, and key related issues of governance. This study also attempts to explain how parents' subjective expected utility of vaccinations (derived from their perceptions of vaccine benefits and risks) and their beliefs regarding current vaccine policies actually translate into their vaccination-related behaviors in regards to the immunization of their own children.

The first empirical chapter (Chapter 3) explains how individuals' grid-group cultural orientations shape their perceptions regarding vaccine benefits and risks at both the societal and individual levels. As Mary Douglas and Aaron Wildavsky's cultural theory of risk perception (Douglas and Wildavsky, 1982) claims, empirical findings derived from robust regression analysis with heteroskedasticity consistent covariance estimation of errors and Bayesian posterior simulations reveal that those with a strong hierarch orientation tend to envision greater vaccination benefits and smaller risks, while those with a strong fatalist tendency are inclined to emphasize risks and downplay benefits. Situated between hierarchs and fatalists, egalitarians are prone to perceive greater benefits and smaller risks than individualists.

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likelihood of child taking all recommended vaccines.

Knowing that the benefits and the risks of vaccinations are understood as a sociopolitical construct and a reflection of the competing values and beliefs of different members of society (notably manifested in the form of cultural predispositions), this dissertation research proceeds to examine whether people still hold similar (value motivated, rather than factual evidence based) reasoning patterns when they are involved in policy debates on vaccination. The second empirical chapter (Chapter 4) seeks to explain how individuals' fundamental values regarding a preferred social ordering shape their opinions on controversial vaccination policies and key related issues of governance. As Aaron Wildavsky's cultural theory of policy preference formation (Wildavsky, 1987) posits, empirical findings grounded on robust regression analysis with heteroskedasticity consistent error covariance estimation and Bayesian posterior simulations show that cultural biases have a significant impact on the formation of preferences toward various vaccination policies and governance issues. Hierarchs and egalitarians are more likely to be pro-vaccination, while individualists and (especially) fatalists tend to oppose this view. Hierarchs advocate mandatory vaccination, disapprove of religious and philosophical exemptions, and believe that the government, not parents, should control childhood immunizations. By contrast, fatalists are inclined to reject mandatory vaccination policy in favor of religious and philosophical exemptions and the role of parents in determining vaccination of children. Egalitarians' pro-vaccination inclination is relatively weaker and less consistent than hierarchs', while individualists' anti-vaccination leanings are overall less robust than those of fatalists.

Government health authorities can utilize knowledge concerning the way

individuals' cultural orientations shape vaccine benefit-risk perception and policy preference to improve risk communication between the government, experts, and the lay public and to encourage "desirable" (public health enhancing) changes in the general public's attitude toward vaccine risks and related policies. However, this assertion alone does not provide much assistance in terms of practical implications as to how an actual policy outcome can be realized through changes not only in individuals' attitudes and thoughts, but also in their behaviors. This line of thought led to the third empirical chapter (Chapter 5), which essentially examines how American parents' policy related beliefs (e.g., their perceptions of vaccine benefits and risks and related policy preferences) actually translate into their behaviors regarding child vaccinations. The results of an empirical analysis using nested dichotomies logistic regression reveal that parents who perceive high levels of societal and individual benefit from vaccination, a high (very favorable) benefit-risk ratio, and low levels of individual risk are more strongly motivated to have their own child (or children) receive all recommended vaccines. In addition, parents who more strongly support mandatory vaccination policy and are not in favor of religious and philosophical exemptions and parental decision-making rights regarding children's immunizations are more strongly motivated to have their own child(ren) receive all recommended vaccines.

The most important element of these findings is that the vaccine policy debate and related vaccination behaviors are not solely based upon efficacy in reduction of disease or the resulting societal benefits and costs. Rather, it actually gains considerable momentum from the clash of worldviews. An intrinsic value dimension, notably in the form of grid-group cultural orientation, is reflected in the way this debate

and related vaccination behaviors have come to stand in for an overarching contest among competing sets of societal norms. Many government health authorities and experts believe that people oppose vaccinations because of their own inability to access quality vaccine-related knowledge or due to dissemination of false information. In response, health advocates have tried to enlighten the general public and thereby increase compliance with mandatory vaccination policies, thereby improving public health. Of course, proliferation of quality knowledge and sound information provided by the scientific community is essential. However, the results of this analysis show that vaccine benefit/risk perceptions, preferences for vaccine-related policies, and consequent vaccination behaviors are significantly influenced by individual values and beliefs regarding desirable social relationships, notably in the form of cultural predispositions. Furthermore, from a cultural cognition perspective, individuals' cultural biases work as a set of heuristics in the processing of pertinent information and in the course of reasoning (Kahan and Braman, 2006; Kahan, Jenkins-Smith and Braman, 2011; Silva, Jenkins-Smith and Barke, 2007; Silva and Jenkins-Smith, 2007). That is, when individuals with a particular cultural bias encounter new information, they will reinterpret it through the filters of their own cultural biases and use the results in their reasoning and policy evaluation. Even the seemingly unrelated matter of crediting expertise, which is integral to deciding whether a policy is beneficial or risky, is subject to cultural cognition (Kahan, Jenkins-Smith and Braman, 2011). With this in mind, three related concepts from risk communication perspectives may prove useful to public health authorities in the effective dissemination of vaccine-related knowledge: identity affirmation, pluralistic advocacy, and narrative framing (Kahan, Jenkins-Smith, and

