Generation Gaps: An Agent-Based Model of Opinion Shifts among Cohorts

Ivan Puga-Gonzalez [1,2[0000-0003-2510-6760]] and F. LeRon Shults [1,2[0000-0002-0588-6977]]

[1] University of Agder, Kristiansand, Norway
[2] Center for Modeling Social Systems at NORCE, Kristiansand, Norway
ivanpuga@gmail.com

Abstract. This paper presents the findings of an agent-based model of the shift toward liberal opinions over time within contemporary European populations. Empirical findings and theoretical reflection on this sort of shift suggest that cohort effects, and especially changes in the opinions of teenagers, are a primary driver of liberalization at the population level. We outline the core features and dynamics of the model and report on several optimization experiments that clarify the conditions under which – and the mechanisms by which – opinions become more liberal as agents interact with one another within and across cohorts.

Keywords: Opinion Dynamics, Age effects, Agent-Based Modelling, Religiosity.

1 Introduction

In many contexts today, the dynamic flow of opinions seems to be shifting with cohorts rather than within individuals, i.e., opinions appear to change intergenerationally. Empirical evidence suggests this is the case for attitudes related to issues such as traditional gender roles [1], [2], LGBTQ rights [3], [4], and religious beliefs and behaviors [5], [6]. This phenomenon, where societal change occurs as a consequence of cohort replacement rather than changes during the lifetime of an individual, can be called demographic metabolism [7]. Obviously, societal changes may also be a consequence of age (A), and/or period (P), instead of cohort (C) effects. A growing number of scholars, however, are finding evidence that supports the claim that cohort effects are a dominant force in the shift of opinions and/or attitudes within societies [8], [9]. One of the best documented examples is the decline of religiosity among western European nations [10]–[13]. However, the conditions under which – and the mechanisms by which – such intergenerational changes occur remain elusive. It seems plausible that the answer has something to do with what happens during the teenage years, which recent psychological experiments suggest are a period of life during which individuals are more easily influenced by others [14], [15].

Here we use an agent-based model (ABM) to investigate how mechanisms related to age may drive intergenerational changes in opinion. The model and simulation experiment we outline and report on below are designed to explore the mechanisms by which opinions shift among cohorts in a population spanning 300 years. Although our model does not explain all the relevant factors in such shifts, it does provide an empirically informed, theoretically inspired, and relatively realistic artificial society with a causal architecture that enables scholars to explore these factors and conditions with more precision. We are explicitly attempting to respond to the concerns identified by Flache, et al. [16] regarding the relative lack of empirical validation in most opinion dynamics models. Our goal is to provide an ABM that can simulate the emergence of population level changes among cohorts that are observed in the real world. The realism of the model is strengthened by the inclusion of reproduction and mortality rates informed by UN census data. Hence, in our model agents reproduce, age, and die at rates that are like those of human populations. Further, as explained below, we optimize the model against empirical findings from research on shifts in religious opinions in the European Social Survey. We used shift in religious opinions as an example because it is a very well documented phenomenon about which we have good data in relation to which we can optimize the model parameters. Our artificial society thus mimics the intergenerational opinion changes documented in real human societies.

2 Methods

2.1 The Model

The model was written in AnyLogic v.8.7.3. Our approach involves using a basic opinion dynamics model of positive and negative influence on top of which we build mechanisms related to age effects, as explained below.

Agents. The artificial society represented in the model is inhabited by individual human agents who have an opinion value (range [0,1]), an age, and belong to a specific five-year cohort or generation (calculated according to the year of birth). On initialization, 1000 adult agents (age 0-100) are created. The initial opinions of agents are drawn from a normal distribution N (μ=0.99, σ = 0.005). The agents' age distribution follows a typical pyramid shape. Every year (52 weeks) agents age by one year, and die or give birth with a probability according to their age (agents give birth only between ages 15-49). Birth and mortality rates, and initial age distribution, come from UN census data. For simplicity, we assume asexual reproduction and on average agents give birth to ~1.02 agents, so the population size remains stable. Note, however, that mortality and reproduction are stochastic in the model, thus we expect some degree of variation in the number of offspring each agent has. Every two weeks agents that are 12 years old or older hold a dyadic social interaction with another randomly selected agent (age >=12). The social interaction may affect the opinion value of the agent in a positive, negative, or neutral way (see below).

