# Deliberative Democracy and Public Discourse: The Agent-Based Argument Repertoire Model[1]

*Encouraging Reasoning Abilities by Engaging in Direct Conversations about Substantive and Complex Issues*

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Agent-based modeling is a technique used to study relationships between variation in parameter values or patterns of interaction at the micro-level and outcomes at the macro-level. By using computer simulation of landscapes inhabited by cells, or "agents," the modeler can produce many virtual histories of the landscape under different initial conditions (randomized or not) and under various experimental conditions. In this article we report the findings of experiments run with the Agent-Based Argument Repertoire (ABAR) Model—experiments designed to help answer some of the practical questions that arise in discussions of the contribution-enhanced public discourse, that is, more and better deliberation or argumentation among citizens might contribute to the quality of democracy [1].[2]

## POSING QUESTIONS THAT CAN BE ADDRESSED BY AGENT-BASED MODELING

Most discussions of deliberative democracy focus primarily on its potential as a vehicle for increasing political participation and the quality of democratic decision-making. They are linked to hoary civic and republican traditions and to research in sociology, communications, and political science, identifying small group interaction as a fundamental transmission belt, and brake, on the effects of mass media. But the idea of deliberative democracy developed in the 1990s specifically in reaction to negative assessments of the quality of political discourse in the United States. With public debate seemingly dominated by huge amounts of money spent on media advertisements and by the politics of insult and personal scandal, mechanisms are being sought for encouraging citizens to exercise their reasoning abilities by engaging in direct conversations about substantive and complex issues. Such practices, it is argued, can counterbalance the emotion-laden images and slick slogans that dominate the mass media and displace public engagement with real issues and the implications of collective choices for the public good.

Regardless of the specific mechanisms used (e.g., deliberative opinion polls, invigoration of associational life, monitoring and evaluation of campaign advertise-

**The Agent-Based Argument Repertoire (ABAR) Model is used to explore key propositions about key relationships posited by students of deliberative democracy. Our experiments support the contention that democratic polities can maintain stability, civility, and an effective problem-solving capacity by maintaining at least moderate levels of education among citizens. We found that low levels of education, modeled as citizens lacking the ability to understand more than a small fraction of the arguments being made by other citizens, are associated with very high levels of pervasive disagreement and with the low levels of "agreement clustering"—the absence of the kind persuasion that occurs among communities able to understand the arguments being made by the mass media and by their neighbors. We also found that opinion leaders have multiple and important roles. When education levels in the general population are low, even small proportions of opinion leaders decrease the pervasive amount of disagreement and incivility in a polity. The presence of opinion leaders also significantly increases agreement clustering, thereby enhancing formation of discursive communities in a society threatened by atomization. When education levels are very high, a "flip" occurs in the role played by opinion leaders. Very high levels of sophistication tend to lead to levels of disagreement so low and stable that self-reinforcing communities of agreement discourage citizens from changing their arguments, even when new conditions render those arguments invalid. We found, however, that the presence of opinion leaders improves the ability of well-educated citizens to exploit their sophistication in response to mass media-provided evidence.**

ments, programs of civic education, town meetings, cybercommunities), deliberative democracy imagines that by exchanging views with one another, citizens increase their reasoned attention to evidence [2–7]. Instead of reinforcing existing prejudices and tendencies toward selfish regard, short-term thinking, and alienation from political life, such conversations are seen as producing wider access to more relevant knowledge and as triggering agreement on compromises that tap latent concerns for the good of others while encouraging increasingly positive-sum solutions to problems that might otherwise be treated in zero-sum terms. In its various forms it is widely promoted as a device for reducing the role of shrill partisanship, ad hominem arguments, and emotional appeals. Citizens, it is hoped, will not only thereby become better informed, but also more able, and more inclined, to become active in the civic realm. As Rodin and Steinberg [8] have argued, democracy can more successfully cope with a variety of contemporary threats to responsible and effective government by capitalizing on the "faculties" of reasoned discussion within "discursive communities"—communities whose diverse leaders both represent and guide their constituencies. By invigorating public discourse, they argue, the quality of public policy can be improved, the diversity of political society respected, the capacity of democracy for self-*correction* exploited, and the boundaries of civil speech and conduct established [9–14].

But some scholars have been skeptical in response to this kind of argument and exhortations of any kind toward improvements in public discourse or the introduction of various models of deliberative democracy. For example, Susan Stokes [15] and Adam Przeworski [16] warn that deliberation can actually reduce the quality of decisions and lead to outcomes significantly more divergent from participants' interests and available knowledge than without deliberation.[3] Others have emphasized the importance of clear operationalization of the concepts so that normative and empirical claims about public discourse and deliberative democracy can be fairly evaluated. Thus, James Fearon [17] advocates framing questions about deliberative democracy in ways that could allow measurement of the phenomenon and its effects. He has suggested why it might be better to focus on the concrete and measurable practice of "discussion" rather than on the intangible evocations of "deliberation." Other analysts approach the problem from the perspective of social choice theory, wondering whether deliberative argument per se can help solve various indeterminacy problems in formal models of how preferences can be aggregated to produce more rational collective decisions [18, 19]. Political theorists, such as Joshua Cohen, Jurgen Habermas, and John Rawls, try to think carefully about the meaning of public deliberation for principles of fairness, equality, and community that they value, and as a vehicle for the production of better citizens [20–22]. Public policy-oriented analysts consider the contribution deliberative democracy might make to enhancing the efficacy of policy choices by reducing the constraints of bounded rationality.

These are separable but overlapping theoretical, philosophical, policy-oriented, and civic-minded conversations. Many of the questions posed by participants in these conversations are not susceptible to investigation by the technique of agent-based modeling or at least not suitable for examination with the use of our ABAR model. But we believe that a significant subset of these questions can be effectively addressed in this way, and that by thinking about public discourse through the lens of agent-based modeling, fundamentally important questions arise that may otherwise have been ignored. In this article the following questions will be addressed.

1. What are the implications of different proportions of opinion leaders and differentially sophisticated populations on patterns of agreement,

disagreement, diversity, and change within a polity?
2. Under what conditions can diversity be preserved and kept in balance with levels of disagreement that are invigorating but not polarizing and opportunities for consensus that make effective action possible?
3. What role do opinion leaders and varying levels of education play in making deliberative democracy sustainable in volatile, risky, or turbulent situations?

It is worth emphasizing that the use of the ABAR model to simulate patterns that may be taken to represent public discourse or deliberative democracy, their requisites, or their hypothesized consequences should not be mistaken for an attempt to replicate the intrapsychic experience or emotional result of such behavior. Nor is this a technique for making point predictions about particular political systems, such as the United States, or highly discriminating judgments about subtly different theories of public discourse or deliberative democracy. Instead, this kind of simulation, the hypotheses considered, and the results obtained should be understood as plausibility probes that can be relevant to "real world" events and patterns because of the streamlined, controlled, and precise results of the interaction of a small number of crucial assumptions and variables. As the questions listed above suggest, this model of public discourse can help refine and test expectations of a relationship between enhancing capacities for the public interchange of views based on evidence and the character and efficacy of a democratic system.

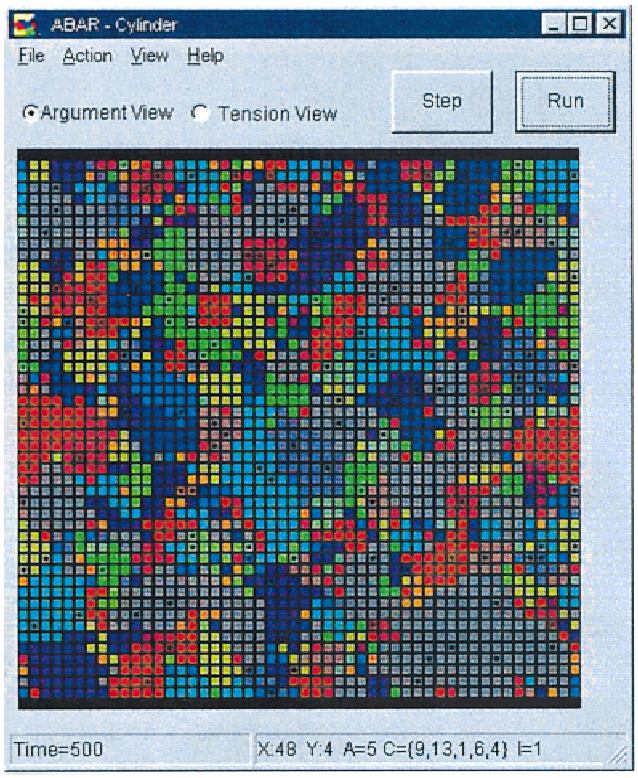
## A BRIEF OUTLINE OF THE MODEL

The ABAR model imagines a polity as a two-dimensional array of citizens. The size and shape of the landscape can vary, with boundaries and barriers distributed according to the modeler's preferences. Agents in the landscape represent citizens and are shaped as squares. Each has direct contact with the eight other in its "Moore neighborhood"—those touching its four sides and its four corners. Each citizen appears as a particular color, corresponding to the argument that that citizen is currently articulating. For tracking purposes a number is assigned to each color, that is, to each argument present in the polity. At the beginning of a "run" the landscape is "reseeded," randomizing both the distribution of articulated arguments and that of subscribed arguments. A citizen's articulated argument is one among a stipulatable number of arguments that comprise each citizen's "argument repertoire" (AR). The arguments in each citizen's repertoire, including its articulated argument, comprise a subset of the total number of arguments present in the argument repertoires of all citizens in the landscape. This number, of arguments present across the landscape, is also stipulatable, though in the current version of the model the limit for this number is 20.

In accordance with classic theories of social impact, attentive publics, and the relationship between mass opinion and small group interaction, there are two kinds of citizens in the polity: ordinary citizens (whom we shall refer to simply as "citizens") and opinion leaders [23, 24]. The exact proportion of each in any landscape is stipulatable for experimental purposes, as is the size of the argument repertoire of opinion leaders. In a work summarizing a well-substantiated body of research, Gabriel Weimann [24] characterizes opinion leaders as more influential than ordinary citizens, spreading their influence in interactions with intimate associates, somewhat more knowledgeable of their environments, more "cosmopolitan" and "less dogmatic" than ordinary citizens, more willing to take risks, and more apt to take information from those with whom they interact (pp. ix, 57, 71–77, 84).

