

Why Do the Godless Prosper? Modeling the Cognitive and Coalitional Mechanisms That Promote Atheism

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This article offers an affirmative construal of atheism: the attempt to make sense of the world with naturalist explanations and to act sensibly in society following secularist principles (i.e., without relying on supernatural agents or complying with supernatural authorities). After briefly describing the conceptual framework behind this positive conception of a nonreligious worldview, we outline the construction and present the findings of two computational models that simulate some of the cognitive and coalitional mechanisms that engender and nurture religious and nonreligious worldviews. These models allow us to explore the causal dynamics within complex adaptive systems involving (dis)belief in supernatural agents and (dis)affiliation from religious institutions.

Keywords: atheism, nonreligion, computer simulation

“Why do the godless prosper? . . . let them drink of the wrath of the Almighty.”

—Job

“The wrath of God is revealed from heaven against all ungodliness. . . . You are storing up wrath for yourself on the day of wrath.”

—Paul

“He has made it straight and clear in order that He may warn the godless of a terrible punishment from Him.”

—Muhammad

What’s with all the wrath and punishment? Of course, not all religious people are as vitriolic or vindictive toward the godless as the authors of these three epigraphs. Often enough, however, surprisingly high levels of anxiety and anger are aroused in the godly by the prosperity (or even the existence) of individuals whose beliefs and behaviors do not correspond to those of their own religious ingroup. Scientific research on the psychological dynamics at work within religious worldviews makes this less

surprising. The way in which shared ritual engagement with imagined person-like, coalition-favoring, disembodied forces amplifies antagonism toward outgroup members and intensifies mistaken attribution biases is well attested in the literature (Alcorta & Sosis, 2013; Galen, 2017; Hobson & Inzlicht, 2016; Labouff, Rowatt, Johnson, & Finkle, 2012; Rieki, Lindeman, & Raij, 2014; Saleam & Moustafa, 2016; Shults, 2018; van Elk, 2013).

But what are the causes and consequences of *nonreligious* worldviews? In terms of sheer numbers, the godless have prospered in many parts of the world, and a growing number of scholars in psychology, cognitive science, anthropology, sociology, and other disciplines have begun to focus their research on the mechanisms that engender and sustain modes of human life that do not rely on appeals to supernatural agents and authorities. For a long time research on atheists and agnostics was “arrantly absent” in the psychological literature (Brewster, Robinson, Sandil, Esposito, & Geiger, 2014), but efforts to fill this gap are expanding rapidly (Arweck, Bullivant, & Lee, 2014; Caldwell-Harris, 2012; Cragun, Hammer, & Nielsen, 2015; Galen, 2015; Zuckerman, Galen, & Pasquale, 2016). This special issue of *Psychology of Religion and Spirituality* is evidence of that trend.

This article describes a broad theoretical framework for understanding godly *and* godless worldviews and introduces two computational architectures that simulate their emergence within a population. These models of (a)theism shed light on some of the key cognitive and coalitional mechanisms that engender (dis)belief in supernatural forces and (dis)affiliation with ingroups held together by supernatural rituals, and allow us to experiment with virtual agents in artificial societies (*in silico*) to explore the conditions under which individuals are most likely to go godless. Although we focus on the value of computer modeling for understanding (non)religion, along the way we also touch on questions

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related to stigmatization, analytical thinking, the comparative study of atheists and theists, prosociality, atheism as a next step in human cultural evolution, and a complex adaptive systems approach to nonbelief.

Affirming Atheism

It is important to begin by clarifying our use of terms. One of the major goals of this special issue is to identify constructs of “non-religion” that are not focused on purely *negative* identities (not a theist, not religious, etc.). The word *atheist* is rather obviously etymologically constructed as a negation. However, like *nonviolent*, *unbiased*, and *fearless*, we argue that it can have a *positive* meaning. Despite widespread prejudice toward atheists (Gervais et al., 2017), research suggests that in many contexts they are better at resisting cognitive biases, have higher levels of (analytical) intelligence, and are less parochial in their altruistic attitudes and behaviors toward outgroup members than theists (Dagnall, Drinkwater, Parker, & Rowley, 2014; Galen, Sharp, & McNulty, 2015; Lynn, Harvey, & Nyborg, 2009; Pennycook, Cheyne, Koehler, & Fugelsang, 2013).

For our purposes here, we use a stipulated definition of *worldview*, taking the term to designate the way in which a person tries to *make sense* of, and *act sensibly* within, the causal nexus and social networks within which he or she is embedded. Our definitions of *theism* and *atheism* are set out in more detail below where we outline a way of conceptualizing *religion* and *nonreligion* within the context of a broader theoretical framework that guides the construction of some of our computer models. At this stage, suffice it to say that, in the sense in which we are using the term here, a person’s worldview is *religious* insofar as he or she does *not* think that humans can explain ambiguous phenomena or organize the social field without relying on supernatural agents and complying with supernatural authorities.

On the other hand, a person’s worldview is nonreligious to the extent that he or she thinks: *yes, we can*—or at least we can live trying. In other words, an atheist worldview is characterized by *positive* attempts to make causal interpretations and normative inscriptions based on naturalist and secularist principles. As is the case with many individuals who would self-identify as an agnostic or skeptic, atheists (in our sense of the term) do not need gods to make sense of the world or religious norms to act sensibly in society. We realize, of course, that our usage of these terms is somewhat idiosyncratic. We proffer these unconventional formulations in this context as way of highlighting our *affirmative* conception of atheism, which is spelled out in more detail below.