Bias inheritance of opinion values. Newborns inherit opinion values from their parents with some bias, i.e., *parent's value * bias*, where *bias* is a random value drawn from a Weibull distribution. The Weibull distribution is truncated at [0,1] values, and its scale and shape parameters were optimized (see optimization experiments). Agents may thus inherit the same opinion value of their parent or a value somewhat lower depending on the shape and scale of the distribution. The rationale behind this decision is informed by research indicating the inheritability of religiosity [17], [18].

Social interactions. Social interactions can influence agents' opinion values in three different ways; positive, negative, or neutral. Here we are adapting previous studies of positive and negative influence [16], [19], [20].

Positive influence. The opinion value of the agent (Ego) moves in the direction of the interaction partner's opinion if the partner's opinion is within the positive confidence threshold (Fig. 1).

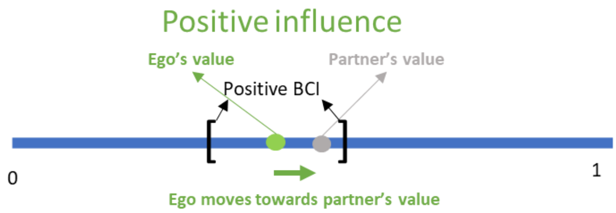

Fig. 1. Positive social interaction

The update of Ego's opinion value is then given by equation (1):

$$Ego\_Opi_{t+1} = Ego\_Opi_t + (Partner\_Opi_t - Ego\_Opi_t) * Pos\_Age\_Impact \quad (1)$$

where the age impact is a value between [0,0.5] that is modulated by the age of Ego (see age effects). Note that the interaction is unidirectional, i.e., Ego is the only one potentially changing its opinion value; the partner does not get this chance.

Negative influence. The opinion value of the agent moves in the opposite direction of the partner's opinion if the partner's opinion is outside the negative confidence interval (Fig. 2).

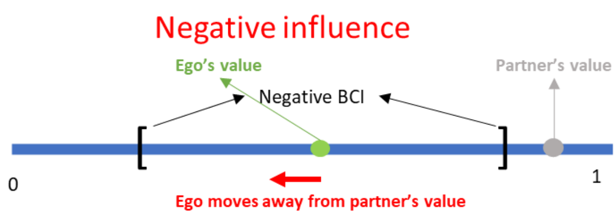

Fig. 2. Negative social interaction

The update of Ego's opinion depends on whether the absolute difference between Ego's opinion and that of its partner is larger than the negative confidence interval. This is given by equations 2 and 3.

If Ego opinion > partner opinion:

$$Ego\_Opi_{t+1} = Ego\_Opi_t + (1 - Ego\_Opi_t) * Neg\_Age\_Impact \qquad (2)$$

If Ego opinion < partner opinion

$$Ego\_Opi_{t+1} = Ego\_Opi_t + (Ego\_Opi_t) * Neg\_Age\_Impact \qquad (3)$$

where the negative age impact is a value between [0,0.5] that is modulated by the age of Ego (see age effects). Note that the more extreme the opinion of Ego the lower the change after the social interaction. As in the positive interactions, negative interactions are unidirectional; partner opinions do not change due to the interaction.

Neutral influence. The opinion value of the agent remains the same if the partner's opinion is neither within the positive influence interval nor outside the negative confidence interval (Fig 3).

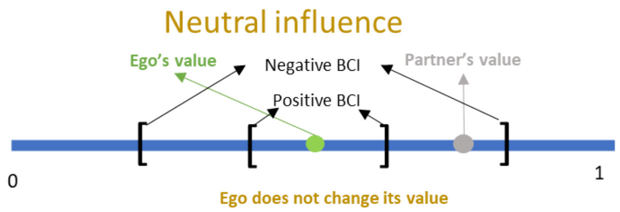

Fig. 3. Neutral social interaction

Age effects. Age effects act on the value of the positive and negative impact of a social interaction (eq. 1-3). Both the positive and negative impact of social interactions decrease with age. For positive interactions this means that as agents get older they will be less impacted by (more reluctant to adopt) other's opinion; when they are young, they are more impacted by others. For negative interactions this means that as agents get older they become more tolerant and less repulsed by opinions different than their own; when they are young they are more easily repulsed by others' opinions. The decrease of the impact value occurs in a linear or nonlinear way according to equation 4.

$$Age\_Impact = Max\_Impact * \left(1 - \frac{Age}{Max\_Age}\right)^{\gamma} \qquad (4)$$

where *Max_Impact* is the maximum possible value of the impact, *age* is the age of the agent, and *Max_Age* is the maximum age agents can achieve, i.e., 100. Hence, depending on the value of gamma (γ), the decrease of the impact value can be linear (γ=1); or nonlinear (Fig 4). Note that when age is 12, the value of impact is maximum.

