Political Homophily in a Large-Scale Online Communication Network

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Abstract

As communication increasingly occurs in online environments, it is important to know the structure of such conversations in social networks. Here, we investigate patterns of conversation in online forums concerning politics, as well as patterns of cross-ideological interactions in forums that are not expressly political. First, we demonstrate a method for measuring the latent ideological preferences of more than 690,000 individuals using patterns of political commenting. Using this measure, we find that communication between ideologically dissimilar individuals becomes more common in periods of increased engagement with politics, that political homophily decreases as more individuals contribute to a conversation, and that forums dedicated to nonpolitical topics exhibit substantially less homophily than political forums. Theoretical implications for political communication on online platforms are discussed.

Increased information sharing and information seeking through the Internet has enabled people to engage with others about their political views in unprecedented ways. However, the effect of technological innovations on the form of public debate about political topics is an area of active scholarly research. The ability to engage with a wide set of people through the Internet increases the possibility for engagement with diverse others who may not be accessible in an individual's local environment. However, online environments enable users to self-select into engagement with

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like-minded others (Garrett, 2009a, 2009b), perhaps with increasing precision. Understanding how and when particular forms of online media promote self-selection versus engagement with diversity is critical to understanding the effects that media features have on the ideological composition of the resulting interactions.

Although much of the scholarly attention to political information on social media has focused on Facebook and Twitter, many other sites facilitate discussion of politics and the features of a site may substantially impact how such discussion takes place. In this article, we examine a large-scale network of comments about politics on the site Reddit.com. Reddit is widely used, ranking 18th in the world and fifth in the United States in site visits (Alexa, n.d.). Approximately 6% of Americans use Reddit, and 68% of users report that it serves as a source of news (Shearer & Gottfried, 2017). Furthermore, in a 2016 Pew study, approximately 45% of users reported getting campaign news from the site (Barthel, Stocking, Holcomb, & Mitchell, 2016).

Importantly, the features of Reddit are different from Twitter and Facebook. For example, Reddit is structured as a collection of many different forums, which may pertain to any number of topics. Anyone with an account can participate in discussion on any forum, and the back-and-forth comment structure is visible to everyone. Moreover, the most popular discussion threads are pushed algorithmically to a "front page," where users who are not subscribed to the forum where the thread originated can see and contribute to the discussion. These features may have a profound impact on users' ability to engage with a diverse composition of other users, or they may facilitate distinct discussion spaces for specific viewpoints. We investigate how these features affect the structure of political discussion.

Ideology and Online Communication

A growing area of research concerns the extent to which online communication about politics shows evidence of political homophily between interacting individuals. Research on political discussions offline suggests that often our political discussion networks are made up of mostly like-minded conversation partners, but that conversations do occur between politically different individuals (Eveland & Hively, 2009; Huckfeldt, 2007). The extent to which the Internet fosters opportunities for conversations that cross ideological divides is an area of open research. Understanding these phenomena helps us to know when and how online social media contribute to or detract from normative goals such as increased political knowledge and participation. Similarly, investigating these phenomena helps researchers to understand how conversation online contributes to or detracts from political polarization and social network heterogeneity.

The most common argument for a process that would engender increased political homophily is the selective affiliation thesis. Simply put, the argument suggests that in circumstances where people have increased choice in communication partners, they will tend to select those conversation partners with whom they share a common set of beliefs (Kossinets & Watts, 2009; Lazarsfeld & Merton, 1954). Selection can be motivated by similarity on a variety of both relevant and seemingly irrelevant characteristics

(Centola & van de Rijt, 2015). In social media contexts, studies have found powerful selection effects (e.g., Lewis, Gonzalez, & Kaufman, 2012), though comparatively little attention has been paid to the ways in which selection might be contextual. Further research has defined the mechanisms through which selective affiliation takes place. For example, research has suggested that positive selection is much stronger than avoidance (Huckfeldt, 2007). The mechanism of selective affiliation for online political discussion more often takes the form of selection into conversations with like-minded groups and through seeking out pro-attitudinal content, rather than avoidance of ideologically distant groups or counter-attitudinal content (Garrett, 2009b). If so, the extent to which online media affords users mechanisms for positive selection should structure if and when politically homophilic groups emerge, rather than the extent to which online media facilitate avoidance.