Identifying atheists is not as straightforward as it might seem. We are prone to say that this or that person *is* an atheist (or a theist). Technically, however, we are not dealing with two distinct groups of people but with traits whose expression can vary depending on individual differences and changing social environments. A person’s worldview may be religiously expressed in some contexts and nonreligiously in others. Moreover, there are a diversity of nontheistic beliefs correlated with a variety of social conditions (Clements, 2017) and many pathways to atheism (Norenzayan & Gervais, 2013). All of this is further complicated by the powerful prejudice that most people have against atheists, which reduces the number of (literally) godless individuals who are willing to self-identify as atheist.

A worldview can be thought of as a complex adaptive system, which may well have both religious and nonreligious components. Moreover, worldviews operate within or in conjunction with other networks (e.g., families, cultures, natural environments), which are themselves complex adaptive systems—that is, relatively robust networks of heterogeneous components whose interactions lead to nontrivial emergent and collective behaviors (Mitchell, 2009). Computer modeling offers one of the most powerful methodologies for analyzing this kind of system (Miller & Page, 2007). In the latter half of this article, we present two such models, exploring some of the mechanisms that generate religious and nonreligious expressions within a person’s worldview which, as defined above, is itself a kind of complex adaptive system. First, however, we need to introduce our methodology and explain more fully the theoretical framework that informs the construction of our computational architectures.

Computer Modeling and Simulation of (Non)Religion

The normally functioning human mind regularly and somewhat easily creates mental models of past and present events, and simulates future scenarios. In this nontechnical sense, modeling and simulation (M&S) are a natural part of human psychology. We imaginatively project answers to more or less existentially relevant questions such as, “What will happen if I ask Chris out for a date?” or “How might other scholars react to the models presented in this article?” Not only is this sort of imaginative simulation normal, it is a necessary part of everyday human life. In the religious and spiritual dimensions of life, such projections can be particularly intense and highly relevant: “What will happen to me and those I love after we die?” or “How might I align myself to transcendent forces today?” For many people, answers to such questions are sought in the predictions or proposals offered by holy texts, astrological advisors, or wisdom traditions.

Scholars of (non)religion are also interested in imaginative projections about the future, although they are typically suspicious of outright predictions and only utilize methodologically naturalistic research designs. Indeed, scientists in the various fields that make up the academic study of religion have always been interested in hypotheses about the potential effects of causal complexes on religious individuals and groups. They regularly ask, and offer tentative answers to, questions such as, “What will happen to British Muslims if secularizing trends continue?” or “How might the growing acceptance of homosexuality impact the attitudes of southern Baptist youth in the United States?”

Computer M&S offers a suite of tools for analyzing the mechanisms involved in complex adaptive systems. Such analytical and predictive techniques have been a methodological staple for decades in the natural sciences, and have long been used by business corporations, military agencies, disease control organizations, and similar institutions to simulate the probable impact of different policies on alternative future scenarios (Tolk, 2012).

The use of M&S in the social sciences has grown significantly in recent years. A review of the publication of social simulations in major journals shows how rapidly this subfield has matured in the last 10 years (Hauke, Lorscheid, & Meyer, 2017). Insights from the psychological sciences are increasingly being incorporated into cognitive and affective architectures that attend to the emotional and psychological dimensions of social interaction (AL-

varez, 2016; Gratch & Marsella, 2014; Squazzoni, Jager, & Edmonds, 2014). M&S has also been applied within fields such as social psychology and organizational psychology (Smaldino, Ciallanchini, & Pickett, 2015; Smith & Conrey, 2007). All of this has led to the emergence of what some scholars have called *computational social science* (Epstein, 2006; Squazzoni, 2012).

Could there also be a computational social science of *religion* (and nonreligion)? Can we explain the cognitive and coalitional mechanisms that drive religiosity up (or down) and cause people to change the way they publicly describe their religious (or nonreligious) identity? In the last few years, several studies have utilized computational techniques to explore the psychological and social dynamics within religious groups, including the function of costly beliefs and practices in group stability (Wildman & Sosis, 2011), the transmission of religious violence in the Radical Reformation (Matthews, Edmonds, Wildman, & Nunn, 2013), the emergence of priestly elites in the emergence of large-scale cooperative societies (Dávid-Barrett & Carney, 2016), and the role of cooperation style and contagious altruism in proselytizing religions (Roitto, 2015).

The authors of this article are members of an international team of computer modelers and subject-matter experts who have been developing several simulations related to religiosity and secularity. Below, we summarize the computational architectures and experimental results of two of our models that are particularly relevant for this special issue. The overall goal of our collaboration is to introduce M&S—which has been called the “third pillar” of science, alongside theory and experimentation (Yilmaz, 2015)—into the heart of the scientific study of (non)religion.

What’s All the Fuss?

Why is interest in computer M&S growing so rapidly in the psychological and social sciences in general, and more recently within the academic study of religion? These tools and techniques have many virtues that set them apart. For example, M&S methodologies require researchers to be precise in the conceptualization and operationalization of their variables, and to formalize their assumptions about the causal interactions among them. Once this information is quantified within algorithms that drive computational architectures (typically involving state charts or stock-and-flow diagrams), high-powered computers or high-performance-computing clusters can explore the multidimensional parameter space of the social simulation far more efficiently and rapidly than the human mind.

