The Effect of Network Structure on Preference Formation

There may be two sides to every argument, but one perspective is often more prevalent than the other. As Stimson (2004) explains, "there are many matters where one side is dominant and is the only message the public hears" (p. 18). In American political discourse, an asymmetric playing field is the norm, rather than the exception. During the 2012 Presidential campaign, for example, advertising expenditures by the two competing parties were split as equitably as 40:60 in only 7 states. In the average state, 77% of campaign advertising expenses were spent by just one party,[1] creating competition between a dominant campaign and an underdog.

Exposure to campaign messages depends in large part on who people know, as political information is often communicated in social settings (Sinclair 2012). We investigate how the structure of the social network underlying information transfer can help to mitigate disparities in exposure to messages from asymmetrically-resourced campaigns. Building on existing social network theories, we hypothesize that certain networks exacerbate the dominance of high-resourced campaigns while others more readily expose people to messages from low-resourced underdogs. We then turn to literature from political psychology to formulate and test hypotheses about how such exposure can facilitate learning and influence political preferences.

The effects of network structure are difficult to ascertain with observational data (Manski 1993). People in certain types of networks may be different from those in other networks, and so the effects of structure are easily conflated with personal traits. In this study, we manipulate network structure by randomizing a sample of adults into one of two social networks that vary in structure: in one, people's contacts tend to be connected to each other and to reside in the same

[1] http://www.slate.com/articles/news_and_politics/map_of_the_week/2012/10/campaign_spending_map_shows_where_obama_romney_campaigns_spend_.html, accessed February 25, 2016

region of the network; in another, one's contacts tend not to be connected and reside in different network regions. We asymmetrically seed competing pieces of information in each network and track their spread. By comparing these cases, we find that people connected to distant network regions are exposed to dominant and underdog information at near equal rates. As a result, they learn about both sides of an issue and shift their attitudes towards the underdog. When contacts tend to be connected to the same region, on the other hand, a single perspective dominates. We use computer simulations to generalize our findings and to identify causal mechanisms. Our study provides important evidence regarding the influence of network structure on preferences.

The Influence of Social Network Structure on Information Exposure

Encounters with unfamiliar information may provide individuals with opportunities to become more informed, but individuals tend to dismiss information that casts doubt on their predetermined allegiances (Redlawsk 2004). In fact, people resist opportunities to encounter such information in the first place (Sears and Freedman 1967). Yet, despite this resistance, counter-attitudinal information can make its way into people's information environments in unexpected ways (e.g. Walsh 2004; Wojcieszak and Mutz 2009).

A key contributor to the transmission of novel information is what network scientists call *weak ties*. Strong ties, by virtue of being one's close contacts, tend to know each other. Weak ties, like casual acquaintances, are less likely to know each other and more likely to reach distant regions of the broader social network (Granovetter 1973). The advantage of weak ties is their tendency to connect individuals to regions of the network to which they otherwise could not access and, subsequently, to expose them to new information (Barbera 2014). Indeed, weak ties drive the majority of information diffusion on social network platforms like Facebook (Bakshy et al. 2012). When the structure of an individual's social network provides access to distant regions of the network, exposure to both perspectives on an issue should increase (Hypothesis 1).

Exposure to opposing viewpoints increases an individual's ability to justify their own perspective and to understand why others may disagree with them (Price and Cappella 2002). Such exposure should increase citizens' learning and engagement with an issue (Levitan and Wronski 2014). Individuals who are able to reach distant regions of a social network through their contacts should therefore be more likely to learn about new perspectives on an issue as compared with those whose contacts who are connected to similar regions (Hypothesis 2).

The degree to which information exposure leads to *persuasion* is our most stringent test of the effects of network structure. Existing work demonstrates that diverse settings promote even-handed choices (Price and Cappella 2002), loosen prior attachments (Mutz 2002), and weaken opinions (Klar 2014). Whereas Huckfeldt et al. (1995) show that social networks low in cohesion more accurately reflect the distribution of opinions in the broader information environment, we expect to find a previously untested benefit of social networks that facilitate access to distant regions: the distribution of opinions should be less dependent on the balance of information seeded in the network. People in such networks should thus form opinions that better reflect underdog views (Hypothesis 3).

Procedure

A key challenge of studying the effects of information exposure is that "we do not know how many and what kind of people are exposed to which messages" Prior (2013, p. 102). In our study, we observe the information to which people are exposed with two controlled cases. We invited 756 adult subjects[2] to participate in a mock social network, which we called *Political*

[2] ResearchNow, a research firm, provided subjects. See the Web Appendix for full detail on the sample, design, content, and survey questions we used.

