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ARTICLE

Dogmatism and Domination: A Simulation Study

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Abstract

Some epistemic agents will not change their position on a claim. These are dogmatists, common creatures in our epistemic communities. This paper discusses the population-level epistemic effects of increasing numbers of dogmatists. All agents in the model are assigned a degree of belief (using a Likert-type scale) and adopt the beliefs of others in interactions. Subsets of agents are dogmatists. Analysis of model results suggests that even a modest increase in a group's dogmatists can have substantial effects on belief spread. I conclude by arguing that the model (a) helps identify two kinds of dogmatists and (b) suggests another way epistemic bubbles can form.

Keywords: Agent-based model; dogmatism; conformity; echo chambers; formal epistemology; computational modeling

1. Introduction

William Whyte's *The Social Life of Small Urban Spaces* documents how people use space in city plazas. Most often, people will eat their lunches, enjoy the sunshine, play board games, or just chat. What's novel about this documentary is that Whyte (1980) looks at congregation in city spaces over the course of days and weeks. He takes a step back and focuses on the larger picture. In doing so, he's able to find patterns in space use that are not obvious from the view on the ground and perhaps seem trivially true on reflection. For instance, the first major insight he offers is: people sit where there's seating. He adds to this it can't just be any old seat. Seats need to be low enough for people to use and wide enough to accommodate people sitting back-to-back. But the key was in getting back far enough to see how people actually used public spaces.

In developing agent-based models of social epistemic phenomena, we're doing something similar: stepping back to focus on larger patterns. One curious phenomenon concerns dramatic shifts of attitudes in a population. Consider:

1. Between 1959 and 2013, acceptance of interracial marriage among Americans moved from 4% to 87%.[1]

[1]Frank Newport, "In U.S., 87% Approve of Black-White Marriage, vs. 4% in 1958," news.gallup.com, Gallup Inc., 25 July 2013, news.gallup.com/poll/163697/approve-marriage-blacks-whites.aspx.

2. Approval of gay marriage grew from 27% in 1996 to 71% in 2022.[2]
3. Support in the US for legalizing marijuana in 1969 was 12%; in 2021 it was 68%.[3]
4. In 1937, only 33% of Americans would consider voting for a woman as president; in 2019, it was 94%.[4]

Why do some attitudes come to dominate in a population? One explanation might be a successful propaganda campaign. O'Connor and Weatherall (2019; see also Weatherall *et al.* 2020) describe one such model. In it, propagandists influence policymakers. The influence propagandists wield is in manipulating information coming from scientists. Policymakers never get to talk to scientists directly, only to propagandists. The result is that policymakers end up converging on the worse belief.[5] Extending this model to larger populations, policymakers converging on a belief can put that policy into action. This can generate massive changes in attitudes in a population. Call these 'external' models of opinion dynamics. What's explanatorily important in these models is the epistemic network, not what's happening inside the agent. In this case, the opinion dynamics are driven by propagandists controlling the flow of information.

Another 'how-possibly' story depends on an 'internal' model of opinion dynamics, where a central explanatory factor is agent internal. On this story, dogmatists sway those around them with their unyielding commitment. The strategy for ideological factions is to fill the ranks with true believers who'd rather be cast from society than recant the faith. There are dramatic examples throughout history. Christian martyrs, for instance, and suicide bombers and Kamikaze pilots. Mundane cases abound too, like sports fans convinced beyond doubt that their underdogs will have their day.[6] Both kinds of cases share an unwillingness to move from one's belief.

No matter how much evidence or argument, these dogmatists will not change their opinions. Sometimes, dogmatism can be admirable: a dogmatist might be in possession of a knockdown argument for P. Other times, it is loathsome: a dogmatist might believe P because it's politically expedient to do so.[7] People ought to be dogmatic about some things: no one should think the Holocaust was a Good Thing. But for other cases, people shouldn't be dogmatic: scientists ought to be willing to revise their positions. Being dogmatic is neither good nor bad per se for an individual cognizer. In fact, dogmatic tendencies are likely a reflection of what people care about, those beliefs and projects around which their lives are oriented (cf. Frankfurt 1988). But what about the role of a dogmatist within an epistemic community: what benefits accrue as more of an ideology's followers are dogmatic? What are the population-level effects of varied dogmatic subpopulation sizes?

