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Mapping the Morality of Vaccine Hesitance: Associations of Moral Foundation Values with Vaccine Hesitance

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Abstract

Mapping the Morality of Vaccine Hesitance: Associations of Moral Foundation Values with Vaccine Hesitance

By Avnika B. Amin

Each year, there is an increase in vaccine hesitance and refusal throughout the world, indicating a need for effective interventions. Existing messaging interventions demonstrate modest short-term success, but some may backfire and worsen hesitance. Values-based messages appeal to core morality, which influences the attitudes individuals then have on topics like vaccination. To better tailor interventions, we must understand how underlying moral values, not just attitudes, differ by hesitance type. Here we show that values of harm and fairness are not significantly associated with vaccine hesitance, but values of purity and liberty are. We found that medium-hesitance parents were twice as likely as low-hesitance parents to highly emphasize purity (aOR: 2.08, 95% CI: 1.27-3.40). High-hesitance respondents were twice as likely to strongly emphasize purity (aOR: 2.15, 95% CI: 1.39-3.31) and liberty (aOR: 2.19, 95% CI: 1.50-3.21). Our results demonstrate that the importance of harm and fairness, two values often emphasized in traditional vaccine-focused messages, are not predictive factors for vaccine hesitance. This, in conjunction with significant associations of purity and liberty, indicates a need for inclusion of broader themes in vaccine discussions. These findings have the potential for application to other health decisions and communications as well.

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TABLE OF CONTENTS

BACKGROUND AND LITERATURE REVIEW

Introduction

This background and literature review explains what vaccine hesitance is and why it poses a significant public health problem before presenting a review of select interventions to address vaccine hesitance. This review will highlight the limitations of such interventions and the gaps that still need to be addressed. The original research presented in subsequent sections will attempt to provide novel insight into vaccine hesitance and guide future development and testing of appropriate interventions.

Background

Vaccines are widely considered to be one of the most successful public health interventions, as they have dramatically decreased global mortality and morbidity from vaccine-preventable diseases.[1] They not only provide direct protective effects to the individual receiving the vaccine, but also decrease community transmission and provide indirect protection from disease for unvaccinated individuals. This indirect protection relies on maintaining a sufficiently high level of vaccine coverage, known as the community protection threshold, within geographic regions.[2] This threshold is reliant on factors like the pathogen's infectivity and the effectiveness of the vaccine's direct protection.[2]

Especially in developed countries, vaccines have become a victim of their own success. Their protective effects decrease disease incidence, but younger generations only see the reduced disease burden and often question the necessity of immunization.[3,4] This

trend is reflected in the growing numbers of parents in the United States who request exemptions to vaccine requirements for non-medical reasons.[5,6] Because the success of immunization relies heavily on high levels of uptake, individuals who refuse vaccines or follow delayed vaccination schedules jeopardize the strength of the indirect protective effects a community enjoys. While national vaccine coverage remains high, high immunization rates do not necessarily indicate high overall confidence in the importance of vaccination.[7] Further examination of U.S. state-level coverage reveals spatial clustering of under- or unimmunized individuals.[8,9] These clusters are more susceptible to outbreaks of vaccine-preventable diseases because, within that geographic area, the vaccine coverage levels are lower than the requisite community protection threshold.[10] Although vaccine-preventable diseases have remained at very low levels in America's recent history, some are experiencing a resurgence due to geographic clusters of susceptibles.[9,11,12] Such clusters are symptomatic of a larger public health problem, that of vaccine hesitance.

Vaccine Hesitance

Individual attitudes towards immunization range on a continuum from vaccine-acceptance to vaccine-refusal. Vaccine-hesitant individuals showcase more nuanced attitudes towards immunization, rather than blanket acceptance of all vaccines.[13] Such individuals may accept some vaccines but refuse or delay others.[14,15] Vaccine hesitance broadly encompasses three types of individuals: those who receive all vaccines but express concerns about vaccination, those who selectively delay or refuse vaccines, and those who refuse all vaccines (demonstrating the extreme of vaccine refusal).[13]

Because of the diversity of attitudes and concerns, vaccine-hesitant individuals can be classified in different ways. One method, developed by Gust *et al*, used a k-means cluster analysis to identify five different profiles of vaccine attitudes based on the types of concerns cited by parents: immunization advocate, go along to get along, health advocate, fencesitter, and worried.[16] Immunization advocates are characterized by their highly positive attitudes towards immunization and their engagement with health issues in general.[16] While the go along to get alongs also feel positively about vaccines, they do so to a lesser degree and are less interested in health issues; they also feel neutral about their relationship with their healthcare provider.[16] The remaining profiles feature attitudes characteristic of vaccine-hesitant individuals. Health advocates understand the necessity of immunization but are skeptical about their safety, and are more concerned with health and wellness overall.[16] Fencesitters, as implied in the name, express very neutral attitudes overall about the value of immunization, their vaccine confidence, and their relationship with their healthcare provider.[16] Worrieds actually disagree that vaccines are necessary or safe, and are skeptical that the medical community has the best interests of the children at heart.[16]

Another method, developed by Opel *et al*, seeks to classify vaccine hesitance based on both the number and the strength of vaccine attitudes. The Parent Attitudes about Childhood Vaccines questionnaire assesses hesitance using three different constructs: historical immunization behaviors, beliefs about vaccine safety and efficacy, and trust in healthcare providers and immunization information.[17] This method is simpler to use and can be calculated quickly, as parents are classified as low, medium, or high hesitance based on their questionnaire score.[14,17] Although such methods of hesitance

assessment may be different on the surface, they actually correlate well with each other, even though the Gust categorization is non-additively determined, while the Opel scale is.[18] This suggests that there may be some underlying pattern in vaccine attitudes and hesitance not captured by either scale.

The sources parents use to gather information about vaccines widely vary, further complicating the problem if trusted sources disagree. Healthcare providers are still consistently ranked as the most common, influential, and high-quality source of information about vaccinations.[19,20] However, other sources like close family members, friends, various internet sites, news reports, and even celebrities are increasingly reported as influential in the evaluation of vaccine information.[16,19,20] Antivaccination information is far more commonly found on the internet than in other sources of media like televised news.[21] Those who report using the internet are significantly more likely to have used antivaccination websites to inform themselves and to believe that sources of misinformation, like the National Vaccine Information Center, are trustworthy sources.[19,22]

The profiles developed by Gust *et al* demonstrate that the type and magnitude of parental vaccine-related concerns and attitudes can vary widely, with even those parents who recognize the importance of vaccines expressing concerns.[7] An analysis of the 2010 HealthStyles survey indicated that only 23% of parents had no concerns whatsoever about vaccination.[7] Moreover, the many different sources of information used by parents can complicate the decision-making process and cause confusion. Vaccine misinformation, especially on the internet, is becoming more prevalent and easier to find, further adding to the confusion around the true benefits of and risks from vaccination.