The degree to which online conversations occur primarily between politically like-minded individuals is an area of debate in the research community (Colleoni, Rozza, & Arvidsson, 2014; Garrett, 2009a; Munson & Resnick, 2010). Research has suggested that the circumstances in which online conversation takes place may impact the extent of political homophily in online conversation partners. For example, Garrett (2009b) shows that people use the affordances of the web to increase exposure to information they are likely to agree with. Recent research also suggests that social interactivity and algorithms may increase people's likelihood of encountering such information (Bakshy, Messing, & Adamic, 2015). As such, understanding how the affordances of a website affect user choices enables researchers to understand how online conversations about politics take place.

Similarly, the degree to which online interactions about politics resemble "conversations" differs depending on the features of the online environment in which one interacts. Some sites enable users to only post a message, while others enable users to interact through comments on messages, to comment on comments on messages, and so on. Sites that enable this type of interaction, such as Reddit, enable users to interact through conversations that are more similar to traditional conversations than other forms of online media. Such forums enable rounds of conversations with messages, replies, replies to replies, and others joining existing conversations, and constitute conversations that are more similar to face-to-face interactions.

Although some features of the web may increase the tools available to individuals who wish to encounter more opinion-reinforcing information, other theories suggest that the effect may be more limited. The inadvertancy thesis suggests that individuals may be exposed to a more diverse set of political ideas online because they encounter these ideas without seeking them out (Brundidge, 2010). Research in online contexts has shown that social network site usage in general is correlated with exposure to diverse political views (Y. Kim, 2011; Y. Kim, Hsu, & Gil de Zúñiga, 2013; B. Kim & Kim, 2017; Lee, Choi, Kim, & Kim, 2014). Research in offline contexts has shown that in relatively apolitical spaces, such as the workplace, people are more likely to encounter political difference as the selection processes, particularly concerning politics, are weak (Mutz, 2006; Mutz & Martin, 2001). This may map onto online spaces, particularly when users are engaged in apolitical activities, or when they encounter

one another in forums that are not explicitly dedicated to political topics (Wojcieszak & Mutz, 2009). Recent evidence from Twitter suggests this may be the case—users discussing political topics show high rates of interaction with like-minded users, but for otherwise similar news events that are less political, people interact with users with a wider array of ideological preferences (Barberá, Jost, Nagler, Tucker, & Bonneau, 2015; Himelboim, McCreery, & Smith, 2013).

More generally, the differences between situations in which political homophily emerges may be attributed to the extent to which selection into like-minded groups occurs through active engagement versus through more passive processes. Recently, scholars have begun to differentiate between two processes that may drive positive selection. One process is through *exposure* to information that is similar or dissimilar to one's existing beliefs. In some circumstances, there is homophily in terms of exposure (e.g., Bakshy et al., 2015), but in others there is exposure to diversity (e.g., Brundidge, 2010). Another process concerns *engagement* with information that is similar or dissimilar to existing beliefs. Recent work has suggested that, using these criteria, homophily is substantial (Flaxman, Goel, & Rao, 2016). Because conversation requires a more active selection into an interaction and engagement with others, it is likely that conversations will exhibit significant homophily.

Research on offline conversations suggests that people's interactions frequently cross ideological divides (Eveland & Hively, 2009; Huckfeldt, Johnson, & Sprague, 2004), but that as people exhibit further choice in conversation partners they are likely to have a preference for those who are ideologically similar (Mutz, 2002, 2006). Similarly, research on online environments has consistently shown that people tend to interact with others who are ideologically similar (Barberá et al., 2015; Himelboim et al., 2013), but that social media use may increase perceptions of disagreement (Barnidge, 2017). However, most research concerning online interaction focuses on interactions that do not resemble conversations, such as Facebook friendship or Twitter following. Moreover, studies of these social networking sites tend to treat the entire interaction space as one forum, whereas the structure of Reddit allows for topically discrete forums, which in turn may impact how users further select into engagement with similar or dissimilar discussion partners.