However, all opinion leaders have repertoires that are larger than those of citizens. Opinion leaders also differ

**FIGURE 1**




Screenshot of ABAR model: argument view. Cylinder, 50 × 50, 15 Arguments, Citzens 6 arguments, Opinion Leaders 9, Opinion Leader density 5%, Bias Volatility 0.005, Range –2 +1.

**These meliorative results for the presence of opinion leaders were considerably more dramatic under conditions of more rapid and sizeable changes in mass media reports concerning the validity of different arguments.**

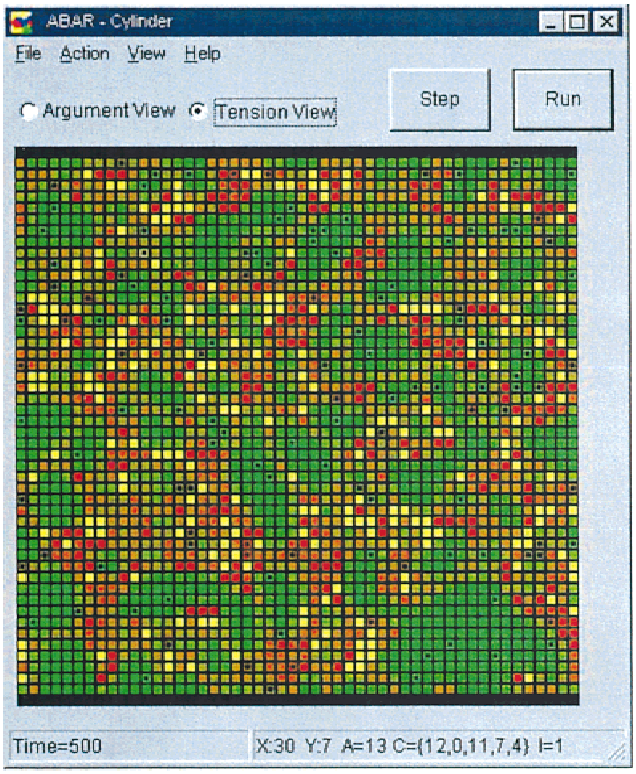
from citizens in the rules governing their interaction with neighbors. In every time period each citizen compares its own articulated argument to the articulated arguments of its neighbors. (The exact micro-rules are attached to this article as the Appendix.) These calculations are performed synchronously, except that all opinion leaders make their calculations and implement the results before citizens do. By adding the number of its neighbors articulated on different arguments, each citizen determines argument weights in its neighborhood. If the neighborhood argument weight of the citizen's articulated argument is equal to or higher than the argument weight of other available arguments, then no change occurs. The citizen's articulated argument remains the same. If the argument weight of another articulated argument in the citizen's neighborhood, which is also in its repertoire, is significantly higher than the weight of its articulated argument, the citizen changes its articulated argument to conform to that with the greatest argument weight. Its previously articulated argument remains in its repertoire.

The calculation of argument weights is adjusted by two factors in addition to the number of Moore neighborhood citizens articulated on individual arguments. In every time period each argument present in the repertoire of any agent in the landscape is assigned a bias value, indicating the amount of evidence for the validity of the argument currently being made available to all agents in the polity by the mass media. This value changes randomly with stipulatable frequency (volatility) and range (extent of possible change in negative or positive direction).

Calculation of argument weights is also affected by the presence of opinion leaders in the Moore neighborhood of any agent. The argument articulated by an opinion leader is counted by agents in its neighborhood as two, rather than one. Opinion leaders, in other words, are figured as more influential than citizens. The algorithms determining opinion leader behavior also differ from those producing basic agent calculations in that an opinion leader changes its articulated argument to one within its repertoire after noticing even a slight argument weight difference. Likewise, although citizens can substitute new arguments for old ones in their repertoires if the argument weight superiority of the new argument is overwhelming compared to their articulated argument, opinion leaders are more sensitive to, and more ready to discard, arguments within their repertoires for new but attractive arguments. In sum, opinion leaders are modeled as having larger repertoires, more influence, more sensitivity to shifts in their incentive structure, and more openness to changing their repertoires as well as their articulated arguments.

Statistical monitors are used to track changes in the distribution of articulated and subscribed (within repertoire) arguments over time and to describe changing "tension" or "disagreement" levels. Tension levels model aggregate amounts of disagreement in the polity and are determined, at each time period, by counting the number of encounters between agents articulating different arguments. The model can be viewed dynamically in two displays. The articulated argument display shows expansion and contraction in the articulated presence of different arguments in the polity, with each argument assigned a distinct color. In the tension display, the evolving history of the landscape can be viewed in terms of locally present encounters between agents articulating similar or dissimilar arguments.

**FIGURE 2**




Screenshot of ABAR model: tension view. Cylinder, 50 × 50, 15 Arguments, Citzens 6 arguments, Opinion Leaders 9, Opinion Leader density 5%, Bias Volatility 0.005, Range –2, +1.

In this display, yellow represents high levels of difference, red represents medium levels, dark green low levels, and light green no difference. Figures 1 and 2 show typical ABAR screenshots of an argument and a tension level display of one run of the model at 500 time periods.

## EXPERIMENTAL RESULTS

In this article we report three groups of experiments—experiments focusing on three measures of the character of a democratic society. These three attributes are of interest:

- The amount of publicly expressed disagreement in a polity.
- The amount of clustered agreement, or consensus, in a polity.
- The amount of diversity in a polity.

In the discussion section we explore the implications of our findings for the achievement of the kind of balance that supporters of deliberative democracy seek in public discourse between disagreement, coherence, and variety.

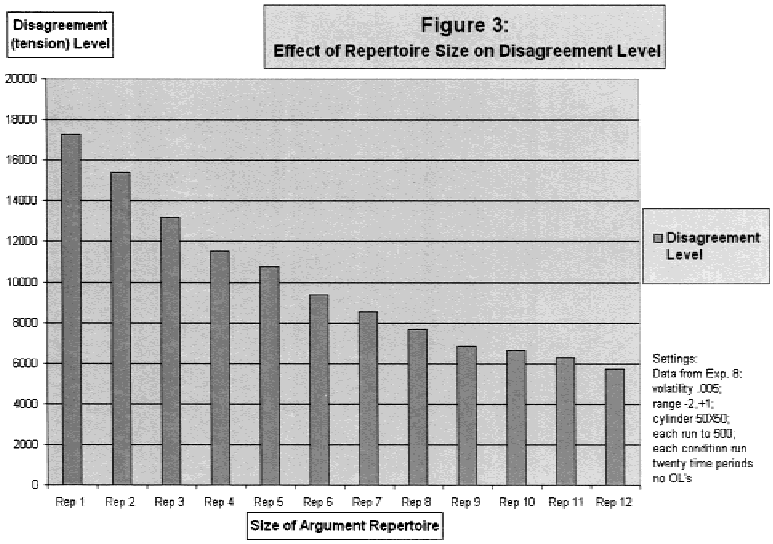
In all our experiments we arrange the model with two categories of settings. In the first category are those settings that we keep the same for all the experiments reported in this article. In the second category are those settings we adjust so their effects can be evaluated. The first category includes the size and shape of the landscape, or polity itself, the number of runs of the model conducted for each experimental condition, and the number of time periods comprising each run of the model. These settings were used for all experiments and will not be repeated in each section of the article. They are as follows:

Size and shape: The polity is arrayed as an unrolled cylinder whose vertical and horizontal dimensions are 50 citizens by 50 citizens. One hundred of the citizens—50 along the top and 50 along the bottom—are replaced with impermeable and inactive squares that serve as boundaries. The "sides," however, "wrap around" and touch one another, as in a cylinder. This shape was chosen because it incorporates the notion of a border separating the polity from the outside world while also providing the potential for continuous processes of sequential interactions to spread across the entire polity from almost every point in almost every direction.

Number of runs: Each condition of each experiment was run 20 times.

Length of runs: Each run of each condition in each experiment was run to 500 time periods. Extending the length of these periods is likely to yield somewhat different results in some experiments and under some conditions. For most experiments, however, experience with the model suggests that relatively stable patterns have emerged by the completion of 500 time periods.

**FIGURE 3**

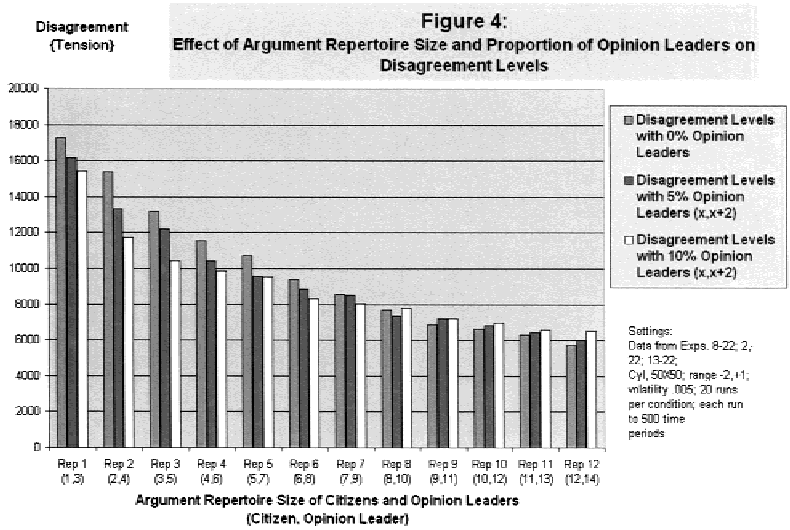



Effect of repertoire size on disagreement level.

### Disagreement

When citizens are said to "talk past each other," what is meant is that the argu-

**FIGURE 4**




Effect of argument repertoire size and proportion of opinion leaders on disagreement levels.

ments made by citizens in the same communicative field, however coherent and important or wrongheaded and baseless, are not being listened to or understood by other citizens making other arguments. Deliberative democrats deplore such patterns, hoping to replace them, not with a uniformity of argument, but with a public discourse of disagreement and agreement based on mutual intelligibility and evidence-based persuasion.