Approximately 10% of parents ranked the Internet as one of their top three sources of vaccine information,[23] but this had significantly risen to 24% only a year later.[7] This increasing use of the Internet as a means of health self-education, in conjunction with the misleading information prevalent in the medium, is a worrisome combination, especially with respect to maintaining current levels of vaccine uptake.

Public confidence in immunization has been challenged by increasing skepticism around the necessity and safety of vaccination. For example, the pandemic 2009 H1N1 influenza vaccine became widely available in the Northern Hemisphere after the peak of the outbreak; by that point in time, the public was less concerned by the perceived mild severity of the virus and more concerned about the safety of the adjuvants used in the vaccine.[24] The increasing popularity of alternative vaccine schedules (where the CDC-recommended schedule can be spaced out or selectively followed),[25] the acceleration in requests for non-medical vaccine exemptions,[6] and the regularity with which parents ask questions about vaccines during routine office visits (approximately 60%)[23] all indicate that parental vaccine hesitance is on the rise. This gives cause for concern about maintenance of high immunization coverage, especially in clusters of under- or unimmunized children, to prevent vaccine-preventable diseases from experiencing a resurgence in incidence. Effective communication strategies to combat misinformation and positively impact and reinforce parent attitudes towards immunization are needed now more than ever.

Existing Interventions

As vaccine hesitance has trended upward, an increasing number of vaccine-focused messaging interventions have been developed to try to address this issue. These interventions attempt to promote vaccination at each stage of the decision-making process and fall into several overlapping categories. This review focuses on three types of interventions: opt-in versus opt-out messages and reminders, gain-framed versus loss-framed messages, and culturally tailored messages. The messaging categories are not mutually exclusive, and different aspects of the same intervention may fall into different categories.

Opt-in and Opt-out Messages and Reminders

Opt-in messages and reminders set the default choice as non-participation and require a specific action to participate, while opt-out messages and reminders make participation in an activity the default. As an example, individuals in an opt-in situation would have to go out of their way to schedule a clinic visit to receive a flu shot, as the default is to not have a pre-scheduled visit. Individuals in an opt-out situation would be automatically scheduled to receive a flu shot unless they specifically cancelled their appointment.

A study randomizing university staff members to the above conditions demonstrated that individuals who had to opt out of their flu shot appointment were more likely to have had an appointment at the end of the study period and to have received a flu shot.[26] These findings were also replicated in a similar study among healthcare

workers.[27] Those in the opt-in condition had to reply to an email to get an appointment and those in the opt-out condition had to reply to cancel their appointment.[27]

Other interventions leverage the natural influence of physicians to set the default to vaccination in a patient visit setting. Initiation of discussion can either be participatory ("Would you like for your son to be vaccinated today?") or presumptive ("It's time for your son to receive his meningitis vaccine today.") in nature. Use of a participatory communication method by the provider was associated with significantly decreased likelihood of vaccine receipt at that same visit.[28] Thus, a presumptive approach would be associated with a substantially higher likelihood of vaccine receipt.

It can also can be useful to use this type of default-setting when it comes to physician vaccination orders, as they already have many other things to remember during a patient visit. Primary-care providers generally accept standing orders and view them favorably,[29] which also makes it much easier to convince them to regularly use such interventions. However, with the transition from paper to electronic health records, the barrage of alerts and reminders physicians handle with each patient lead to alert fatigue, resulting in decreased responsiveness to the alerts in general.[30] Alerts that remind the provider to order a patient's vaccine thus diminish in effectiveness, but standing orders do not generate such alerts, helping them to be more successful in promoting vaccine uptake. Standing orders are also useful for vaccines that are traditionally underused in elderly populations, like influenza and pneumococcal vaccines, because such individuals are unassessed for their vaccination status.[31]

Substantial evidence for the increase in vaccinations due only to implementation of standing orders abounds. For example, a retrospective analysis of physicians at an

ambulatory clinic found that, over a four-year period, patients of physicians who issued verbal or written standing orders about influenza vaccination for elderly patients had 63% of their patients receive the vaccine, compared to only 38% of patients of physicians without standing orders.[32] The magnitude of this increase does vary, although in most instances there is a substantial, double-digit increase in vaccination uptake. When comparing vaccination rates between hospital-based standing orders and the surrounding community, standing orders increased the absolute rate of vaccination by 22%.[33] Other studies have seen absolute increases of 78%[34,35] and 87%[35] when compared to their respective control facilities.

Many studies indicate that use of standing orders more effectively increases vaccination rates than other healthcare institution-based interventions. In a study with several community hospitals, standing orders yielded influenza vaccination rates of 40.3%, compared to just 17% and 9.6% for physician reminders and educational programs, respectively.[36] Such methods can also help reduce the burden on healthcare providers' time and energy by having pharmacists activate a standing orders protocol. When examining rates of influenza vaccination in the elderly, only 15% of eligible patients were vaccinated against influenza with a computerized reminder to the physician, while 73% of eligible patients were vaccinated when pharmacists activated standing orders protocols.[37] Development and implementation of a computerized standing orders system for influenza and pneumococcal vaccination in a public teaching hospital that patients eligible for either or both of these vaccines were more likely to receive them with the default computerized standing orders.[38]

However, setting defaults for vaccination can cause underlying resentment towards the individuals promoting vaccination. Patients with providers using a presumptive approach report decreased visit satisfaction and may be less likely to return to that provider in the future or continue vaccination if they feel strongly against immunization.[28] Hesitant individuals may also feel pressured to go along with vaccine recommendations they disagree with because of the authoritative manner in which these interventions are implemented, which may ultimately reinforce or even worsen their negative vaccine attitudes.[39]

Gain-Framed and Loss-Framed Messages

Gain- versus loss-framed messages, as implied by their name, focus on emphasizing what stands to be gained by vaccinating and lost by not vaccinating. They leverage prospect theory, which suggests that the manner in which an outcome is presented (the prospect of a loss or a gain) influences the decision to act (or not) that an individual ultimately takes.[40] An individual's valuation of the loss that may be sustained or the gain that may be made is weighted against the resource cost of taking an action.[40] People generally will take more action to avoid a loss than to obtain a gain, although this is not always the case within certain contexts.[40]

When applying prospect theory to vaccine-focused messages, gain-framed messages emphasize the positive results from vaccination (i.e. If you decide to get the vaccine, you may decrease your chance of contracting the potentially deadly H1N1 flu virus").[41] "If you decide not to get the vaccine, you may increase your chance of contracting the potentially deadly H1N1 flu virus" is the same message framed as a

loss.[41] Generally speaking, gain-framed messages tend to be better for promoting preventive health behaviors like immunization.[42,43] However, loss-framed messages (sometimes referred to as fear appeals) have their place and, when used selectively and appropriately, can also be useful for promoting vaccination.