Pulse. Forty-six percent agreed to participate (n=348). Following Centola (2010), we randomly assigned each subject to a node in either a clustered lattice or a random network.[3] The former is characterized by large distances between nodes; in the latter, nodes reach many regions of the network through their contacts. Each subject in our study was connected to exactly six other subjects. In each network, we seeded information about two policy issues: genetically modified organisms (GMOs) and electric cars. For each issue, two individuals received information about one perspective (either pro or con), while only one received information about the opposing perspective. This created asymmetry in seeding across perspectives.

On each day of our study, participants received an email alerting them about information that their connections viewed the previous day, along with links to the information that those contacts had viewed. Crucially, each link contained a unique eight-digit number identifying the subject who received the email. We used Google Analytics to infer which subjects viewed what information when. We allowed information to flow through both networks for 8 days. At the end of the study, we administered a final survey to ask subjects about their learning experience and opinions on the issues. Fifty-eight percent of the subjects completed this final survey (n=201).

Results

Our first hypothesis states that individuals in the random network will experience greater relative exposure to low-seeded information in comparison to those in the clustered lattice. The top panel of Figure 1 depicts cumulative views of the dominant information in support of GMOs and the underdog information against GMOs over time. In the clustered lattice, the dominant

[3] We randomly assigned 60 subjects to a control group. This group completed a survey about the issues in our study, which provides a baseline level of support for these issues.

perspective received more than twice as many views as the underdog perspective. The bottom panel of Figure 1 illustrates the diffusion of underdog pro-electric car and dominant anti-electric car information. Across both issues, the dominant perspective was viewed more frequently than the underdog perspective in the clustered lattice but not in the random network.

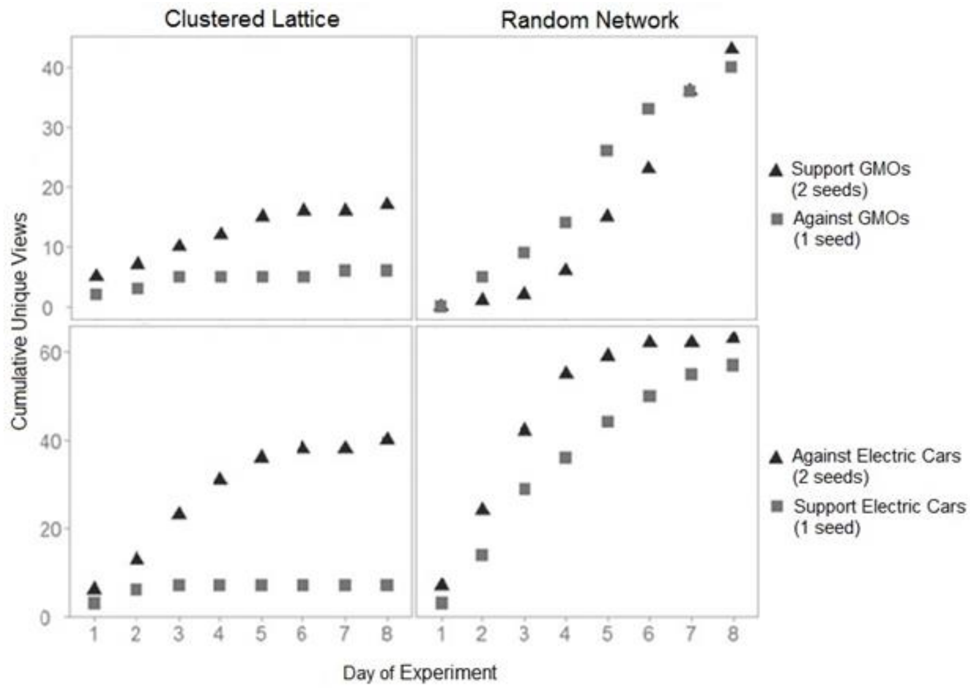

Figure 1. *Across both issues, the dominant perspective was viewed more frequently than the underdog perspective in the clustered lattice but not in the random network.*

A key strength of these controlled cases is that individuals are randomized into controlled networks that only vary in structure. Any difference in diffusion across networks is attributable only to network structure. However, since we only employ two networks, our design prohibits statistical analyses of exposure at the individual level, since the probability of exposure depends on whether or not one's contacts in the network viewed the information. The assumption of independent observations that underlies most statistical tests is therefore violated. By conducting computer simulations, we can replicate these data many times, treating each network as a unit of observation, and test our theory with more iterations. These computer simulations, which we discuss in the robustness section, provide additional evidence that differences in exposure to underdog and dominant messages are more prevalent in clustered lattices than in random networks. We first continue to review the findings that emerge from our case studies, before turning to evidence from the simulated data.