In addition to forcing more conceptual clarity and providing more computational processing power, M&S methodologies have several other virtues, such as enabling us to construct and execute experiments in artificial societies that would not otherwise be feasible or ethical, to explain the emergence of a complex social phenomenon by “growing it” from the bottom-up, to integrate insights from qualitative and quantitative research within the same computational model, to shift the burden of proof in long-standing theoretical debates about the causal dynamics at work in historical events, and to explore the multidimensional space of a social system to determine the parametric and probabilistic conditions for specific configurations.

Social simulation offers important advantages over traditional methods in the social sciences, such as statistical data analysis. In both M&S and statistical analysis, the researcher may begin by

examining relevant theories about the phenomenon to be simulated, and identifying the key variables and mechanisms that are thought to govern the dynamics. In M&S, however, theoretical postulates about the relations among variables must be cast in mathematical form and implemented in a computational architecture. This forces researchers to state their assumptions clearly and in detail, rendering their claims more susceptible to correction by critics.

The two models we describe below should be of interest to readers of this special issue for several reasons. First, they are *agent-based* models focusing on the way interaction among individuals (with distinctive psychological variables) generates social phenomena. This ought to encourage psychologists who worry that other social scientific approaches all too quickly jump to level of the collective and gloss over the role of individual agents. Second, they are materially focused on *mechanisms* that are hypothesized to *promote* religious or nonreligious worldviews (as defined above). Each of the models explores some of the conditions under which—and the mechanisms by which—the religiosity of a population may be ratcheted up or down. Third, the computational architecture of each model involves a *multidisciplinary* theoretical integration that is rendered plausible by its ability to simulate the emergence of macrolevel phenomena from microlevel agent behaviors and interactions.

These models were designed to shed light on the operation of complex adaptive (non)religious systems. However, powerful analytical tools and techniques are of little value if we do not have empirically grounded theoretical hypotheses on which to use them. In the next section, we introduce one way of conceptualizing the range of disciplinary findings that help to explain how and why godly and godless traits fluctuate within human minds and cultures.

Theogonic Reproduction Theory

The computer models described below incorporate empirical findings and theoretical developments from a variety of disciplines that study (non)religion, but we can explain their construction and experimental results within the context of a broader framework outlined by the first author of this article (Shults, 2014a, 2014b, 2015, 2018). Insights from a diversity of fields have converged to support the claim that gods (supernatural agent conceptions) are born(e) in the mental and social life of human beings as a result of naturally evolved, hyper-sensitive biases that activate *inferences* about hidden human-like forms and *preferences* for distinctive ingroup norms. Moreover, these biases are reciprocally reinforcing, especially when people are confronted with ambiguous or frightening phenomena. These are the basic hypotheses of theogonic reproduction theory (TRT).

Gods are easily *born* in human minds that are characterized by high levels of mentalizing, schizotypy, and ontological confusion (Lindeman, Svedholm-Häkkinen, & Lipsanen, 2015; Norenzayan, Gervais, & Trzesniewski, 2012; Wlodarski & Pearce, 2016). Gods are easily *borne* in human cultures that are characterized by costly signaling through credibility enhancing displays, risk aversion strategies activated by ecological duress, and low levels of existential security (Bulbulia, 2012; Lanman & Buhrmester, 2017; Norris & Inglehart, 2015). These are only some of the cognitive

and coalitional mechanisms that engender and nurture gods within the human Imaginarium.

A full exploration of these and other relevant perceptual and affiliative biases is beyond the scope of this article, but the diagram in Figure 1 provides us with a broad conceptual framework for discussing some of the most significant mechanisms at work in the promotion of religious and nonreligious worldviews.

The extent to which individuals tend to scan for supernatural agents when trying to make sense of causally ambiguous events can be tracked along the continuum represented by the horizontal line. Most humans are *anthropomorphically promiscuous*; that is, they intuitively seek out hidden human-like disembodied forces to explain confusing natural phenomena, especially when anxious or excited. The extent to which individuals are likely to stick with supernaturally authorized parochial norms when trying to act sensibly in socially stressful contexts can be tracked along the continuum represented by the vertical line. The spontaneous biocultural tendency in this case is toward *sociographic prudery*; that is, most human beings intuitively prefer the moral norms and idiosyncratic ritual behaviors of the religious coalition in which they were raised (or into which they have been converted).

The integration of these reciprocally reinforcing mechanisms produces “religion” (or “theism”), which we take in this context to designate shared imaginative engagement with axiologically relevant supernatural agents. We call these “god-bearing mechanisms,” but “god” should be understood here in the broad sense to include all kinds of supernatural agents (e.g., animal-spirits and ancestor-ghosts, as well as gods like Yahweh or Zeus). TRT hypothesizes that some of the mechanisms contributing to anthropomorphic promiscuity are the result of cognitive biases that engender mistaken attributions of intentionality, and that some of the mechanisms that lead to sociographic prudery are the result of coalitional biases that were naturally selected in early ancestral environments because they aided in the management of affiliative risks. If these hypotheses were true, we would expect the available data to provide evidence of the phylogenetically ancient emergence of these god-bearing mechanisms, of their relatively early ontogenetic emergence across cultures, and of individual and con-

textual variance in their distribution across human populations. And this is indeed what we do find (see Shults, 2014a, 2014b, 2015, 2018, for expositions and analyses of the evidence).

