CHAPTER THREE

CAN WE PREDICT AND PREVENT RELIGIOUS RADICALISATION?

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Developing the capacity to predict and prevent religious radicalisation and violent extremism is a high priority for a variety of stakeholders, including local and state governments, law enforcement institutions, NGOs, national and international security organisations, and concerned citizens everywhere. Policy-makers wonder: what policies (if any) can help mitigate the causes and effects of forms of extremism that appear to be motivated – or at least justified – by religion? Policy-analysts wonder: what scientific tools (if any) can determine the conditions under which – and the mechanisms by which – radicalisation processes are likely to occur? Subject-matter experts wonder: what role (if any) does religion play in processes of radicalisation?

This chapter explores each of these questions and highlights the way in which their answers – or at least the processes involved in seeking those answers – are closely intertwined. My discussion of the academic question about the causal relationship between religion and radicalization (and the methodological question about identifying the variables that predict extremism) will be couched in the context of an introductory presentation of some recent developments in the application of computer modelling and simulation techniques to research problems within the scientific study of religion. One of the most significant potential payoffs for this sort of research, of course, would be the discovery of new insights and new tools that could inform the development of more effective policies for reducing religious radicalisation and violent extremism. I discuss the possibilities for such a payoff in the last section.

Although violence inspired by religion is nothing new, it does increasingly seem to dominate the news, with all too regular reports of terrorist attacks by religiously radicalised individuals and escalating conflicts between religious in-groups throughout the world. In recent

years, research in cognitive psychology, anthropology, sociology and other fields has shed light on some of the causal dynamics at work in the emergence of extremist behaviours related to religion. At the level of cultural variance, for example, structural equation models based on global measurements of religious freedom suggest that state restrictions on the latter may lead to an increase in religiously sanctioned violence (Grim and Finke 2011). At the level of individual variance, for example, statistical path analyses of psychological surveys indicate that personality factors such as social dominance orientation and religious fundamentalism mediate prejudice toward religious out-groups (Banyasz, Tokar, and Kaut 2016). There is little doubt that both individual and cultural variance play a significant role in shaping the levels of religiosity and violence in any given context (Shaver et al. 2016).

Despite these scientific advances, researchers and policy-makers interested in these phenomena still face the theoretical challenge of integrating relevant empirical findings from so many diverse disciplines. They are also faced with the pragmatic challenge of discerning the relevant policy implications of the multiple (and often reciprocal) causal connections within complex adaptive systems such as those in which radicalisation processes are embedded. These are just the sort of challenges that computer modelling and simulation methodologies are designed to tackle. Building on findings from prior computer models that identify some of the mechanisms involved in the escalation of religious violence in general, I suggest a path forward toward the goal of predicting and preventing religious radicalisation. The first step is to clarify the mechanisms that contribute to its activation (or deactivation) and its acceleration (or deceleration).

What are the causes (and consequences) of religious radicalisation? A great deal depends, of course, on what we mean by "religious" and what we mean by "radicalisation." Below I will set out an operationalised definition of religion that has been successfully used within several computational models to explore the parameters and variable interactions that predict (and prevent) religiosity in a population. At this stage, however, suffice it to say that there is little doubt among religion scholars that religiosity is related to mechanisms that can trigger or exacerbate intergroup violence in general, and radicalisation in particular. But how “religious” is religious violence? Empirical findings and theoretical developments in the cognitive science of religion suggest that: “violence *is* attributable to religion because it rests on evolved human organisational and behavioural patterns. While religion need not cause violence and can, in fact, foster beneficent behaviour, religion is prone to violence given its

set of dangerous dynamics (both coalitional and ideological) that stimulate underlying biological tendencies toward violence" (Tremlin 2013, 38).

Religious beliefs about person-like, coalition-favouring supernatural agents, and religious behaviours within emotionally arousing, in-group rituals are part of a complex of evolutionary mechanisms that all too easily lead to anxiety about and violence toward out-group members under stressful conditions (Alcorta and Sosis 2013; Sosis, Phillips, and Alcorta 2012; Avalos 2013; Clarke, Powell, and Savulescu 2013; Sela, Shackelford, and Liddle 2015; Shults 2018).

Violence has historically been an important part of religion, from ritual mutilation and human sacrifice to the justification of wars allegedly commanded or sanctioned by the god or gods of an in-group, and religious violence is still with us today (Juergensmeyer, Kitts, and Jerryson 2016; Brubaker 2015; Nelson-Pallmeyer 2005). Of course, violence is not the only feature of religion, and religion is not a necessary or a sufficient condition for violent radicalisation. Some religious people are not radicals, and there are radicalised people who are not religious. Multiple *motivational* factors can be at work driving individuals into, through, and out of the radicalisation process, including social, cultural, political, psychological and religious factors. Moreover, multiple *situational* factors also need to be taken into account. For example, radicalisation may be more likely to occur in contexts where some members of the population experience economic distress or prejudice against their in-group.