Hypotheses 2 and 3: Learning and Preference Formation

The left bars in Figure 2 depict subjects' responses to the questions: "To what degree did you become more informed about genetically modified organisms?" and "To what degree did you become more informed about electric cars?" A fully-labeled 7-point response scale was provided ranging from "I did not learn any new information" (1) to "I gained a very large amount of new information" (7). We collapse across issues and show the percentage of subjects who report that they learned a large or very large amount of new information. In the clustered lattice (dark bars), 10 percent of the subjects reported becoming more informed, while 19 percent of those in the random network (light bars) became more informed.

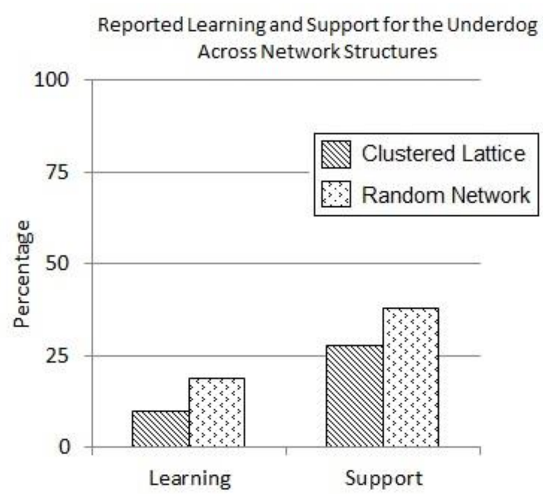

Figure 2. *Participants reported greater learning and support for the underdog in the random network than the clustered lattice.*

Next, we examine perhaps the most consequential outcome of network structure: opinion change. Recall that, in each network, we seed one perspective (i.e. the underdog's) half as frequently as the other. Our examination so far suggests that networks enabling broad access allow underdogs to achieve exposure equal to dominant perspectives. In networks where one's contacts are connected to the same region (i.e. clustered lattices), underdogs are underexposed. Our third hypothesis states that wider exposure causes opinions to shift in favor of the underdog. We first examine the percentage of subjects who agreed with the underdog viewpoint in the final survey. The questions read: "Would you say you oppose or support genetically modified foods?" and "Would you say you oppose or support electric cars?" Responses ranged from "definitely oppose" (1) to "definitely support" (7). In Figure 2, we collapse across the issues and show, in the right two bars, the percentage of subjects who report that they "support" or "definitely support" the underdog perspective. In the clustered lattice, 28 percent support the underdog, which is lower than the 38 percent who support the underdog in the random network.

Our results should be viewed as preliminary evidence of the effects of network structure on underdog exposure, learning, and opinion formation. In our Web Appendix, we provide three statistical analyses and discuss in more detail the assumptions about independence that underlie them. First, we model learning and support for the underdog to explore how the effect of network structure varied by party affiliation. In doing so, we find that the additional exposure to underdog viewpoints only changed attitudes among those who did not already agree with them. Second, we incorporate the control (no network) condition to show that opinions changed because subjects in the random network moved away from the baseline level of support; opinions among subjects in the clustered lattice did not significantly differ from the baseline. Finally, we show that there was no selective attrition that might have affected the findings.

Robustness: Computer Simulations

An underlying assumption of many statistical tests is that observations are statistically independent from one another. A limitation of our study is that we explicitly impose dependence: a participant's likelihood of viewing information is dependent on the viewing decisions of those assigned to the same network condition. While our two networks serve as useful cases, statistical analyses comparing information exposure in the clustered lattice to those in the random network rely on the independent observations assumption to hold.

We therefore ran computer simulations to test if differences in exposure across networks (Hypothesis 1) hold across a large number of replications and under different assumptions about network structure and the diffusion process. We simulated various networks structures: clustered lattices, random networks, and several small world networks – which can be thought of as being 'in between' a clustered lattice and a random network (Watts and Strogatz 1998). We also tested click rates of 0.09, 0.14, 0.19 (the click rate in our study), 0.24, and 0.29. For each network and click rate, we simulated twenty thousand diffusion processes, split across dominant and underdog information. These simulations confirm that what we observe for random networks holds across click rates and for small world networks. Complete details can be found in the Web Appendix.

Conclusion and Discussion

We present two cases in which subjects are randomly assigned to networks that vary in structure. The diffusion we observe in these networks suggests that campaigns competing with fewer resources can compensate for their resource disadvantages by seeding messages in networks with connections between distant regions. We find that exposure to these viewpoints can have important consequences: people report that they learn more from this exposure and, ultimately, preferences shift in favor of the underrepresented perspective (particularly among those who did not already support it, as we show in the Web Appendix).