In this paper, I present and analyze model simulations in which one subpopulation has more dogmatists than another. When there are many agents open to changing their

[2]Justin McCarthy, "Same-Sex Marriage Support Inches Up to New High of 71%," news.gallup.com, Gallup Inc., 1 June 2022, news.gallup.com/poll/393197/same-sex-marriage-support-inches-new-high.aspx.

[3]Gallup Organization, "Support for Legal Marijuana Holds at Record High of 68%, news.gallup.com, Gallup Inc., 4 November 2021, news.gallup.com/poll/356939/support-legal-marijuana-holds-record-high.aspx.

[4]Lydia Saad, "Gallup Vault: A History of Reluctance to See Women Working," news.gallup.com, Gallup Inc., 26 March 2021, news.gallup.com/vault/341822/gallup-vault-history-reluctance-women-working.aspx.

[5]This model bears a resemblance to scale-free models (cf. Barabási and Albert 1999) insofar as one node has an outsized influence compared with other nodes.

[6]Milwaukee Brewers fans, I'm looking in your direction. 52 years is a long time to hold out hope for another World Series win.

[7]Cf. Battaly (2020).

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minds and there are dogmatists among two competing subpopulations, who ends up with more followers? Simulations suggest a non-linear relationship between the ratio of dogmatists and non-dogmatic followers an ideology has. In short: more dogmatists means, on average, more believers. This is as obvious as Whyte's insight that people sit where there is seating. But like Whyte's insight, details make the difference. Here are two initially surprising results:

1. Having more dogmatists (relative to another group) pays off handsomely at first, but the benefits tend to level off at a certain point.
2. One group doesn't even need that many more dogmatists relative to another group to secure a majority; in a 5-way contest, one group having just 0.1 more dogmatists than another group is enough to get the majority 0.65 of the time.

But this is getting ahead of ourselves. First up: a dive into the model's concepts and parameters.

2. Probability of Belief Change

Dogmatists are characterized using the concept of probability of belief change, 'PBC' from here on (Lassiter 2021). An agent's PBC is the likelihood that they will change their mind with respect to some belief when interacting with others. A PBC of 1.0 means that the agent will adopt the belief of whomever the agent next talks to. A PBC of 0.0 means the agent's belief will not change. These are dogmatists.

We might in principle discover an agent's PBC in a few ways. Here is one: by comparing the agent to doxastic doppelgängers. The idea is similar to physicians' predictions of health outcomes. The likelihood of my having a heart attack is given by comparing my health with a data set of others with similar health states. Given the state of my health, some fraction of people experience a heart attack. My health profile is compared with many others and the likelihood is thereby figured out. These many others are my health doppelgängers. This is called a "doppelgänger search" (Stephens-Davidowitz 2017). My doxastic doppelgängers share my doxastic profile. The number of doxastic doppelgängers who changed their mind on an issue helps me figure out the likelihood of me changing my mind.

An agent's PBC does not keep track of some interesting epistemic properties: reasons, warrant, virtues, or justification. Given its limited scope, PBC is nonetheless an interesting and useful concept. Interpreting dogmatists as agents with a PBC of 0 is the general case of a class of formal models satisfying the following conditions:

1. Agents can communicate with one another.
2. There exists a proper subset S of agents that do not update their doxastic state in response to testimony.
3. Agents in the complement of S at least sometimes update their state in response to testimony.

Examples include Bayesian models in which agents do not update their beliefs, or weighted averaging models in which one agent assigns weights of 0 to all other agents. And for Bayesian or weighted averaging (or other) models in which opinion can change in light of new evidence, a PBC greater than 0 indicates that the belief can change.

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Bayesian and weighted averaging models of credence change are the specific cases for which PBC is the generalization.[8]

3. Model overview

This model imagines members of a population talking to one another. Each agent picks one other agent to talk to. Call the choosing agent the 'Speaker' and the chosen agent the 'Hearer.' The Speaker attempts to "convince" the Hearer to adopt its attitude. Some agents are dogmatists, and so will not change their attitudes. With dogmatists anchoring attitudes, the target question is: what benefits, if any, accrue with greater ratios of dogmatists?

