Chapter 41
Modeling Radicalization and Violent Extremism

F. LeRon Shults and Ross Gore

Abstract Given public anxiety about radicalization and violent extremism, it is not surprising that these topics have grabbed the attention of so many scholars in recent years. However, some have expressed concern over the fact that only a few studies in this relatively new field contain empirical data or systematic data analysis or develop causal models of the mechanisms generating these phenomena. We believe that computational modeling and simulation techniques can make a significant contribution to this scientific literature and eventually provide new tools for improving policy analysis. Here we briefly describe (1) an integrative theory of violent extremism proposed by Kruglanski and colleagues and (2) an agent-based model that instantiates this theory in a computational architecture.

Keywords Agent-based model · Radicalization · Violent extremism · Kruglanski

41.1 A "Needs, Narrative, and Networks" Theory

The work of Kruglanski and colleagues is based on social psychological research on the role that quest for significance (a microlevel variable) can play in motivating individuals toward radicalization and violent extremism [1]. However, their model also accounts for meso- and macro-level variables such as social processes and cultural ideologies that can promote and justify violent behaviors, which in turn provide some individuals with a significance gain. They propose that such behaviors are the result of the conjunction of three factors: a need that motivates one to (re)gain

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personal significance, the availability of a narrative or ideology that can justify the behavior, and a social network whose group dynamics lead an individual to embrace the ideology [2]. Finally, their theory also recognizes that an individual must have the ability (subjective and objective capacity) to carry out the extreme behavior.

Extremism is “motivated deviance from general behavioral social norms,” which occurs as a result of “a shift from a balanced satisfaction of basic human needs afforded by moderation to a motivational imbalance wherein a given need dominates the others” [3, p., 217]. The authors apply this general psychological theory of extremism to the special case of violent extremism. All humans need significance, although this variable is differentially distributed among individuals in a population. Engaging in extreme behaviors takes a great deal of energy, and most people maintain their motivational balance by engaging in moderate behaviors that fulfill a variety of needs. However, motivational imbalance can be triggered by traumatic experiences or cultural threats, which can increase the quest for significance. If that need is sufficiently high, and an individual becomes entangled in radicalizing social networks whose group dynamics lead him or her to accept a violence-justifying ideological narrative, and that individual has the ability to perform such acts, he or she is more likely to engage in extremist behaviors.

Elsewhere, our research team has developed models directly or indirectly related to these themes, including simulations of the dynamics involved in terror management systems [4], mutually escalating religious violence [5], and existential security and secularization [6]. Some of these models included variables related to those discussed by Kruglanski and his colleagues, including identity fusion, sacred values, and concerns about threat or existential anxiety. The model outlined below implements the “needs, narrative, and network” theory within a computational architecture that incorporates the relevant micro-, meso-, and macro-level variables. This is our first attempt to demonstrate the value of computational modeling and simulation techniques for predicting and preventing radicalization [7, 8].

41.2 A Computational Model of Radicalization and Violent Extremism (RAVE)

Each agent in RAVE has a quest for significance level (QS), a level of motivational imbalance (MI), a cultural threat threshold, an ideological narrative violence level (INV), a threshold specifying a willingness to commit violence (VE), and a minimum, mean and maximum ability to commit violence. In addition, each agent is assigned a social network, which reflects its set of active social relationships. The number and weight of the links within the network is constructed by an algorithm that mirrors real human social networks, in which individuals tend to have $\sim$135 active relationships [9]. Based on homophily indicators derived from research in social anthropology, we tie strong relationships within the network to higher levels of emotional closeness. In our implementation, emotional closeness is also correlated with an agent's INV level. The degree to which the INV of an agent is correlated to the emotional closeness of its network relations is determined by the parameter INV-homophily (INV-H).

The model environment produces cultural threats every time step. Every threat has an intensity determined by a triangular distribution with a minimum, mode, and maximum parameter. The values of these parameters can range from 0 (no intensity) to 1 (maximum intensity). Each agent also has a threshold ranging from 0 (no threshold) to 1 (maximum threshold) that determines how intense a cultural threat needs to be for them to perceive it. The perception of cultural threats causes agents to increase their motivational imbalance. By contrast, not perceiving threats decreases an agent's level of motivational imbalance. Within each agent, a motivational imbalance level is represented as a real number.