Micro, meso and macro level mechanisms

But are the primary causal drivers of radicalisation to be found at the micro, meso, or macro level? Scholars disagree. Some emphasise the importance of *micro*-level variables. A recent study of the determinants of religious radicalisation in Kenya, for example, found "no evidence that macro-level political or economic grievances predict radicalisation." On the contrary, the authors argued, radicalisation is "strongly associated with individual-level psychological trauma" (Rink and Sharma 2017). Some studies have found that support for violence is strongly predicted by factors like religious conspiracy beliefs and religious fundamentalism (Beller and Kröger 2017; Beller 2017). Additional psychological factors known to be contributors to radicalisation include identity conflicts, group relative deprivation, various personality characteristics, and identity fusion (King and Taylor 2011; Swann et al. 2014).

Other scholars focus more on the *macro*-level factors that shape religious radicalisation. A study of Islamic radicalisation in Ghana, for

example, explored a variety of variables, including socio-economic and political dynamics, different doctrinal and interpretational approaches to the concept of jihad, external financial support and the presence of a youth bulge. The authors concluded that the intensity and frequency of radicalisation and violence are promoted, first and foremost, by intergroup struggles for doctrinal pre-eminence (Aning and Abdallah 2013). Another study that explored the multiple pathways to violence, and analysed mechanisms of political radicalisation at the individual, group, and mass-public levels, concluded that the trajectory of action and reaction at the level of intergroup competition was the key. Radicalisation should be understood "as emerging more from the dynamics of intergroup conflict than from the vicissitudes of individual psychology" (McCauley and Moskalenko 2008, 415).

This tension between theorists who emphasise micro- or macro-level variables is not unique to scholars of religious radicalisation and violent extremism. It is the reflection of a long-lasting debate within and across a variety of disciplines between those who tend to explain behaviour by appealing primarily to personality traits, those who refer mainly to contextual factors, and those who try to balance or integrate both.

One approach to the latter strategy is to look for mechanisms at the *meso* level. For example, a study of the behaviour of Jewish settlers in the West Bank identified organisational membership, or "networks of mobilisation," as a key mechanism that served as a bridge between religious identity and radical action. The authors found that "settler populations in non-religious settlements were significantly less likely to engage in radical action than those in religious communities" (Hirsch-Hoefler, Canetti, and Eiran 2016, 512). Another study of the evolution of the Hamburg Cell, which played a role in the 9/11 attacks, explored the interplay of social networks and religious violence. The study found that coercion and social tension increased the likelihood that groups distanced themselves from broader society, which in turn augmented the probability that group members would adopt more extreme beliefs. This process is facilitated by religious beliefs and practices that heighten the tension between the group and society (Everton 2016).

Another approach is to develop theoretical models that explicitly incorporate both micro- and macro-level factors. For example, one study of the role of religion and identity in the Turkish Diaspora in Germany emphasised the influence of three factors that contributed to violent radicalisation. These factors were the status of Islamist movements in the home country of immigrants, the extent to which religion fulfils material (rather than only spiritual) needs of immigrants in the host country and

personal crises that render individuals more susceptible to extremist ideology (Sirseloudi 2012). Another example is the "personality x threat x affordance" hypothesis about the motivation for aggressive religious radicalisation, which is grounded in goal regulation theory (McGregor, Hayes, and Prentice 2015). In this model, three sorts of variables combine to produce extreme behaviour:

- personality factors (such as oppositional and identity-weak traits),
- threat factors (such as external control threats and life circumstances that promote hopelessness), and
- affordance factors (such as situational opportunities for engagement, religious narratives that justify aggression, and religious arguments that cannot be disproved).

The development of models of religious radicalisation based on research on "new religious movements" (NRMs) or "conversion theory" provide another way of bridging the gap between micro- and macro-level factors. We know a great deal about the processes involved in the emergence of NRMs, as well as the conditions under which their separation from conventional religions can lead to violence. It makes sense to apply these insights when trying to understand the paths to violence taken by some emergent religious groups (Shterin & Yarlykapov 2011). Conversion theory also has decades of research behind it, and offers insights into the role of (and relationship between) both "predisposing conditions" and "situational factors." Taking advantage of this research can help radicalisation scholars "get beyond a dualistic view and begin the much-needed journey to understand how features of the person and the situation/context recursively influence one another throughout the radicalisation and engagement process" (Borum 2011a, 25).