2.2 Empirical data

As noted above, our goal is to link this exploratory model to empirical data. We have selected an influential study by Voas [13] that demonstrates the change among cohorts in opinions related to the shift from religious to secular societies across several countries in Europe. This is a phenomenon that has been documented and well-studied by scholars over the last few decades [21]. Voas documents the decline of religiosity and provides a model producing an s-shape trajectory of the decline of religiosity over time, from a very religious country at year 0 to a very secular one around year 200. Given that in the model the maximum opinion value is 1 and the minimum is 0 and that 200 years corresponds to ~40 five-year cohorts, we converted the trajectory provided by Voas to values according to five-year cohorts in the x-axis and used this trajectory as a target trajectory against which to optimize the parameters of the model (Fig 5).

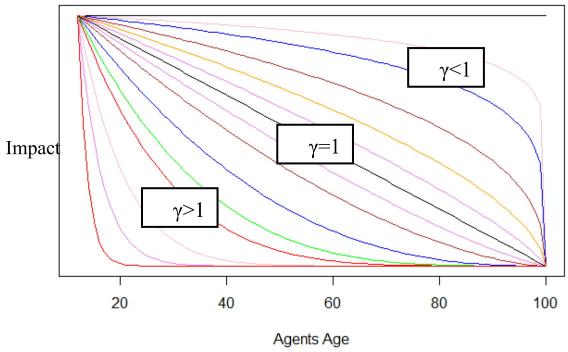

Fig. 4. Impact values according to the agent's age and values of γ.

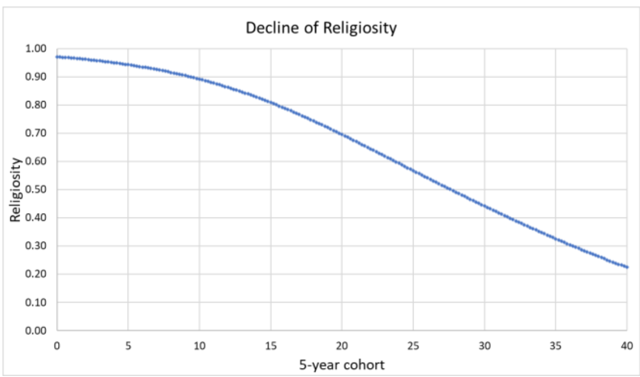

Fig. 5. Decline of religiosity.

2.3 Optimization, Simulations and Parameters Variation

We ran optimization experiments to find combinations of parameter values (Table 1) that could lead to a decrease in opinions (religiosity) among cohorts in a similar fashion to the decline in religiosity found by Voas in the European Social Survey [13]. We used the optimization engine of AnyLogic, which allows the user to obtain a combination of values that increases or decreases a specific output value obtained from an input function. In our case, the input function calculated the residual sum of squares (RSS) between the model cohort values and the cohort values of the decline of religiosity (Fig 6). The optimization experiments found the combination of parameters that minimize the output value (RSS). We ran a total of five optimization experiments from which we obtained five different combinations of optimized values (Table 2).

Simulations were run for 300 years. We did this because cohort number 40 would have only been born at year 200 and we wanted to allow for agents in that last cohort to alter opinions during their whole life span. This required us to let the model run for 300 years. Each year consists of 52 weeks and agents have a random social interaction every two weeks. During the simulation we collected the average opinion of each five-year cohort (agents were grouped from cohort 0 to 40 according to their year of birth) and used this value to calculate the RSS at the end of the simulation. The parameters that were optimized are shown in Table 1. We constrained the potential range of values that each parameter could have.

Table 1. Parameters optimized.