TRT also hypothesizes that these theogonic tendencies are reciprocally reinforcing. Another reason shared imaginative engagement with supernatural agents has been so prevalent across human cultures throughout history is the mutual intensification of god-bearing mechanisms, which increases the stability and reproductive capacity of complex adaptive religious systems. This hypothesis would be corroborated by the discovery of statistical correlations between levels of anthropomorphic promiscuity and sociographic prudery (and their component mechanisms), by empirical evidence of the mutual amplification of these mechanisms under relevant conditions, and by the detection of individual and contextual variation in the reciprocal intensification of these evolved biases. Here too we find overwhelming support from the data (see references above for details).

But what about *nonreligious* worldviews, that is, ways of making sense and acting sensibly that do not depend on shared imaginative engagement with gods or other axiologically relevant supernatural agents? This way of viewing (and behaving in) the world has been expanding rapidly in the human population, and seems to be picking up momentum especially among younger generations (Kosmin & Keysar, 2013; Twenge, Exline, Grubbs, Sastry, & Campbell, 2015). Atheism appears to have been relatively rare up to the last couple of centuries but by 2007 estimates of the number of nonbelievers in God ranged as high as 749 million worldwide, making this the fourth largest group after Christianity, Islam, and Hinduism (Zuckerman, 2007). The “unaffiliated” overtook Hindus by 2014, climbing to over 1.1 billion, representing 16.45% of the world’s population (Pew Research Center, 2015). No doubt there are significant complexities involved in the various counting methodologies used by these kinds of studies, but there does seem to be a transformation afoot.

What factors have contributed to this prosperous expansion of godless worldviews, at least within developed western nations? The conditions for the emergence of atheism are as complex as those that produce theism, but we can describe them broadly as fitting into two types of god-dissolving (or theolytic) mechanisms. The first is *anthropomorphic prudery*: the tendency to resist supernatural agent conceptions when making causal interpretations about the structure of the world. The second is *sociographic promiscuity*: the tendency to pursue nonparochial ethics when making normative inscriptions within a pluralistic social field. These two tendencies are integrated in the upper right quadrant of Figure 1. (The other two quadrants, which are less relevant for our purposes here, are discussed in Shults, 2014b and Shults, 2018).

These two tendencies can also be associated with naturalism and secularism respectively. Naturalists typically resist including supernatural agents as part of their explanations of the causal structure of the world, especially when operating in academic contexts. Secularists typically prefer policies for organizing pluralistic societies that do not appeal to sectarian supernatural authorities, especially when operating in public contexts. The presence of naturalism and secularism in a population seems to be correlated with factors such as education, existential security, pluralism, and freedom of expression.

We turn now to a description of two computer models, each of which simulates some of the key factors that shape the growth (and

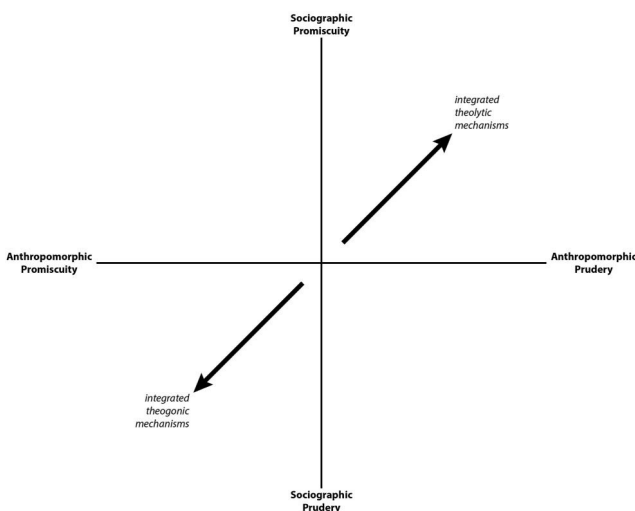


Figure 1. Theogonic and theolytic mechanisms.

decline) of (non) religious worldviews within a population. The second model simulates the effects of two mechanisms that contribute to the prosperity of the godless: education and existential security. The first model simulates the interactions among high levels of religiosity, anxiety events and xenophobically inspired conflict between groups.

Simulating Causes and Consequences of Theism: Death Anxiety and Intergroup Violence

In this context, we are using the term *theism* in a broad sense: belief in and ritual interaction with gods (supernatural agents). What are the relationships among theism (in this broad sense), mortality salience, and violence between groups in diverse human populations? This was the research question guiding the construction and experimental design of our computer model on mutually escalating religious violence (MERV). Of course, anxiety and violence are not the only or even the most significant variables associated with religious worldviews, but understanding the connection between them is of particular importance in our increasingly interconnected, globalized environment.

MERV was an adaptation of a previously published model of the impact of the mechanisms postulated by terror management theory (TMT) on religiosity (Shults et al., 2018). Research in the literature on TMT suggests that anxiety related to death awareness tends to ratchet up religiosity both in terms of scanning for invisible causes and scrambling to protect ingroups (McGregor et al., 1998; Norenzayan, Hansen, & Cady, 2008). When human cognitive systems encounter hazards that produce anxiety about death as an “input,” they quite often have two sorts of “output”: increased belief in hidden intentional forces (especially supernatural agents) and decreased openness to outgroup members.

In other words, the intensification of mortality salience can amplify belief in supernatural agents (anthropomorphic promiscuity) as well as behavioral dispositions toward participating in parochial ritual practices (sociographic prudery). These mechanisms help to mitigate psychological distress and to strengthen ingroup cohesion, both of which provided a survival advantage in ancestral environments. For many individuals today, perceptions of life-threatening natural events or worrisome social “others” strengthens their commitment to a religious (supernatural) worldview (Norenzayan & Hansen, 2006; Sibley & Bulbulia, 2012).