Another example of a multifactor approach is Hafez and Mullins' use of a "puzzle" metaphor. To understand how ordinary individuals transform into violent extremists, they argue, one has to fit together at least four sorts of factors: personal and collective grievances, networks and interpersonal ties, political and religious ideologies, and enabling environments and support structures" (Hafez & Mullins 2015, 958).

The complex interplay of both individual *and* contextual factors in religious radicalisation has implications not only for the prediction but also for the prevention of this phenomenon. Often policy-makers and counter-terrorist teams focus on the long-range causes (e.g., historical, social or political grievances) or the short-range precipitants of terrorist campaigns (e.g. acquisition of weapons, the hiring of external experts). Such a focus

leaves out medium-range "proximate" causes, such as specific actor (or audience) constellations, and intra-group dynamics within a concrete conflict situation (Sirseloudi 2005). Appropriate prevention, as well as qualified prediction, requires attention to all of these levels and their reciprocal interactions.

Scholars of religious radicalisation are well aware that this level of complexity poses severe challenges for researchers in the field, and helps to explain why, despite the apparent practical significance of the topic, the amount of empirically rigorous research on it is surprisingly low (Neumann & Kleinmann 2013). A systematic review of the research evidence in the field observed that despite the prolific output of research, very few studies contained *empirical* data or systematic data analysis, or developed *causal* models of the relevant dynamics. Instead, most of the literature "listed several probable factors, usually social-psychological models, but failed to specify the interactions between the listed factors in any detail" (2012, 42). Another survey of the leading conceptual models and empirical research in the field described radicalisation as "multiply-determined. Radicalisation may be driven and sustained by multiple causes," including "push" and "pull" factors, and pathways that are characterised by "equifinality," i.e., different pathways can lead to the same outcome, as well as by "multifinality," i.e., different persons on the same pathway may have different outcomes (2011b, 57).

What do scholars in this field think is needed to tackle a phenomenon this complex? Some have noted that although particular theories are valuable, "a *comprehensive* effort to verify our understanding of radicalisation, using empirical verification as a standard, might be more beneficial to the current state of knowledge concerning the transformative processes that precede acts of terrorism" (King and Taylor 2011, 618, emphasis added). Others call for research designs that do not simply select the dependent variable but select "cases where the presumed causal variables are present, even if radicalisation is not. In other words, researchers should seek evidence that disconfirms the putative causes of radicalisation to nuance their analysis of what's necessary, sufficient, or inconsequential in the radicalisation phenomenon" (Hafez & Mullins 2015, 971). Still others express the need for "empirically testing leading hypotheses on radicalisation in multiple conflict settings… [and] research designs that attempt to examine the correlates of extremist behaviour in different contexts" (Rink & Sharma 2017, 25).

On top of all this, radicalisation researchers face severe ethical and experimental challenges. As Bjørgo and Gjelsvik point out in their summary of Norwegian research on the prevention of radicalisation and

violent extremism, scholars in this field have to face several ethical challenges at the boundaries of the usual standards for ethical research. Such complicating factors include transparency requirements, informed consent, and the limits of confidentiality and anonymity when dealing with individuals who may be dangerous to the broader society (Bjørgo & Gjelsvik 2015, 21). Another ethical problem, not mentioned by these authors, is that experimental research on religiously radicalised individuals and their effect on the environment is neither feasible nor ethically appropriate. No internal ethics review board would approve a research design in which one *experimented* with different policies for preventing – or predicting – religious violence in the real world. For example, we cannot merely insert more or less radicalised individuals into different sorts of social networks to see what happens.

We need some powerful new methodological tool to help us tackle the job of determining the conditions under which – and the mechanisms by which – some individuals in some contexts move through the radicalisation process and commit acts of violence.

How computer modelling and simulation can help

Computer modelling and simulation (M&S) offers a suite of tools and techniques for analysing the mechanisms involved in complex adaptive systems of the sort in which radicalisation processes are embedded. Such analytical and predictive approaches have been a methodological staple for decades in the natural sciences, and have been adopted by businesses, military agencies, disease control organisations and similar institutions to simulate the probable impact of different policies on alternative future scenarios (Law & Kelton 1991; Tolk 2012). The successful track record and rapid growth of M&S have even led some scholars to refer to it as the "third pillar" of science, alongside theory and experimentation (Yilmaz 2015). Over the last ten years, M&S has also become increasingly popular in the social sciences and begun to mature as a sub-field (Hauke, Lorscheid, & Meyer 2017). The success of this approach has contributed to the emergence of what some scholars call "computational social science" (Epstein 2006a; Alvarez 2016; Squazzoni 2012).

