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Explaining illness with evil: Pathogen prevalence fosters moral vitalism

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Abstract: Pathogens represent a significant threat to human health leading to the emergence of strategies designed to help manage their negative impact. We examined how spiritual beliefs developed to explain and predict the devastating effects of pathogens and spread of infectious disease. Analysis of existing data in Studies 1 and 2 suggests that moral vitalism (beliefs about spiritual forces of evil) is higher in geographical regions characterized by historical higher levels of pathogens. Furthermore, drawing on a sample of 3,140 participants from 28 countries in Study 3, we found that historical higher levels of pathogens were associated with stronger endorsement of moral vitalistic beliefs. Furthermore, endorsement of moral vitalistic beliefs statistically mediated the previously reported relationship between pathogen prevalence and conservative ideologies, suggesting these beliefs reinforce behavioral strategies which function to prevent infection. We conclude that moral vitalism may be adaptive: by emphasizing concerns over contagion, it provided an explanatory model that enabled human groups to reduce rates of contagious disease.

Key Words: Pathogens, morality, spiritual belief, vitalism, disease

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Throughout human history, pathogens have posed a persistent threat to the survival and growth of humans. To mitigate this threat, humans may have developed a suite of psychological responses known as a "behavioral immune system" that protects against the spread of infectious disease (e.g., Fincher & Thornhill, 2008; Gelfand et al., 2011; Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010; Murray, & Schaller, 2010, 2012; Oaten, Stevenson, & Case, 2009; Park, Faulkner, & Schaller, 2003; Schaller & Murray, 2008; Schaller & Park, 2011). While prior work has assumed detection mechanisms capable of identifying pathogen threats and activating the behavioral immune system (e.g., Schaller & Park, 2011), human threat detection is enhanced in the presence of a theory (lay or scientific) on which to base prediction and response. Here, we propose that "moral vitalism" beliefs—beliefs in contagious and agentic spiritual forces of evil—provided a lay theoretic model of the origin and spread of disease amongst pre-germ-theory societies. Furthermore, we suggest that moral vitalism is associated with key elements of the behavioral immune system, reinforcing avoidance of pathogen cues in the immediate environment, and bolstering adherence to traditional norms and ethnocentrism. Moral vitalism may have emerged as humans tried to explain the spread of disease and persisted because it conferred an adaptive advantage to groups who were threatened by pathogens.

Moral Vitalism and Explanations for Infectious Disease

People often posit the existence of supernatural "forces" or "spirits" to explain events that do not have a clear biological or psychological explanation—a tendency that is especially acute for harmful events (Cashmore, 2010; Gray & Wegner, 2010; Inagaki & Hatano, 2004; Kirschner, Gerhart, & Mitchison, 2000). We suggest that disease outbreaks represented such events amongst pre-germ-theory societies. In these groups, people needed a theory for predicting, and from which they could attempt to control, the spread of disease. A belief in contagious and

contaminating evil forces—which we label “moral vitalism”—would have provided a functionally equivalent framework for prediction and management, identifying both the infection and transmission profile of pathogens.

Buttressing this possibility is the observation that cultures vary widely in their lay explanations for disease and suffering (Shweder, Much, Mahapatra, & Park, 1997), including a tendency to explain and respond to disease by drawing on a belief in moralistic supernatural forces; a tendency that has been observed across Africa, Asia, Europe, and North America (Murdock, 1980; Park, 1992; a case in point is the escalation of witch-hunts in response to the Black Death). Furthermore, spiritual responses to physical illness and disease remain popular in modern societies (e.g., faith healing, spiritual healing), where health complaints are sometimes attributed to the will of God or the work of the Devil (Hamdy, 2009; Legare & Gelman, 2008) thus illustrating their attractiveness as intuitive explanations.

The concept of moral vitalism (Bastian et al., 2015), draws on previous work documenting theories of vital forces, energies, power, “soul-stuff,” or spirits in many traditional belief systems (Atran et al., 2002; Frazer, 1890/1959; Mauss, 1902/1972; Tylor, 1871/1974), in early scientific and psychological theorizing (Bechtel & Richardson, 1998; Jung, 1917/1983), in children’s understanding of biology (Inagaki & Hatano, 2004; Morris, Taplin, & Gelman, 2000), in adult thinking about natural and psychological events (Cashmore, 2010; Lindeman & Saher, 2007), and in reasoning about interpersonal contagion or transmission (Douglas, 1966; Nemeroff, 1995; Nemeroff & Rozin, 1994, 2000; Rozin & Nemeroff, 1990). A belief in moral vitalism has been associated with concerns that people are vulnerable to possession (infection) by evil forces, and that these forces are interpersonally contagious (transmission; Bastian et al., 2015).