Parameter	Description	Potential values
Bias inheritance (Weibull distribution)		
Shape	The shape parameter of the distribution	[0.1-2.0]
Scale	The scale parameter of the distribution	[0.01-1.0]
Positive Interactions		
Max Opinion Difference	Determines size of the interval of attraction (fig. 1)	[0.005,0.1]
Max Impact value	Maximum impact of interactions (eq. 1)	[0.05,0.5]
γ Age Impact	Age Impact modulator when older partner (eq. 4)	[0,100]
Negative Interactions		
Min Opinion Difference	Determines size of the interval for repulsion (fig. 2)	[0.05,0.8]
Max Impact Value	Maximum impact of interactions (eq. 2-3)	[0.05,0.5]
γ Age Impact	Age impact modulator when older partner (eq. 4)	[0,100]

3 Results

3.1 Decrease in opinion among cohorts

Figure 6 shows the decrease in the average value of opinions among cohorts in the model (red) and demonstrated in empirical data (black). The model decrease fit the empirical data moderately (RSS in Table 2 below). Nevertheless, average opinion (conservative religiosity) in the model does decrease with time and appears to differ among cohorts. More interestingly, later cohorts also appear to have a lower opinion value (become more liberal) than earlier cohorts (Fig 6).

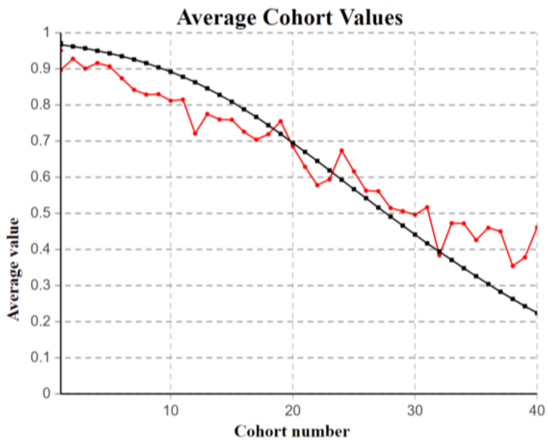

Fig. 6. Average cohort value in the model (red) in comparison with empirical decay (black). The x-axis represents cohort number (the farther to the left the older the cohort). The y-axis represents the average opinion value per cohort.

3.2 Bias inheritance of opinions

Results of the five optimization experiments are shown in Table 2. The optimized values of the Weibull distribution suggest that the inheritance of opinions follows a skewed distribution (Fig 7). Most agents (~80%) inherit an opinion value that is 80-100% equal to that of their parents; only a minority (~6%) inherit opinion values that are half or less than half the value of their parents (Fig 7).

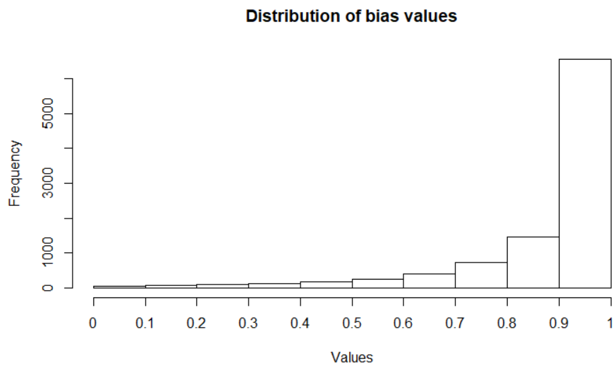

Fig. 7. Distribution of bias values. Agents inherit an opinion value equal to their *parent's value*bias*.

3.3 Confidence Intervals (CI): positive and negative

The experiments show that in all cases the maximum opinion difference for positive influence was much lower than the minimum opinion difference for negative influence (Table 2). In other words, agents were positively influenced only by others that had a very similar opinion and negatively influenced only by others that had a very different opinion than theirs; and the zone of neutrality, where agents are neither attracted nor repelled by other's opinion, was large (Fig 3). Hence, to be repulsed by others' opinions, interacting agents must have extreme opinions.