In recent years, we have also seen the emergence of what we might call a computational social science of *religion*. Computational techniques have been utilised to explore a variety of psychological and social dynamics within religious groups, including the role played by costly beliefs and practices in enhancing group stability (Wildman and Sosis 2011), the distinction between imagistic and doctrinal modes of religiosity

(Whitehouse et al. 2012a), the relationship between group size and religious identification (Hoverd, Atkinson, and Sibley 2012), the transmission of religious violence in the Radical Reformation (Matthews et al. 2013a), the relation between priestly elites and large-scale cooperative societies (Dávid-Barrett and Carney 2015), the role of cooperation style and contagious altruism in proselytising religions (Roitto 2016) and the function of cognitive and coalitional variables related to religion in the Neolithic transition (Shults and Wildman forthcoming).

What's all the fuss? M&S approaches have many virtues that set them apart from other methodologies. For example, the process of constructing a computer model forces researchers to be exceptionally precise in the conceptualisation and operationalisation of their variables and to formalise their assumptions about the causal interactions among them. After quantifying this information within algorithms that drive computational architectures (usually structured by state charts or stock-and-flow diagrams), high-powered computers or high-performance computing clusters can explore the multi-dimensional parameter space of the social simulation far more efficiently and rapidly than the human mind. To study religious radicalisation, several other features of M&S methodologies stand out. For example, they allow researchers to

- construct and execute experiments in "artificial societies" that would not otherwise be feasible or ethical,
- explain the emergence of a complex macro-level social phenomenon by "growing" it from the bottom-up from micro-level agent behaviours and interactions (thereby shedding light on plausible causal mechanisms rather than merely establishing correlation),
- integrate insights from qualitative and quantitative research within the same computational model, and
- explore the multi-dimensional space of a social system to determine the parametric and probabilistic conditions for specific configurations (such as the emergence of radicalisation).

Given these advantages, it is not surprising that M&S methodologies have already been used to illuminate a variety of issues related to social conflict in general. For example, computational models have been used to predict patterns of violence and segregation (Weidmann and Salehyan 2013), the escalation of ethnonationalist radicalisation (Neumann 2014), and the decline of ethnic civil war (Cederman, Gleditsch and Wucherpfennig 2017). In fact, several volumes have brought

computational methodologies to bear on issues related to radicalisation, such as counterterrorism, political ideology, and ethnic violence (e.g., Subrahmanian 2013; Voinea 2016; Fellman, Bar-Yam and Minai 2014). Increasingly, one finds studies that even focus explicitly on radicalisation processes. For example, one scholar recently constructed an agent-based model based on the Individual Vulnerability, Exposure and Emergence (IVEE) framework for understanding radicalisation (Pepys 2016).

To my knowledge, however, no computational models of radicalisation have been developed that explicitly include agent-level religious ideology and religious ritual participation variables, which most theories in the field hypothesise to be the most relevant *causal* factors related to *religion*. The remainder of this chapter outlines some of the initial steps the author has already taken (along with colleagues within an international research team – see acknowledgements below) toward the development of such a computer model and outlines what the final steps would require. If we are interested in understanding the causal relationship between religion and radicalisation, it makes sense to begin by clarifying the causal mechanisms that drive *religiosity* up (or down) within a population.

The cognitive and coalitional mechanisms that engender "religiosity"

In the following section, I will describe two computer models that our research team has already developed which shed light on the conditions under which – and the mechanisms by which – religiosity increases or decreases among individuals in a population. In this sense, they "predict" when religiosity is likely to grow or decline. They also disclose some of the policy-relevant levers that could "prevent" (or promote) a rise in the sort of supernatural beliefs and behaviours that exacerbate intergroup tensions. The first step, however, is to be clear on what we mean by "religiosity." Both of the models briefly outlined below were constructed on the basis of a broad conceptual framework called "theogonic reproduction theory," which operationalises religiosity in relation to the cognitive and coalitional mechanisms that engender and nurture god-conceptions in a population (Shults 2014, 2015, 2018).

The term religion is at least as contentious as the term radicalisation, but for the purposes of these computer models, we do not need a universally valid definition. All we need is to identify a set of statistically measurable traits that consistently engender recurrent sorts of beliefs and behaviours that mutate culturally in relatively predictive ways. The traits we are interested in are those that induce beliefs in gods and foster ritual

behaviours oriented toward engaging them. In other words, "religiosity" has to do with individual and situational factors that contribute to the emergence and maintenance of shared imaginative engagement with existentially relevant supernatural agents within a population. This sort of imaginative engagement can promote cooperation, commitment, and cohesion in the face of out-group threats and environmental challenges.