We use the ABAR model to study variation in aggregate disagreement levels by counting the number of encounters between proximate citizens articulating the same or different arguments. Each citizen can articulate one argument at a time. Each argument is drawn from the set of subscribed arguments that that particular citizen understands at that time. His/her repertoire of understood or subscribed arguments is itself a subset of the whole set of arguments understood by at least one citizen in the population. Extremely high levels of disagreement indicate a kind of cacophonic public discourse in which few citizens are agreeing (articulating the same argument simultaneously). Extremely low levels of disagreement indicate a kind of totalitarian public discourse in which one and only one argument is being made by virtually all citizens.

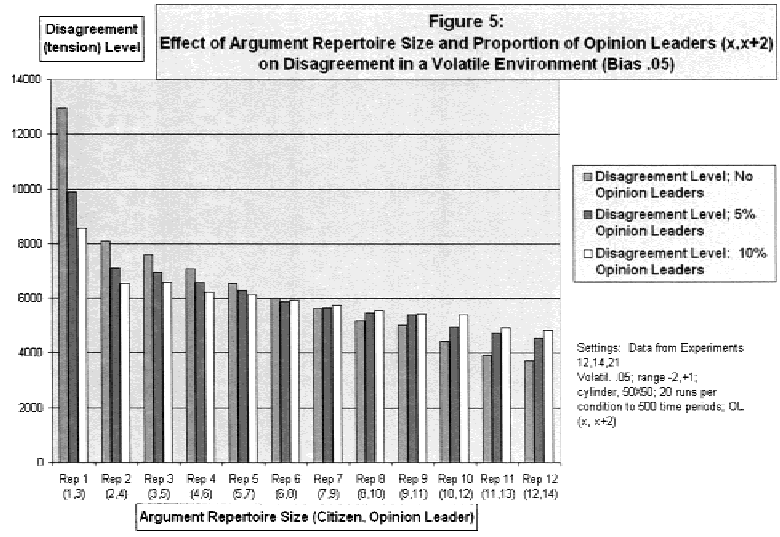
We began by examining how much disagreement would be exhibited in a polity as a function of the sophistication of that polity's citizens. We therefore compared the amount of disagreement observed in the polity after 500 time periods at various levels of sophistication. By sophistication we mean the number of arguments in the repertoire of a citizen in the polity.[4] For most of our experiments we envisioned the polity as having a total of 15 arguments distributed randomly across the population of citizens, although under no circumstances could any one citizen have in his/her repertoire all 15 of these arguments. We then observed levels of disagreement at each of 12 levels of citizen sophistication—citizens "understanding" (having in their argument repertoire) 1, 2, 3, . . . , 12 arguments. This baseline experiment was run with no opinion leaders present. The bias settings were designed to be relatively stable. The volatility of evidentiary biases supplied by the mass media was set at 0.005 (meaning that for each argument at each time period there is a 0.005 probability that its bias value will be eligible for reassignment). The range of possible variation in these bias levels was also set fairly narrowly. No bias could be lower than $-2$ or higher than +1. Together these settings were used to produce a "stable" (though not stagnant) environment.

**In general, our study of the relationship among general disagreement levels, the extent of the clustering of agreement in the polity, and the amount of diversity of points of view available to the polity shows that there are complicated trade-offs among these three values, that a desirable balance among them is more likely to be achieved in stable conditions than in unstable conditions, and that in all conditions the role of opinion leaders is positive, important, and roughly proportionate (within low levels) to their proportion of the population.**

The results of this experiment are displayed in Figure 3. We see that at very small repertoire sizes disagreement levels are very high. In polities imagined as containing citizens with more sophistication (i.e., having larger individual argument repertoires) disagreement levels drop. This decline is rapid at first and then moderates in its slope as argument repertoires become larger. With high levels of sophistication (argument repertoires that include the large majority of arguments present in the population), the decline in amounts of disagreement continues, but at a small and diminishing rate. Overall levels of disagreement in the high sophistication conditions are between one half and one third as low as those in the low sophistication conditions.

These results are consistent with the view that even small amounts of education to marginally increase the flexibility of a citizenry's thinking could very significantly decrease the amount of nonunderstood "shouting" of arguments that could be expected in a polity

**FIGURE 5**




Effect of argument repertoire size and proportion of opinion leaders (*x, x*+2) on disagreement in a volatile environment (bias, 0.05).

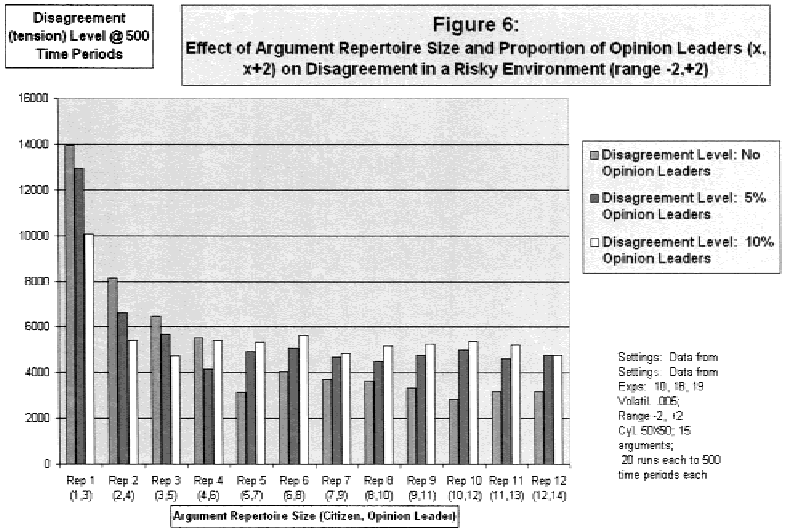
unguided by a strongly biased mass media and deprived of a significant stratum of opinion leaders. Investments in such programs will continue to produce results, but less robustly as the sophistication of the population rises.

But most societies do have significant proportions of opinion leaders—individuals who are more sophisticated, more influential, more attuned to the media's signals, and quicker to be persuaded by evidence. What are the implications of the presence and proportion of opinion leaders for the relationship between citizen sophistication and disagreement levels? Figure 4 compares the results of making 5 or 10% of the polity's citizens opinion leaders.[5] We can see from this figure that the presence of opinion leaders does have an effect—an effect that is proportionately stronger in the 10% condition compared to the 5% condition. Opinion leaders accelerate the decline in disagreement levels in relatively unsophisticated populations. This effect declines in robustness until it disappears altogether between AR sizes 7 and 9. In the higher ranges of citizen sophistication the presence of 5 or 10% opinion leaders produces slight increases in the amount of disagreement.

In other words, there is a kind of "flip" in which opinion leaders have the effect or, as it were, play the role, of reducing unproductive shouting when narrow-mindedness produces a public discourse with too much disagreement and not enough persuasion. However, when moderately high levels of sophistication lead to relatively low levels of disagreement (because citizens can quickly reach agreement with one another and then support each other in maintaining their views), opinion leaders serve as a kind of "yeast" that preserves a measure of deliberative fermentation in the public arena.

In this stable environment these effects are of limited magnitude. In particular, the amount of disagreement in polities populated by very sophisticated citizens (AR more than two thirds of total arguments in the polity) is only marginally increased by the "fermenting"

**FIGURE 6**

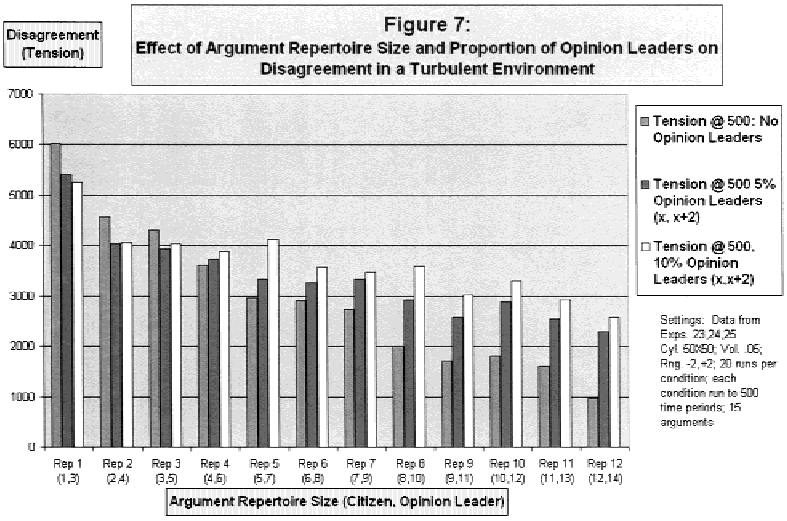



Effect of argument repertoire size and proportion of opinion leaders (*x, x*+2) on disagreement in a risky environment (range: –2, +2).

presence of opinion leaders at either the 5 or 10% level. In these conditions, it appears that the added influence, inquisitiveness, and receptivity to evidence opinion leaders manifest can do little to prevent or reverse the tendencies of sophisticated citizens to form tight circles of reinforcing agreement with their neighbors. This kind of "early lock-in" appears to reduce opportunities for citizens, however sophisticated, to hear different views from their neighbors, as opposed to simply receiving information from the mass media about arguments they understand.

The question then arises as to the effects of opinion leaders under conditions of instability in the environment.

**FIGURE 7**




Effect of argument repertoire size and proportion of opinion leaders (*x, x*+2) on disagreement in a turbulent environment.