Many of the subreddits we examine are explicitly ideological or partisan (e.g., r/conservative or r/liberal). Others, however, are devoted to general political discussion or attempt to promote discussion across ideological divides (e.g., r/NeutralPolitics and r/moderatepolitics). The decision to submit a post or comment to a subreddit is an active form of engagement. Notably, the users we examine are making active choices to engage in discussion of politics from particular points of view and of particular topics with other users who, presumably, have engaged in the same forums for similar reasons. As such, we expect that there will be political homophily in the network of comments on Reddit—we expect positive selection.

Hypothesis 1 (H1): *Online political conversation dyads will show evidence of positive selection into networks of like-minded individuals.*

Less is known about how patterns of ideological conversation change over time. Users who are highly interested in politics may discuss political matters frequently, whereas those with a more mild interest in politics may only do so during election campaigns or when significant political events take place. Hardy and Scheufele (2009) show that the rate of people's face-to-face conversations about politics spikes surrounding significant campaign events. Furthermore, the authors suggest that in these conversations, people express less certainty about candidate issue positions as people attempt to reconcile political events with their political views. Previous work using survey data on self-reported interactions showed that political homophily decreased as the 2008 election approached (Gentzkow & Shapiro, 2011). Evidence from Twitter suggests a similar pattern—Twitter posting activity is highly reactive to political media events (Lin, Keegan, Margolin, & Lazer, 2014). This makes sense theoretically as well, as individuals are driven to encounter information with high utility, including information that has utility because it is counter-attitudinal (Garrett, Carnahan, & Lynch, 2013). On Reddit, the way in which conversation threads are presented algorithmically may impact these processes (Thorson & Wells, 2016). On days on which political events take place, threads discussing these matters may attract many users, pushing them to the front pages of their respective forums or to the front page of the site overall.

It is likely that when high-profile political events occur, two processes could take place. First, users who frequently post in political forums could change their activity by increasing their posting behavior or by changing where they post. If users were to post in a broader set of subreddits, the diversity of interactions on such days would increase. Second, users who infrequently post in political forums may be drawn to comment about these events in forums dedicated to politics. These users may seek information in order to better understand these events or they may feel that in typical political environments they do not have much to contribute, but as high-profile events take place they may be more likely to engage in political forums they otherwise would not engage in. Therefore, we expect that in periods in which high-profile political events take place, conversations on Reddit will be more diverse.

Hypothesis 2 (H2): *Political conversations will be more likely to occur between ideologically diverse dyads surrounding high-profile political events.*

An important aspect of online communication, particularly in discussion forums, is that conversations may grow to include more individuals over time. The size of the group has been shown, in other contexts, to have important impacts on how communication takes place (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002) and the subsequent outcomes of the group process (Balliet, 2009). Research on online networks has shown that network size is positively related to news use (Barnidge, 2015). However, the extent to which new group members affect the diversity of political views in a given conversation is an open question.

On Reddit, a user may make a post and another user may reply, and subsequent users may reply to either the original post or to the reply through iterative interactions.

Comment threads attract a highly varying number of users. One of the chief features of forums such as Reddit is low barriers to participation; nearly anyone with an account can join the conversation. Reddit is an amalgam of many different forums, and so interactions are not limited to one space. These affordances arguably weaken social barriers on the site, increasing the potential for users to inadvertently encounter other users with dissimilar views (Brundidge, 2010). Reddit enables nearly any user to join nearly any conversation. These low barriers, and one-way selection (i.e., a user may join a conversation even if those she is responding to do not want her to join), may enable users to diversify existing conversations in terms of ideology.

Research Questions 1 (RQ1): *As new members join a conversation, do they increase the political diversity in the conversation?*

The degree to which people separate into like-minded conversation spaces is likely to be significantly influenced by the extent to which they are self-selecting into conversation spaces in which politics is likely to be discussed. That is, Reddit offers users a very easy and active process through which they may engage with or avoid politics. We expect that when users wish to engage with political information, in most instances they are actively seeking out forums in which they will engage with others with similar views. However, when users post to forums dedicated to other aspects of life, such as popular culture or nonpolitical news, the active selection process is based on other characteristics, such as shared interests, that are only weakly correlated with political views (Brundidge, 2010). Previous work on Twitter has shown that in such instances, people may be less likely to encounter political information, but when they do, they are more likely to encounter counter-attitudinal information (Barberá et al., 2015).