By providing a framework for predicting the spread of infectious disease, moral vitalism would also have facilitated (or at least cognitively justified) behavioral strategies designed to limit infection. We argue that moral vitalistic beliefs may have contributed to these antipathogen psychological tendencies in two ways. First, moral vitalism would have reinforced evolved tendencies to avoid pathogen cues in the immediate environment (Oaten et al., 2009; Schaller & Park, 2011; Tybur, Lieberman, & Griskevicius, 2009). This is consistent with evidence showing that endorsement of moral vitalism is associated with heightened disgust sensitivity and avoidance of indirect contact with suspicious strangers (Bastian et al., 2015; see also Nemeroff, 1995; Nemeroff & Rozin, 1994). Second, moral vitalism would have reinforced the emergence of conservative ideologies within high pathogen environments (Fincher, Thornhill, Murray, & Schaller, 2008; Murray, Schaller, & Suedfeld, 2013; Navarrete & Fessler, 2006; van Leeuwen, Park, Koenig, & Graham, 2012). Conservatism has been linked to adherence to culturally evolved norms and rituals which neutralize local pathogen threats (e.g., food preparation norms; Tybur et al., 2016) and ethnocentrism which encourages behavioral avoidance of strangers, limiting exposure to novel pathogens for which one's immune system resistance is low (e.g., Fincher et al., 2008; Murray & Schaller, 2012; Murray et al., 2013; Navarrete & Fessler, 2006; van Leeuwen et al., 2012; although see Bromham, Hua, Cardillo, Schneemannm, & Greenhill, 2018; Hadley & Hruschka, 2017; Petersen, 2017). This is consistent with prior work showing that endorsement of moral vitalism is associated with conservative attitudes, fundamentalist thinking, and religiosity (Bastian et al., 2015).

The Current Studies

The above reasoning suggests three key predictions. Our first and main prediction is that moral vitalistic beliefs should be especially evident in contexts characterized by higher historical

pathogen prevalence. That is, given their utility in limiting the spread of infection, such beliefs should flourish and become entrenched under conditions of high pathogen prevalence. We tested this prediction using both archival data (Studies 1 and 2) and our own multi-national survey (Study 3). Across all three studies we examined the link between belief in evil forces (Study 1 – evil eye beliefs, Witchcraft; Study 2 – belief in the Devil; Study 3 – belief in evil forces) and geographical variation in historical pathogen prevalence. Our second prediction is that because moral vitalism provides a functional framework for managing the spread of disease, it should be associated with antipathogen psychological tendencies linked to the behavioral immune system. We tested this prediction in Study 3 by examining the relationship between moral vitalism and conservative attitudes and group-binding moralities. Our third prediction is that if moral vitalism represents the more proximal influence of pathogen threat on human cognition and culture, then it should help to explain the previously reported relationships between pathogen prevalence and antipathogen psychological tendencies linked to the behavioral immune system. We explored this prediction in Study 3 by asking if moral vitalism statistically mediated the link between pathogen prevalence and conservative attitudes as well as group-binding moralities.

Study 1: Evil Eye Belief

We began with the Standard Cross-Cultural Sample (SCCS). This includes an index of the existence of the evil eye belief within various cultural contexts. The evil eye refers to another person who casts a curse, leading to misfortune or injury, through a malevolent glare. The SCCS also includes an index of the extent to which people in a particular culture ascribe any impairment of health to the existence of Witchcraft. The most common strategy witches are believed to rely on when causing impairment is the evil eye, highlighting conceptual convergence between these two concepts of illness causation (Murdock, 1980). We focused on these two beliefs as they both entail the idea that evil forces can be contagious and

contaminating, analogous to the transfer of pathogens, and in a way that is structurally similar to a belief in moral vitalism (see Bastian et al., 2015; see also Gershman, 2015; and Quinlan & Quinlan, 2007 for alternative accounts). For instance, a belief in the evil eye suggests the possibility of interpersonal transmission of evil and the practice of Witchcraft explicitly refers to the channeling of evil spirits, both of which have the capacity to cause harm. In line with our main prediction, we examined whether a belief in the evil eye and Witchcraft was more apparent in contexts characterized by higher levels of historical pathogen prevalence.