This model finds a family resemblance in Weatherall *et al.* (2020), (WOB from here on). The WOB model examines the influence of propagandists on policymakers using Bala and Goyal's (1998) model of learning from neighbors. When policymakers listen directly to scientists, the former nearly always come to hold the true belief. When propagandists interfere, policymakers almost always converge on the belief supported by the propagandists. Dogmatists function like WOB's propagandists, failing to update their beliefs in light of new information. But there are two differences. The first is in the degree of specificity of the opinion updating mechanisms. Propagandists are Bayesians for WOB. The present model abstracts away from the underlying mechanisms. This simplification is a major one but doesn't affect this model; the important point is not *how* agents change their commitments but *whether* they do so. The second important difference is that WOB's networks are static. Network structures include the cycle, in which every agent is connected to two other agents to create a ring-like structure, and the complete network, in which everyone is connected to everyone else (see Figure 1). In this paper's model, Speakers have neighbors from which the Hearer is chosen, and the Hearer changes at every time step.

While the network explored in this paper's model isn't static, it's also not a well-mixed model in which every agent has an equal chance of interacting with any agent. It is more reflective of our actual situation as agents in epistemic communities. There are some people we are very likely to talk with, others with whom we are unlikely to interact, and many people we will never encounter. Those closest to us – spatially in the model but not necessarily in reality – are the ones with whom we speak the most.

There are three kinds of properties in the model: intra-agent, inter-agent, and population properties.

3.1. Intra-agent properties

Every agent, represented as a patch in a 41×41 grid, has the following properties: (a) PBC, (b) attitude, (c) memory, and (d) PBC decay function. Here's what they are:

1. PBC: described above, every agent has a PBC between 0.0 and 0.05, representing their likelihood for changing their mind about some belief. Agents with a PBC of 0.0 are dogmatists. Agents with a PBC greater than 0.0 are, at least in principle, open to changing their attitudes.
2. Attitude: a value ranging from 1 to 5, like a Likert scale. And like a Likert scale, values closer together represent similar attitudes towards some issue: the

[8]See also Deffuant *et al.* (2002).

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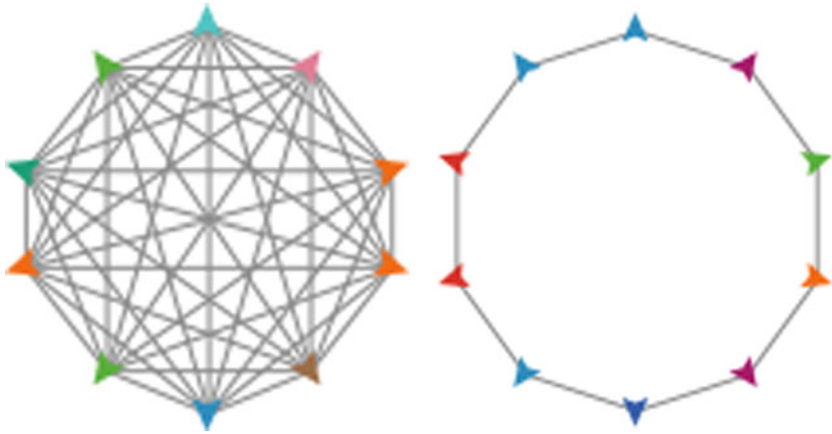

Figure 1. Two types of network structures used to analyze the influence of propagandists in the WOB model.

difference between agents with values of 1 and 2 respectively is the same as the difference between agents with values of 4 and 5. The attitudinal distance between 1 and 4 is greater than the difference between 2 and 4. Each attitude from 1 to 5 is assigned to 0.2 of the total population.

3. Memory: every agent has a memory, which is a list ranging between 2 and 10 items long. Memory tracks each agent's previous attitudes.
4. PBC decay function: A patch's PBC decays in one of four ways. First is linear decay; the agent's PBC decreases by the same amount at every time step. Second is exponential decay; PBC drops quickly at first but then gradually slows down. Third is logarithmic decay; PBC drops slowly at first but then very quickly. Fourth is no decay; PBC remains the same throughout the entire run.[9] Decay is triggered once the agent's memory is entirely populated with the same value. Why this condition? The intuition is that agents become less and less likely to change their minds if they can only recall one attitude. One function is applied to all agents in a given run and only varied between runs. Each function was constructed so that, once the decay process is triggered and continues uninterrupted, the agent's PBC reaches a value of 0.0 after 20 time steps. Decay functions are described in the Appendix.