Table 2. Optimized parameters values.
Values from five optimization experiments. RSS = residual sum of squares

Parameter	Median value	Min-Max	RSS
Bias inheritance			Median: 0.263 Max-Min: [0.221-0.312]
Shape parameter	1.259	[0.100-1.974]	
Scale parameter	0.127	[0.010-0.795]	
Positive influence			
Max Opinion Difference	0.036	[0.026-0.039]	
Max Impact value	0.402	[0.396-0.478]	
γ Age Impact	44.902	[39.414-57.970]	
Negative influence			
Min Opinion Difference	0.708	[0.666-0.722]	
Max Impact Value	0.331	[0.321-0.344]	
γ Age Impact	2.269	[0.000-3.424]	

3.4 Effect of age on the positive and negative impact of interactions

In all five simulation experiments, the impact of positive interactions appears higher than that of negative interactions (Table 2). However, the impact of positive interactions decreases much faster with age than the impact of negative interactions. In fact, positive interactions stop having a significant influence in agents' opinions (impact value < 0.001) when they reach an age of [20-25] years old. In contrast, the impact of negative interactions appears to last for a much longer time, with the value of impact remaining higher than 0.001 up to the age of [85-100] years old. Hence, although agents in the model stopped being attracted by others' opinions at an early age, they continued to be repulsed by others' opinion during most of their lifetime.

4 Discussion

Results of our simulations show how age effects during the teenage years may help explain the phenomenon observed among human societies where change in opinions appears to happen among cohorts (or generations) rather than during individuals' lifetimes. The simulation experiments showed two different forces acting at the agent level. First, as already suggested by empirical studies and social experiments [14], [15], agents are positively influenced (attracted) by others' opinions most strongly during their teenage years; once they reach adulthood, they are less influenced by others' opinions. Further, agents are primarily attracted to opinions that are like the ones they currently hold (median absolute difference <= 0.036, table 2). Our results also suggest that agents remain sensitive, in a negative way, to others' opinions during most of their lifetime. However, repulsion primarily occurs when interacting agents hold extreme opinions (median absolute difference >= 0.7, table 2). It seems, therefore, that once agents reach adulthood (20-25 years old), their opinions do not change unless they encounter agents with extreme opposite opinions.

In the model, the inheritance of biased opinion values transmitted from parents to offspring is a necessary process for the emergence of the intergenerational change in opinions. When in our simulations bias inheritance values are drawn from a normal distribution (μ=1, σ=[0.164-0.2]) rather than from a Weibull distribution, the fit between the empirical data and the model's results is worst (median RSS value = 0.635). This suggests that the simulation requires that least a small percentage of agents (~6%) inherit an opinion value that is half (or lower) than that of their parent. This inheritance process produces a population of agents whose opinions are at the extreme of the continuum. The presence of agents with extreme opinions seems necessary to start the process of opinion change among cohorts. Note, however, that this inheritance process alone (i.e., inheritance of biased opinion values without age effects and social interactions) is not enough to produce intergenerational changes. Simulation runs that only include this inheritance process show a worse fit than simulations with this inheritance process plus age effects and social interactions (median RSS with no age effects and social interactions = 0.359). Furthermore, running the model without social interactions is somewhat unrealistic since it is well known that people's opinions are readily influenced by others. It is also important to note that the biased inheritance of opinion values can be seen as an abstraction of additional social forces that are not explicitly modeled (e.g., the influence of role models [22]).

Social interactions occur randomly in the model. Every agent has the same possibility of meeting any other agent. Networks are thus not represented in the model. However, we do not think that the lack of a network structure has a major effect on the model's results. From literature, we know that social networks are usually comprised of others with similar opinions [23]. This is the type of social network we would expect to emerge in the model if we were to quantify and link agents that have positive interactions among each other. This is because the confidence interval for positive interactions is small and thus the networks of agents that positively influence each other's opinions must be comprised of agents with homophilous opinions. Further, if we were to constrain agents into opinion homophily networks, we would be missing interactions among agents with extreme opinions and thus preclude the effect of negative social interactions on the agents' opinions.

The model presented here was designed with the goal of exploring potential mechanisms underlying intergenerational changes in opinions in populations spanning over 300 years. In particular, motivated by empirical findings in social learning [13] [14], we were interested in testing whether mechanisms related to age effects could give rise to the intergenerational decay in religiosity, a phenomenon observed across many

European countries. Our findings suggest that age effects, particularly during teenage, may be behind the observed shifts in religious level among cohorts. Indeed, several studies on secularization suggest that religious socialization during the formative years is a pivotal time determining whether religious beliefs are acquired and maintained during adulthood [24]–[26].