Materials and Methods

Archival Data

The SCCS is a representative sample of the world's known and well described cultures, each pinpointed to the smallest identifiable subgroup of the specific society at the time it was constructed (Murdock & White, 1969). The SCCS includes observational data for 186 distinct cultures spanning a wide range of diverse societies worldwide (covering preindustrial societies to technologically advanced agricultural societies) and documented at a time of maximum cultural independence with the explicit aim of overcoming the problem of co-influence between cultures (commonly referred to as Galton's problem).

Evil eye belief. This was coded for in the SCCS by Roberts (1976; see also Gershman, 2015) on a scale from 1 (*incontrovertibly absent)* to 8 (*incontrovertibly present*).

Witchcraft. This explanation attributed illness to the suspected voluntary or involuntary aggressive action of a member of a special class of human beings believed to be endowed with a special power and propensity for evil (1 = *absence of such a cause*, 2 = *minor or relatively unimportant cause*, 3 = *an important auxiliary cause*, 4 = *predominant cause recognised by the society*; Murdock, 1980).

Historical pathogen prevalence. An index of historical pathogen prevalence for the 186 SCCS cultures has been developed by Cashdan (2014). A combined index uses the mean of *z*-scores for the historical prevalence of 10 pathogens (malaria, dengue, filariae, typhus, trypanosomes, leishmanias, schistosomes, and plague, leprosy and spirochetes) derived from historical sources, chiefly global maps published in the mid-twentieth century.

Control variables. We included a number of control variables coded in the SCCS which allowed us to rule out the possibility that our observed relationship was an artefact of religious belief, extent of internal or external conflict, frequency of adverse events such as famine, resource uncertainty, or wealth inequality. We also controlled for explanations for health impairment, other than Witchcraft, as coded by Murdock (1980). See supplementary materials for a full discussion of control variables.

Results

Zero-order correlations indicate that the evil eye belief is significantly and positively correlated with historical pathogen prevalence, $r(186) = .24$, $p = .001$, as is a reliance on witchcraft as an explanation for illness, $r(131) = .57$, $p < .001$ (see Table S1 for all correlations including control variables). Given extensive missing data across all control variables, to maintain power we analysed each separately to maintain a reasonable sample size. Multiple regression analyses revealed the relationship between historical pathogen prevalence and evil eye beliefs (all *ps* < .030) and witchcraft remained significant (all *ps* < .038) in all cases (see Table S2 and S3 for full reporting).

Study 2: Belief in the Devil

The findings from the SCCS data set revealed that in contexts where historical pathogen prevalence was high, so too was the tendency for these cultures to endorse a belief in the

existence of contagious and contaminating evil forces which can cause illness. Next, we examined data from the World Values Survey (WVS) in which respondents were asked whether they believed in the Devil (0 = *no*, 1 = *yes*; a binary outcome variable which be understood as a proportion). We used Wave 3 survey data because more cross-national data were available on this question compared to all other waves. A belief in the Devil entails the existence of a specific evil force in the world and is therefore relevant to moral vitalism. We therefore predicted this belief would be higher in countries which historical higher levels of pathogens.

Materials and Methods

Archival Data

We used survey data from Wave 3 (conducted from 1995 to 1998) of the WVS in which 60,454 respondents (M_{age} = 40.89, *SD*=15.91, 51.6% female) from 50 countries were asked whether they believed in the Devil (0 = *no*, 1 = *yes*). Four countries had missing data on the country-level predictors, therefore, leaving a maximum sample size of 58,076 at Level 1 and 46 at Level 2 for the multilevel analyses.

Socio-Demographic Covariates

The following socio-demographic variables were included as individual-level covariates: *age*, *gender* (recoded: 0 = *male*, 1 = *female*), *level of education* (recoded: 1 = *lower*, 2 = *middle*, 3 = *upper*), *social class* (recoded: 1 = *lower class*, 5 = *upper class*), *religiosity* (recoded: 1 = *religion* not at all important in life, 4 = *religion very important in life*), *political orientation* (1 = *left*, 10 = *right*), and *subjective health* (1 = *very poor*, 5 = *very good*).

Country-Level Variables

Historical pathogen prevalence. Historical pathogen prevalence estimates were obtained from Murray and Schaller (2010) who compiled an index incorporating nine distinct diseases (leishmanias, schistosomes, trypanosomes, leprosy, malaria, typhus, filariae, dengue,

and tuberculosis) derived from epidemiological atlases mapping the prevalence of each disease in each region.

Country-level control variables.

Human development index. We argue that belief in evil forces may be relied on when more scientific explanations are not available, suggesting that the level of development may be important. Therefore, we obtained country scores on the Human Development Index (HDI; http://hdr.undp.org/en/countries) which is composed of national income, education and life expectancy (expressed as a value between 0 and 1). We averaged the country scores from 1990 to 2000 so that the HDI data corresponds to the time when the WVS data were gathered[1,2].