The structural features of Reddit make it an ideal testing ground for understanding how one's intention to engage with others about political ideas impacts the diversity of those with whom one engages. Conversation on Reddit is divided into a wide array of subreddits, or sub-forums dedicated to specific topics. Some subreddits cater to ideologically specific political talk, whereas others invite a wider array of political discussion, and many more still are concerned with topics that are not typically political. This assortment enables users to make active choices regarding whether to engage in political discussion at all, and if so, with either like-minded or dissimilar users. However, other subreddits either specifically invite diverse discussion or avoid the question entirely. In these instances, the ability to engage in selection or avoidance for political preference is limited. We expect that users who post and comment in subreddits devoted to politics are likely to engage with others with mostly similar ideas, as users may make active choices to selectively affiliate with a community that they perceive to be made up of like-minded users. However, we expect that in subreddits in which politics is not the predominant conversation topic, dyads will exhibit much less evidence of political similarity.

Hypothesis 3 (H3): *Conversations about politics in forums in which the topic of conversation is unlikely to be about politics will show little or no evidence of political preference in conversation partners.*

Measurement of Ideology From Social Media Engagement

Many theories of political communication rely on relationships between the ideological positions of the actors involved. For example, theories concerning selective affiliation (i.e., homophily; Lazarsfeld & Merton, 1954; McPherson, Smith-Lovin, & Cook, 2001), echo chambers (e.g., Garrett, 2009a, 2009b), and exposure to cross-cutting political information (Mutz, 2002) rely on estimates of the political preferences of interacting individuals. However, the ideology of individuals is often difficult to unobtrusively measure because researchers must rely on indicators of it rather than observing it directly. The increasing availability of behavioral indicators of political preferences, particularly from large-scale online data, enables researchers to estimate ideology from the behavior of users. In doing so, the set of individuals for whom an ideological measurement may be estimated is vastly increased. Because social media data often also have evidence of the communication patterns of users, these techniques offer researchers opportunities to study political communication in new ways and at vastly larger scales. Methods that enable researchers to infer political preference from such data provide opportunities for testing theories of political communication in online environments and in social networks. Indeed, previous work has used data from Facebook (Bond & Messing, 2015) and Twitter (Barberá et al., 2015; Colleoni et al., 2014) for precisely these purposes.

Below, we present a method for estimating the ideological positions of users of Reddit. Similar to other forms of social media such as Twitter, users may signal their ideological positions through where they choose to post messages on the website. The method we detail enables us to estimate the ideological positions of a broad set of Reddit users—as long as a user has contributed a post or comment (submission) to at least one subreddit related to politics, we are able to estimate an ideological position for the user.

Structure of Reddit

Reddit is a social media website that enables users to post content to the site, to comment on the posts made by others, and to vote on the content made by others, among other functionalities. Content on the site is organized into user-created and user-moderated "subreddits" that may be about nearly any topic or content area. Politics is a popular area of conversation on the site. Many subreddits have been created for the discussion of a variety of political ideologies, parties, candidates, issue areas, and so on. This makes Reddit an important data source that may be used to understand online political discussion.

The subreddit structure of the website enables users to engage in both positive selection—into subreddits where one expects like-minded users—and avoidance—away from subreddits where one expects dissimilar users. Reddit should facilitate conversations between like-minded users in subreddits that are politically homogeneous. We first examine subreddits that are expressly about politics. The vast majority of the

subreddits concern ideological positions, candidates, or issue positions that should map easily onto the ideological spectrum.

The structure of Reddit means that, in most instances, users engage in active selection processes to encounter other users and the information they provide. Users must select which subreddits to encounter, whether or not to subscribe to them, how frequently to consume information, and whether or not to actively engage with other users on a given subreddit by posting and commenting. As such, the selection processes suggest that users who do post and comment are engaging to a significant degree in ways that are different from exposure on other forms of social media, such as on Facebook (Bakshy et al., 2015), where exposure to political information may be a byproduct of using the site for other purposes.