Further, our results also raise other interesting questions. For instance, can these teenage-related mechanisms be generalized to other contexts or beliefs? In the opinion dynamics literature, researchers usually classify beliefs in two categories: subjective and objective beliefs. Subjective beliefs, such as religion or politics, usually elicit strong convictions and/or emotions. Objective beliefs on the other hand are governed neither by convictions nor emotions. If the (teen)age effects suggested by our results are a general mechanism for the acquisition, change, and maintenance of beliefs, we should expect similar patterns of intergenerational change in beliefs whether they are subjective or objective. However, the intergenerational change in beliefs observed in human societies usually occurs in moral and political subjects, i.e., subjective beliefs. Hence, the mechanisms behind the acquisition, change, and maintenance of objective beliefs may be different from the ones here suggested. When it comes to subjective beliefs (moral or political values), these may be adopted at an early age and become difficult to change in adulthood; when it comes to objective beliefs, other mechanisms underlying learning and change of opinions may be at play.

In the model, the religious opinion value is a continuous variable ranging between 0 and 1, meaning that there are preestablished maxima and minima. Without these limits, agents with extremely low religiosity may become more and more radical as long as they keep meeting others with extremely high religiosity; i.e., parts of the population would polarize. For polarization to happen, however, some agents need to escape the pull of the population towards increasingly lower religiosity. Once agents with a low enough religiosity start to emerge, there would be a self-sustaining mutual repulsion of low and high religiosity agents (given that they interact). In such cases, enclaves of high religiosity agents may then remain in the population.

In sum, our results do not show a perfect fit between the model and empirical data. The fit could be considered moderate. This suggests that other factors are likely playing a role in the way individuals acquire and change their opinions. Future work might involve the integration of aspects of the current model with aspects of other ABMs of secularization processes that have more complex cognitive architectures [27]–[30]. Nevertheless, our model was designed to explicitly test these age-related mechanisms, leaving out several other potential processes such as social networks (friends, family, acquittances, neighborhood, job, etc.), spatially explicit interactions, influence of role models or prestigious individuals, different types of social learning strategies, and individuals' personality. Exploring all these mechanisms at the same time would have made the model more complex and thus more difficult to understand. Nevertheless, our results add plausibility to the claim that (teen)age effects are an important mechanism in intergenerational changes in beliefs. We hope our work will motivate further exploration of this important societal phenomenon.

References

[1] C. Brooks and C. Bolzendahl, "The transformation of US gender role attitudes: Cohort replacement, social-structural change, and ideological learning," *Social Science Research*, vol. 33, no. 1, pp. 106–133, 2004.

[2] C. I. Bolzendahl and D. J. Myers, "Feminist attitudes and support for gender equality: Opinion change in women and men, 1974–1998," *Social forces*, vol. 83, no. 2, pp. 759–789, 2004.

[3] R. Andersen and T. Fetner, "Cohort differences in tolerance of homosexuality: Attitudinal change in Canada and the United States, 1981–2000," *Public Opinion Quarterly*, vol. 72, no. 2, pp. 311–330, 2008.

[4] G. B. Lewis and C. W. Gossett, "Changing public opinion on same-sex marriage: The case of California," *Politics & Policy*, vol. 36, no. 1, pp. 4–30, 2008.

[5] E. M. Hamberg, "Stability and change in religious beliefs, practice, and attitudes: A Swedish panel study," *Journal for the Scientific Study of Religion*, pp. 63–80, 1991.

[6] A. Crockett and D. Voas, "Generations of decline: Religious change in 20th-century Britain," *Journal for the scientific study of religion*, vol. 45, no. 4, pp. 567–584, 2006.

[7] W. Lutz, "Demographic metabolism: A predictive theory of socioeconomic change," *Population and Development Review*, vol. 38, pp. 283–301, 2013.

[8] The Economist, "Societies change their minds faster than people do," *The Economist*, Oct. 31, 2019. Accessed: Aug. 21, 2021. [Online]. Available: https://www.economist.com/graphic-detail/2019/10/31/societies-change-their-minds-faster-than-people-do

[9] E. Striessnig and W. Lutz, "Demographic strengthening of European identity," *Population and Development Review*, vol. 42, no. 2, p. 305, 2016.

[10] J. M. Twenge *et al.*, "Generational and time period differences in American adolescents' religious orientation, 1966-2014," *PLOS ONE*, vol. 10, no. 5, pp. 1–17, May 2015.

[11] C. Funk and G. Smith, "Nones" on the rise: One-in-five adults have no religious affiliation," *Washington, DC, Pew Research Center*, 2012.

