actually increased the spread of disease: for example, the well-known spread of the CJD-like disease among the Fore tribe in Papua New Guinea due to cannibalistic rituals. The rapid spread of HIV in Africa is connected to cultural practices that increase the risk of transmission, such as circumcision, medicinal bloodletting, and blood rituals, as well as sharing instruments during ritual sacrificing, tattooing, and piercing (Hrdy 1987).

F&T present a solid model for parasite-stress factors shaping large-scale patterns of human family, cultural, and religious systems. I believe, however, that they cast a net too large to reveal the causal relationships between parasite threat and specific human behavior. Immune responses to parasite threat as well as human social systems are amazingly complex and dynamic, involving many interactions over time. F&T address the legitimate threat that parasites have posed, but the precise manner in which parasite-stress and human psychological, cultural, and religious beliefs and practices have coevolved is somewhat overlooked in their current model.

Coping with germs and people: Investigating the link between pathogen threat and human social cognition

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Abstract: Group assortative biases are stronger in regions where pathogen stress has been historically prevalent. Pushing the logic of this approach, extensions should include investigations of how cultural norms related to prosociality and relational striving may also covary with regional pathogen stress. Likewise, the pan-specific observation that diseased animals show decreased motor activity to facilitate recovery suggests that norms relevant to sickness behaviors may also vary as a function of regional parasite stress.

Fincher & Thornhill (F&T) extend both theory and evidence for a *behavioral immune system* theory of cognition and behavior to the level of cultural norms regarding family and religion. The theory posits the existence of an evolved psychological system that generates prophylactic, pathogen-avoidant response strategies to pathogen threat in the environment, which may consist of beliefs, attitudes, and psychological orientations that serve as the psychological substrates for avoiding potential disease vectors. Unlike the somatic immune system, which typically responds to pathogen attacks via the activity of pro-inflammatory cytokines, the behavioral immune system responds to perceptual threats – before infections occurs – which may include assortative biases for one's own group versus others as a defense against vectors of novel parasites.

In a bold extension of this framework, F&T hypothesize that the behavioral immune system may extend to beliefs and customs transmitted at the cultural or societal level, where norms regarding the tightness of family ties and religiosity ("assortative sociality") are expected to be stronger in environments where pathogen loads have been historically prevalent. In an inter-regional and cross-national analysis, F&T demonstrate that such assortative sociality is indeed predicted by historical parasite stress in the region. These findings hold even when controlling for factors expected to covary with disease threat, such as economic development. There are many potential alternative explanations for why parasite threat might covary with assortative biases (such as more general existential fears). However, F&T find that their effects are strongest in environments where human-specific transferred diseases were most prevalent, relative to those transferred through other means. I don't think the importance of this last point about the disease specificity of this phenomenon can be underemphasized, because it is so compelling as to all but preclude the plausibility of any competing theory in explaining these findings. F&T have made a solid advance in the scientific understanding of some of the most fundamental domains of the human condition – families, groups, and religion – by extrapolating from a major theme in biology: disease, an adaptive problem for all life forms.

The arguments and findings of F&T are compelling in their conceptual clarity and theoretical integration, and are sweeping in their explanatory power. The authors have clarified and built on the ruminations of others (e.g., Curtis & Biran 2001; Fessler 2002; Navarrete & Fessler 2006; Schaller 2006; Wronska 1990) to develop an enterprise that is maturing much faster and more convincingly than anyone would have imagined possible just a few years ago.

Given their success, I am tempted to push them even further. As F&T are aware, but do not emphasize, the behavioral immune system need not be relegated solely to a psychological system whose functions are only prophylactic. F&T rightly paraphrase Navarrete and Fessler (2006) in noting that assortative sociality not only serves protective functions, but can also function as an "insurance policy" to facilitate the healing process after the fact. If this is indeed the case, might F&T be able to find evidence for greater prosociality relevant to helping the sick and weak within families and religious groups in response to disease threat cross-culturally? I'm not sure how readily testable this notion is compared with what the authors have already heroically demonstrated, but the challenge is put.

Along similar lines, one might push the notion even further that the behavioral immune system should generate not only behavioral prophylaxis, but should also include psychological mechanisms underlying behavioral responses to infection that allow the organism to heal and recover, should prophylaxis fail (*sensu* Hart 1988). The action of pro-inflammatory cytokines not only serves to neutralize pathogens in the body, but also may play a role in neurological changes that increase the likelihood of sickness behaviors, which cause an organism to not over-exert itself while it is still vulnerable and on the mend. Research describes a syndrome associated with cytokine activity where diseased animals will show decreased motor activity and food intake, reduced foraging, less exploratory behavior, increased sleep, and decreased grooming behavior (Kelley et al. 2003).

Previously believed to be mere artifacts of exogenous cytokines, these changes in behavior are now widely believed to be an important part of the healing process, and can be considered to be the expression of a motivational state that resets an individual's priorities to promote resistance to pathogens and facilitate recovery from infection (Kelley et al. 2003). In humans, this may include an increase in relational cognition, designed to foster social or coalitional support when one is most vulnerable, as suggested elsewhere (Navarrete & Fessler 2006; Navarrete et al. 2007). Perhaps cross-geographic studies of emotions, attitudes, personalities, beliefs, and norms could be conducted that would shed light on the understudied phenomenon of the evolved psychology of sickness behavior as has been demonstrated across species. It would take considerable reflection on the animal literature to extrapolate what the relevant psychological or cultural expressions of pan-species chronic sickness behavioral strategies might look like. However, a straightforward instantiation might be along the lines of a study of the beliefs, attitudes, and norms regarding the function of calmness, quietude, and "taking it easy" compared to themes that emphasize assiduousness, industriousness, tenacity, and negative views of "idleness." Sleep duration and daily activity patterns may be relevant as well. Such a scientific investigation could be politically sensitive to be sure, but may be as worthwhile as the present research;

and it would be no more potentially sensitive than is F&T's bold and impressive work at hand.