One study randomizing older adults to one of the above two messages found that when the individual already believed that the flu vaccine was effective, the gain-framed message yielded a higher intention to vaccinate than the loss-framed message; however, the opposite was true if the individual perceived low effectiveness for the flu vaccine.[41] Results from studies using non-parental adult populations also support the idea that gain-framed messaging is more effective when perceived vaccine effectiveness is high, while loss-framed messaging is more effective when perceived effectiveness is low.[44] Thus, the decision to use a gain-frame or a fear appeal may be dependent on the individual's perceived effectiveness of a vaccine.

However, another study examining the effect of framing on women's intention to vaccinate their children with MMR vaccine indicated that loss-framed messages increased vaccination intention more that gain-framed messages.[45] This was especially true for women who had previously rejected MMR vaccination for their children, as gain-framed messages actually decreased their intention to vaccinate.[45] Prior vaccination decisions may indicate perceived vaccine effectiveness, which thus further demonstrates that those who perceive low vaccine effectiveness may be more motivated to vaccinate with a loss-framed message.

Another study comparing gain- and loss-framed messages for HPV vaccination noted that the frequency of the behavior (i.e. how many injections were needed) impacted

the effectiveness of their messages. Loss-framed messages were more effective for increased vaccination intention when only one injection was needed, while gain-framed messages were more effective when multiple injections were required.[46] This demonstrates that the effects of gain- and loss-framing are subject to behavioral frequency, which suggests that loss-framed messages are best when promoting a specific vaccine instead of promoting general positive attitudes towards immunization.

Ethnicity can also play a role in how effective gain- or loss-framed messages are. Another study evaluated messages for intention to receive the HPV vaccine, but stratified their analyses by ethnicity (Hispanic, non-Hispanic white, and African-American). For Hispanics and African-Americans, a loss-framed message was more effective at increasing vaccination intention, but both types of messages were equally effective for non-Hispanic whites.[47] The authors posited that the difference in effectiveness was due to underlying cultural values, with individualist cultures (as experienced by non-Hispanic whites) focused more on distinguishing themselves through their personal accomplishments and collectivist cultures (as experienced by Hispanics and African-Americans) focused more on fulfilling their obligations to others and avoiding loss.[47]

Culturally Targeted Messaging

Targeted messages can take many forms, with the ultimate goal of providing the information in a manner that is consistent with the shared characteristics of a population or population subgroup.[48] The types of characteristics that can be targeted include those of unifying passions like sports teams, shared cultural identity, and even valuations of morality. This section focuses on culturally targeted messaging, which aims to emphasize

and leverage cultural similarities between the message recipient and the message itself. This intervention type is heavily reliant on appropriate audience segmentation and formative work to identify unifying cultural factors.[48] This can involve using culturally identifiable actors, using the target audience's native language or preferred entertainment, or simply being mindful of the differences in underlying cultural values as illustrated in the previous study.

A study conducted with inner-city clinic patients, most of whom were African-American, randomized participants to an educational video about the pneumococcal vaccine, the same video with an additional brochure, or an education brochure about general health and nutrition. The video featured black actors modeling physician-patient discussion about the vaccine, with content developed from prior focus groups about motivators for and barriers to immunization in this same population.[49] Both interventions were effective, but the video was more effective when paired with the brochure compared to the video by itself and the unrelated health brochure for both occurrence of a vaccine-related discussion and receipt of the pneumococcal vaccine.[49]

A similar intervention, this time promoting HPV vaccination for girls, used an interactive video featuring cultural and gender tailoring of the actors and the content. While there was not a significant difference in the proportion of participants initiating the HPV vaccine series, those randomized to the intervention arm were more likely to receive the remaining two doses.[50]

Another study focused on promoting HPV vaccination for the daughters of Hispanic parents. Parents were randomly assigned to listen to either a public service announcement about prostate cancer screening or a short radionovela where a young girl

learns about the HPV vaccine, both of which were presented in the middle of normal Spanish radio programming.[51] Parents who listened to the radionovela scored much better than those who listened to the public service announcement on assessment of HPV vaccine knowledge and myth belief.[51]

Both this intervention and the previous one would likely not have as substantive an effect in different study populations if left untailored for the new population. This prevents them from being broadly applicable to the problem of vaccine hesitance. Additionally, both interventions were heavily reliant on formative work to develop the messages themselves, which makes such interventions very resource-intensive, especially when attempting to use these methods in different populations.

General Limitations

The above interventions all focus on evaluating outcome of vaccine receipt or intention to vaccinate. Vaccine-focused interventions would ideally focus on changing the root of the problem, the negative vaccine attitudes themselves, but the impacts of the above interventions on such attitudes are unknown. The effectiveness of default-setting strategies can have positive short-term impacts but may ultimately cause resentment and negatively impact long-term outcomes. Gain- versus loss-framed messages are highly dependent on the specific vaccine being promoted and an individual's perceived effectiveness of the vaccine. Tailored messages are highly effective within specific audience segments, but require heavy customization and are not easily adaptable across different cultural and geographic contexts. Thus, it is clear that an easily-adaptable

strategy that promotes long-term satisfaction is needed to effectively promote positive vaccine attitudes.

Information Processing

Social Judgement Theory posits that, for any topic, messages are judged to be acceptable, neutral, or unacceptable based on the attitude that the message recipient holds. Acceptable positions are those judged "close enough" to the individual's personal attitudes that any discrepancies between the two are treated as unimportant.[52] Messages that fall into this latitude of acceptance tend to reinforce the individual's existing attitude. Unacceptable positions are those that have at least one major component the message recipient deems totally incongruent with their personal attitudes and do not stimulate any sort of attitude shift within the message recipient.[52] However, messages that the recipient classifies as neutral (i.e. those that the individual has no strong opinion on) have the most potential to shift an individual's attitude towards a different opinion.[52]

Within the specific context of vaccines, the Extended Parallel Processing Model is also important to consider. This model serves as a behavioral framework for situations when an individual perceives a "threat" which is, in this instance, contracting a harmful disease. In such situations, an individual will either directly confront the hazard or become cognitively frozen and incapable of taking any action.[53] Vaccine-focused messages must be find the balance between stimulating risk perception (i.e. perceiving that one is at risk for a particular disease) while not provoking such a cognitive freeze. They must additionally promote an individual's response efficacy (i.e. there is an

effective action to avoid getting sick) and self-efficacy (i.e. the belief that one is capable of taking such preventive action).[53]

Communication interventions all face one common hurdle: ensuring the recipient can cognitively process the message and integrate it with existing information in the manner desired by the messenger. Core tenets of Social Judgement Theory and the Extended Parallel Processing Models should be carefully considered and properly incorporated when designing messaging interventions. However, the integration of these concepts into health messaging interventions is relatively new. Use of the above models may also help to address vaccine attitudes directly, as they work on a subconscious level and address attitudes that drive intention to vaccinate and vaccine uptake.