[12] D. Voas and S. Bruce, "Secularization in Europe: An Analysis of Inter-Generational Religious Change," in *Value Contrasts and Consensus in Present-Day Europe*, W. Arts and L. Halman, Eds. Leiden: Brill, 2014.

[13] D. Voas, "The rise and fall of fuzzy fidelity in Europe," *European Sociological Review*, vol. 25, no. 2, pp. 155–168, 2009, doi: 10.1093/esr/jcn044.

[14] L. Molleman, S. Ciranka, and W. van den Bos, "Social influence in adolescence as a double-edged sword," PsyArXiv, 15 Feb. 2021. Web.

[15] L. Molleman, P. Kanngiesser, and W. van den Bos, "Social information use in adolescents: The impact of adults, peers and household composition," *PloS one*, vol. 14, no. 11, p. e0225498, 2019.

[16] A. Flache *et al.*, "Models of Social Influence: Towards the Next Frontiers," *Jasss-The journal of artificial societies and social simulation*, vol. 20, no. 4, p. urn:issn:1460-7425, Oct. 2017, doi: 10.18564/jasss.3521.

[17] Y. Ganzach and C. Gotlibovski, "Intelligence and religiosity: Within families and over time," *Intelligence*, vol. 41, no. 5, pp. 546–552, 2013, doi: 10.1016/j.intell.2013.07.003.

[18] L. Ellis, A. W. Hoskin, E. Dutton, and H. Nyborg, “The future of secularism: a biologically informed theory supplemented with cross-cultural evidence,” *Evolutionary Psychological Science*, pp. 1–19, 2017.

[19] G. Deffuant, D. Neau, F. Amblard, and G. Weisbuch, “Mixing beliefs among interacting agents,” *Advances in Complex Systems*, no. 3, p. 11, 2001.

[20] A. Flache and M. W. Macy, “Small worlds and cultural polarization,” *The Journal of Mathematical Sociology*, vol. 35, no. 1–3, pp. 146–176, 2011.

[21] J. Stolz, “Secularization theories in the twenty-first century: Ideas, evidence, and problems. Presidential address,” *Social compass*, vol. 67, no. 2, pp. 282–308, 2020.

[22] M. Moussaïd, J. E. Kämmer, P. P. Analytis, and H. Neth, “Social influence and the collective dynamics of opinion formation,” *PloS one*, vol. 8, no. 11, p. e78433, 2013.

[23] M. McPherson, L. Smith-Lovin, and J. M. Cook, “Birds of a feather: Homophily in social networks,” *Annual review of sociology*, vol. 27, no. 1, pp. 415–444, 2001.

[24] J. P. Gregory and T. S. Greenway, “Is there a window of opportunity for religiosity? Children and adolescents preferentially recall religious-type cultural representations, but older adults do not,” *Religion, Brain and Behavior*, pp. 1–19, 2016, doi: 10.1080/2153599X.2016.1196234.

[25] T. F. Martin, J. M. White, and D. Perlman, “Religious Socialization: A Test of the Channeling Hypothesis of Parental Influence on Adolescent Faith Maturity,” *Journal of Adolescent Research*, vol. 18, no. 2, pp. 169–187, 2003, doi: 10.1177/0743558402250349.

[26] C. Mikoski and D. V. Olson, “Does Religious Group Population Share Affect the Religiosity of the Next Generation?,” *Journal for the Scientific Study of Religion*, 2021.

[27] R. Gore, C. Lemos, F. L. Shults, and W. J. Wildman, “Forecasting changes in religiosity and existential security with an agent-based model,” *Journal of Artificial Societies and Social Simulation*, vol. 21, pp. 1–31, 2018.

[28] F. L. Shults, R. Gore, C. Lemos, and W. J. Wildman, “Why do the godless prosper? Modeling the cognitive and coalitional mechanisms that promote atheism,” *Psychology of Religion and Spirituality*, vol. 10, no. 3, pp. 218–228, 2018.

[29] W. J. Wildman, F. L. Shults, S. Y. Diallo, R. Gore, and J. E. Lane, “Post-Supernaturalist Cultures: There and Back Again,” *Secularism & Nonreligion*, 2020.

[30] R. Cragun, K. McCaffree, I. Puga-Gonzalez, W. Wildman, and F. L. Shults, “Religious Exiting and Social Networks: Computer Simulations of Religious/Secular Pluralism,” *Secularism and Nonreligion*, vol. 10, no. 1, 2021.