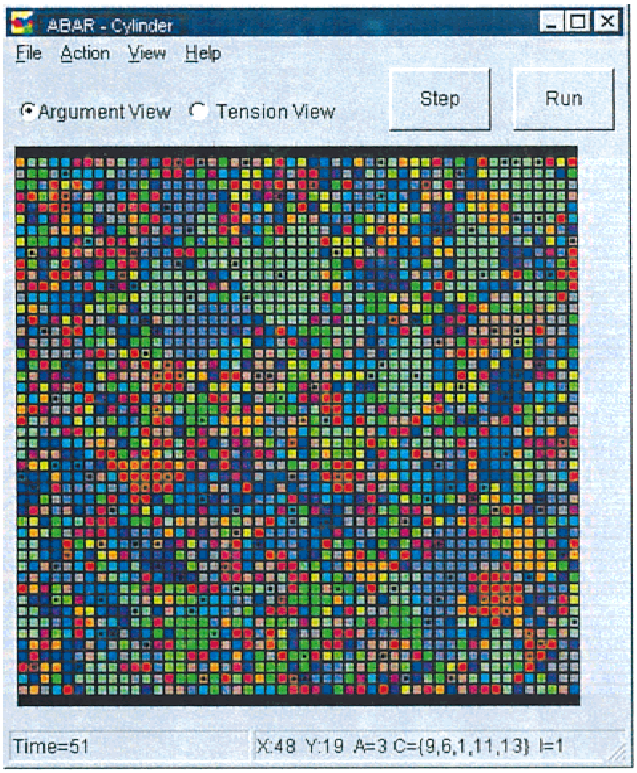
Specifically, what effect does instability of different kinds have on the relationship between citizen sophistication and disagreement or on the role and significance of opinion leaders for maintaining a healthy public discourse?

To study the effects of instability in the environment, or at least in the messages about the environment transmitted to citizens by the mass media, we distinguish between volatility and range. Volatility refers to the pace of change, the likelihood at any time period that new evidence will appear with respect to the validity of an argument. Range is about the size of the swings in the biases assigned to specific arguments that can occur when new evidence appears. Thus, range pertains to the weightiness of the evidence, not the likelihood it will change. By increasing the rate of change without increasing the range of variation of assigned biases, environments can be made to exhibit instability due to added volatility. By increasing the range of variation without increasing the pace of changes in assigned biases, environments can be made to exhibit instability due, as it were, to the increased possibility of drastic mistakes and rich rewards. We describe this kind of less stable environment as one characterized by increased riskiness. When both volatility and riskiness are increased, we describe the environment as "turbulent" (though not in the technical meaning of the term).

Figure 5 shows the results of experiments designed to test the effect of the presence of different proportions of opinion leaders in populations of varied sophistication under relatively volatile conditions. In these experiments the volatility of evidentiary biases supplied by the mass media was set at 0.05 (rather than 0.005 for stable environments), meaning that for each argument at each time period there is a 0.05 probability that its bias value will be eligible for reassignment. By comparing Figure 5 with Figure 4 we can see, perhaps surprisingly, that levels of disagreement at every sophistication setting are significantly lower under conditions of volatility than in stable environments. This occurs as a result of an accelerated stream of opportunities for citizens to discover that arguments made by some of their neighbors correspond to newly available validating evidence. In both figures, that is, under stable and volatile conditions, we observe that the overall shape of the disagreement curve, moving from less to greater citizen sophistication, is similar, but we see that the effects noticed under stable conditions are amplified under volatile conditions. That is, the effect of very small increases in sophistication in unsophisticated polities is even more pronounced, and differences in disagreement across moderately and very sophisticated conditions are even smaller. We also see that the "flip" in the role of opinion leaders remains, although it takes place "earlier" (at AR 7, rather than AR 9). In other words, under conditions of volatility, and given a moderately sophisticated citizenry, opinion leaders act to foster greater amounts of public discourse rather than to replace public disagreement with greater consensus.

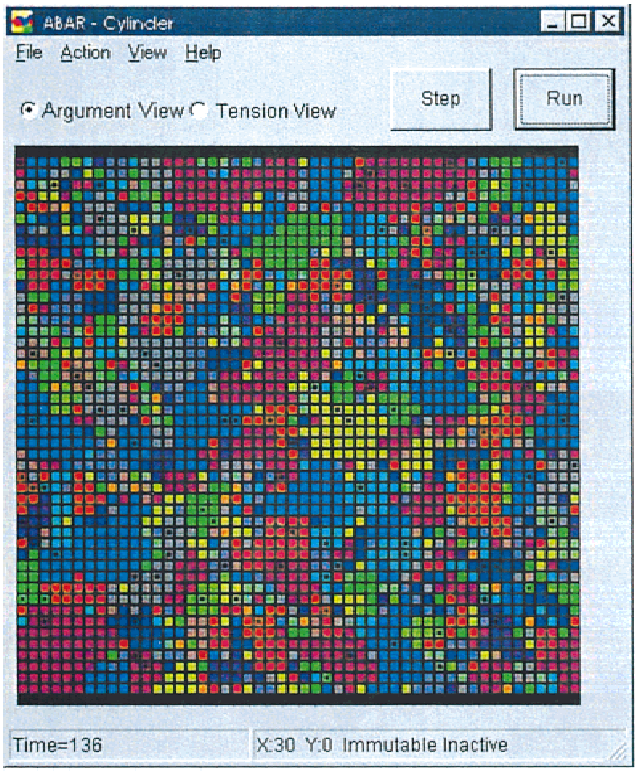
The next set of experiments considered the effect, not of volatility, but of an increased range in the absolute size of evidentiary biases assigned to particular arguments. The range of evidentiary bias variation was increased from $-2,+1$ to $-2,+2$. The effects of thereby making the environment more risky, without making it more volatile, are evident in Figure 6. We can see that the results of this form of instability are roughly similar to that of volatility when compared to the levels of disagreement under different sophistication levels in a stable environment. But not only are disagreement levels in the risky condition lower than in the stable condition, they are also lower than disagreement levels in the volatile condition. Indeed when citizens confront an environment that appears to be changing in relatively more consequential ways with respect to the arguments they are making, we

**FIGURE 8**




Low agreement clustering. Cylinder, 50 × 50, 15 Arguments, Citizens 6 arguments, Opinion Leaders 9, Opinion Leader density 5%, Bias Volatility 0.005, Range –2, +1.

**FIGURE 9**




Medium agreement clustering. Cyclinder, 50 × 50, Citizens 6 Arguments, Opinion Leaders 9, Opinion Leader Density 5%, Bias Volatility 0.05, Range –2 +1, 2 Arguments between 10%–20%.

see that small increases in sophistication from very unsophisticated levels (AR = 1 and 2) have even more dramatic effects on the reduction of cacophonous disagreement than when instability is expressed as volatility. We also observe that disagreement levels arrive closer to their minimum at lower levels of sophistication than in the volatile condition.

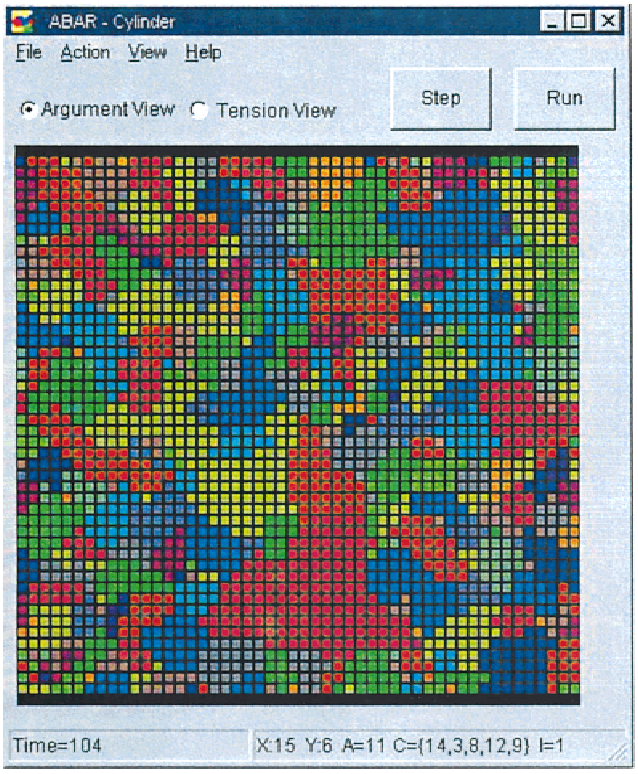
Of particular interest is that in the risky condition, where the range of variation in evidentiary biases is wider, the flip in the effect of opinion leaders occurs at a lower sophistication level (AR 4), compared to the volatility condition (AR 7). This would seem quite consistent with the interpretation that opinion leaders help citizens find common ground when that is the strategic problem for the polity and help animate or sustain deliberation in response to new evidence when the strategic problem is that self-reinforcing groups have become so set in their opinions that they resist the implications of evidence that their arguments are incorrect. We also observe that with respect to their role as discourse encouragers, the scale of the effects of the presence of opinion leaders in the risky condition is significantly greater than in the volatile condition. It is also worth noting that because arguments can be relatively more or less "wrong" or "right" in a risky environment, the polity as a whole gains more from the presence of opinion leaders under risky conditions than in more stable times. Another way of putting this is that in risky environments the absence of opinion leaders is more likely to lead to disturbingly high levels of cacophony (when citizens are unsophisticated) and disturbingly lower levels of public deliberation (when sophistication levels are medium or high) than in stable or even volatile conditions.

When evidentiary biases reported by the mass media are volatile *and* changing within a wider range, that is, when the environment is experienced by citizens as both volatile and risky, we may consider it as "turbulent." Figure 7 displays the results of experiments comparing the effect of the presence of 0, 5, and 10% opinion leaders at different sophistication levels under turbulent conditions (volatility set at 0.05; bias range set at $-2,+2$). Most striking is that although the overall shape of the curve is more similar to the steadier rate of reduction in disagreement characteristic of our study of stable environments, the curve shows disagreement levels that are 60 to 70% lower at every level of sophistication. Thus, when volatility and risk are combined, the polity experiences a rather drastic decline in deliberative public discourse. Under turbulent conditions, and with no opinion leaders present, disagreement levels when the size of argument repertoires is small (AR 2 or 3) are lower than those registered in stable conditions even when the AR is at its maximum (12). Again we see that opinion leaders flip "appropriately" and at low levels of citizen sophistication, from seeking to reduce disagreement when citizens are too unsophisticated to understand much of what is being said to them by their neighbors, to promoting open-minded discourse when, after AR = 3, citizens appear locked-in to opinions they previously discovered they share with their neighbors.