Moral Foundations Theory

Moral Foundations Theory was originally developed to reconcile variances in the specifics of cross-cultural morality with recurrent themes in morality that transcend cultures. This theory posits that six core values - care/harm, respect for authority/subversion, loyalty/betrayal, liberty/oppression, purity/degradation, and fairness/cheating – comprise every individual's system of morality. These values subsequently shape attitudes and opinions for each topic the individual encounters. Intention to act is subsequently affected by attitudes, and ultimate action is shaped by intention. Each foundation features a positive and negative attribute, and the extent to which each individual factors both attributes into his or her decision-making process can be used to assess the importance of each foundation to the individual's system of morality.[54]

The first foundation, care/harm, focuses on virtues of kindness and nurturance to both the self and to others. Respect for authority/subversion centers on ideas of leadership and deference to social authorities and traditions. Loyalty/betrayal is related to the human ability to generate an "us vs. them" mentality and focuses on virtues of patriotism and self-sacrifice for the perceived "us". Liberty/oppression acts in tension with respect for authority, as this foundation is shaped by feelings of resented to those perceived to be oppressors or illegitimate leaders. Purity/degradation invokes both religious ideals of spirituality, as well as more physical purity from perceived contaminants. Finally, fairness/cheating centers on ideas of justice and rights for all. All six foundations together form an individual's unique moral matrix.

Two sets of questionnaires can be used to assess an individual's moral matrix: the Moral Foundations Questionnaire and the Liberty Foundation Questionnaire. The first questionnaire assesses the original five foundations – all of those listed above except liberty – and features six questions per foundation.[54] It also contains two attention check questions to make sure the individual is not just randomly choosing answers, resulting in a scale comprised of a total of 32 items. Each foundation score ranges from 0-30, with higher numbers indicating stronger endorsement and relevance of that particular foundation.[54] The second questionnaire features nine questions to assess an individual's endorsement of the liberty foundation. Scores range from 0-45, with higher numbers again indicating stronger endorsement of this foundation.[55] It is important to note that stronger endorsement of a foundation is not equivalent to how much an individual cares about a particular value, but to what extent this value factors into his or her decision-making.

Moral Foundations Theory has been previously used to demonstrate that liberals and conservatives have distinctly different patterns in their moral matrices.[56] Liberals tend to highly emphasize principle of harm and fairness, with low emphasis on the other foundations, while conservatives emphasize all foundations more equally.[56] Patterns of values in the moral matrix help to predict the positions individuals may take on various political issues. For example, strong endorsement of the purity/degradation foundation has been shown to predict an individual's opposition towards equal rights for same-sex marriages and unmarried couples, as well as opposition towards adoption of children by same-sex couples.[57] This is suspected to be due to a perceived violation of the purity foundation; same-sex and unmarried couples are, on some level, viewed as a threat to the sanctity of the traditional family.[57] Moral Foundations Theory has also shown some success with shifting political attitudes by appealing to the strongly endorsed values to reframe the issue in terms of the values most important to the message recipient.[58-60] Thus, this approach may also prove useful if similar moral matrix patterns can be found among vaccine-hesitant parents.

Study Premise

This study seeks to characterize vaccine hesitance in terms of values, rather than specific attitudes or concerns held by parents, using the Moral Foundations Theory framework described above. The correlation between two different vaccine hesitance assessment methods (Parent Attitudes about Childhood Vaccines and the Gust *et al* methodology) suggests a common underlying driver behind the diversity of vaccine attitudes and concerns held by vaccine-hesitant parents.[18] Thus, it is important to assess

associations between patterns in the moral matrices and vaccine attitudes in parents for two reasons: 1) to determine if there are deeper moral values and patterns that may predict vaccine hesitance, and 2) to assess if Moral Foundations Theory may hold potential for use in vaccine attitude change.

MANUSCRIPT

ABSTRACT

Rising vaccine hesitance in the United States indicates a need for evidence-based strategies to positively impact parental vaccine attitudes. Moral Foundations Theory quantifies individuals' emphasis on different moral values, which subsequently influence attitudes. This study is the first to utilize this framework in the context of healthcare decisions. We investigated associations of vaccine hesitance with moral values in parents of under-13 children. Medium-hesitance parents were twice as likely as low-hesitance parents to highly emphasize purity (aOR: 2.08, 95% CI: 1.27-3.40). High-hesitance respondents were twice as likely to strongly emphasize purity (aOR: 2.15, 95% CI: 1.39-3.31) and liberty (aOR: 2.19, 95% CI: 1.50-3.21). The null associations of harm and fairness, in conjunction with significant associations of purity and liberty, indicate a need for inclusion of broader themes in traditionally harm- and fairness-based vaccine discussions. This work has the potential for broad application to other health decisions and communications.

INTRODUCTION

Growing numbers of parents requesting non-medical vaccine exemptions for their children indicate cause for concern about maintaining sufficiently high coverage levels in the United States.[5,6] However, of greater concern are the clusters of children more susceptible to outbreaks of vaccine-preventable disease due to being partially or fully unvaccinated.[10,12] Researchers classify the parents of such children as vaccine-hesitant; the different types of hesitance are based on the type and strength of their concerns about vaccination.[16,17] Effective communication in both healthcare practice settings and public campaigns is key to effective vaccine attitude shift.

Overall, there are few existing evidence-based strategies to address vaccine hesitance, and even fewer that have been quantifiably evaluated for effectiveness.[6] Recent messaging interventions have focused on vaccine knowledge and education [62,63] and message framing [28,64] as methods to change vaccination attitudes and intention to vaccinate. Most demonstrate short-term success, but some backfire and worsen parental hesitance about vaccines [64] or temporarily increase vaccination rates but may lead to long-term dissatisfaction and decreased intention to vaccinate.[28]

To avoid problems created from head-on confrontation of vaccine hesitance, moral values underlying decision-making processes may be used to improve an individual's attitudes about vaccination. The resultant positive attitudes may then subsequently impact intention to vaccinate and ultimately increase rates of immunization action. Moral Foundations Theory suggests that six key dimensions of moral concern – care/harm, respect for authority/subversion, loyalty/betrayal, liberty/oppression, purity/degradation, and fairness/cheating – influence the attitudes an individual develops

on a particular topic [55,65]. Moral foundations have been associated with attitudes and attitudinal shift on topics ranging from climate change to philanthropy [58-60,66,67] but, to the best of our knowledge, they have not been specifically studied in the context of attitudes towards specific medical decisions.

The advantage of Moral Foundations Theory is its ability to quantify individuals' multiple moral values and provide an empirical, evidence-based framework within which to develop communication strategies. Characterization of the strength and magnitude of the associations of these moral foundations with parental vaccine attitudes would provide a promising direction for development of a values-based messaging intervention. Here we present the results of an investigation into the association of moral foundation values with parental vaccine hesitance. This study is the first of its kind to directly examine associations of healthcare decision attitudes with a values-based approach like that used by Moral Foundations Theory.