3.2. Inter-agent properties

There are important relationships holding between patches as well: Hearer, spatial proximity, and attitudinal proximity.

1. Hearer: Each patch, when it is selected to be a Speaker, chooses a partner with which to potentially change its opinions.
2. Spatial proximity: Each patch has eight neighboring patches with which to talk. Additionally, each patch can talk to its neighbor's neighbor. The further away the patch, the less likely that patch is to be chosen as a conversational partner.

[9]This is the same as a static PBC and functions as a baseline for comparison.

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3. Attitudinal proximity: The further away two patches' attitudes are, the less likely they are to influence one another.

3.3. Population properties

Finally, the population-level parameters: distribution of attitudes and ratio of excess dogmatists.

1. Distribution of attitudes: Attitudes were uniformly distributed across the population. Each agent had a 0.2 chance of being assigned a particular attitude, and each attitude was held by (on average) 0.2 of the population.
2. Ratio of excess dogmatists: The 5-group always had as many or more dogmatists than the 1-group. This difference is expressed in terms of a ratio of 5-dogmatists to 1-dogmatists. 5-dogmatists had anywhere from 1.05–10 times as many dogmatists as the 1-group.

This model captures several properties that, intuitively, contribute to holding an opinion: memory, spatial and attitudinal proximity, and likelihood of changing one's mind. The prime virtue of this approach is that agents aren't committed to one way of processing information. Maybe agents are Bayesian or take weighted averages. Maybe they change their decision-making strategies midstream. Hell, maybe they make their decisions by flipping coins. It doesn't matter, and that's the upshot of this abstracting move: we're able to focus on dogmatists qua dogmatists. How a dogmatist reasons is of less interest than the effects of their dogmatism on others.

The outcome this simulation looked at was how much of the population came to be members of the 5-group given changes to the ratio of excess dogmatists. As the 5-group gained more dogmatists, how much of the population joined them?

4. Running the Simulation

Here are the parameters and their values:

	Value	
Parameter	Minimum	Maximum
Memory	2	10
Initial dogmatists	0.01	0.20
Excess dogmatists	1.05	10
PBC decay	Linear, logarithmic, exponential, none	

Why these parameters? The bounds for memory come from two studies on memory. The first is the famous 7 ± 2 chunks as the upper bound on working memory (Miller 1956), rounding up to 10 from Miller's upper bound of 9. The second is a recent updating, suggesting that 3 ± 1 is a more accurate guess on the bounds of working memory (Cowan 2010). Since Miller's upper bound was increased by one, aesthetic demands of symmetry demand decreasing the lower bound by one.

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The parameters for initial dogmatists – the number of dogmatists the 1-group and 5-group begin with – are constrained by the distribution of attitudes. There are five groups evenly divided among the population, and so an upper value of 0.2 on initial dogmatists is equivalent to beginning with every member of the 1-group or 5-group as a dogmatist. The upper bound for excess dogmatists was chosen because the model was not substantially sensitive to changes in excess dogmatists greater than a factor of 10. So for data visualization purposes, the value of excess dogmatists was kept to a maximum of 10.

Each combination of parameters was run 100 times for a data set of 1.12 million simulations.[10]

Each run went like this. Attitudes were uniformly randomly distributed among the patches, and dogmatists were uniformly randomly distributed among 1-group patches and 5-group patches. Each Speaker picks a Hearer. With a likelihood of 0.94, the patch addresses one of its immediate neighbors. With a likelihood of 0.04, a patch would address one of its neighbors' neighbors. With a likelihood of 0.02, it wouldn't talk to anyone. When a Speaker didn't talk to anyone, it updated its attitude with an item from its memory. This captures what we occasionally find in the world: someone changing their own beliefs not because they're being convinced by another but because they reflect on what they've heard.

Once a Speaker chooses a Hearer, the Hearer randomly chooses a real number n between 0 and 1 from a uniform distribution. If $n < PBC_H^S$, where PBC_H^S is the PBC of the Hearer H relative to the Speaker S, then the Hearer adopts the attitude of Speaker.