## Agreement Clustering

Our measure of disagreement in a polity is quite general. As an index, it registers gross amounts of disagreement among citizens without indicating anything directly about its spatial distribution or organization. The reciprocal of a disagreement level would represent just as gross an index of "agreement." However, we wanted to investigate determinants of the organization of agreement. To accomplish this objective we use a statistical monitor built into the program. The output of this monitor is a description, at each time period, of the number of citizens articulating each argument being made by anyone in the polity. This information is then processed into a report of the proportion of

**FIGURE 10**




Medium agreement clustering: low tension. Cylinder, 50 × 50, 15 Arguments, Citizens 6 Arguments, Opinion Leaders 9, Opinion Leader, Density 0%, Bias Volatility 0.05, Range –2 +1, 5 Arguments Between 10%–20%.

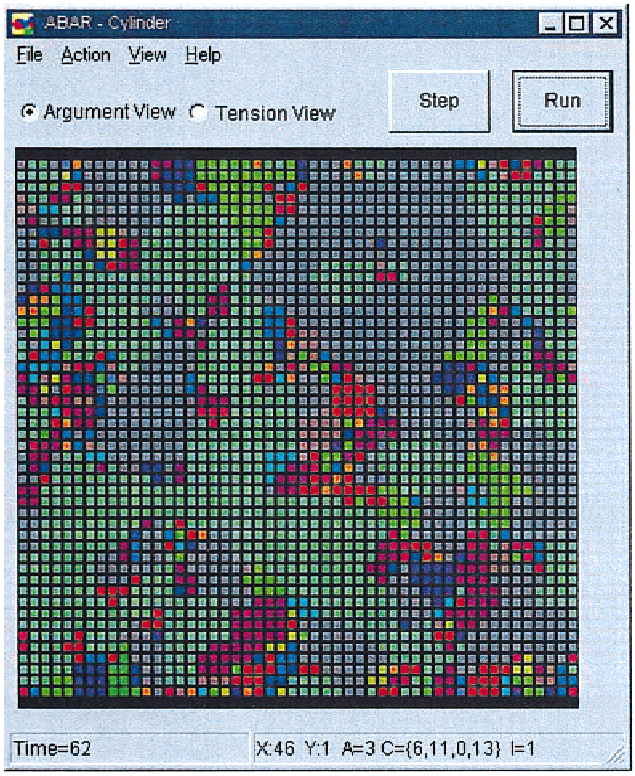
the polity's citizens currently articulating particular arguments. The final output of the monitor is a tally of how many arguments, at each time period, are being articulated by 0–10%, 10–20%, 20–30%, 30–40%, and so on of citizens. Each run of each condition can then be described by using the Herfindahl Index—traditionally employed to describe the extent of concentration in an industry or market. This aggregate index is calculated as equal to the sum of the squares of the market shares. If, for example, in a particular run, one argument is being articulated by between 10 and 20% of citizens and two other arguments are being articulated by between 20 and 30%, then the Herfindahl index for that run is calculated by treating the first argument as articulated by 15% of the polity, and each of the other two arguments as articulated by 25%. The square of 0.15 is 0.0225. The square of 0.25 is 0.0625. Doubling 0.0625 (because there were two arguments made by between 20 and 30% of citizens) and adding it to 0.0225, a Herfindahl index of concentration is calculated as 0.1475.[6]

We read the average Herfindahl index scores for an experimental condition as a report of the coherence and organization of public discourse—a description of what may be termed "agreement clustering." Thus relatively low values indicate, in general, a disorganized array of atomized individuals making large numbers of arguments on different topics in faint or indistinguishable regions. Medium values correspond to a small number of distinct and sizable groups surrounded by disorganized regions or a relatively large number of smaller but coherent groups arguing directly with one another in highly focused ways. High values indicate polarization of the polity's citizens along one or two cleavage lines. At the extreme, as values of the Herfindahl index approach 1.0, the polity is dominated by one and only one opinion. Figures 8 to 12 show sample screen shots of runs at 500 time periods typical of these conditions.

As in our experiments regarding general amounts of disagreement in the polity, we were also interested in the effect citizen sophistication, the presence of opinion leaders, and unstable environments would have on variation in agreement clustering. Figure 13 compares the results of experiments that trace the average Herfindahl index for differing sophistication levels when there are different proportions of opinion leaders. We observe that in all conditions a mild curvilinearity is observed within Herfindahl index scores that are low to medium, at most. Within this range, the amount of agreement clustering rises as low levels of sophistication increase from the random distribution of argument articulation from which all runs originate. In each condition the amount of argument clustering reaches a peak between AR = 3, when 10 or 15% of the citizens are opinion leaders, and AR = 9, when there are no opinion leaders. These peaks are then followed by declines that tend to be more precipitous when the proportion of opinion leaders is lower.

Apparent here, again, is the change in the role of opinion leaders. Notice how in the low sophistication conditions the lines tracing changes in amount of agreement clustering when opinion leaders are present show values that are higher than those in the absence of opinion leaders. Between AR = 4 and AR = 5, however, the opinion leaders lines cross and begin registering agreement clustering values that are lower than those produced in the medium and higher AR ranges when opinion leaders are absent. Opinion leaders, in effect, are fostering concentration or aggregation of agreement—building communities of like-minded citizens—when citizens are unsophisticated and have difficulty realizing any common approach to problems with their fellows. Then, as levels of aggregated agreement increase, opinion leaders

**FIGURE 11**




High agreement clustering: polarization. Cylinder, 50 × 50, 15 Arguments, Citizens 5 Arguments, Opinion Leaders 7, Opinion Leader, Density 0%, Bias Volatility 0.05, Range –2 +2, 2 Arguments Between 30%–40%.

switch to play the role of argument sustainers—encouraging citizens, as it were, to avoid overcommitment to particular arguments in the face of changing evidentiary biases.

The steadying role of opinion leaders in a polity is even more striking under conditions of instability. Figures 14 and 15 show, respectively, how heightened volatility and increased risk in the environment as presented to citizens by the mass media significantly increase the levels of agreement clustering at every citizen sophistication level and in every opinion leader condition. Again the riskiness factor has a more robust impact than volatility. But also note that in both figures the change in the role of opinion leaders is again evident. It may be observed that in all of these conditions, and again in Figure 16 indicating the effects of turbulence (featuring both volatility and riskiness), that the range of variation in agreement clustering across sophistication levels is very much reduced when opinion leaders are present, and smaller. If very high levels of agreement clustering can be taken to represent an overweening concentration of opinion, a kind of oversimplification of a polity's response to a complex and changing world, then opinion leaders would seem to play a crucial role in holding these "panicky" tendencies in check. We may further observe that although high levels of citizen sophistication do seem to reduce the tendency of unstable environments to encourage tendencies toward uniformity of opinion, this faculty loses its potency under turbulent conditions. Thus, in Figure 16 we see agreement clustering reaching extremely high values when opinion leaders are absent. When they are present, however, they do provide that steadying influence that, in this condition, seems to prevent the polity from freezing into an inflexible and uniform stance toward a "frightening" world.[7]

### Diversity

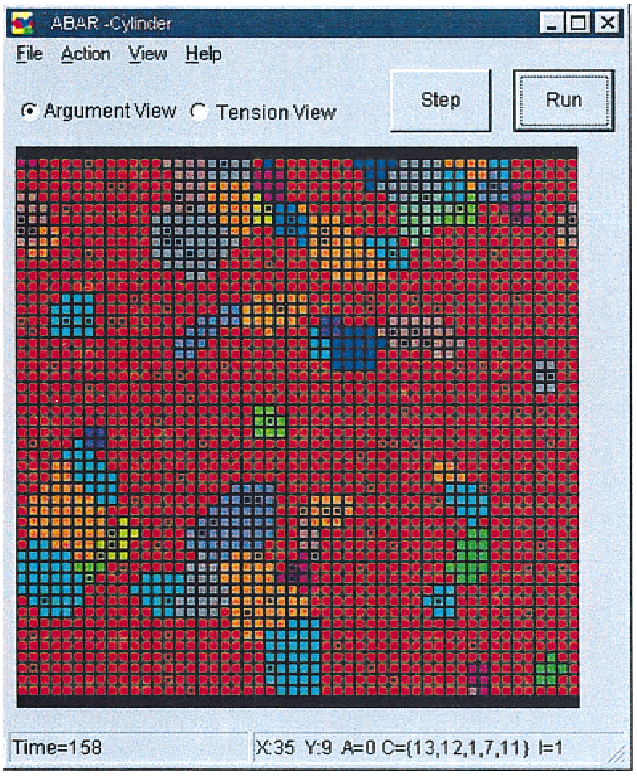
Prevailing treatments of deliberative democracy value an enriched public discourse not only because it can reduce tensions and unproductive or vituperative interaction among citizens and not only because it can help create the basis for coherent collective understandings and joint problem-solving, but because diversity of opinion and cultural style is held to be a good in and of itself. But from an evolutionary and complexity theory perspective, this accent on diversity has its own powerful logic and rationale.

Worlds change in fundamentally unpredictable ways. The burning of Amazon and Southeast Asian rain forests are a human tragedy, not because we know how plant and animal species there can help us now, but because they contain a vast reservoir of species whose value may only be discoverable with future technologies and only may be apparent in relation to problems that have not yet arisen.

The same principle can be applied to arguments. Some arguments may seem, and even be, chronically and foolishly wrong, but unless we deem them to exist beyond some absolute moral pale, the community can be seen to benefit by their existence. The benefit is associated with the historical fact, and logical possibility, that arguments and ways of thinking that are wrong today may be right, under vastly different conditions, tomorrow. Therefore political systems and designs for enhancing public discourse should reasonably establish maintenance of diversity as one of three objectives—along with reduction in unintelligent disagreement and promotion of opportunities for consensus—to be brought into balance.