METHODS

Study Population Recruitment

We received approval from Emory University's Institutional Review Board (Study #00075928) for this study. Parents of under-13 children were recruited online through Amazon Mechanical Turk (MTurk). A link to the survey was posted on the MTurk website, along with a brief description of the study and the associated small monetary compensation. Interested respondents answered a brief series of screening questions to ensure that they met eligibility criteria (between 18 and 50 years of age,

resident of the United States, and at least one child no older than 12 years of age). Eligible individuals then saw a consent form displayed and were required to answer a question asking if they consented to take part in the study. Only individuals who selected "Yes" when asked if they were willing to take part in the study were allowed to answer the remainder of the survey questions.

Survey Instrument

The survey was developed based on the Parent Attitudes about Childhood Vaccines short scale, the Moral Foundations Questionnaire, and the Liberty Foundation Questionnaire. The 5-item Parent Attitudes about Childhood Vaccines short scale was the vaccine hesitance outcome analyzed in this study. The Parent Attitudes about Childhood Vaccines portion of the survey contained items answered on a 3-point scale (Yes, No, Don't Know) within 3 categories: vaccine behaviors, attitudes about vaccine safety and efficacy, and general health attitudes.[17,68]

The Moral Foundations Questionnaire contained items on a 6-point Likert scale designed to capture each moral foundation construct.[54] For each foundation, three questions asked about the relevance of the foundation when determining if something was right or wrong (0 = not at all relevant; 5 = extremely relevant), and three questions asked about the importance of such considerations when making decisions (0 = strongly disagree; 5 = strongly agree). The Liberty Foundation Questionnaire used similar questions to assess the liberty foundation, although there were nine items assessing this foundation instead of the six items used for the other five foundations.[55] Two previously-validated attention checks were included to test whether or not the respondent paid

sufficient attention to the questions. These attention checks asked the respondents to rate how relevant someone's ability to do math was (acceptable answers included "Not at all" to "Somewhat") and how much they agreed with the statement "Killing someone can usually not be justified" (acceptable answers ranged from "Neutral" to "Strongly agree"). Demographic information collected included respondent's age, number of children, level of education, and gender.

Scoring and Cleaning Data

Survey data were analyzed using SAS 9.4 (32 bit, English) software (The SAS Institute, Cary, NC). Respondents who failed either of the two attention checks in the survey were removed from the analysis. The Parent Attitudes about Childhood Vaccines items were each scored on a 0-2 scale, with a summary score ranging from 0 to 10. Summary scores were then categorized into level of vaccine hesitance: low hesitance (0-4), medium hesitance (5-6), and high hesitance (7-10).[68] Moral Foundations and Liberty Foundation Questionnaire items were scored on a 0-6 scale, with a summary score ranging from 0 to 30 for each moral foundation except liberty. The liberty summary score initially ranged from 0 to 45, and was linearly scaled down to range from 0 to 30 to allow direct comparison with other constructs. All moral foundation summary scores were dichotomized into low relevance and high relevance based on the mean sample score for each of the foundations. All sociodemographic variables were categorized based on the response options except for age, which was dichotomized into 18-40 years and 41+ years. Categories for number of children included 1, 2, 3, 4, and 5 or more. Categories for level

of education included high school level education at most, some college-level education, college degree, some graduate-level education, and graduate degree.

Statistical Analysis

Selected characteristics of the study participants according to Parent Attitudes about Childhood Vaccines hesitance category were compared using Fisher's exact test for categorical variables and a one-way ANOVA for continuous variables. A logistic model was then created to investigate associations of the six moral foundations with each Parent Attitudes about Childhood Vaccines hesitance category. We used unconditional polytomous logistic regression models, treating Parent Attitudes about Childhood Vaccines hesitance category as a nominal categorical variable and the relevance scores for each moral foundation as dichotomous categorical variables. Age, number of children, gender, and level of education were included as covariates as interest as they are known in the literature as influences of degree of vaccine hesitance. Interaction terms to assess any difference in magnitude of effect at the low and high level of moral foundation relevance by a covariate were also included in this model.

Backwards elimination was performed on the interaction terms, with the significance level for elimination set at $p < 0.05$. Removal of all non-significant interaction terms produced the fully-adjusted model used as the gold standard for assessment of confounding by the covariates of interest. Confounding was assessed using an all-possible subsets approach on covariates eligible for removal (that is, not featured in any remaining interaction terms). A subset was deemed unsuitable if any of the adjusted odds ratio estimates for the six moral foundations was more than 10% away from the

respective estimate in the fully-adjusted model. The most parsimonious of the unconfounded models generated was selected as the final model.

RESULTS

The study included 1,007 consented adult participants who met eligibility criteria and answered an online survey about moral foundations and vaccine attitudes (see Figure S1 for study participant flow chart). Participants were 66.4% female. Most were between 18 and 40 years of age (76.6%) and had either one (40.1%) or two (36.1%) children (see table S1 for full demographics of the study population). Seventy-three percent of respondents were classified as low hesitance according to their Parent Attitudes about Childhood Vaccines score, while approximately 11% were classified as medium hesitance and 16% as high hesitance (see table S2 for study population demographics stratified by hesitance).

Our first unconditional polytomous logistic regression model included variables for all six moral foundations, as well as for level of education and age due to observed confounding effects, in this model. Odds ratios and 95% confidence intervals calculated from this model are presented in Figure 1 (see Table S3 for numerical values for all odds ratios, 95% confidence intervals, and p-values for this model).

Medium-hesitance parents were twice (aOR: 2.08, 95% CI: 1.27-3.40) as likely as low-hesitance parents to place high emphasis, rather than low emphasis, on purity. High-hesitance parents were also twice as likely as low-hesitance parents to place high emphasis on either purity (aOR: 2.15, 95% CI: 1.39-3.31) or liberty (aOR: 2.19, 95% CI:

1.50-3.21). Inversely, high-hesitance parents were half (aOR: 0.43, 95% CI: 0.27-0.67) as likely as low-hesitance parents to place high emphasis on respect for authority. Strength of emphasis on harm and fairness were not statistically significantly (p-value < 0.05) associated with degree of vaccine hesitance.

In further exploration of this model, the age group to which an individual belonged impacted the odds ratios for liberty emphasis (Figure 2). The odds ratios for purity and respect for authority described above remained almost identical; however, a differential association of liberty with hesitance by age was observed (see Table S4 for numerical values for all odds ratios, 95% confidence intervals, and p-values for this model).

Medium-hesitance parents over the age of 40 were one-third (aOR: 0.33, 95% CI: 0.13-0.81) as likely as their low-hesitance counterparts to place high emphasis on liberty; however, there was no statistically significant association between medium hesitance and high emphasis on liberty in the younger parents. High-hesitance parents less than 40 years of age were two and a half (aOR: 2.48, 95% CI: 1.59-3.87) times as likely as their low-hesitance counterparts to place high emphasis on liberty, although there was no statistically significant association for parents less than 40 years of age.