I mentioned previously that the closer two agents' attitudes, the easier it would be for one to adopt the attitude of the other. The function for modifying the Hearer's PBC is:

$$PBC_H^S = \begin{cases} \dfrac{PBC_H}{|A_S - A_H|}, & \text{if } A_S - A_H \neq 0 \\ PBC_H, & \text{otherwise} \end{cases}$$

A_X is the attitude for X. The greater the distance between attitudes, the lower the PBC value.[11]

Patches traded attitudes like this for 100 time steps, after which the model stopped. At every time step, each patch would add its currently held attitude to its memory. When its memory was filled with the same value (no matter the memory size), it triggered the PBC decay function. After 20 time steps, the patch's PBC would decrease from 0.05 to 0.0. In this model, once a dogmatist, always a dogmatist.

[10]Some readers will note a potential problem. The lower the value of excess dogmatists, the greater the number of observations, given the other constraints of the model. A ratio of 2.0 is satisfied in the model when the 1-group has 0.05 dogmatists and the 5-group has 0.10 dogmatists; when the 1-group has 0.06 dogmatists and the 5-group 0.12 dogmatists, and so on. Bootstrapping was used to avoid problems in analysis because of unequal distribution of data. The set on which analyses were done drew 10,000 observations randomly (with replacements) from each value for excess-dogmatists, for a working data set of 1.18 million observations.

[11]Of course, if the distance between the Speaker's and Hearer's attitudes is 0, it doesn't much matter if the Audience adopts the attitude of the Speaker since they have the same attitude. This case is included for completeness and also to simplify the model code.

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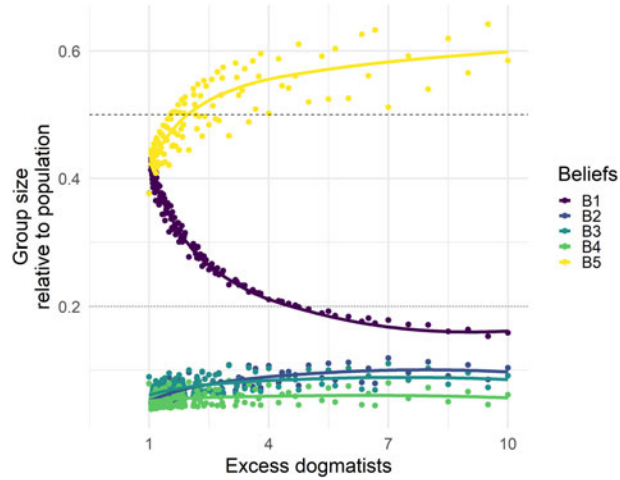

Figure 2. Average group sizes by belief and excess dogmatists.

5. Results

Overall, as the ratio of 5-group dogmatists to 1-group dogmatists increases, the 5-group population likewise increases. That's obvious. What's less obvious are the tipping points. Figure 2 shows each group's average size as a ratio relative to the entire population.

The 2-, 3-, and 4-groups each end up with less than 0.1 of the population. The 1-group and 5-group, when they have equal ratios of dogmatists, each end up with 0.38 of the total population. Putting a thumb on the scales, even lightly, in favor of the 5-dogmatists immediately translates into losses for the 1-group. Increasing the ratio of dogmatists has the greatest returns on group membership when the 5-group has between 1.05 and 2.5 excess dogmatists. After that, the 5-group continues to dominate but the returns aren't as great. Notice, however, the first tipping point: two 5-dogmatists for every 1-dogmatist.[12] Here, the 5-group doesn't just get a plurality of members. It gets the majority. And the majority only increases as the ratio of 5-dogmatists to 1-dogmatists increases. Now the second tipping point is at 4.75 excess dogmatists. At this point, the 1-group ends up with *fewer* members than when it started out. It's not enough, then, for one group to have dogmatists among its ranks if it is to flourish. It has to have enough dogmatists relative to another group.

One condition in which the gains for the 5-group are slower is when PBC decays exponentially and when memory-size is low. Figure 3 shows the differences.

If it turns out that PBC decays in this way and memory is relatively small, then 5-group gains aren't as dramatic, though they are still there.

In some runs, the 5-group ended up with fewer followers overall, despite starting with more dogmatists. But on average, having more dogmatists makes it more likely that a group will end up having more followers. Define "contest" as attempts by the 1-group and 5-group to gather more members. The winner is whichever group has a greater population by the end of the run. Take a look at Figure 4. This shows us that the number of contests won is highly sensitive to the ratio of excess dogmatists for

[12]More precisely, it's 2.1 5-dogmatists for every 1-dogmatist.