Corruption. We reasoned that people might rely on a belief in evil forces to explain unfair and unethical behaviour. If so, such beliefs should be especially common in contexts wherein corruption is high. To this end, we drew on the Corruption Perception Index (Transparency International, 2015) ranging from 0 (*highly corrupt*) to 100 (*very clean*).

Democracy. We argue that believing in evil forces provides a sense of prediction and control, something that might also be relevant in non-democratic contexts wherein citizens feel they have little control. To test this, we used an index of Democracy, drawing on data from The Economist Intelligence Unit's Democracy Index (2015). This is a single score based on five categories: electoral process and pluralism; civil liberties; the functioning of government; political participation; and political culture.

Peace. Believing in evil forces might also be relied on to explain contexts characterised by intergroup conflict. As such, we drew on a measure of a country´s peacefulness, using data from the Global Peace Index (GPI) Report from 2013 (Institute for Economics and Peace, 2013). The index assesses the level of safety and security in society, the extent of domestic and

international conflict, and the degree of militarization. The index was recoded so that higher scores reflect more peacefulness.

Analytic Strategy

We used Multi-Level Modelling (MLM) which allowed us to examine the effect of pathogen prevalence on belief in the Devil while controlling for relevant covariates at both the individual and country-level. Given that the criterion variable is binary, we analyzed the data with multilevel logistic regression specifying a Bernoulli distribution and restricted penalized quasi-likelihood estimation in HLM 7 (Bryk & Raudenbush, 2004). We used grand-mean centering for all individual- and country-level predictors which is most appropriate when the focus of interest is on examining the predictive power of a Level 2 variable while controlling for Level 1 covariates (Enders & Tofighi, 2007).

Results

Correlating pathogen prevalence with the proportion of individuals believing in the Devil in each country shows that there is a significant association between the two variables, $r(46) = .52$, $p < .001$ (see also Figure S1). Table 1 shows the results of the multilevel logistic regression analyses predicting belief in the Devil. Analysing a random-intercept model with no explanatory variables (Model 0) yielded an intra-class correlation coefficient (ICC) of 0.37 meaning that 37% of the total variance in the criterion variable is due to differences between countries. In Model 1 we entered all individual-level variables as fixed effects and found that age, gender, religiosity, conservative political orientation, education, social class and subjective health were significant predictors of belief in the Devil.

We then tested the country-level predictors and found that pathogen prevalence (Model 2) was a significant predictor of belief in the Devil when controlling for socio-demographics. In Model 3, we accounted for the possibility that individual-level associations vary across countries

by including random slopes into the model and found that it did not affect the predictive power of Pathogen Prevalence, $B = 0.553$, *Odds Ratio* = 1.738, $p = .011$ (see Table 1). We proceeded controlling for each country-level covariate at once because of the relatively small country-level sample size (when all country-level predictors were entered simultaneously, none were significant predictors; see Table S4, model 6). The effect of historical pathogen prevalence on belief in the Devil remained significant when controlling for the Corruption Index ($p = .022$) and the Democracy Index ($p = .012$) but became marginal when controlling for the Peace Index ($p = .086$) and the HDI ($p = .094$)[3]. None of the country-level controls were themselves significant predictors: Corruption Index ($p = .578$), Democracy Index ($p = .597$), Peace Index ($p = .707$), and HDI ($p = .778$). The full results are reported in the Supplementary Materials (Table S4).

Study 3: Moral Vitalism

As a direct test of our theory, we conducted a large multi-national survey incorporating a measure of moral vitalism (see Bastian et al., 2015), a construct that specifically assesses belief in the existence of spiritual forces of good and evil (e.g., "There are underlying forces of good and evil in this world"). As noted above, a belief in moral vitalism has been associated with concerns that people are vulnerable to possession by evil forces and that these forces are interpersonally contagious (Bastian et al., 2015). A belief in moral vitalism is therefore sensitive to the avenues through which pathogens are known to cause harm to humans – through infection and interpersonal transmission – and offers a functionally equivalent theory of pathogens effects on human health to that provided by modern day germ theories.

In this study we also sought to provide additional evidence for our claim that moral vitalistic beliefs function to manage the spread of infection. As noted, prior work has revealed that conservative attitudes and group-binding moralities emerged within high pathogen environments. In line with our second prediction, we examined associations between moral

vitalistic beliefs and these antipathogen psychological tendencies, basing our prediction on previous work showing a relationship between moral vitalism and conservative attitudes, fundamentalist thinking, and religiosity (Bastian et al., 2015).