DISCUSSION

Effective communication strategies for use in discussions with vaccine-hesitant parents continue to need more quantifiable, evidence-based methods for their development and testing. Here we demonstrate that several distinct values are associated

with parental vaccine hesitance, but associations of these values are dependent on the strength of the hesitance. For medium-hesitance parents, the main factor is a high emphasis on purity, while high-hesitance parents hold factors of not only purity, but also liberty and authority, as relevant to their decisions. The influence of different generational values may also prove important, as younger parents have a strong association between high emphasis on liberty and high vaccine hesitance. It is important to note that values of harm and fairness do not differ by magnitude of hesitance. This may explain why parents receiving information about the societal benefits of vaccination (i.e. herd immunity) show no increase in intention to vaccinate;[69] after all, such arguments are couched in principles of what is fair to others as well as the self.

Prior studies focus on the overt concerns commonly cited by vaccine-hesitant parents;[7] however, their concerns may be directly linked to the moral foundations emphasized as demonstrated in this study. For instance, parents who are concerned about the toxicity of vaccine components (as reflected in anti-vaccine messages that simply list the unnatural-sounding chemicals contained in vaccines) may place high emphasis on the purity foundation. A parent wanting their child to receive fewer vaccines in one visit may strongly emphasize liberty and desire to have more choice in their child's vaccination schedule.

Limitations

We recognize there are a few limitations to this work, as the data have been collected from an online convenience sample of parents. Our results may be of limited

generalizability, although studies have indicated that samples from Amazon Mechanical Turk may be more representative of the United States than initially believed,[70] but these results are internally valid. Additionally, the cross-sectional nature of this study prevents us from determining if the currently-emphasized moral values do in fact drive vaccine hesitance, or if participant attitudes about vaccines stimulate specific moral values. This limitation does not impact the validity of the results given that we aimed to develop a predictive model instead of an explanatory one.

Strengths

This work also has several strengths, the primary being its quantification of individual beliefs. This standardized assessment of moral values makes this framework easily translatable to other areas within public health. Use of previously-validated scales for assessment of moral values and vaccine hesitance also allows for replication of this study in the same population and exploration of the values-hesitance relationship in other cultural populations. The study's sample size is another strength. General guidelines for sample sizes when characterizing unknown associations indicate between 10 and 30 observations, at minimum, per intended predictor.[71-73] With the strength of associations between moral foundations and vaccine hesitance as-yet uncharacterized, our sample size of 1,007 exceeds the normative sample size for similar studies and allows for sufficient power and robust sub-analyses.

Conclusions

Overall, this work provides the first quantified insights into the associations of moral values with vaccine attitudes. These results indicate a promising direction for development of messaging interventions formed by quantitative evidence and less reliant on cues from common sense. They also suggest that health decisions are, to some extent, morally driven. This would need to be replicated in studies focused on other health behaviors. More importantly, this values-based approach can easily be applied to other health decisions and may provide a standardized, yet easily adaptable, approach for public health interventions.

PUBLIC HEALTH IMPLICATIONS AND POSSIBLE FUTURE DIRECTIONS

Public Health Implications

This work has several implications for public health knowledge and application. The immediate implications of the results presented here indicate that attitudes about immunization are, to some extent, driven by an individual's moral values. By extension, this suggests that all healthcare decisions and behaviors have individual morality as a factor. It is only recently that public health researchers have begun to integrate more qualitative areas like cultural anthropology and psychology into development of public health interventions. Qualitative considerations boost the success of interventions, but are hard to replicate in a standardized way due to their inherent qualitative nature. Our work suggests aspects of these qualitative features can, to some extent, be quantified. This provides better replicability for interventions developed using Moral Foundations Theory.

Future Directions

The results of this work provide guidance for development of novel, vaccine-focused messages to positively impact parental vaccine attitudes and reduce vaccine hesitance. Messages could be customized to appeal to the individual's highest-scoring moral foundations and frame vaccine hesitance issues in terms of the most relevant foundations. Another method would be to develop standardized messages for parents classified as medium and high hesitance based on the moral matrix patterns observed for each level of hesitance.

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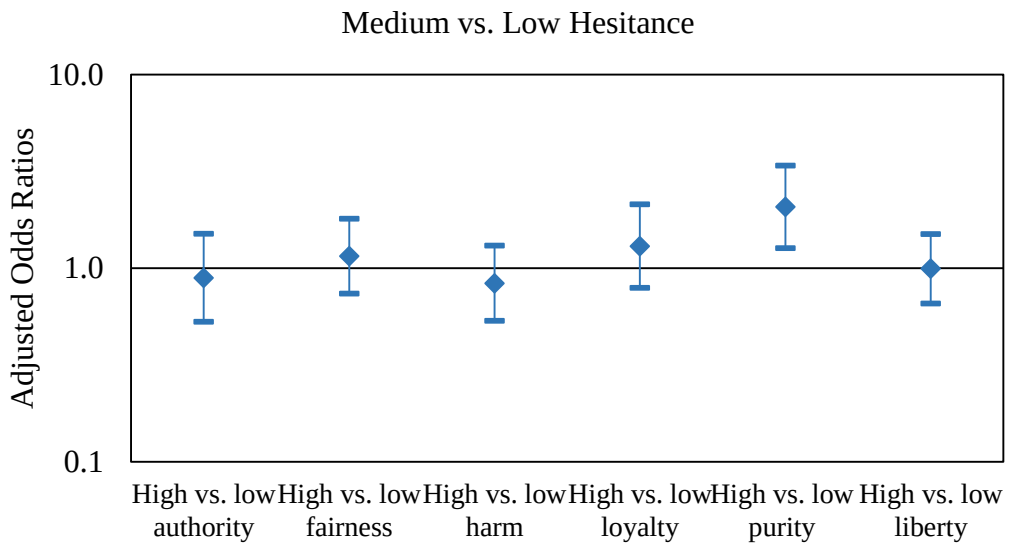
FIGURES

A



B

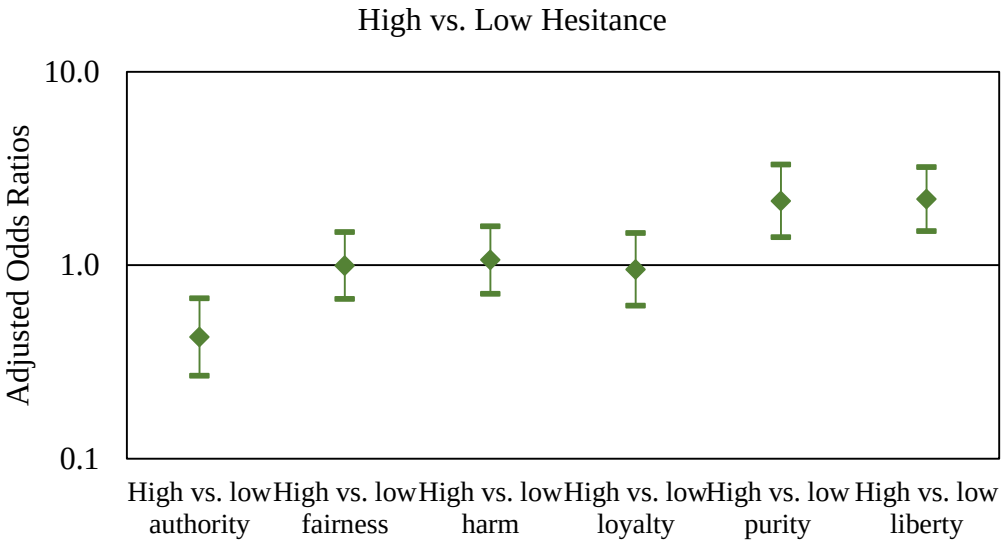


Figure 1. Odds ratios and 95% confidence intervals from an unconditional polytomous logistic regression model, adjusted for level of education and age.