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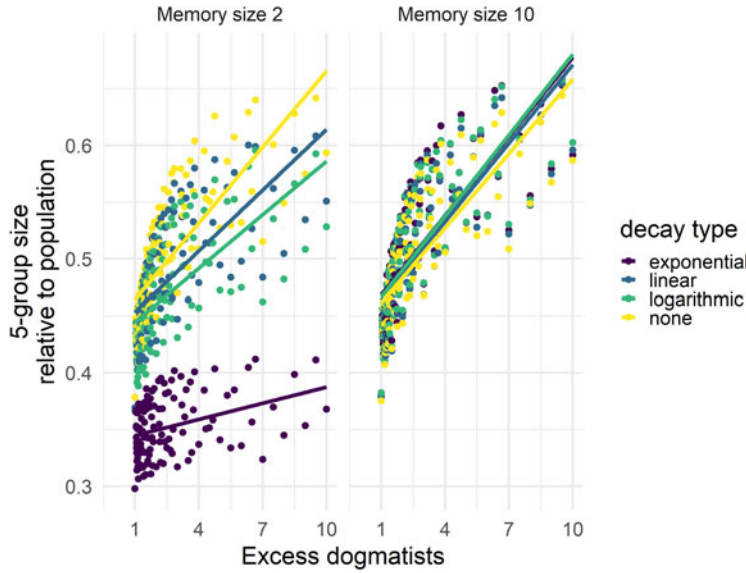

Figure 3. Interaction of memory size and PBC decay type.

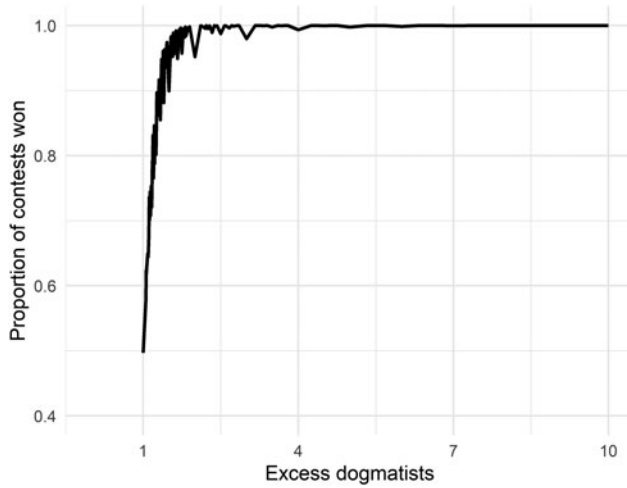

Figure 4. 5-group wins.

values less than 2.0. At 1.8 times as many dogmatists, the 5-group ended up with more followers more than 98% of the time. With a factor of 3.25 or higher, the 5-group wins just about every contest against the 1-group.[13]

[13]For some values, the 5-group loses once every 1000 rounds.

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6. Discussion

The model gives us three central insights. First, one way to increase the number of followers for some position is to have more dogmatists than the other guys. More True Believers means more followers.

Second, this strategy pays off with even modest increases in the ratio of dogmatists in one group relative to another. We see in Figure 4 that increasing the ratio of dogmatists even a little bit can put the odds of having more followers in one's favor. Doubling the number of dogmatists relative to ideological competitors is enough to nearly guarantee having more followers.

Third, the 5-group dominates no matter the memory size (keeping in mind that memory size is a rough proxy for easily accessible information). When agents can't keep that much in mind and the PBC decay process is triggered relatively early in a run, agents quickly go to their separate corners. When agents have more expansive memories, the ubiquity of 5-dogmatists has a cascading effect in the population. One case to keep in mind: if PBC decays exponentially – and especially in cases where memories are lower capacity – then the dominance by the 5-group isn't as dramatic. The reason is clear on reflection. The window for joining the 5-groupers narrows quickly when decay is exponential. Even though its PBC goes to 0.0 after 20 time steps, it plunges to very near 0.0 after a few steps.

For the political strategist or branding consultant, the preceding results are more than enough: get more dogmatists talking to lots of people. Before long you'll have more people buying your product. A strategic follow-up question to note but not pursue in any detail: how does one create dogmatists? Presumably, it happens in part by reducing uncertainty in one's own position, while othering the many others. Setting this aside, here are two nearby epistemological issues.