There are many biologically evolved and socially entrained mechanisms that contribute to this set of phenomena, but we can compile most of them into two categories: the tendency to detect supernatural agents (human-like, coalition-favouring, disembodied intentional forces) and the tendency to protect supernatural coalitions (in-groups whose coherence depends in part on ritual interaction with such agents). Both of these tendencies are easily activated when individuals experience ambiguous or frightening phenomena. In other words, religiosity involves the intensification and integration of a hyperactive propensity toward inferring gods (hidden supernatural agents) and a hyperactive tendency toward preferring the supernaturally authorised norms of an in-group. There is no space here to outline the empirical evidence in support of these claims (but see Shults references above for details).

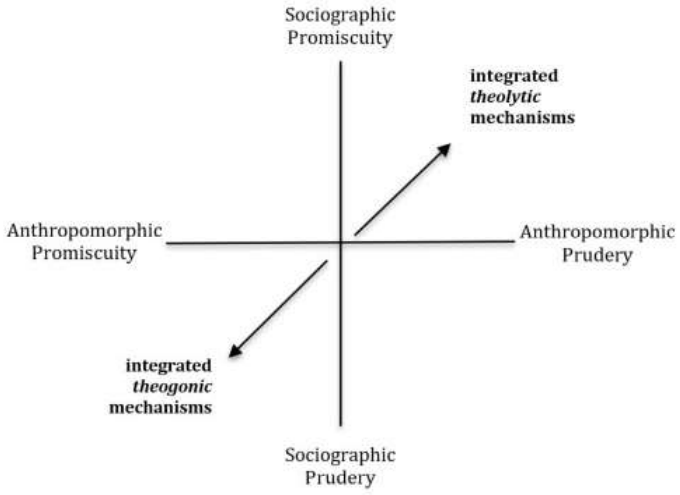

Figure 1. The "god-bearing" mechanisms that predict religiosity are in the lower left quadrant; the "god-dissolving" mechanisms that prevent it are in the upper right quadrant.

The coordinate grid in Figure 1 portrays the integration of these two sorts of tendencies, which I refer to as anthropomorphic promiscuity and sociographic prudery. The horizontal line represents a continuum on which we can mark the tendency of persons to guess "supernatural agent" when confronted with ambiguous phenomena in the natural environment. The anthropomorphically promiscuous are always on the lookout, jumping at any opportunity to postulate such agents as causal explanations. The anthropomorphically prudish, on the other hand, are suspicious about such appeals. They tend to reflect more carefully before giving in to their intuitive desire to grab at agential explanations.

The continuum represented by the vertical line registers the extent to which a person holds on to supernaturally authorised norms and modes of inscribing the social field. Sociographic prudes are firmly committed to the authorised social standards of their in-group, following and protecting them even at significant cost to themselves. They are more likely to be suspicious of out-groups and to accept claims or demands that appeal to authorities within their coalition. The sociographic promiscuity of those at the other end of the continuum, on the other hand, leads them to be more open to intercourse with out-groups about different normativities and to the pursuit of new modes of a creative social inscription. Such persons are also less likely to accept restrictions or assertions that are based only or primarily on appeals to ritually engaged disembodied intentional forces.

High levels of anthropomorphic promiscuity and sociographic prudery "predict" high levels of religiosity, i.e., shared imaginative engagement with supernatural agents that are ritually engaged by an in-group. In other words, gods are born(e) as a result of a variety of sub-mechanisms that contribute to religious belief and behaviour. Such mechanisms include individual-level factors like poor analytical reasoning skills, ontological confusion, and high schizotypy (Gervais and Norenzayan 2012; van der Tempel and Alcock 2015; Lindeman, Svedholm-Häkkinen and Lipsanen 2015). Contextual factors like ecological duress, socioeconomic dysfunction, and existential insecurity also play a role (Pazhoohi et al. 2017; Paul 2009; Norris and Inglehart 2011).

On the other hand, religiosity is “prevented” by high levels of anthropomorphic prudery, which can be the result of science education based on naturalistic principles, and by high levels of sociographic promiscuity, which can be fostered by strong, relatively transparent secular institutions that provide existential security to a population. For example, individuals who are more highly educated and have analytic thinking styles are less likely to be religious (Gervais and Norenzayan 2012; Lewis 2015). And democratic countries in which the state invests

significantly in social welfare, thereby providing existential security for its citizens, will tend to have lower levels of church attendance and religious affiliation in the population (Scheve, Stasavage, et al. 2006; Habel and Grant 2013).

These are not the only factors that prevent (or predict) religion, but they are among the most well researched and empirically validated. As we will see below, this way of articulating the mechanisms of "religiosity" can give us some traction as we attempt to answer questions about their role in accelerating or decelerating "radicalisation."