(A) Likelihood of high emphasis on a moral foundation relative to likelihood of low emphasis for a parent classified as medium hesitance, as opposed to low hesitance.

(B) Likelihood of high emphasis on a moral foundation relative to likelihood of low emphasis for a parent classified as high hesitance, as opposed to low hesitance.

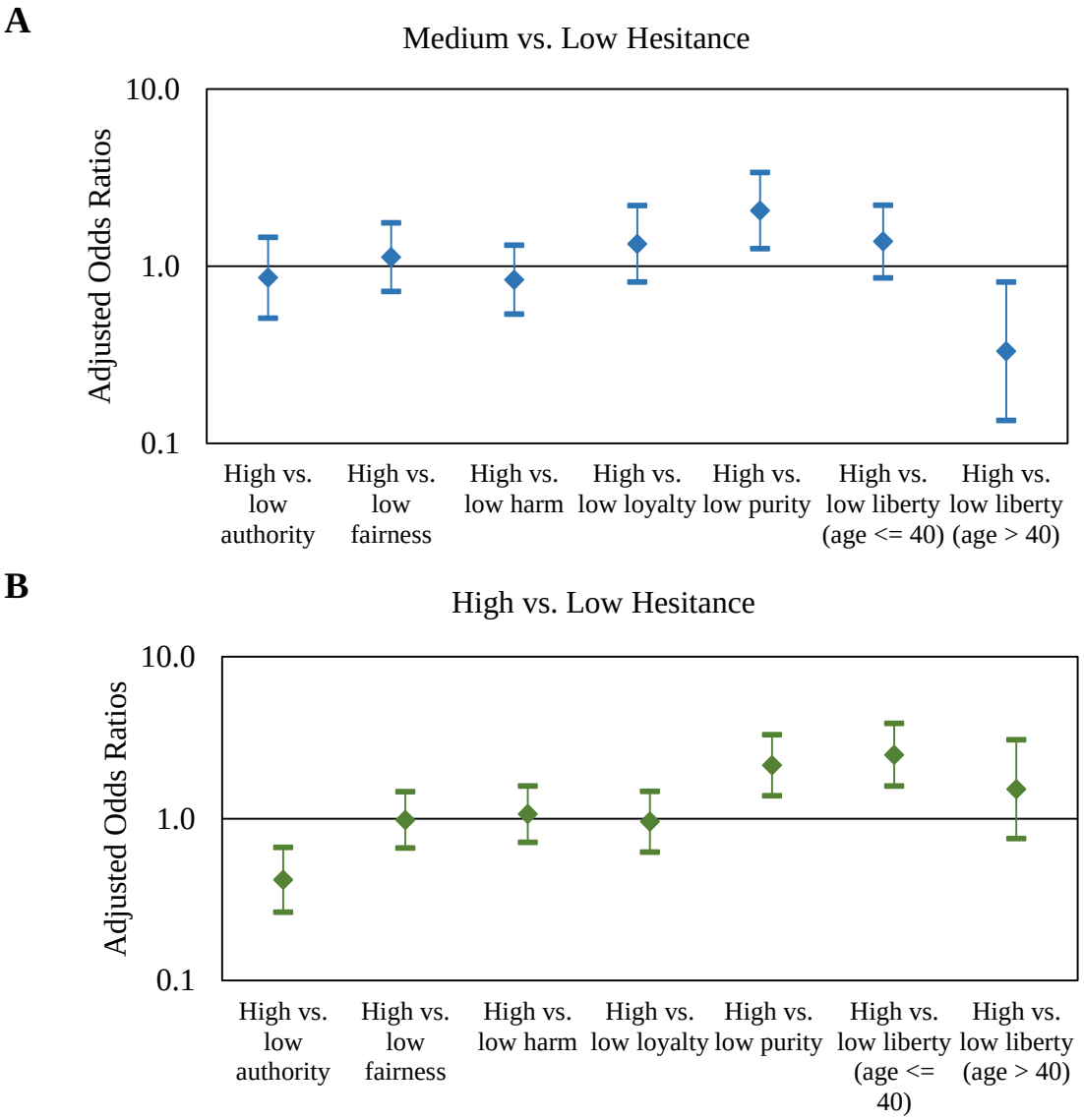


Figure 2. Odds ratios and 95% confidence intervals from an unconditional polytomous logistic regression model featuring an age-liberty interaction term, adjusted for level of education and age. (A) Likelihood of high emphasis on a moral foundation relative to likelihood of low emphasis for a parent classified as medium hesitance, as opposed to low hesitance. **(B)** Likelihood of high emphasis on a moral foundation relative to likelihood of low emphasis for a parent classified as high hesitance, as opposed to low hesitance.