Figure 41.1 summarizes the interactions and decisions made by entities within the model at each time step. The left side of Fig. 41.1 represents those actions that occur if an agent's MI level is below the agent's QS threshold. In this case, cultural threats are created for the agent. The intensity of each threat is determined by sampling the triangular distribution defined by the model-level parameters. Once

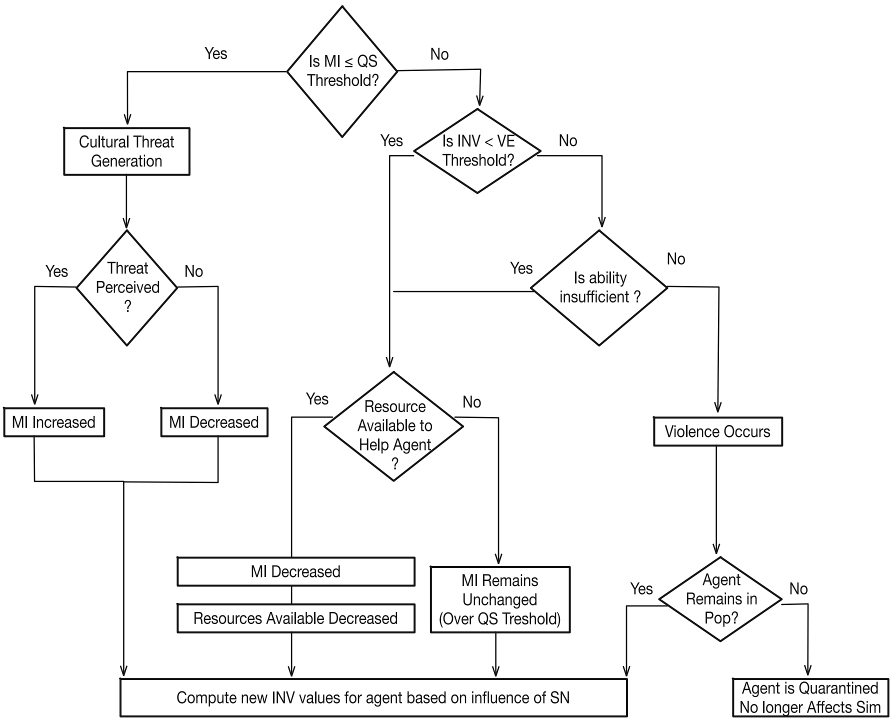

Fig. 41.1 Decisions made by entities within RAVE at each time step

an agent tests for hazard perception, it interacts with its social network, and its INV level is updated using a Rescorla–Wagner formula for classical conditioning [10]. In our implementation, this formula is $MI_{current} + [\alpha\beta(\lambda - MI_{current})]$. In the formula, when hazards are perceived, the rate of the stimuli (β) is set to 1, and the association value (λ) is set to 1. These parameters reflect the increase of the MI level of an agent in response to incoming cultural threats. Conversely, when hazards are not perceived, the rate of the stimuli (β) is set to 0.1 and the association value (λ) is set to 0. This reflects the decay of the agent's MI without the presence of the stimulus. The value of α remains constant in both cases.

The right side of Fig. 41.1 depicts actions that are initiated if an agent's MI exceeds its quest for significance threshold (QS). When this occurs, the agent checks its INV level (the current level of violence associated with the agent's ideological narrative), which is influenced by the agent's social network. If an agent's INV exceeds its willingness to commit violence (VE), then the ability of the agent to commit violence is determined by sampling the triangular distribution with the minimum, mode, and maximum parameter. The uncertainty within these parameters reflects the variance in an agent's capacity to commit violence over time. If the agent's ability is over the specified threshold for the model, then the agent commits a violent act. When an agent commits a violent act, then the simulation checks to see if the agent will be removed from the population. This check is performed by sampling the triangular distribution (described above) and testing whether the sampled number is above the removal after violent act threshold; if so, the agent is removed from the simulation and no longer affects the run. If not, the agent remains in the simulation with a motivational imbalance that is above the QS threshold, and its INV level is updated based on its interaction with its social network.

If (1) an agent's INV does not exceed their willingness to commit violence or (2) an agent's ability to commit violence is less than or equal to the specified threshold, then the agent does not commit a violent act. In either case, the agent checks to see whether there are resources in the environment that could provide some other way to fulfill the quest for significance (e.g., community programs), thereby decreasing motivational imbalance level. If resources are available in the environment, then (1) the motivational imbalance of the agent is decreased, and (2) the number of resources available in the environment for all future agents is decreased by one. If resources are not available, the motivational imbalance of the agent remains over the QS threshold. In either case, the agent then interacts with its social network and updates its INV level. In this interaction, the INV variable within the agent is influenced by the INV value of other agents within their social network. It is important to note that Fig. 41.1 shows that the influence of the social network is exerted every time step of the model on an agent even if she/he does not perceive a cultural threat. The only way an agent can avoid being influenced by their social network during a time step is if the agent is quarantined.