High illness loads (physical and social) do not always force high levels of mass religiosity

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Abstract: The hypothesis that high levels of religiosity are partly caused by high disease loads is in accord with studies showing that societal dysfunction promotes mass supernaturalism. However, some cultures suffering from high rates of disease and other socioeconomic dysfunction exhibit low levels of popular religiosity. At this point, it appears that religion is hard pressed to thrive in healthy societies, but poor conditions do not always make religion popular, either.

The hypothesis by Fincher & Thornhill (F&T) in the target article (see also Fincher & Thornhill 2008) that high levels of popular religiosity are correlated with and perhaps, in part, caused by high disease loads, is a subhypothesis within the larger socioeconomic dysfunctionality hypothesis that proposes that religious supernaturalism tends to suffer serious losses in popularity as general living conditions improve. This uncertainty hypothesis is being supported by a rapidly expanding set of studies, and, as such, strongly contradicts the thesis that supernaturalistic religiosity is the innate, universal human condition (Barber 2011); Delamontagne 2010; Gill & Lundsgaarde 2004; Norris & Inglehart 2004; Paul 2009; 2010a; 2010b; in press; Rees 2009; Ruiter & Tubergen 2009; Verweij et al. 1997; Zuckerman 2009).

However, there are certain under-appreciated factors that impact the subject. It has commonly been assumed that levels of supernaturalism are persistently high among "primitive" populations that live under harsh conditions. This appears to not be the case. African Hadza hunter-gatherers are currently living lives not dramatically different than they did in the late Pleistocene. Yet they exhibit minimal religiosity (Barber, in press; Marlowe 2002; 2010; Paul 2010a; in press). Although the Hadza fear death, they do not believe in an after-life. In Hadza cosmology the sun is a supernatural entity, but they do not actively worship it or try to influence its actions in their favor. Pre- and post-hunting rituals are absent, and other rituals are limited in scope. Shamans are absent, and the tribe has proved highly resistant to Christian recruitment. Similarly, the Amazonian Piraha are also theistically unconvertible; Everett (2008) found the Piraha to be markedly less religious than devout Christians, especially in their absence of god figures that provide moral guidance.

Preindustrial civilizations have also exhibited strong variations in mass religiosity. The Chinese majority has never developed or adopted major god figures (Yao & Zhao 2010), and the relatively philosophical civilization appears to have been markedly less pious than neighboring India or pre-Renaissance Europe.

It appears that the high parasite loads and other forms of dysfunction that are continuing to afflict peoples living in undeveloped societies have not consistently forced the development of high levels of religiosity in the population. For example, it is unlikely that the infection, symptom, and mortality rates of the Hadza (Marlowe 2004) are markedly lower than those of other recent hunter-gatherers with much higher levels of supernaturalism. On the other hand, all First-world democracies with historically low levels of socioeconomic dysfunction exhibit historically low levels of religiosity. These patterns suggest that although an inadequate habitat commonly encourages mass religiosity, the effect is not consistent, but that the highest levels of economic and physical security are reliably antithetical to mass religious faith. These hypotheses warrant further research and analysis in a field of human behavior that has not received the full scientific attention it needs.

An ethical and prudential argument for prioritizing the reduction of parasite-stress in the allocation of health care resources

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Abstract: The link between parasite-stress and complex psychological dispositions implies that the social, political, and economic benefits likely to flow from public health interventions that reduce rates of non-zoonotic infectious disease are far greater than have traditionally been thought. We sketch a prudential and ethical argument for increasing public health resources globally and redistributing these to focus on the alleviation of parasite-stress in human populations.

If Fincher & Thornhill's (F&T's) thesis is correct, there should be significant changes to the priorities of global health institutions, as well as a substantial increase in the overall global investment in health care. The link between parasite-stress and complex social psychological dispositions implies that the ethical, social, economic, and political benefits that are likely to flow from public health interventions that reduce rates of non-zoonotic/multi-host infectious disease are far greater than have traditionally been thought. These include not only immediate health benefits to afflicted individuals and averted medical costs due to reduced rates of infection, but also the ontogenetic production of personality configurations that promote democratic values and could lead to a significant reduction of intergroup conflicts and human rights violations worldwide within a short time frame. Here, we sketch a prudential and ethical argument for increasing public health resources globally and redistributing these to focus research and development efforts on the alleviation of parasite-stress in human populations.

The dominant approach to the evaluation of health care policy is cost-effectiveness analysis, which compares the cost of biomedical interventions with their medical efficacy (Beauchamp & Childress 2001). This narrow focus on illness, averted medical costs, and other health-related impacts has caused policy makers to underestimate the expected utility of many public health interventions. A growing body of research indicates that the well-established causal pathway from higher income to better health also runs in the opposite direction, with health underwriting economic development through its effects on labor productivity, fertility rates, education, and cognitive development (Bloom & Canning 2000). The impact of public health on economic growth has been demonstrated for the use of antibiotics, antimicrobials, vaccination, sanitation measures, and vector reduction (Bloom et al. 2005; Hotez et al. 2006).