We have therefore used the ABAR model to study the consequences of increasing sophistication levels, opinion leaders, and environmental instability for maintaining diversity in the polity. To compare the effects of different conditions on the diversity of the polity we created a "diversity index." The diver-

**FIGURE 12**



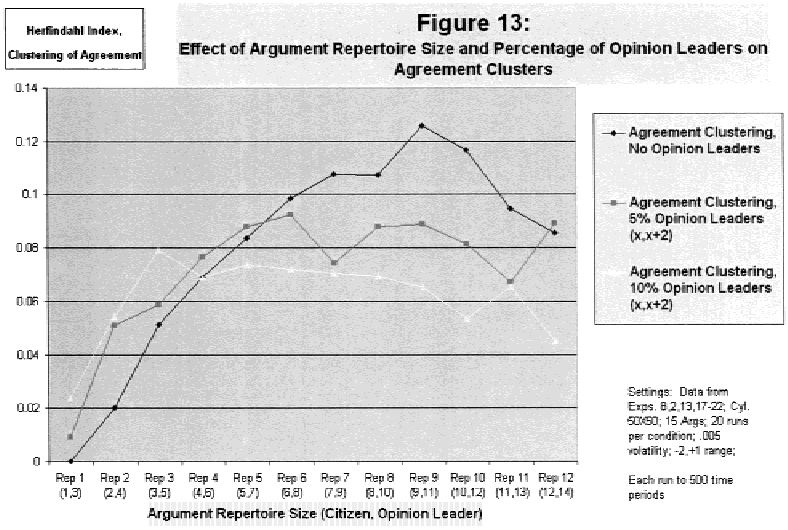

High agreement clustering: totalitarian. Cylinder, 50 × 50, 15 Arguments, Citzens 6 Arguments, Opinion Leaders 9, Opinion Leader Density 5%, Bias Volatility 0.05, Range –2 +2, 1 Argument Between 70%–80%.

sity index is computed by counting the number of arguments being articulated in a population at the end of a run (500 time periods in these experiments) by no more than 1% of citizens. We then subtract this number of effectively "extinguished" arguments from the total number of arguments that were being articulated at the beginning of the run.[8] This number represents our diversity index. A diversity index score for each condition is produced by averaging the diversity indexes resulting from each of the 20 runs of that condition.

The experiments we ran show that under stable conditions diversity remains high across all sophistication levels. When the citizenry of the polity is very unsophisticated (AR = 1 to 4), there is hardly opportunity for citizens to come to understandings that change their articulated arguments from the ones each articulated at the outset. But even in the medium and high AR ranges, when citizens are able to communicate effectively and respond to evidence of validity for their arguments by collective adjustments in their positions, relatively few arguments are reduced to such obscurity that the proportion of citizens articulating them is less than 1%. As Figure 17 shows, even with no opinion leaders the diversity index never drops below 14.3 (with a maximum of 15).

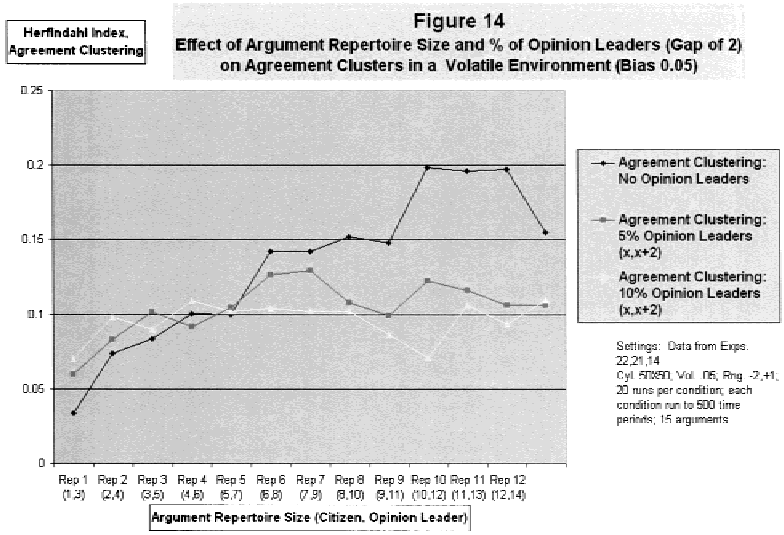
In a relatively volatile environment, diversity levels do begin declining significantly as the sophistication level of the population increases above AR = 5. It is apparent from Figure 18 that this decline in diversity occurs with sophistication levels that are otherwise relatively desirable in that, as we have seen, disagreement levels are lower and agreement clustering levels higher in this AR range. But we can also see again that the presence of opinion leaders serves the polity well by protecting it against the drop in diversity at AR = 5 and beyond that otherwise occurs. What we may say is happening is that the opinion leaders help insure the continued availability of minority opinions despite chronically low evidentiary bias values. They can perform this role because a few of them are able to use their greater persuasive powers to protect small groups of citizens articulating the

**FIGURE 13**



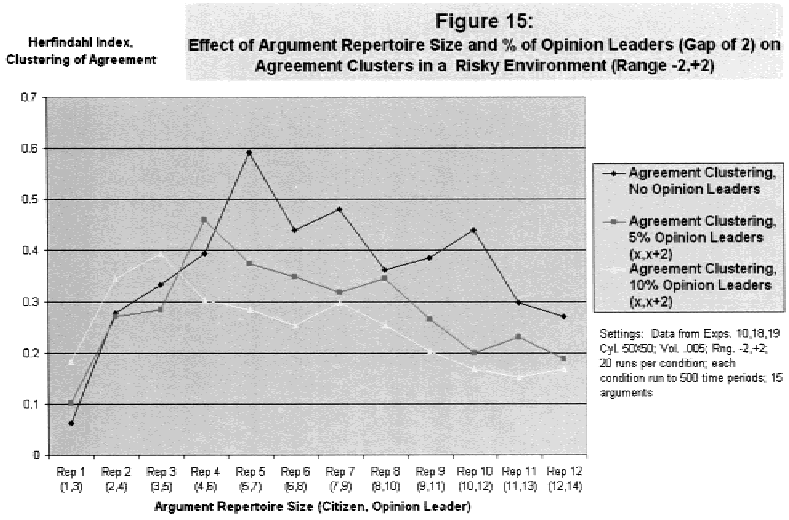

Effect of argument repertoire size and percentage of opinion leaders on agreement clusters.

**FIGURE 14**




Effect of argument repertoire size and percentage of opinion leaders (gap of 2) on agreement clusters in a volatile environment (bias, 0.05)

**FIGURE 15**



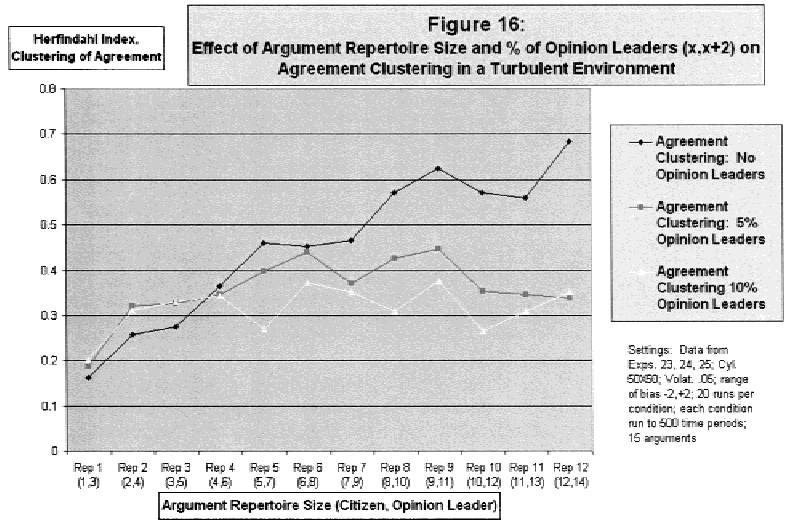

Effect of argument repertoire size and percentage of opinion leaders (gap of 2) on agreement clusters in a risky environment (range, –2,+2)

minority view from overweening pressures to conform to the wider array of arguments that, at one time or another in the volatile condition, are being portrayed by the media as more valid than their iconoclastic views.

As we have seen earlier, the effects of instability are amplified in the risky condition. Figure 19 shows how diversity levels dropped to between 11 and 9.5, even in low sophistication levels. In the absence of opinion leaders, the diversity index continued dropping until bottoming out at 8 at AR = 6. But with 5 or 10% of the citizenry acting as opinion leaders, diversity indexes began rising at the AR = 3 to 4 level, maintaining diversity scores of 11 or above from AR = 5. Interestingly, high diversity appears to have been maintained, even in the absence of opinion leaders, when sophistication levels of the citizenry were extremely high (AR = 11 to 12). This suggests that in a risky environment the likelihood is high that most arguments will, before being extinguished, enjoy at least a brief period during which their validity will be strongly supported by signals coming from the mass media. If citizens are flexible enough in their thinking, they can respond to these opportunities with enough facility to establish neighborhoods of reassurance capable of preserving their availability. It is possible, however, that further research may show that this effect could disappear if the time horizon is lengthened.

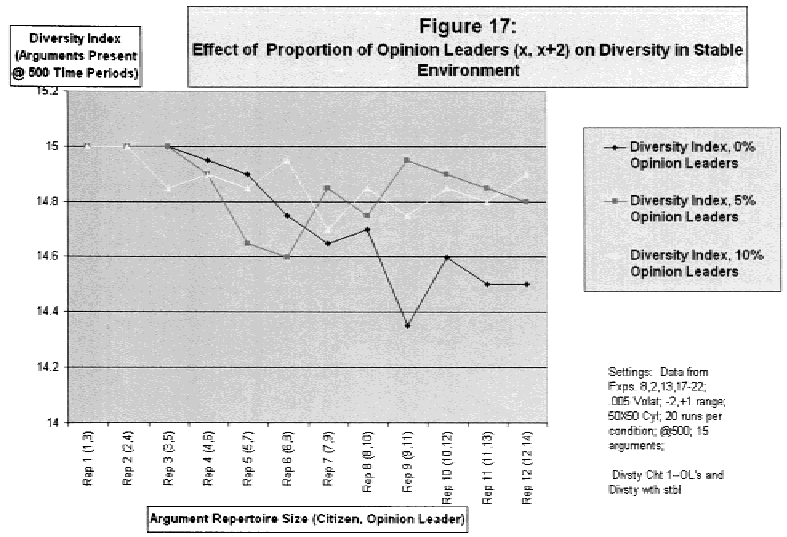
Evidence that this may in fact be the case is available in Figure 20, reporting results of experiments testing the impact of turbulence on the relationships among sophistication, opinion leaders, and diversity. In the absence of opinion leaders, diversity index scores, after dropping in low and medium AR levels to below 8, do not then rise under conditions of citizen sophistication. In fact they go even lower, dropping to between 7 and 4 in the AR = 8 to 12 range. Under these both risky and volatile conditions, the contribution of opinion leaders to the preservation of diversity is particularly striking. When 5% of citizens are opinion leaders, diversity levels are sustained above 8 for all sophistication levels. When 10% of citizens are opinion leaders, diversity levels stay between 9 and 11. It would appear that the neighborhoods of reassurance that sophisticated citizens build to protect minority views in a risky environment are unable to survive when those neighborhoods are also subjected to high rates of change in the amount of evidence available to them. That is, when citizens are sophisticated enough, high evidentiary biases will, with great probability, eventually trigger enough positive responses in the disfavored and minority opinion neighborhoods that the overall presence of that

**FIGURE 16**




Effect of argument repertoire size and percentage of opinion leaders (*x, x*+2) on agreement clusters in a turbulent environment.