Computational models that predict (and prevent) religiosity

In this section, I briefly outline three of the computer models our team has already developed, all of which build on the integration of leading theories in the bio-cultural study of religion. The first model simulates the reciprocal interaction between religiosity and terror management (Shults et al. 2018). Psychological experiments based on terror management theory (TMT) indicate that anxiety related to death awareness tends to ratchet up religiosity both in terms of scanning for supernatural causes and scrambling to protect in-groups (Norenzayan et al. 2008; Vail, III et al. 2016; McGregor, Hayes, and Prentice 2015; McGregor et al. 1998).

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 out-group members. In other words, the intensification of mortality salience can amplify belief in supernatural agents (anthropomorphic promiscuity) as well as behavioural dispositions toward participating in local ritual practices (sociographic prudery). Our simulation experiments were able to replicate many of the findings in the TMT literature. They also led to new insights into the micro-level mechanisms that can lead to macro-level phenomena, such as higher average religiosity among members of minority groups.

The next model began with the same agent architecture but incorporated critical aspects of Joshua Epstein's Agent_Zero (Epstein 2014). Based on neurological and psychological research on affect, deliberation, and social contagion dynamics, agent interactions in that model were configured in such a way that the intensification of affect within an individual agent could reach a tipping point such that its disposition would pass a threshold that could be taken as a proxy for initiating violence. This model of mutually escalating religious violence (MERV) was able to simulate some of the conditions under which

mutually increasing religious violence could emerge within a population composed of two different religious groups. The technical details of this model are explained in more detail in (Shults et al. 2017).

The architecture of this model was also designed to incorporate insights from two other well-known theories that shed light on psycho-social mechanisms that play a role in generating violence between groups: social identity theory (SIT) and identity fusion theory (IFT). The former argues that the human need to evaluate one's group positively (in the context of comparison with an out-group) leads to stronger differentiation between groups. The interaction between groups can be powerfully determined by "value-laden social differentiation" that increase tensions between the groups and can lead to conflict and violence (Tajfel and Turner 1979, 41). Empirical research guided by IFT has identified ways in which personal and situational factors work together to influence extreme behaviours. 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). People with less identity fusion may have strong beliefs about what "ought" to be done for their group. People with high identity fusion, however, are far more willing to act on these beliefs even, or especially, when that involves dying or killing for the group (Swann et al., 2014; Swann et al., 2010).

MERV's computational architecture was able to clarify some of the conditions under which the behaviour of—and interaction among—individual agents can lead to mutually escalating religious violence, drawing on insights from these theories. For a graphic illustration, see Figure 2.

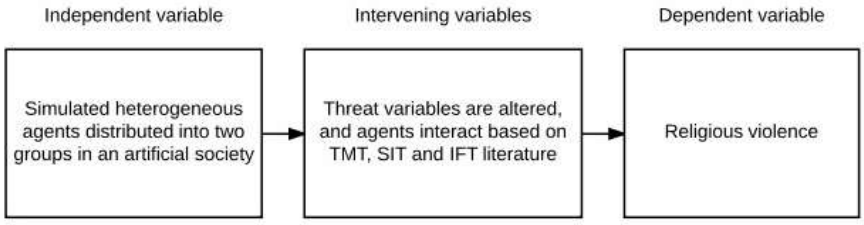

Figure 2. Variable dependencies within MERV that allow for identifying conditions under which mutually escalating religious violence emerges.

When the model initialises, agents in MERV are assigned to one of two groups, distinguished by their (simulated) variance of beliefs and ritual behaviours in relation to the supernatural agents postulated by each

group. At each time step, agents may meet hazards of different sorts (social threats, disease contagion, predation, and natural disasters), which heighten 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 in-groups, which increases their propensity towards violence against out-group members (as predicted by SIT and IFT).

Our simulation experiments were able to "grow" macro-level religious intergroup violence from the micro-level behavioural rules guiding dispositional contagion within and among agents in the model. Optimisation 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 >= Contagion Hazard Tolerance) AND (Social Hazard Intensity >= Social Hazard Tolerance). This model was validated using trace analysis and face validation techniques (for details, see the electronic supplemental materials available at https://github.com/SimRel/Merv1.0).

One of the limitations shared by the first two models was that the religiosity of the (heterogeneous) agents could not go below the levels set at the initiation of each simulation run. This was adequate for the task of those models, which was to explore the way in which anxiety and violence can *increase* religiosity. However, when we turned to the work of simulating and analysing the mechanisms that *decrease* religiosity, we needed a new sort of agent architecture.