Our simulation experiments on the relationship between terror management and religiosity variables led to several interesting results. For example, agents in a “minority” group were more likely to increase their religiosity under stress than members of a “majority” group. This is consistent the sociological literature showing that Black Americans are far more likely to be religious than White Americans (Taylor, Chatters, Jayakody, & Levin, 1996). The model suggests that this effect is largely due to the fact that “minority” agents are more likely to encounter “majority” agents; the anxiety of the former about the (potentially socially threatening) presence and prevalence of the latter is triggered more often, leading to heightened sociographic prudery.

These TMT-related experiments also revealed that large ritual clusters were more likely to form in the model within homogenous populations having low tolerance levels. In other words, we were able to “grow” the virtual equivalent of white, suburban, megachurches in our artificial society. The model suggested that the

formation of larger ritual clusters occurs primarily in simulation runs where “prior” sociographic prudery in the population is initialized at a relatively high level. It is important to keep in mind that these macrolevel patterns emerged from the microlevel behaviors and interactions of simulated heterogeneous agents.

However, the original TMT model was not designed to simulate the conditions under which—and the mechanisms by which—intergroup violence can emerge. The latter would require a computational architecture that could incorporate insights from empirically grounded theories of the psychological mechanisms and social conditions that can trigger conflict and violence, and whose simulated agents could pass thresholds beyond which they would engage in (proxies for) mutually escalating religious violence.

Constructing MERV

We began by incorporating several key aspects of Joshua Epstein’s (2014) *Agent_Zero* into the architecture of the TMT model. Based on neuroscientific and psychological research on affect, deliberation, and social contagion dynamics, agent interactions in Epstein’s model are configured in such a way that (under certain conditions) the intensification of affect within an individual agent can reach a tipping point such that his or her disposition passes a threshold that can be taken as a proxy for initiating, for example, a lynching or a genocide. The basic state-chart structure and parameters of MERV were the result of this integration of these *Agent_Zero* features into the TMT model. For technical details, see Shults et al. (2017) and the online additional materials available at <https://github.com/SimRel/Merv1.0>.

MERV’s architecture was also designed to incorporate insights from two other well-known theories that shed light on psychosocial mechanisms that play a role in generating violence between groups. The first is the social identity theory (SIT) of intergroup conflict. Here, “social identity” refers to aspects of a person’s self-image that are linked to his or her sense of fitting into a particular social category. The basic idea is that the need to evaluate one’s own group positively (in the context of comparison with an outgroup) leads to stronger differentiation between groups. Such value-laden differentiations amplify the tension between groups and increases the chances of conflict and violence (Tajfel & Turner, 1979). The interaction between groups can be powerfully determined by “value-laden social differentiations” that ratchet up tension between the groups and then lead to conflict and violence.

Another relevant set of literature that bears on the escalation of intergroup violence is built around identity fusion theory (IFT). This research suggests that when personal and social identities are blurred, an individual can come to regard his or her group as functionally equivalent to his or her sense of self (identity fusion). IFT identifies ways in which personal and situational factors work together to influence extreme behaviors. For example, less fused people may have strong beliefs about what “ought” to be done for their group, but highly fused people are far more willing to act on these beliefs, even dying or killing for the group (Swann et al., 2014).

Drawing on insights from these theories, MERV’s computational architecture models some of the conditions under which the behavior of—and interaction among—individual agents can lead to mutually escalating religious violence. For a graphic illustration, see Figure 2.

When the model is initialized, agents in MERV are assigned to one of two groups, distinguished by their (simulated) variance of beliefs and ritual behaviors in relation to the supernatural agents postulated by each group. At each time step, agents may be subjected to hazards of different sorts (social threats, disease contagion, predation, and natural disasters), which heightens their mortality salience. These encounters can increase an agent's disposition to seek explanations or help from his or her group's supernatural agents, and comfort and protection by being surrounded by fellow group members, thereby increasing his or her desire to engage in shared rituals (as predicted by TMT). As these ritual engagements intensify, some agents become more fused to their ingroups, which increases their propensity toward violence against outgroup members (as predicted by SIT and IFT).

Our simulation experiments were able to "grow" the macrolevel of religious intergroup violence from the microlevel behavioral rules guiding dispositional contagion within and among agents in the model. Optimization experiments explored the parameter space to discover the conditions (combinations of parameter settings) under which mutually escalating violence was most likely to occur between religious groups. This condition was (% of Population in Majority Group ≤ 70) and (Contagion Hazard Intensity \geq Contagion Hazard Tolerance) and (Social Hazard Intensity \geq Social Hazard Tolerance).

The model was programed to simulate the behaviors and interactions of agents (with varying levels of initial religiosity) in reaction to a variety of natural and social environments (with more or less numerous and threatening perceived hazards). Exploring this multidimensional complex system revealed the most likely conditions for mutually escalating religious violence in the model: the *size disparity* between the majority and minority group is not too large at initialization, and the average intensity of the *contagion* and *social* hazards that agents encounter meets or exceeds the average tolerance for such hazards. In addition to the trace validation techniques described in (Shults et al., 2017), this model can also be face validated by looking at the actual conditions that gave rise to historical cases of mutually escalating religious violence, such as the 2002 riots between Hindus and Muslims in Gujarat, India.

One of the limitations of MERV is that agent's religiosity could not go below the levels set at the initiation of each simulation run. Because the goal of that model was to explore ways in which anxiety and violence can *increase* theism (in our broad sense), its agents did not require that capacity. However, if we want to simulate and explore the mechanisms that *lower* theism or, to put it more positively, that *increase* the capacity to make sense and act sensibly without appealing to the supernatural agents of a religious ingroup, we need a new sort of agent architecture.