6.1. Varieties of dogmatism

Consider the no PBC decay condition. The 5-group continues to dominate as the ratio of excess dogmatists grows: see Figure 3.

This condition of the model suggests a difference between two kinds of dogmatists.[14] *Internal* dogmatists are the ones with which we're familiar. They have a PBC of 0. They will not change their mind. *External* dogmatists could, in principle, change their beliefs, but they have found themselves in an epistemic context in which they are unable to do so. Their dogmatism isn't grounded in an internal property. Rather, it's a product of being in a particular socio-epistemic place at a particular socio-epistemic time. If they were transported to a different epistemic context they would change their minds. Behaviorally, they are indistinguishable. It's only counterfactually that the difference is apparent.

Even so, it's a difference that makes a difference. It's the community keeping the belief in place, not an internal conviction. It seems *prima facie* possible to effect change with external dogmatists. One example is the use of propaganda by the US during World War I. To support the US's involvement in the war, the government's Committee of Public Information used radio, print news, and film to encourage planting victory gardens and reducing waste to help support the war effort (Larson 1939). During any sort of film, the Committee's trained speakers would talk to the audience

[14]The literature on dogmatism is enormous and continues to grow, especially in vice epistemology. For discussion, see Battaly (2018, 2020).

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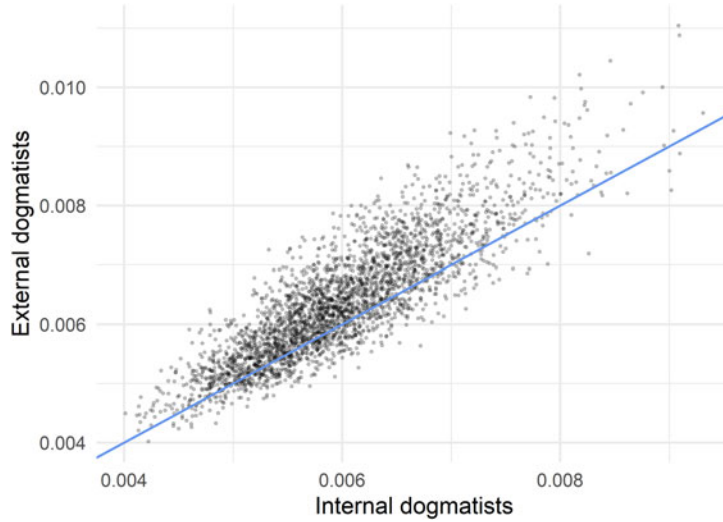

Figure 5. Conversions by internal and external dogmatists.

about the war effort and what they could do to support their doughboys abroad. The Committee also actively suppressed any counter-propaganda suggesting that the US should not be involved in the war. Changing minds and hearts by these means is exactly what is captured in the model. Unfortunately, we don't have the data about popular support for the Great War before and during these propaganda campaigns. But if some of the recipients were in principle open to changing their minds, the model suggests the campaign would have had its desired effect. These external dogmatists could then go on to propagate support for the war without themselves ever being internal dogmatists. The cultural-epistemic scaffolding of the propaganda campaign would have denied external dogmatists the opportunity of changing their attitudes.

How do internal and external 5-dogmatists compare at increasing the 5-population? Figure 5 illustrates that external dogmatists slightly outperform internal dogmatists, controlling for population size. (There were on average 3.5 times as many external as internal dogmatists.) If the groups were equally effective, most points would lie on the line. This suggests that external dogmatists play an important role in the dynamics of the epistemic community. While they are not as committed as internal dogmatists, they bring as many – or more – into the fold.

6.2. Formation and persistence of epistemic bubbles

Nguyen (2020) distinguishes between echo chambers and epistemic bubbles. Echo chambers involves discrediting alternative, relevant voices. Following the lead of Jamieson and Capella (2008), he points to Rush Limbaugh as a paradigm of this sort of discrediting. Limbaugh would develop alternative explanations for worldly happenings, and these explanations would often hinge on denying the credibility or authenticity of other sources of information. This is what creates an echo chamber: not just offering one view but rather limiting the range of trusted sources by discrediting others.