Our Non-Religiosity Model (or NoRM) was based on an integration of several empirically grounded theories that show how non-religious worldviews emerge and expand in a population as critically thinking individuals learn about natural causes and human capacities within a broader social field in which they feel safe and secure. In other words, religiosity is "prevented" (or lowered) in a population as education and existential security are increased. These are not the only relevant mechanisms, but their effects in reducing religiosity are among the most well documented (Hungerman 2014; Ellis et al. 2017; McLaughlin and McGill 2017; Strulik 2016; Shults 2018). The construction of NoRM also involved the development of structural equation models based on factor analysis of the International Social Survey Programme.

The details for this model (Gore et al. 2018) are available in the supplementary materials online at https://github.com/rossgore/JASSS-Special-Issue. See Figure 3 for a graphical representation of this process.

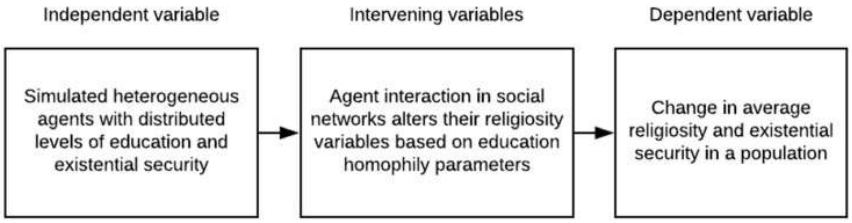

Figure 3. Variable dependencies within NoRM that allow for identifying changes in religiosity and existential security in a population

The validity of the NoRM architecture depends on the degree to which we can simulate the emergence of macro-level shifts in religious practices and existential security within a population (in a way that matched their change over time in the real-world data sets) from the micro-level agent interactions in our model. 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. Using the calibrated model, we then predicted changes in the relevant variables for 22 countries (including 11 *not* initially calibrated for the model) during a *different* 10-year period (2000-2010).

The predictions of our model were up to *three times more accurate* than its closest competitor, which used linear regression analysis. It is important to emphasise that this macro-level shift was not programmed into the algorithms guiding micro-level agent interactions, but emerged within the complex adaptive system based on the parameterised data from each country. The results of these simulation experiments strengthen the plausibility of arguments that education and existential security are mechanisms that decrement religiosity within a population. But what does any of this have to do with radicalisation?

Toward a Computational Model of Religious Radicalisation

Why not go right for a model of religious radicalisation and extremism, and skip the process of developing models of the causal mechanisms that

increase or decrease religiosity? One of the reasons to go slow is to avoid the loss of "cognitive control" that too often occurs with overly complicated models. If one begins with too many variables and mechanisms, it is not always clear precisely what is causing what. Building on our success in constructing models of the cognitive and coalitional mechanisms that impact religiosity, our team plans to adapt and expand those models to include additional variables and mechanisms unrelated to religion (Shults and Gore 2018). The successful construction of such a model could help to address some of the concerns raised by radicalisation scholars noted above. In particular, it could provide an ethically acceptable methodology for data-driven experimentation (within artificial societies) that sheds light on the causal relationships between religion and other variables in the promotion or demotion of radicalisation. This sort of modelling and simulation might also contribute to the growing theoretical literature on de-radicalisation and provide concrete insights for policies oriented toward countering violent extremism (Doosje et al. 2016, Koehler 2016, Kruglanski et al. 2017, Webber et al. 2017).

What are the next steps? As with the construction of any new model, we would need to identify a particular theory (or integrate a set of theories) and operationalise the relevant variables in a way that could be implemented in a computational architecture. We would also need to decide which parameters the model needs to facilitate the sort of simulation experiments that could provide insights into the causal dynamics of those aspects of the radicalisation process in which we are most interested. Moreover, we would need to identify empirical data sets that could be used to calibrate and validate the model. These steps do not necessarily have to be in any particular order; the process is iterative, moving back and forth between theory, data, and experimental design until everything falls together.

In the first section of this chapter, I reviewed just a few of the many (more or less complementary) theories of radicalisation in the literature and alluded to some of the currently available data sets. How do we decide which approaches and which data to use? How do we choose to operationalise "radicalisation?" Should we go with a definition that focuses on the individual: "Radicalisation is a personal process in which individuals adopt extreme political, social or religious ideas and inspirations, and where the attainment of particular goals justifies the use of indiscriminate violence" (Wilner and Dubouloz 2011, 38). Or, do we need a definition that involves groups: "Radicalisation refers to an increase in or reinforcing of extremism in the thinking, sentiments or behaviour of individuals or groups" (Mandel 2010, 111). Or, is there some other

definition that would serve us better for this task? There is no way to find the "right" answer to this question ahead of time. In my experience, the best approach is to bring together a team of subject-matter experts and computer programmers for a few days to discuss the options and develop a strategy (Wildman, Fishwick and Shults 2017).