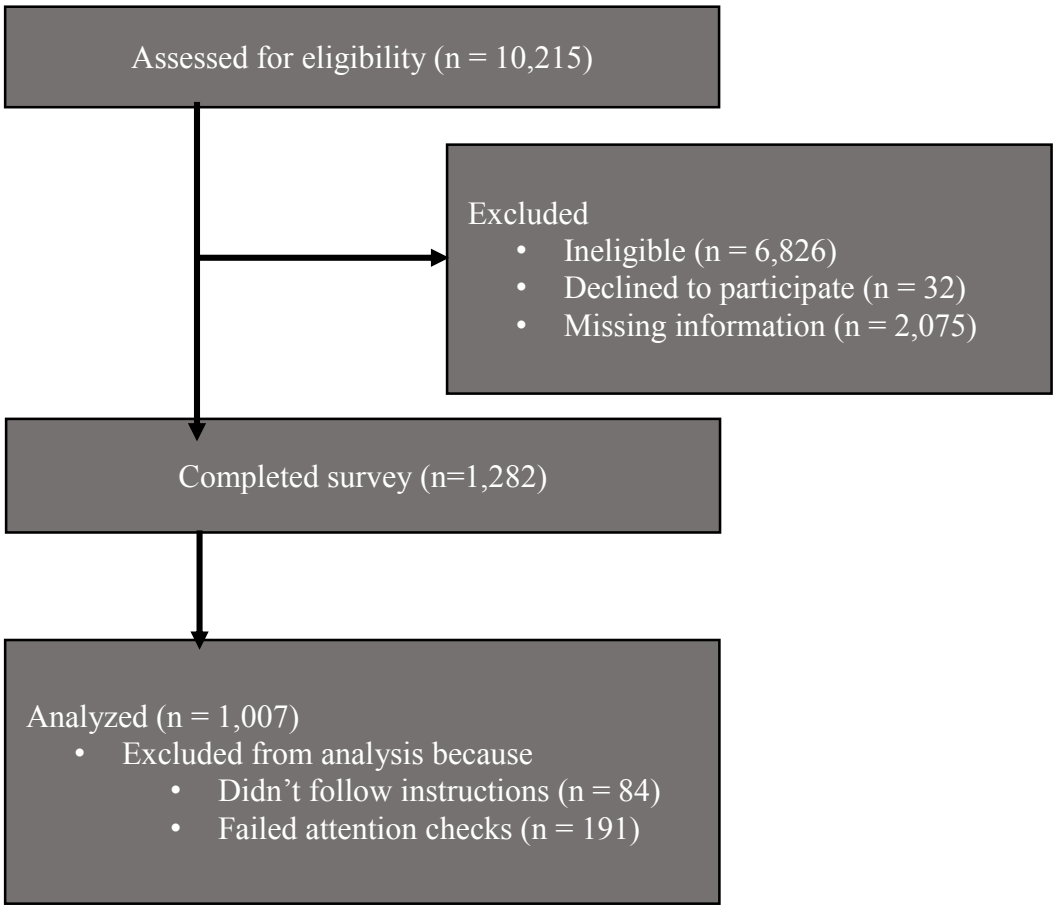


Figure S3. Flow chart for study participant screening, survey completion, and inclusion in analysis. Over 10,000 individuals were screened for eligibility. Approximately 1,300 participants were consented and completed the survey. Final sample size was 1,007 after exclusion of completed surveys that didn't follow the instructions at the end or failed intrasurvey attention checks.

TABLES

Table S1. Selected sociodemographic characteristics of the study population (n=1,007).

Characteristics	N (%)
Gender	
Male	338 (33.6)
Female	669 (66.4)
Age	
18-40 years old	771 (76.6)
41+ years old	236 (23.4)
No. of children	
1	404 (40.1)
2	363 (36.1)
3	149 (14.8)
4	61 (6.1)
5+	30 (3.0)
Education	
High school at most	97 (9.6)
Some college	307 (30.5)
College degree	392 (38.9)
Some graduate school	61 (6.1)
Graduate-level degree	150 (14.9)
High moral foundation relevance	
Authority/subversion	553 (54.9)
Fairness/cheating	558 (55.4)
Harm/care	537 (53.3)
Loyalty/betrayal	545 (54.1)
Sanctity/degradation	535 (53.1)
Liberty/oppression	493 (49.0)
Degree of vaccine hesitance	
Low	735 (73.0)
Medium	115 (11.4)
High	157 (15.6)

Table S2. Selected sociodemographic characteristics of the study population, stratified by level of vaccine hesitance according to the Parent Attitudes about Childhood Vaccines short scale.

Characteristics	Low Hesitance (n = 735)	Medium Hesitance (n = 115)	High Hesitance (n = 157)	P-value
Gender				0.37
Male	34.4	34.8	28.7	
Female	65.6	65.2	71.3	
Age				0.12
18-40 years old	78.1	74.8	70.7	
41+ years old	21.9	25.2	29.3	
No. of children				<0.01
1	41.4	39.1	35.0	
2	37.4	38.3	28.0	
3	13.7	15.7	19.1	
4	5.6	3.5	10.2	
5+	1.9	3.5	7.6	
Education				<0.01
High school at most	8.5	11.3	14.0	
Some college	27.5	40.0	37.6	
College degree	40.5	31.3	36.9	
Some graduate school	6.4	5.2	5.1	
Graduate-level degree	17.1	12.2	6.4	

Table S3. Odds ratios, 95% confidence intervals, and p-values for the associations between vaccine hesitance (determined by Parent Attitudes about Childhood Vaccines short scale) and moral foundations in a no-interaction unconditional polytomous logistic regression model (adjusted for age and level of education).

	Medium vs. Low Hesitance			High vs. Low Hesitance		
Moral Foundation	Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value
High relevance on authority	0.89	0.53, 1.51	0.67	0.43	0.27, 0.67	<0.01*
Low relevance on authority	Ref.	-	-	Ref.	-	-
High relevance on fairness	1.16	0.74, 1.80	0.52	1.00	0.67, 1.48	0.98
Low relevance on fairness	Ref.	-	-	Ref.	-	-
High relevance on harm	0.84	0.54,1.31	0.43	1.06	0.71, 1.59	0.77
Low relevance on harm	Ref.	-	-	Ref.	-	-
High relevance on loyalty	1.30	0.79, 2.14	0.30	0.95	0.62, 1.46	0.81
Low relevance on loyalty	Ref.	-	-	Ref.	-	-
High relevance on purity	2.08	1.27, 3.40	<0.01*	2.15	1.39, 3.31	<0.01*
Low relevance on purity	Ref.	-	-	Ref.	-	-
High relevance on liberty	0.99	0.66, 1.50	0.98	2.19	1.50, 3.21	<0.01*
Low relevance on liberty	Ref.	-	-	Ref.	-	-

*Statistically significant ($p < 0.05$).

Table S4. Odds ratios, 95% confidence intervals, and p-values for associations between vaccine hesitance (determined by Parent Attitudes about Childhood Vaccines short scale) and moral foundations in an unconditional polytomous logistic regression model with a liberty-age interaction term (adjusted for age and level of education).

	Medium vs. Low Hesitance			High vs. Low Hesitance		
Moral Foundation	Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value
High relevance on authority	0.86	0.51, 1.46	0.58	0.42	0.26, 0.66	<0.01*
Low relevance on authority	Ref.	-	-	Ref.	-	-
High relevance on fairness	1.13	0.72, 1.76	0.60	0.98	0.66, 1.46	0.93
Low relevance on fairness	Ref.	-	-	Ref.	-	-
High relevance on harm	0.84	0.54, 1.31	0.44	1.07	0.71, 1.59	0.75
Low relevance on harm	Ref.	-	-	Ref.	-	-
High relevance on loyalty	1.34	0.81, 2.20	0.25	0.96	0.62, 1.48	0.85
Low relevance on loyalty	Ref.	-	-	Ref.	-	-
High relevance on purity	2.06	1.26, 3.38	<0.01*	2.14	1.39, 3.29	<0.01*
Low relevance on purity	Ref.	-	-	Ref.	-	-
High relevance on liberty (18-40 years old)	1.38	0.86, 2.21	0.18	2.48	1.59, 3.87	<0.01*
Low relevance on liberty (18-40 years old)	Ref.	-	-	Ref.	-	-
High relevance on liberty (41+ years old)	0.33	0.13, 0.81	0.02*	1.52	0.75, 3.07	0.24
Low relevance on liberty (41+ years old)	Ref.	-	-	Ref.	-	-

*Statistically significant ($p < 0.05$).