Our reasoning also suggests that moral vitalism may represent a more proximal influence of pathogen threat on human cognition and culture and therefore should help to explain the previously reported relationships between pathogen prevalence and these psychological tendencies linked to the behavioral immune system. In line with this prediction, we explored whether moral vitalism statistically mediated any relationship between historical pathogen prevalence and conservative values and a group-binding morality.

Materials and Methods

Participants and Procedure

A total of 3,202 university students residing in 28 countries (North and South America, Europe, Asia, and Australasia) participated in this study for course credit. Participants were only included in the analyses if they were nationals from the respective countries or if they had lived in the country for more than 10 years leaving an effective sample size of 3,131. The average age of the total sample was 22.61 years (SD = 6.27) and 64.4% of all participants were female. An overview of sample characteristics for each country is presented in Table S6 (see Supplementary Materials). Respondents who took part in the study either received course credits or reimbursement. All samples were collected in line with relevant ethical protocols and informed consent procedures for each country.

Measures

Participants responded to a larger questionnaire and only the measures relevant for the present study are described here. The questionnaire was developed in English and established translations of scales were used whenever possible. All other measures were translated into the

respective language of the country by bilinguals and the accuracy of the translation was verified through back-translations or a committee approach.

Individual-level variables

Moral vitalism. Bastian et al.'s (2015) measure of moral vitalism served as our dependent variable. It features five items assessing the belief in real, agentic forces of good and evil (e.g., "There are underlying forces of good and evil in this world", "Good and evil are aspects of the natural world") on a 6-point Likert scale ranging from 1 *(strongly disagree)* to 6 *(strongly agree)*. Cronbach´s alphas based on standardised items were satisfactory across countries (*M* = .75, range: .63 to .85). Tests of approximate measurement invariance across countries (see Rudnev, Vauclair, Bastian et al., 2019) supported only a *weaker* form of measurement invariance (partial *metric* invariance). However, dropping one of the items yielded acceptable fit indices for a partial *scalar* model (*strong* form of measurement invariance; see Rudnev, Vauclair, Bastian et al, 2019). Re-running the main model with the 4-item measure, yielded virtually the same results as for the 5-item measure (except for the non-significant main effect of gender and the non-significant random slope of religiosity with the 4-item measure, see Table S7 in Supplementary Materials).

Antipathogen psychological tendencies. We adopted two measures designed to tap antipathogen psychological tendencies, each of which has been linked to historical pathogen prevalence in past work (e.g., Murray & Schaller, 2012; Murray et al., 2013; van Leeuwen et al., 2012). Participants completed 14 Moral Relevance Items developed by Graham, Haidt, & Nosek, 2009) assessing the three moral binding foundations: Ingroup/loyalty, Authority/respect, Purity/sanctity (1 = *never relevant* to 6 = *always relevant*). Cronbach´s alphas based on standardized items were satisfactory across countries (*M* = .84, range: .76 to .91). We used the Short Schwartz´s Value Survey (SSVS) to assess individuals´ endorsement of conservative

values (e.g., honoring elders). We employed Lindeman and Verkasalo´s (2005) equation to obtain individuals´ scores on the main value dimension conservation vs. openness-to-change.

Control variables

Given that moral vitalism is associated with religion and political conservatism (see Bastian et al., 2015) and that both of these variables have been linked to historical pathogen prevalence (e.g, Fincher & Thornhill, 2008) we sought to control for whether people indicated following a religion and their political orientation.

Religion. Participants were asked whether they followed a religion (0 = *no* and 1 = *yes*).

Political orientation. Participants completed a measure of political orientation towards social issues ("Please indicate your political beliefs from left/liberal to right/conservative on social issues; e.g., immigration, homosexual marriage, abortion") (1 = *Left/Liberal*; 7 = *Right/Conservative*) and economic issues ("Please indicate your political beliefs from left/liberal to right/conservative on economic issues; e.g., social welfare, government spending, tax cuts") (1 = *Left/Liberal*; 7 = *Right/Conservative*). Political orientation items were significantly correlated in all countries, except in China (r = .06, p = .475) and so were kept separate in the analyses.

Country-level variables

Historical pathogen prevalence. We drew on the same existing data for historical pathogen prevalence estimates from Murray and Schaller (2010) as in Study 2 above.