**FIGURE 17**




Effect of proportion of opinion leaders (*x, x*+2) on diversity in a stable environment.

argument in the arena of public discourse falls below the line of extinction for that argument (1%).

## CONCLUSIONS

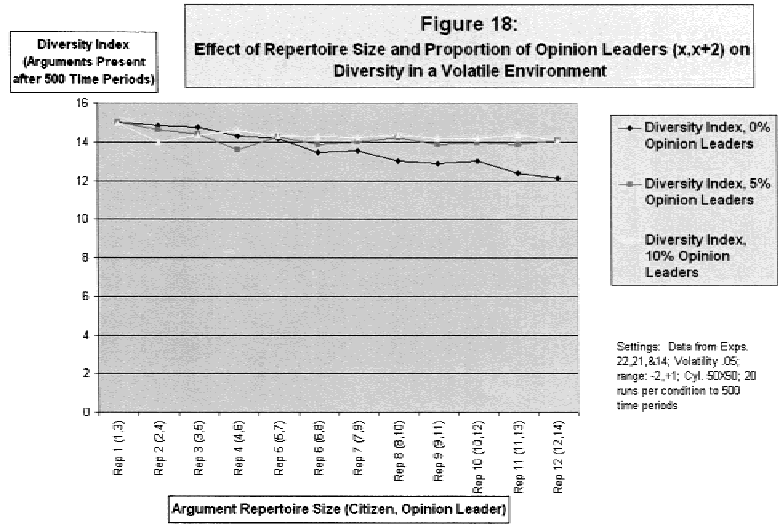
Certain patterns appear in the results of our experiments with the ABAR model that help address some of the questions about the potency with which civic education, reasoned discourse, and active leadership can enhance the political faculties of deliberative democracy. We found solid evidence that overall levels of noncommunicative disagreement in polities as modeled by ABAR tend to fall sharply as the education level (meaning increased sophistication in the understanding of more publicly heard arguments) of the population increases. We found that agreement clustering, indicating convergence among discursive communities in response to evidence about the validity of differing points of view, rises when education increases from low levels. We saw relatively clearly that there is a trade-off in populations with low education levels. Associated with high levels of disagreement, and even atomization, which we may generally view as undesirable, are high levels of diversity—generally seen as desirable. But without the capacity to communicate coherently about changing aspects of the polity's environment, undereducated citizens cannot build the kind of substantial but not universal consensus that communities need to make use of the good ideas that a diverse polity generates.

The challenge that emerges is to achieve a balance among:

1. Disagreement levels that are low enough to avoid cacophony but high enough to insure vitality and flexibility in the polity as a whole; agreement clustering levels that represent robust communities of agreement
2. Coherent collective responses to perceived challenges, and sustained attention to particular points of view, without effectively reducing the diversity of opinions available across the polity
3. Diversity levels that are high, so as to preserve options for an uncertain future, while not sacrificing coherence and community to an insistence on maximizing the availability of difference.

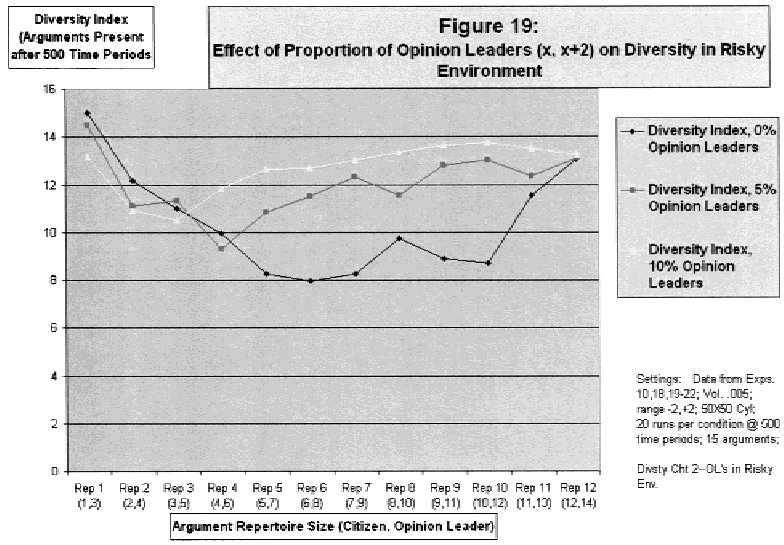
Significantly, we found powerful and repeated suggestions that the presence of even small percentages of opinion leaders—citizens relatively more educated than their fellows, relatively more attuned to changes in their environment as reported by the mass media, relatively more responsive to rational argument, and relatively more influential in deliberative encounters—contribute to the attainment of each of these balances. That is, we found that for each dimension of interest, namely disagreement, agreement clustering, and diversity, that opinion leaders militated against

**FIGURE 18**




Effect of repertoire size and proportion of opinion leaders (*x,x*+2) on diversity in a volatile environment.

**FIGURE 19**




Effect of proportion of opinion leaders (*x, x*+2) on diversity in a risky environment.

extreme values and did so under high or low education levels. When too much disagreement, too little agreement clustering, and/or too much diversity was present, the addition of higher proportions of opinion leaders reduced the first and third measures and increased the second. When the relative absence of disagreement, the emergence of high levels of agreement clustering, or the disappearance of diversity signaled what can be thought of as the "freezing" of the polity, that is, higher proportions of opinion leaders tended to increase the first and third measures and reduce the second.

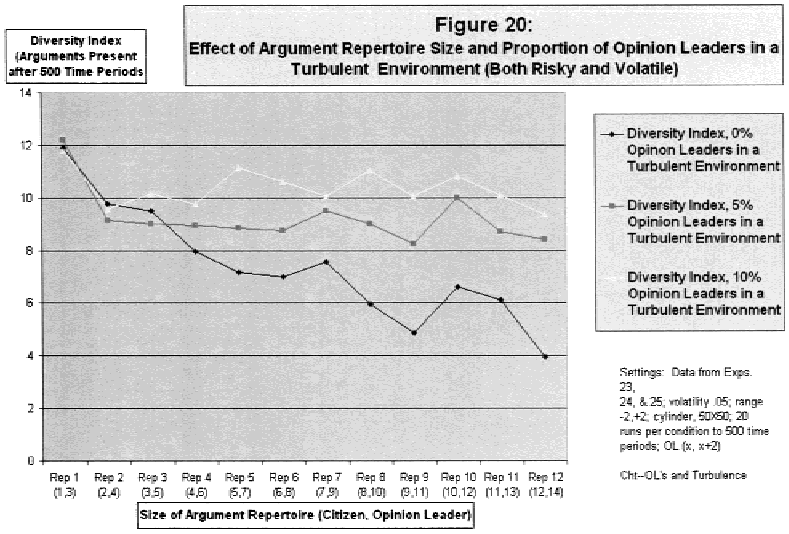
Of particular importance is that when the modeled polities were stressed—when the volatility, riskiness, or turbulence of the environment were increased—opinion leaders could make an even more dramatic contribution toward maintaining the polity in the kind of balance that would preserve public discourse and deliberation as a problem-solving faculty of the democratic community.

There were also some more surprising, but perhaps equally interesting and provocative, findings. Chief among these is that although desirable levels of disagreement, agreement clustering, and diversity are higher in very highly educated populations than they are in populations with very low education levels, generally speaking the most desirable balances seem to be exhibited in the mid-range of education levels. There is some significant variation here. For example, when the environment is turbulent, diversity levels fall dramatically in the high education conditions, whereas agreement clustering levels become extremely, even dangerously, high (in the absence of opinion leaders). But it is perhaps surprising that there is no regular or linear relationship between increasing the education level of the population as a whole and conditions favorable to, or reflective of, good public discourse.

This may have to do with particular aspects of the model. Or it may signal fascinating and nonintuitively obvious relationships between the outcomes of interest and the prevalence of apathy, fanaticism, exclusivism, and the free flow of information in a society. These are all factors that can be reasonably hypothesized to play a key role in the workings of deliberative democracy. Although they can be programmed as features of the ABAR model, they were not included in the experiments reported here.

For example, apathy and fanaticism exist in every polity. That is, there is some proportion of the population that absorbs information and experiences persuasion without seeking to influence those around them, and there is some proportion that aggressively seeks to exert influence while refusing or strongly resisting being influenced. If apathy and fanaticism act as breaks on the speed

**FIGURE 20**




Effect of argument repertoire size and proportion of opinion leaders in a turbulent environment (both risky and volatile).

with which deliberative discourse can spread convincing arguments through a polity, their absence might tend to exaggerate the results of increases in the educational level of the population or adjustments in other variables.

One additional promising avenue of continued research worth mentioning is the question of finding the mix of leadership, education, and heterogeneity that does the best job of maintaining the overall rationality of the polity. By considering the bias values of arguments as indications of the changing character of problems faced by the polity, the polity's "rationality" can be assessed, as well as its overall adaptiveness. By summing the bias value of each argument being made at a particular time period or range of time periods, and by comparing this value to that produced by multiplying the number of citizens in the polity by the highest bias available in that time period or range of time periods, an overall measure of rationality, or efficacy, can be produced. This approach could help clarify thinking about the efficacy of democratic deliberation, its limitations, and its particular strengths. These and other similar experiments, including exploration of the implications of contradictory arguments existing in the same citizen, will be possible as the new and more powerful version of the ABAR model is made operational.