The extent to which the variable is influenced is determined by a time-dependent weighted average. Given a matrix IN that includes an entry for the influence of each of the N agents on every other agent, the total influence exerted on it is computed using the equation described next. Total Influence and a set A that includes all agents enable us to define $\text{TotalInfluence}_i = \sum_{\substack{j=1 \\ i \neq j}}^{N} \text{IN}_{i,j}$. Total Influence and a set A that includes all agents enable us to define $A_{\text{SN}-\text{INV}_{t,i}}$. Set A contains the value of INV, at each time step t, for each agent j, throughout the simulation ($A_{\text{INV}_{t,j}}$). $A_{\text{SN}-\text{INV}_{t,i}}$ is the influence exerted on agent i by his/her social network (SN) for a given variable v at time t. Formally, it is $A_{\text{SN}-\text{INV}_{t,i}} = \sum_{\substack{j=1 \\ i \neq j}}^{N} \frac{A_{\text{INV}_{t,j}} * \text{IN}_{i,j}}{\text{TotalInfluence}_i}$. An agent combines the value of the INV variable from their social network with the agent's existing value for the respective variable using the Cobb–Douglas function [11]. We employ this function because it is an established, flexible, and widely used method to aggregate the influence of the environment with the existing value of a variable though the parameter β. Formally, this combination is computed as $A_{\text{INV}_{t+1,i}} = {A_{\text{INV}_{t,i}}}^{\beta} * {A_{\text{SN}-\text{INV}_{t,i}}}^{1-\beta}$.

The model has several important assumptions. First, note that resources in the model cannot be restored or increased. This reflects the assumption that the model will be used for planning or policy decisions for a fixed period of time. Thus, the model explores how few resources need to be budgeted for a fixed period of time (e.g., a year) to minimize the number of violent actions in the artificial society. Second, a violent action that results in quarantine is assumed to have direct consequences only on the extremist agent who performed the action. This excludes effects on the extremist's network and on the rest of the population. As a result, this model cannot capture some other dynamics that may play a role in radicalization processes, such as imitation. Third, the model assumes that the cultural threats an agent perceives are independent of his or her social network. This assumption precludes cultural threats that stem from one's social network.

In future work, we plan to construct simulation experiments within this artificial society that will allow us to explore the potential impact of various policies for mitigating radicalization and extremism [12, 13].

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References

1. Kruglanski, A.W., Gelfand, M.J., Bélanger, J.J., Sheveland, A., Hetiarachchi, M., Gunaratna, R.: The psychology of radicalization and deradicalization: how significance quest impacts violent extremism. Polit. Psychol. **35**, 69–93 (2014)
2. Webber, D., et al.: The road to extremism: field and experimental evidence that significance loss-induced need for closure fosters radicalization. J. Pers. Soc. Psychol. **114**(2), 270–285 (2017)
3. Kruglanski, A.W., Jasko, K., Chernikova, M., Dugas, M., Webber, D.: To the fringe and back: violent extremism and the psychology of deviance. Am. Psychol. **72**(3), 217–230 (2017)

4. Shults, F.L., Lane, J.E., Diallo, S., Lynch, C., Wildman, W.J., Gore, R.: Modeling terror management theory: computer simulations of the impact of mortality salience on religiosity. Relig. Brain Behav. **8**(1), 77–100 (2018)
5. Shults, F.L., Gore, R., Wildman, W.J., Lynch, C.J., Lane, J.E., Toft, M.D.: A generative model of the mutual escalation of anxiety between religious groups. J. Artif. Soc. Soc. Simul. **21**(4), 1–24 (2018)
6. Gore, R., Lemos, C., Shults, F.L., Wildman, W.J.: Forecasting changes in religiosity and existential security with an agent-based model. J. Artif. Soc. Soc. Simul. **21**, 1–31 (2018)
7. Shults, F.L. Can we predict and prevent religious radicalization?. In: Øverland G. (ed.) Processes of Violent Extremism in the 21st Century: International and Interdisciplinary Perspectives. Cambridge Scholars Press, Cambridge (2018), pp. 45-71.
8. Shults, F.L.: Practicing Safe Sects: Religious Reproduction in Scientific and Philosophical Perspective. Brill Academic, Leiden (2018)
9. Conti, M., Passarella, A., Pezzoni, F. A model for the generation of social network graphs. In: World of Wireless, Mobile and Multimedia Networks (WoWMoM), 2011 IEEE, 2011, pp. 1–6
10. Rescorla, R.A., Wagner, A.R., et al.: A theory of Pavlovian conditioning: variations in the effectiveness of reinforcement and nonreinforcement. Class. Cond. II Curr. Res. Theory. **2**, 64–99 (1972)
11. Cobb, C., Douglas, P.: A theory of production. Am. Econ. Rev. **18**(1), 139–165
12. Christmann, K. Preventing Religious Radicalisation and Violent Extremism: A Systematic Review of the Research Literature. Applied Criminologyv Centre, University of Huddersfield, Huddersfield, UK (2012)
13. Neumann, P., Kleinmann, S.: How rigorous is radicalization research? Democr. Secur. **9**(4), 360–382 (Sep. 2013)