Control variables. The same variables as in Study 2 were used to control for the socio-political and economic context of a country: the HDI (United Nations Development Programme, 2011), the Corruption Perception Index (Transparency International, 2015), the Democracy Index (Economist Intelligence Unit, 2015), and the GPI (Institute for Economics and Peace, 2013).

Analytic Strategy

We employed MLM analysis as in Study 2 to test the link between pathogen prevalence and moral vitalism. This time, however, we used linear multilevel regression (with restricted maximum likelihood estimation) in HLM 7 (Bryk & Raudenbush, 2004), because the dependent variable was continuous. We grand-mean centered all individual- and country-level predictors for the same reasons as the ones mentioned in Study 2.

To test the mediation hypotheses, we employed a 2-1-1 multilevel mediation model within the structural equation paradigm (MSEM) in Mplus 7 (Muthén & Muthén, 1998-2012). This means that the independent variable (*Xj*) is assessed at level-2, both the mediator (*Mij*) and the dependent variables are measured at level-1 (*Yij*). In other words, we expected that historical disease prevalence as a level-2 antecedent influences the level-1 mediator (moral vitalism) which then affects the level-1 outcome variables (conservative values or moral binding foundations). See supplementary materials for a longer discussion of the statistical approach employed.

Results

Descriptive country-level statistics of all variables and sample characteristics are shown in the Supplementary Materials (Table S6). Pathogen prevalence correlated with moral vitalism at $r(27) = .50$, $p = .007$ therefore sharing 24.70% of its variance. Figure 1 illustrates the link between pathogen prevalence and moral vitalism across all 28 countries.

Table 2 shows the results of the multilevel regression analyses explaining beliefs in moral vitalism. Analyzing a random-intercept model with no explanatory variables yielded an intra-class correlation coefficient (ICC) of 0.24 (Model 0). In Model 1 we entered all individual-level variables as fixed effects and found that gender, religion and conservative political orientation were significant predictors of moral vitalism. We then tested pathogen prevalence (Model 2) as a country-level predictor and confirmed that it was a significant predictor of moral vitalism when

controlling for socio-demographics. This model explained 34.87% of the between-country variance and 7.03% of the within-country variance. We accounted again for the possibility that individual-level associations vary across countries by including random slopes into the model, which did not affect the predictive power of pathogen prevalence, $B = 0.379$, $SE = 0.111$, $p = .002$ (see Table 2, Model 3). Similar to Study 2, we proceeded by controlling for each country-level covariate at once, although in this case when all country-level predictors were entered simultaneously pathogen prevalence remained significant, and the strongest predictor (see Table S5, model 5). Pathogen prevalence remained a significant predictor of moral vitalism controlling for the Corruption Index ($p = .003$) and the Peace Index ($p = .003$), but became a marginal predictor when controlling for the Democracy Index ($p = .057$) and the HDI ($p = .062$). None of the country-level controls where themselves significant predictors of moral vitalism: Corruption Index ($p = .387$), Democracy Index ($p = .164$), Peace Index ($p = .728$), HDI ($p = .369$). The full results are reported in the Supplementary Materials (Table S5).

Next, we proceeded with two separate mediation analyses to assess whether moral vitalism mediates the link between pathogen prevalence and (i) conservative values, and (ii) the moral binding foundations. We conducted the analyses in three steps (Zhang, Zyphur, & Preacher, 2008; see Figure S2). Step 1 revealed that respondents were more conservative in their values if they resided in countries with higher pathogen prevalence than in countries with less prevalence ($B = .197$, $p < .05$). However, pathogen prevalence did not significantly predict the moral binding foundation in our sample ($B = .114$, $p > .05$). Since mediation analyses do not require a significant association between the independent and dependent variable (Rucker, Preacher, Tormala, & Petty, 2011), we proceeded with the mediation analyses for the moral binding foundation as well. Step 2 confirmed again that higher pathogen prevalence significantly predicted beliefs in moral vitalism ($B = .449$, $p < .01$). Step 3 showed that a belief in moral

vitalism was associated with greater conservatism (B = .579, p < .001), and a greater endorsement of the moral binding foundation (B = .421, p < .01). Including moral vitalism as a mediator in each model diminished the link between pathogen prevalence and conservatism (B = .074, p < .05) as well as the moral binding foundation (B = -.075, p < .01). The test of the indirect effect corroborated that the association between pathogen prevalence and the two criterion variables decreased significantly after taking into account moral vitalism (*indirect effect*$_{conservatism}$ = 0.259, SE = 0.101, p = .010; *indirect effect*$_{binding\ foundation}$ = 0.189, SE = 0.088, p = .031).