Simulating Causes and Consequences of Atheism: Education and Existential Security

Why do the godless prosper? The author of Job could not understand how the punitive (and putatively just) God whom his religious ingroup imaginatively engaged could permit the flourishing of individuals who did not share his parochial beliefs and norms. Eventually, the hero of his story had to appeal to mystery, kicking the question down the road by deferring to an ambiguous voice in a whirlwind that condemned his impious inquisitiveness.

The scientific study of religion can provide explanations for the (demographic) prosperity of the godless: nonreligious worldviews emerge and expand in a population as critically thinking individuals learn about natural causes and human capacities within a wider social field in which they feel safe and secure. These are not the only variables associated with nonreligious worldviews or atheism (in the sense defined above), but they are among the most commonly discussed and empirically analyzed. In later models, we plan to simulate other variables, such as freedom of expression and encounters with pluralism, but we begin here with a focus on education and existential security.

The negative correlation between religiosity and intelligence (or education, or analytical thinking style) is one of the most consistent and well-documented findings in the psychological literature (Ellis, Hoskin, Dutton, & Nyborg, 2017; Ganzach & Gotlibovski, 2013; Hungerman, 2014; Lewis, 2015). To put it more positively, individuals with higher intelligence and more education will tend to have atheist-leaning worldviews (lower supernatural belief and lower affiliation with religious institutions). A poor understanding of the physical world is a particularly strong predictor of religious beliefs (Lindeman & Svedholm-Häkkinen, 2016). Learning critical thinking through humanities, math, and science education seems to have the effect of reducing commitment to pseudoscientific and religious ideas (McLaughlin & McGill, 2017; Stoet & Geary, 2017).

In other words, anthropomorphic prudery is typically (positively) correlated with level of education and intelligence. Similarly, sociographic promiscuity is positively correlated with existential security. To put it the other way around, in contexts where people feel relatively secure about their physical, mental and economic well-being, they are less likely to feel the need to defend (or participate in) the provincial norms of their religious family of origin. This is particularly clear in Scandinavian societies, where people report lower levels of religiosity compared to other countries. When a high level of existential security is provided by stable, relatively transparent governments with social safety nets, rather than by religious institutions, people can coordinate and cooperate with others without postulating hidden punitive forces.

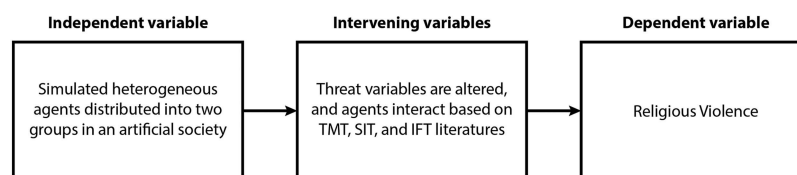


Figure 2. Variable dependencies within the model that allow for identifying conditions under which mutually escalating religious violence emerges.

Evidence for this sort of claim comes from a wide variety of disciplines (Norenzayan & Gervais, 2013; Norris & Inglehart, 2011; Shults, 2018).

These empirically validated theories guided our construction of the agent architecture in the nonreligiosity model (NoRM), to which we will return below. In this case, we used structural equation models (based on new statistical analyses of cross-national data sets) to render these claims about the hypothesized causal relationships among atheism, education, and existential security more plausible.

The Role of Data: Factor Analysis and Structural Equation Models

In the construction of computer models, real-world data can support parameterization (setting plausible values for the input parameters), the validation of results (comparison between the emergent properties of model solutions and actual events), and the search for the appropriate variables to include in agent architectures. Among the most useful techniques for accomplishing the latter are factor analysis (which helps identify a set of latent variables that simplifies the correlational structure of a data set) and structural equation modeling (which helps describe relationships between multiple variables, observed or latent).

The structural equation models used to inform the agent architectures in NoRM were based on exploratory factor analysis of variables in the International Social Survey Programme (ISSP) Religion Cumulation dataset. As reported in earlier work (Lemos, Gore, & Shults, 2017), we applied standard criteria for common variance of the items and reliability of the factor solutions, which revealed four significantly correlated factors for “religion”:

- *F1 - Religious Formation* (church attendance of mother and father when the respondent was around 11–12 years old)
- *F2 - Religious Practice* (participation in religious activities, services, and prayer)
- *F3 - Supernatural Belief* (miracles, heaven, hell, afterlife)
- *F4 - Belief in God* (questions explicitly about belief in God and self-described level of religiosity)

The fact that these four factors emerged as the best explanation of the data in our exploratory analysis has important implications for one of the most contentious arguments among scholars of religion, namely, how (or whether) to define religion. Some scholars in fields such as psychology, anthropology, history, or sociology of religion prefer definitions that incorporate nonsupernatural variables like values, culture, and so forth. Some scholars in religious studies would prefer not to define religion at all because they consider the term a dangerous western, colonialist invention.

Whether or not one chooses to use *religion* to label them, our factor analysis of the ISSP dataset has clearly identified a cluster of interdependent latent variables related to *supernatural beliefs and practices*. Other studies have shown that “supernaturalism” plays a central role in differentiating “religiosity” (Schuurmans-Stekhoven, 2014) and even “spirituality” (Lindeman, Blomqvist, & Takada, 2012) from other psychological constructs. This research stands behind our theoretical construal of (non)religiosity as characterized by (dis)belief in *supernatural* forces and (dis)affiliation with ingroups held together by *supernatural* rituals.