In this final section, I would like to conclude with an observation and a suggestion. First, the observation. It seems to me that the fractionation of religiosity into mechanisms related to belief in supernatural agents (anthropomorphic promiscuity) and behaviour within groups with supernaturally authorised ritual engagements (sociographic prudery) offers a fruitful way to respond to the concern often expressed in the radicalisation literature about the inordinate focus on ideology at the expense of attending to the significant material challenges affecting the daily practice of individuals who are at risk of becoming radicalised (Mythen, Walklate and Peatfield 2017). The process of radicalisation is not merely a cognitive transformation: it also involves collective actions, rituals, and physically embodied "aesthetic" practices that link the individual to a group (Crone 2014).

In other words, a model of religious radicalisation should pay attention to both radical religious ideas and extreme religious actions. As Borum concluded at the end of his review of social science theories on radicalisation into violent extremism: "Radicalisation – the process of developing extremist ideologies and beliefs – needs to be distinguished from action pathways – the process of engaging in terrorism or violent extremist actions" (2011a, 30). One popular image for understanding radicalisation has been a pyramid; the majority of the population at the base of the pyramid has conventional views, and those few at the top have extremist views. More recently, however, some scholars have argued that we need to visualise two pyramids, one that measures radicalisation of opinion and another that measures radicalisation of action (McCauley and Moskalenko 2017). Of course, ideas and action, belief and behaviour, and thought and practice are reciprocally reinforcing. The models described above provide the groundwork for a computational exploration of religious radicalisation that distinguishes between these two features while simultaneously attending to the causal dynamics between them.

Finally, the suggestion: although there is a multitude of theories that are relevant for understanding religious radicalisation, "sacred values theory" (SVT) stands out as a particularly useful approach for our purposes. Decision-making shaped by sacred values is different from the sort of cost-benefit analysis common in decision-making shaped by instrumental values, because the former incorporates moral (and

sometimes religious) beliefs that can drive action independently of its prospect of success (Ginges et al., 2007). A sacred value can be operationally defined as "anything that people refuse to treat as fungible with material or economic goods, for example, when people refuse to compromise over an issue regardless of the costs or benefits" (Sheikh et al., 2013, 12). SVT has also been applied to the analysis of several factors in radicalisation, such as the impact of humiliation on the possibilities for compromise in intractable group conflicts (Atran and Ginges, 2008), and the role of dehumanisation, or lack of attribution of sentience to out-group members, in shaping intergroup conflict resolution strategies (Leidner, Castano and Ginges, 2013). Not surprisingly, there have already been attempts to link SVT to identity fusion theory (Sheikh et al., 2014), one of the theories that we have already used to guide some of our computational architectures.

Because sacred values have "privileged links to emotions, such as anger and disgust at their violation, leading to moral outrage and increased support for violence," people who are pressured to defend such a value "will resist trading it off for any number of material benefits, or even for peace" (Sheikh et al., 2013, 21). All of this has rather obvious implications for public policy and peace-making attempts (Ginges et al., 2011; Ginges and Atran, 2011). When policy-makers or conflict mediators ignore the function of sacred values in intensifying parochial (in-group) altruism, they pursue strategies that make people less likely to compromise. Experimental studies have shown that "devoted actors," that is, those primarily driven by sacred values, become more defensive and less open to conflict resolution when they are offered material incentives to compromise (Atran & Axelrod, 2008). Such offers are considered insulting, and reinforce their commitment to the in-group's sacred values.

It is important to acknowledge the limitations of modelling and simulation; despite advances in computational power and techniques, we should not expect these models to predict events with high levels of specificity or to enable us to prevent all conflicts (Cederman and Weidmann 2017). However, they can help us get a clearer view of the conditions under which radicalisation is likely to occur. Insofar as they can also help us get a grip on the mechanisms underlying these processes, computer simulations can inform the discussions and decisions of policy-makers. Because it forces us to make all of our assumptions explicit (so that they can be rendered in computer code), the construction of such models might also mitigate against the problem of "policy-based evidence making," the process by which a particular political ideology

surreptitiously shapes policy in a way that fulfils its prophecies (Mythen, Walklate, & Peatfield 2017).

To take full advantage of this approach, policy-makers, computer scientists and subject-matter experts working in the field will have to work together closely (Upal 2015, 107). Given the relative lack of interaction among academics and practitioners in the relevant areas (Peddell et al. 2016), one of the most significant challenges as we move forward in the construction of computational models of religious radicalisation may be finding the right people to work together in collaborative teams. But it seems worth the effort. If we can build empirically-validated computer models that can simulate artificial societies (*in silico*) that replicate emergent patterns of extremist ideology and violence in the real world (*in situ*), then we could shed light on the plausibility of hypotheses about the causes – as well as the feasibility of policies aimed at the prevention – of religious radicalization and extremism.

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