In short, the findings reveal a relatively robust association between pathogen prevalence and moral vitalism. Moreover, moral vitalism statistically mediated previously established links between pathogen prevalence and psychological tendencies associated with pathogen avoidance. The latter finding provides additional support for our argument that moral vitalistic beliefs help diminish the spread of infection.

Discussion

Our analysis of archival and contemporary data offers converging support for the notion that pathogen prevalence may reinforce moral vitalistic beliefs. Two archival studies revealed that in contexts defined by higher historical pathogen prevalence, people were more likely to believe in the Devil, the malevolent power of the evil eye, and in Witches who channel evil. This archival evidence was bolstered by a new multi-national study in which participants completed a recently developed measure of belief in moral vitalism. Across all three studies we uncovered consistent evidence that historical pathogen prevalence is related to an increased tendency to believe that there are forces of evil at work in the world.

We argue that moral vitalistic beliefs are likely to be functional. By providing an explanatory framework that functionally mapped the infection and transmission profile of

pathogens, a belief in contagious and agentic spiritual forces of evil allowed for more effective prediction and response to the threat of disease. As reported by Bastian et al. (2015), moral vitalism is associated with concerns over contagion and contamination and this explanatory framework therefore discourages contact with those who may be possessed by the forces of evil. Furthermore, the association between moral vitalism and both political conservatism and ingroup preference suggests that it may have reinforced anti-pathogen behavioral tendencies reported elsewhere in the literature. In this way, moral vitalistic beliefs may represent a psychological mechanism that conferred an adaptive advantage within environments characterized by a high pathogen load.

We argue that our lay explanatory account contributes to the literature in several ways. First, it articulates a psychological theory which may have encouraged people to enact behavioral strategies that functioned to manage the infection threat of pathogens. A theory of evil forces effectively modelled the interpersonal transmission of pathogens, and therefore motivated other antipathogen psychological tendencies. Second, it provides a parsimonious account in which a specific belief system was selected to allow for the emergence of a suite of psychological tendencies (such as conservative ideologies) which limited pathogen transmission. Third, it generates a range of novel hypotheses. Prior work has assumed detection mechanisms capable of identifying pathogen threats (e.g., Schaller & Park, 2011), yet effective threat detection in humans is improved in the presence of a theory (lay or scientific) on which to base prediction and response. Our work suggests that moral vitalism provided a pre-germ-theory explanation that assisted in guiding response to pathogen threat.

Although a reliance on moral vitalism as an explanation for illness would have been especially apparent when scientific explanations were unavailable, such thinking remains evident in many modern societies, wherein health complaints are sometimes attributed to the will of God

or the work of the Devil (Hamdy, 2009; Legare & Gelman, 2008) and spiritual remedies persist (e.g., faith healing, spiritual healing, Reiki). Just as religion has remained attractive in view of scientific advances in evolutionary theory, we suggest a reliance on evil to explain illness has remained attractive due to its capacity to moralize illness (i.e., explain *why* people become ill) compared to biological models that primarily explain *how* (i.e., via transmission and infection). Furthermore, once a belief is embedded, it tends to diffuse across generations in a culture – a process referred to as cultural transmission (e.g., Cavalli-Sforza & Feldman, 1981) – thus providing additional explanation for the persistence of moral vitalistic beliefs.

A strength of the current studies is that they draw on ecological measures of naturalistic contexts, yet this also limits the capacity to draw causal inferences or to rule out third variables and alterative explanations. Nonetheless we see good reason to have confidence in our analyses. First, the nature of our key variables strongly suggests a causal picture; it is unlikely that belief in evil forces increased pathogen load. Second, reverse mediation models provide less statistical evidence for antipathogen psychological tendencies as predicting moral vitalism (see Supplementary materials for full discussion and analysis). Third, we controlled for a wide range of potential third variables in our analyses. Fourth, other potential explanations suggest only a palliative function: disease outbreaks could heighten death anxiety, reduce psychological control, or represent an attributional challenge making morality-based afterlife beliefs and a belief in all powerful and moralizing Gods more attractive (e.g. Hafer, 2000; Jong, Halberstadt, & Bluemke, 2012; Kay, Whitson, Gaucher, & Galinsky, 2009). Yet, these explanations do not model the potential spread of pathogens in the same way that a belief in moral vitalism does. It is the more specific belief in contagious and contaminating evil forces that provides a functionally equivalent framework for predicting and therefore controlling the spread of disease (see Supplemental Materials for additional points of discussion).