The next step was the development of a structural equation model (SEM) based on the findings of the exploratory factor analysis. This sort of modeling enables us to hypothesize causal relationships among the factors and assess the extent to which the hypothesized architecture matches the observed data. Of the possible 588 ways of relating the four factors, the four SEMs with best fit indices all had religious formation (F1) and religious practice (F2) flowing into belief in God (F4), and all but one also had F4 as a sink for supernatural beliefs (F3). In no case did F4 flow into F3. In other words, belief in “God” is conditionally dependent on religious formation, religious practice, and belief in “supernatural agents,” but not the other way around.

As far as we know, these results represent the first published attempt to explore possible causal relationships among these factors using structural equation modeling based on survey analysis. Of the four models with the best fit statistics, one places the factors in an order that is most consistent with theories of religiosity posited in the scientific study of religion. This is the SEM we employ in NoRM. Additional details and fit statistics for this and other candidate models are provided in Lemos et al. (2017).

Computational Architecture, Experimental Results, and Discussion of NoRM

The variables, behaviors, and interactional effects of the agents in NoRM were designed in light of the theoretical frameworks, factor analyses, and structural equation modeling just described. Each agent has religiosity variables defined by the four factors identified above, and the relationship between them is structured according to the SEM chosen based on the procedure described above.

At the beginning of each run, the existential security level of the environment is initialized using data from the *Human Development Report* on the country and the beginning of the time period being modeled. The *Human Development Report* is an annual multifaceted analysis of wellbeing focused on key dimensions of human development including longevity, health, and a decent standard of living (Anand & Sen, 2003). The agents are initialized by randomly sampling ISSP respondents from the specified country and year. The characteristics of each simulated agent are parameterized based on the data from one of the selected respondents. For details, see Gore, Lemos, Shults, and Wildman (2018) and the associated online additional materials.

At each time step the simulated agents engage their social networks, interacting within ranges set by an education homophily parameter. The change in their “religious practice” and “existential security” variables (or attributes) is calculated using the Cobb–Douglas function using a well-established method. Agents are affected (at each time step) by the existential security of the environment and, in turn, have an effect on that environment, which carries over to the next time step. Executing this process over time for many agents in NoRM produces simulation outcomes that provide insight into the dynamics of complex adaptive (non)religious systems. Each of these outcomes can be captured for analysis.

How can we validate the structure of the model and the outcomes of the simulation? Validity depends on the degree to which we can simulate the emergence of macrolevel shifts in religious practices and existential security within a population

(observed in the real-world data of the ISSP and HDI data sets) from the microlevel agent interactions in the model (guided by the relevant literature and our exploratory and confirmatory analyses). See Figure 3 for a graphical representation of this process.

We calibrated the model by comparing its capacity to predict the (real-world) shifts in the relevant variables that occurred during a 10-year period (1990–2000) within 11 countries (selected because they had sufficient ISSP and HDI data). Using the calibrated model, we then predicted shifts in the relevant variables for 22 countries (including 11 the model was not calibrated for) during a different 10-year period (2000–2010).

For our purposes here, two of the findings from our simulation experiments are particularly relevant. First, as expected, the model showed that the extent to which all three (alterable) religiosity variables changed was strongly influenced by the educational level of the social networks within which the agents were embedded. Religious practice, belief in supernatural agents, and belief in God all decreased as agents interacted with more educated agents in the model (across levels of existential security). This provides an initial validation of the microlevel behavioral architecture.

A further and stronger validation comes from a second set of experimental results. NoRM was able to simulate the shift in the relationships among religiosity and existential security variables in all 22 countries over the relevant 10-year period (see Figure 4).

The predictions of our agent-based model were up to three times more accurate than its closest competitor, linear regression analysis. For details and additional results, see Gore et al. (2018). It is important to emphasize that this macrolevel shift was not programmed into the algorithms guiding microlevel agent interactions, but emerged within the complex adaptive system based on the parameterized data from each country. This strengthens the plausibility of arguments that education and existential security are mechanisms that ratchet up atheism within a population.

It might initially seem odd that supernatural belief (F3) goes down at a slower rate than belief in God (F4), even in the context of highly educated social networks and existentially secure environments (see Figure 4). As we saw above, however, the causal relationships among each agent's religiosity variables were programed on the basis of the best-fitting SEMs constructed from our exploratory factor analysis. Belief in God is conditionally dependent on supernatural beliefs. Why not the other way around? Belief in the (miraculous) intervention of supernatural agents who have the power to reward or punish (heaven or hell in an afterlife) appears to be a relatively ancient

biologically evolved disposition. The role of cognitive and coalitional biases about disembodied, potentially punitive intentional forces in strengthening the cohesion of religious ingroups is well documented in the literature.

The idea of a monotheistic “God,” however, only took root in the wake of the axial age (c. 800–200 BCE). When humans lived in small-scale hunter–gatherer societies, the threat that relatively localized and familial supernatural forces (animal spirits or ancestor ghosts) might be watching was enough to keep everyone in line and enhance cooperation and commitment. As groups grew, however, so did the size of their gods. Although scholars disagree on precisely what factors were most decisive in the emergence of cooperation within large-scale societies, there is general consensus that belief in one “God” (or an Ultimate Reality such as Dharma or the Dao)—who is watching over, and capable of punishing, everyone regardless of their ingroup—is correlated with life in contexts strongly influenced by the so-called axial traditions.