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Epistemic bubbles, by contrast, are marked by inadequate coverage through a process of omission. For instance, if I get all my news from left-leaning sources, then I won't hear about issues relevant to other political orientations. Even so, there isn't active discrediting of alternative voices.

Nguyen offers two ways in which epistemic bubbles can form. The first is the agential tendency to seek out like-minded people and sources. Epistemic bubbles form when we build a structure for one purpose and it ends up getting used for others. Our friendship networks are for, well, friendship. And when our friendship network doubles as our information-gathering network, we find ourselves in an epistemic bubble.

The second is by way of algorithmic filtering. Many social media platforms tailor their content to your particular interests. Same with many internet search engines. So if you're interested in veganism, you'll be fed content relating to that. The tailoring happens by means of an algorithm, often proprietary, and often secret. Consequently, we are often exposed only to information and ideas that we're already invested in. Making matters worse is the opacity of the algorithms. That makes it hard to figure out how to epistemically compensate for the filter.

On the account described here, epistemic bubbles can be the joint work of internal and external dogmatists.[15] Within some defined space, they keep trading the same belief. It's not that the opinions of others are actively discredited. It's also not that agents are necessarily seeking out like-minded people. Instead, bubbles are created and maintained when there is a large enough group of people with at least some internal dogmatists. The internal dogmatists anchor the attitude for the surrounding population. When the epistemic bubble begins to shrink at the edges, the internal dogmatist keeps it from collapsing entirely.

7. Conclusion

This study suggests several issues to explore at the intersection of culture, society, and epistemology. Here is one. It concerns ways in which economic and political systems intersect with epistemic ones. This is, of course, a topic that has been explored in feminist epistemology and areas of social epistemology concerned with issues of justice. But this study introduces a new angle on an old problem: how a politically powerful minority ends up extending its influence far and wide. Consider Texas. There, just as in many other states, the members of the state Board of Education appoint citizens to an advisory panel to make textbook recommendations for the state. In Texas, it has led to textbooks claiming the prophet Moses as one of the Founding Fathers of the US.[16] It also led to calling slaves brought to the US 'workers.' And it seemed to suggest that these Africans in the 1800s were immigrants.[17] Now imagine dogmatists on this advisory panel. Theirs would be an oversized influence in virtue of the position. Dogmatists

[15]Why internal *and* external? Contagion models of belief spread, a class of models to which the present model belongs, show that eventually one property will spread to the entire population provided everyone is susceptible (Baronchelli 2008). External, but not internal, dogmatists are susceptible in this way.

[16]Laura Isensee, "Texas Hits the Books," npr.org, National Public Radio, 21 November 2014, www.npr.org/sections/ed/2014/11/21/365686593/texas-hits-the-books.

[17]Michael Schaub, "Texas Textbook Calling Slaves 'Immigrants' to be Changed, After Mom's Complaint," latimes.com, LA Times, 5 October 2015, www.latimes.com/books/jacketcopy/la-et-jc-texas-textbook-calls-slaves-immigrants-20151005-story.html.

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with axes to grind against progressive policies could oversee more textbooks downplaying the impact of Jim Crow or redlining. And dogmatists in the same position committed to the values of a liberal democracy might prefer to make room for discussion of minority voter suppression or the role of Christianity in the development of American culture and politics. This is to say that dogmatists in influential positions is neither good nor bad *simpliciter*. Rather, one can, through prestige and heel-digging, be a powerful force in the shaping of epistemic systems.[18]

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Appendix

The following functions governed the decay of an agent's PBC, depending on trial condition. In each case, once the decay process is triggered, an agent's PBC would be 0 after 20 timesteps.

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1. Exponential decay:

$$V_{t+1} = \begin{cases} V_t - (V_t \times 0.27), & \text{if } V_t \geq 0.0001 \\ 0, & \text{otherwise} \end{cases}$$

2. Logarithmic decay:

$$V_t = \begin{cases} (ln(20 - z) \times 0.0169815, & \text{if } 1 \leq z < 20 \\ 0, & \text{otherwise} \end{cases}$$

The parameter z tracks timesteps from the start of the decay process.

3. Linear decay:

$$V_{t+1} = \begin{cases} V_t - 0.0125, & \text{if } V_t > 0 \\ 0, & \text{otherwise} \end{cases}$$

4. None: $V_{t+1} = V_t$

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