In conclusion, our findings represent a novel perspective on the manner in which pathogens may shape human cognition. While previous attempts have focused on how this ecological variable shapes broad beliefs and intergroup behavior in ways that limit the spread of pathogens, we provide an analysis of how a pre-germ-theory lay explanation for disease would have improved predictability and control of disease outbreaks. In so doing, we also provide insight into how explanations for illness may have shaped or reinforced specific beliefs which have broader social implications.

Notes

1. We used a HDI for Taiwan that had been calculated by its government in 2011 (ROC Taiwan, 2011).
2. The earliest HDI data available for Nigeria was from 2003 and for Macedonia from 2000.
3. This result is based on robust standard errors. When considering non-robust standard errors, pathogen prevalence becomes a non-significant predictor ($p = .128$). We used non-robust standard errors for all analyses because a sample size of at least 100 at level 2 is needed for robust standard errors to be accurate. At the same time, robust standard errors would be more adequate to consider for the non-normally distributed data (Hox, 2010). Hence, the results concerning the HDI as a covariate are somewhat inconclusive which may also be due to multicollinearity with pathogen prevalence ($r(45) = -.682$, $p < .001$).

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Table 1

Logistic Multilevel Regression Predicting Belief in the Devil (Study 2)

	Model 0		**Model 1**		**Model 2**		**Model 3**	
	(*N* = 58,076)		(*N* = 42,482)		(*N* = 42,482)		(*N* = 42,482)	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Fixed Effects								
Intercept	0.092	1.096	0.025	1.025	0.035	1.035	0.117	1.125
Individual-level Predictors								
Age			-0.008***	0.992	-0.008***	0.992	-0.009***	0.991
Gender (0 = male, 1 = female)			0.206***	1.230	0.207***	1.230	0.217***	1.242
Religiosity			0.786***	2.194	0.785***	2.192	0.827***	2.287
Conservative Political Orientation			0.026***	1.026	0.026***	1.026	0.034**	1.034
Education			-0.081***	0.923	-0.080***	0.923	-0.128**	0.880
Social Class			-0.063***	0.938	-0.064***	0.938	-0.068**	0.935
Subjective Health			-0.050***	0.951	-0.050***	0.951	-0.065**	0.937
Country-level Predictors								
Historical Pathogen prevalence					0.630**	1.878	0.553*	1.738
Random Effects								
Intercepts	1.960***		0.750***		0.624***		0.630***	
Age							9.00E-05***	
Gender							0.017**	
Religiosity							0.126***	
Conservative Political Orientation							0.003***	
Education							0.045***	
Social Class							0.017***	
Subjective Health							0.011***	

Note. *p < .05; **p < .01; ***p < .001(two-tailed), k = 46 countries. All predictors are grand-mean centred and unit-specific results with non-robust standard errors are reported. Regression coefficients are log-odds. The reported odds ratios indicate the changes in odds as a result of a one-unit change in the predictor variable, holding all other predictor variables constant. Design weights were used as provided by the World Value Survey.

Table 2

Multilevel Regression Predicting Belief in Moral Vitalism (Study 3)

	Model 0		**Model 1**		**Model 2**		**Model 3**	
Fixed Effects	B	SE	B	SE	B	SE	B	SE
Intercept	3.831***	0.113	3.815***	0.106	3.888***	0.095	3.883***	0.091
Individual-level Predictors								
Age			-0.006	0.004	-0.006	0.004	-0.005	0.004
Gender (0 = male, 1 = female)			0.097*	0.042	0.097*	0.042	0.095	0.050
Religion (0 = no, 1 = yes)			0.524***	0.042	0.524***	0.041	0.497***	0.016
Conservative economic political orientation			0.002	0.014	0.002	0.014	-2.00E-04	0.016
Conservative social political orientation			0.064***	0.013	0.064***	0.013	0.067***	0.017
Country-level Predictors								
Historical Pathogen prevalence					0.445**	0.142	0.379**	0.111
Random effects								
Residuals	1.053		0.970		0.979		0.949	
Intercepts	0.347***		0.304***		0.226***		0.211***	
Age							3.000E-05	
Gender							0.019	
Religiosity							0.037*	
Conservative economic political orientation							0.002	
Conservative social political orientation							0.003	
Variance explained (%)								
Individual-level	-		7.882		7.028		9.877	
Country-level	-		12.392		34.870		39.193	

Note. *$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed). All predictors are grand-mean centred and results with non-robust standard errors are reported.

Figure 1. Scatterplot showing the correlation between historical pathogen prevalence and belief in moral vitalism (Study 3).

[Insert Figure 1 here]