Much of what we know about political mobilization (Bond et al. 2012), the spread of health behaviors (Centola 2010), and emotional contagion (Kramer et al. 2014) emerges from controlled studies of online networks. Such studies suffer from particular limitations and ours is no exception. First, these studies are carried out online, and so may or may not generalize to face-to-face interactions, which can have unique implications (e.g. Klar 2014). Second, the subjects employed in this study are anonymous, which might facilitate different behaviors than what we might see when identities are known. Third, subjects in our study automatically received links to information that their contacts viewed. This passive sharing expedites diffusion beyond what we might expect with active sharing. Finally, the greatest limitation of this exploratory study is the small sample size: we only explore two network cases. We urge scholars to extend this work to a larger scale and across different settings.

Karl Llewellyn described the tendency to rely only on widely available information as "the threat of the available" (1931, 95). Biased information environments encourage attitudinal polarization (Klar 2014), depress knowledge (Jerit and Barabas 2012), and can lead to inequality (Mansbridge 1983) and segregation (Mendelberg and Olseke 2000). Our study suggests that under-resourced viewpoints can gain traction in particular network structures, helping to mitigate bias in the information to which individuals are exposed.

References

Bakshy, Eytan, Itamar Rosenn, Cameron Marlow, and Lada Adamic. 2012. The role of social networks in information diffusion. In *Proceedings of the 21st international conference on World Wide Web* (pp. 519-528).

Barbera, Pablo. 2014. "How Social Media Reduces Mass Political Polarization. Evidence from Germany, Spain, and the US." Paper presented at the Annual Meeting of the 2014 American Political Science Association. Washington DC.

Bond, Robert M., Christopher J. Fariss, Jason J. Jones, Adam D. I. Kramer, Cameron Marlow, Jaime E. Settle, and James H. Fowler. 2012. "A 61-million-person experiment in social influence and political mobilization." *Nature* 489: 295-298.

Centola, Damon. 2010. “The Spread of Behavior in an Online Social Network Experiment.” *Science* 329: 1194-1197.
Granovetter, Mark S. 1973. “The strength of weak ties.” *American Journal of Sociology* 1360-1380.
Huckfeldt, Robert, Paul Allen Beck, Russell J. Dalton, and Jeffrey Levine. 1995. “Political Environments, Cohesive Social Groups, and the Communication of Public Opinion.” *American Journal of Political Science* 39(4): 1025-1054.
Jerit, Jennifer, and Jason Barabas. 2012. “Partisan Perceptual Bias and the Information Environment.” *Journal of Politics* 74(3): 672-684.
Klar, Samara. 2014. “Partisanship in a Social Setting.” *American Journal of Political Science* 58(3): 687-704.
Kramer, Adam D. I., Jamie E. Guillory, and Jeffrey T. Hancock. 2014. “Experimental evidence of massive-scale emotional contagion through social networks.” *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 111(24): 8788-8790.
Levitan, Lindsey C., and Julie Wronski. 2014. “Social context and information seeking: Examining the effects of network attitudinal composition on engagement with political information.” *Political Behavior*, *36*(4), 793-816.
Llewellyn, Karl N. 1931. “Legal Tradition and Social Science Method—A Realist’s Critique.” *Essays on Research in the Social Sciences* 89-120.
Mansbridge, Jane N. 1983. *Beyond Adversary Democracy.* Chicago: University of Chicago Press.
Manski, Charles F. 1993. “Identification of Endogenous Social Effects: The Reflection Problem.” *The Review of Economic* Studies 30(3), 531-542.
Mendelberg, Tali, and John Olseske. 2000. “Race and Public Deliberation.” *Political Communication* 17: 169-191.
Mutz, Diana C. 2002. “The Consequences of Cross-Cutting Networks for Political Participation.” *American Journal of Political Science* 46:838–55.
Price, Vincent, and Joseph N. Cappella. 2002. “Online deliberation and its influence: The Electronic Dialogue Project in campaign 2000.” *IT and Society 1*: 303-328.
Prior, Markus. 2013. “Media and political polarization.” *Annual Review of Political Science*, *16*, 101-127.
Redlawsk, David P. 2004. “What voters do: Information search during election campaigns.” *Political Psychology* 25(4), 595-610.
Sears, David O., and Jonathan L. Freedman. 1967. “Selective Exposure to Information: A Critical Review.” *Public Opinion Quarterly*31(2): 194-213.
Sinclair, Betsy. 2012. *The Social Citizen*. Chicago: University of Chicago Press.
Stimson, James. 2004. *Tides of Consent*. Cambridge University Press.
Walsh, Katherine Cramer. 2004. *Talking about Politics: Informal Groups and Social Identity in American Life*. Chicago: University of Chicago Press.
Watts, Duncan J., and Steven H. Strogatz. 1998. “Collective dynamics of ‘small- world networks.” *Nature* 393(6684): 440-442.
Wojcieszak, Magdalena, and Diana Mutz. 2009. “Online Groups and Political Discourse: Do Online Discussion Spaces Facilitate Exposure to Political Disagreement?” *Journal of Communication* 59: 40-56.