Given this explanation, it makes sense that an idea that requires more institutional and doctrinal scaffolding (God) dissipates more quickly than ideas that are more deeply rooted in our phylogenetic heritage (animal spirits, ancestor ghosts punished in an afterlife, etc.). This also helps to make sense of the relative popularity of being “spiritual but not religious” even in Scandinavian and other highly educated, modernized societies.

Conclusion

In this article, we have proposed an affirmative conception of atheism as the integration of naturalist and secularist tendencies: trying to make sense of the world and act sensibly in society without appealing to the idiosyncratic supernatural beliefs and ritual behaviors of a particular religious coalition. We have presented some of the simulation results of two computational models, identifying and exploring the causal links between theism, anxiety, and violence (MERV), and the causal links between atheism, education, and existential security (NoRM).

Why do the godless prosper? As human beings improve their naturalistic explanatory skills and capture and organize enough energy to sustain secure secular societies, their need for shared ritual engagement with supernatural agents imagined by their ingroup slowly dissolves. In other words, they develop nonreligious worldviews. To address the significant adaptive challenges facing the human species as a whole, we need plausible scientific explanations of the causes of crises like global climate change and feasible secular strategies for providing sustainable existential security in ways that do not fuel religious conflict

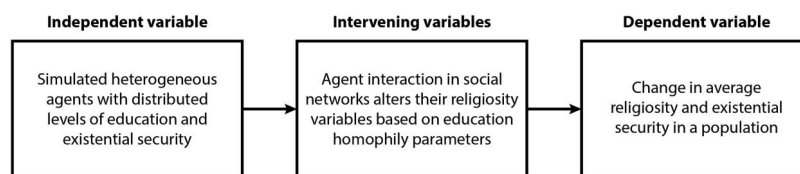


Figure 3. Variable dependencies within the model that allow for identifying changes in religiosity and existential security.

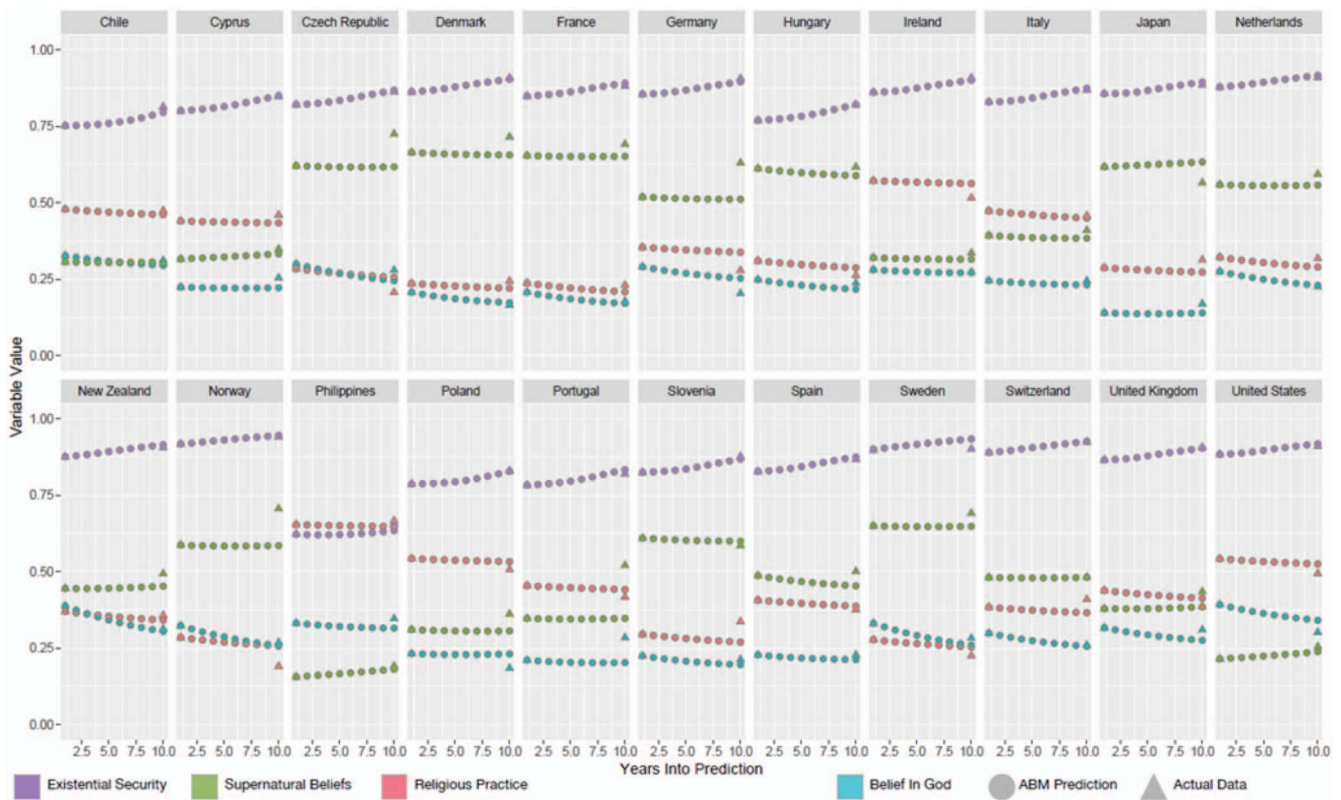


Figure 4. Agent-based models predictions for each country from 2000–2010. See the online article for the color version of this figure.

and violence. Atheism may indeed play an important role in the next step in human evolution.

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