Braman, 2010: 23-24). Firstly, *identity affirmation* has shown that individuals are more likely to embrace information that appears to reinforce their own worldviews and reject conclusions that undermine their values. Individualists, for example, are more likely to respond to vaccine messages that make the point that the decision not to vaccinate children imposes involuntary risks on others than they are to appeals to authority and expertise. Additionally, the concept of *pluralistic advocacy* highlights how individuals reject messages from experts they believe do not share their cultural values and reflexively trust information from experts whose (presumed) values align with their own. Moreover, if experts representing an array of different values appear to fall on both sides of the fence on a given issue, then the individual may be less prone to engage in identity-protective cognition with respect to the information these experts provide. Third, the analytical results suggest that information campaigns for vaccine programs would benefit from *narrative framing* (Jones and McBeth, 2010), in which custom-fit templates or culturally nuanced narratives are employed that bolster feelings of validation for a particular cultural group. Such customized messages are designed to appeal to their target groups by assigning positive value to their worldview, thereby garnering more attention for crucial public messages carrying vaccine-related information.

Obviously, there is not much that can be done to directly affect most of the demographic factors which impact parents' beliefs (and thus, their behaviors) in regard to vaccinating their children. However, having an awareness of how these characteristics influence different people can help the government ascertain which are the most appropriate target groups for their policy endeavors. For example, the

government should amplify its efforts to engage white individuals who are personally acquainted with, or related to, a person who has autism or Asperger's syndrome, regardless of whether the vaccine-autism link argument is correct. In addition, the results of this study show that those who do not have health insurance coverage for their children tend to avoid vaccinations. In order to increase the vaccination rate, then, the United States government should intensify its efforts to improve the national health insurance coverage rate.

This array of research findings poses more fundamental inquiries concerning policy process, which lays the path for my future research agenda. The first is whether empirical findings from the aforementioned analyses of the general public would hold for other major individual policy actors in the related policy subsystems, especially for those who are members of elite groups (e.g., medical scientists, health care professionals, activist groups, etc.). Should I be able to demonstrate that such elite members possess similar patterns of policy reasoning and policy related behaviors in comparison with the general public, this could provide an opportunity for systemic explanations of a fundamental theoretical element of the Advocacy Coalition Framework (Sabatier and Jenkins-Smith, 1993), a major policy process theory, which states that individual policy actors in a given policy subsystem who share similar fundamental values and beliefs also share views on policy problems and preferred solutions and accordingly organize coalitions to advocate their own positions, while competing with other advocacy coalitions composed of individual actors who have opposing (or different) views on policy-related issues within a particular subsystem.

Another important question is how to explain the way in which competing

advocacy coalitions with differing policy views solidify the organization of their coalitions and gain support for their positions from the general public in a given policy subsystem in a pluralistic democracy. What I have focused upon in this regard is a systemic investigation of the role of policy narratives that can be broadly defined as a story frame composed of messages based upon "reconstructed" factual evidences that competing advocacy coalitions utilize to sell their own policy positions in a debate within a policy subsystem. My previous findings based on an Internet survey experiment involving over 2,000 respondents conducted in the springs of 2009 and 2010 suggests that policy narratives worked only when their messages are congruent with the prior values and beliefs of the various members of the general public on the global climate change policy issue (Jones and Song, 2011). I would like to expand the scope of this research and investigate if these findings also hold true for other policy domains, including vaccine controversies.

Finally, this research (especially Chapter 5) provides groundwork for the future research agenda on how individuals' values and beliefs translate into their policy behavior. A significant number of policy issues, including childhood vaccination policy, require "desirable" changes in behavior of individual members of society, which will ultimately lead to "desirable" social changes needed in order to resolve crucial social problems. However, most scholarly works in public policy have focused on how policy agendas are set, how collective decisions are made, and how policies change over time at the collective level, and individual actors' perceptions of policy problems and preferences toward related policies at the individual level. Of course, these perspectives are very important. Yet we also should pay attention to what explains

individual actors' policy behaviors (Schneider and Ingram, 1990), which provides some practical traction for determining whether a given policy actually achieves what it intends. The findings of this research suggest that individual actors' behaviors are motivated by their beliefs, notably subjective expected utility for policy actions and their preferences toward existing policies, all of which are grounded on more intrinsic personal values, notably grid-group cultural orientations. This is certainly true in a case like that of vaccination policy in the United States, which is simultaneously constituted of multiple contradictory policies (e.g., mandatory vaccination and religious and philosophical exemptions). Therefore, theoretical models that can explain individual level policy behavior should be further developed.

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