Finally, it is worth noting that our overall approach to the study of public discourse reflects and encourages a nonstandard point of view. Most students of democratic deliberation focus on what citizens should be, what they do or do not do, and how they respond to discursive opportunities or messages. We also ask questions about citizens and their attributes, but in the polities as modeled in ABAR landscapes and in the dynamic visual displays produced as virtual histories of the polities we focus just as much if not more on arguments rather than individuals [25–27]. Do arguments prevail, disappear, retreat, or return? Are they available when conditions suggest their validity? What difference does the presence of more or fewer arguments within repertoires or within a polity make? Under what conditions do better arguments spread more quickly than poor arguments?[9]

Because polities are communities in time and not only in space, this perspective may be particularly appropriate. Individual citizens are born, develop into maturity, and die. But the political community that joins them is larger and lives on. What in fact lives on are arguments—arguments comprising a public discourse linking citizens to one another in space, but joining them as well to past and future generations in a greater conversation that is the life of the polity itself.

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## APPENDIX

### Rules Governing the Agent-Based Argument Repertoire Model[10]

The Landscape: A population of square-shaped agents (citizens) in a two-dimensional array comprises a landscape (polity). The shape and size of the landscape is stipulatable.

The Environment: The environment of the polity has biases toward each argument present in the repertoires of citizens in the population, that is, toward all subscribed arguments. The set of bias values toward argument $x$, $B(x)$, is stipulatable. Bias values for each argument change randomly and are reported to all citizens by the "mass media" at a rate determined by an environmental volatility setting.

Citizens: There are two types of citizens who inhabit the environment: basic citizens and opinion leaders. Opinion leaders (OL) are both more sensitive to change in their environments and more influential in their impact on citizens in their neighborhood. Each citizen (ordinary or opinion leader) has a repertoire of $C$ arguments. The elements of $C$ will be chosen from a series of $D$ arguments ($D \leq 20$) such that no two elements in $C$ may be identical. For the ordinary citizen, the length of $C$ will be $L$ (de facto 6); for the opinion leader, the length of $C$ will be $H$ (de facto 9), such that $H > L$. The first element of repertoire $C$ is deemed the articulated argument. The articulated argument is the argument being expressed by that particular citizen to its neighbors. Each citizen's arguments in $C$ other than the articulated argument are unknown to other citizens.

During each turn, each agent interacts with its Moore neighborhood of citizens.

All opinion leaders act first and in parallel. Each opinion leader looks to his Moore neighbors and goes through the following process.

1. Argument weights for all articulated arguments in the neighborhood, including the articulated argument of agent OL in the center of the neighborhood, are calculated. The argument weight (AW) of an argument in a neighborhood is equal to the number of citizens in the neighborhood, including OL, articulated on that argument, plus that argument's environmental favorability bias, plus one point for each opinion leader in the neighborhood (including the agent in the center) articulated on that argument. For example, if argument $x$ is articulated in 5 citizens, two of whom (including the citizen in the center of the Moore neighborhood) are opinion leaders, and if the environmental bias for that argument is $-1$, then the AW for that argument is $5 + 2 + (-1) = 6$.
2. If the argument weight of agent OL's articulated argument is equal to or greater than the AW of any other articulated argument in its neighborhood, then OL's articulated argument remains unchanged, OL's repertoire $C$ does not change, and the process ends.
3. If an argument, $x$, in $C$ other than OL's articulated argument, has an AW greater than that of OL's articulated argument, then $x$ becomes OL's articulated argument. The formerly articulated argument becomes a nonarticulated argument in $C$. If the AWs of more than one argument in the neighborhood and within OL's repertoire are greater than the AW of OL's articulated argument, then the argument with the biggest AW becomes the articulated argument for $E$. If these AWs bigger than the AW of OL's articulated argument are equal, then one of these arguments becomes OL's articulated argument. Which one? Answer—the one with the largest subscription in the neighborhood, then in the population, and then the lowest digit between the two argument labels.
4. If an argument, x, not in $C$, is articulated with an AW at least 3 points greater than OL's articulated argument, then $x$ is added to OL's repertoire (but does not activate on that turn) and the argument in OL's repertoire with the lowest AW in the neighborhood is removed from the repertoire. If multiple arguments are thereby candidates for removal, the argument listed to the extreme right in the cache is removed.
5. If an argument, $x$, not in OL's repertoire, is articulated with an AW at least 6 points greater than OL's articulated argument, then $x$ becomes an articulated argument of agent $E$, the formerly articulated argument becomes a nonarticulated argument within OL's repertoire, and an argument in OL's repertoire is removed,

using the same procedure as in step 4 above.

After opinion leaders act, all basic citizens act in parallel. Each ordinary citizen *A* looks to his 8 neighbors and goes through the following process.

1. Argument weights for all articulated arguments in the neighborhood, including the articulated argument of agent *A* in the center of the neighborhood, are calculated. The argument weight (AW) of an argument in a neighborhood is equal to the number of citizens in the neighborhood, including *A,* articulated on that argument, plus that argument's environmental favorability bias, plus one point for each opinion leader in the neighborhood (including the agent in the center) articulated on that argument.
2. If the argument weight of agent *A*'s articulated argument is equal to or greater than the AW of any other articulated argument in its neighborhood, then *A*'s articulated argument remains unchanged, *A*'s repertoire *C* does not change, and the process ends.
3. If an argument *x* in *C,* other than *A*'s articulated argument, has an AW two or more points greater than that of *A*'s articulated argument, then *x* becomes *A*'s articulated argument. The formerly articulated argument becomes a nonarticulated argument in *C.* If the AWs of more than one argument in the neighborhood and within *C* are two or more points greater than the AW of *A*'s articulated argument, then the argument with the biggest AW becomes the articulated argument for *A.* If these AWs two points bigger than the AW of *A*'s articulated argument are equal, then one of these arguments, using the procedure described in step 3, for opinion leader citizens, becomes *A*'s articulated argument.
4. If an argument *x* not in agent *A*'s repertoire is articulated with an AW at least five points greater than *A*'s articulated argument, then *x* is added to *A*'s repertoire and the argument in *A*'s repertoire with the lowest AW in the neighborhood is removed from the repertoire. If multiple arguments are thereby candidates for removal, the removed argument is the argument listed at the extreme right of the cache.
5. If an argument *x* not in *A*'s repertoire is articulated with an AW at least seven points greater than *A*'s articulated argument, then *x* becomes an articulated argument of agent *A,* the formerly articulated argument becomes a nonarticulated argument within *A*'s repertoire, and an argument in *A*'s repertoire is removed, using the same procedure as in step 4 above.

Initial Conditions: Citizens' initial repertoires are given with a uniform distribution and randomly. The percentage of opinion leaders in the population is set at the beginning of each run.

## NOTES

1. An earlier draft of this article was prepared for the Penn National Commission on Society, Culture, and Community. The software for the ABAR model was developed by Vladimir Dergachev, Department of Mathematics, University of Pennsylvania, in cooperation with Ian S. Lustick. All experiments in this paper can be replicated by downloading the model and using the manual available at the sites listed in the article. Please send comments to ilustick@sas.upenn.edu.
2. This model was originally developed as the Agent-Based Identity Repertoire (ABIR) Model in order to test propositions about collective identity and identity change that can be inferred from the constructivist theoretical position. See Ian S. Lustick [1]; http://jasss.soc.surrey.ac.uk/JASSS.html/. With only minor changes in terminology, it has been possible to translate the basic dynamics of this model into a device for studying agents who understand and articulate overlapping sets of arguments to learn about their world and adapt themselves accordingly.
3. This can occur mainly because false beliefs can, via many forms of deliberation and discussion, come to supplant true beliefs. See Susan C. Stokes [15] and in the same volume Adam Przeworski [16].
4. It is important to remember that this notion of "sophistication" does not include some of the aspects of sophistication that common usages of the term might suggest, including enhanced ability to distinguish between the validity of arguments that can be understood.
5. In these experiments opinion leaders have repertoires that are two arguments larger than ordinary citizens. If "*x*" is the size of the argument repertoire of an ordinary citizen, then "*x*+2" is the size of the AR of an opinion leader in this set-up of the model. "*x*+6" would indicate an AR for an opinion leader that is equal to the AR of an ordinary citizen, plus 6.
6. This is actually an adjusted version of the Herfindahl index since the identities occupying between 0 and 10% of the landscape population are not included in the sum of squares.
7. This steadying role of opinion leaders is especially interesting when it is remembered that it arises, at the macro, or polity level, from behaviors at the micro (individual opinion leader) level, which are in fact more fluid, more "mercurial," than is the behavior of ordinary citizens.
8. In the experiments reported here, 15 arguments were present at the beginning of each run. That means, with randomization producing the initial conditions, that each run began with each of the 15 arguments being articulated by between 6 and 7% of citizens.
9. This approach can accurately be interpreted as "memetic," consistent with work by Richard Dawkins [25], Daniel Dennett [26], and Susan Blackmore [27].
10. For a manual describing in detail how to operate the model, described in terms of agents possessing repertoires of "identities" rather than "arguments" and "activated identities" rather than "articulated arguments" go to MACROBUTTON HtmlResAnchor http://www.polisci.upenn.edu/profileil.html. The ABIR model itself can also be downloaded at this site.

## WEBSITES

http://www.la.utexas.edu/course-materials/government/32570/fishkin/fishkin.html

Professor James Fishkin's project on deliberative democracy polling.

http://jasss.soc.surrey.ac.uk/3/1/contents.html

An application of the Agent-Based Identity Repertoire Model to problems of collective identity mobilization and change. See the January 2000, Vol. 3, No. 1, for the Lustick article.

http://www.upenn.edu/pnc/

Penn National Commission on Society, Culture, and Community—a project fostering improvement in the quality of public discourse.