Measurement of Ideology

Data

We collected all submissions made to 101 popular subreddits[1] concerning politics that were made between January 1, 2016, and June 30, 2017. In total, there were 29,752,000 submissions made by 693,498 users over the period. Data were collected from a publicly available database of Reddit submissions maintained by Google's BigQuery tool. This period covers the 2016 U.S. presidential election and the first 6 months of the new administration. The presidential campaign was widely regarded as one of the most negative campaigns in modern U.S. history. Although scholars are only beginning to understand the particular dynamics at play, early work suggests that demographic and partisan trends were substantially different in 2016 than in other recent elections (e.g., Mutz, 2018). Furthermore, the period was marked by a series of significant political events both before and after the election, including controversy over Russian interference with the election.

We begin our exploration of the data by examining the number of submissions made on each day throughout the 18-month period. Figure 1 shows the number of submissions made across all 101 subreddits on each day. The number of submissions varies substantially and important political events correlate with spikes in submissions. On some days in which little occurred in the political world, only a few thousand new submissions are made. On the day with the most new submissions (the day after the 2016 U.S. presidential election), more than 300,000 new submissions were made. On average, each day received 57,191 new submissions ($SD = 25,962$). It is also notable that there is a general increase in political talk from 2016 to 2017—although there was a large increase in submission activity following the presidential inauguration, the level of posting decreased to a more typical baseline by mid-February 2017, but the baseline level in 2017 is substantially higher than the baseline in 2016. Although the number of submissions increases in early 2017, it is possible that this increase is due to a general increase in submissions to Reddit. To distinguish an increase in political talk from an increase in overall Reddit submissions, we separated the 18-month period into three 6-month intervals and calculated the proportion of all Reddit submissions that went to our sample of political subreddits. From January 2016
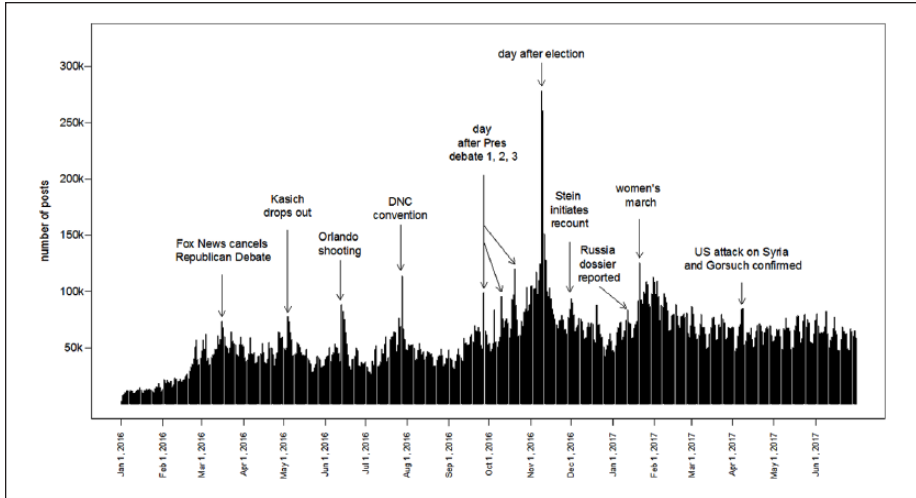
Figure 1. Number of submissions made to 101 political subreddits on each day between January 1, 2016, and June 30, 2017.
Note. DNC = democratic national committee.

to June 2016, the proportion of submissions to political subreddits was 1.5%, from July 2016 to December 2016 it was 2.7%, and from January 2017 to June 2017 it was 2.2%. It is not surprising that the interval including the 2016 U.S. presidential campaign has the highest proportion of posts to political subreddits, but it is notable that the proportion in early 2017 is about 1.5 times as much as in early 2016. This suggests that interest in political conversation, at least among the politically-engaged Reddit community, has increased since the 2016 U.S. presidential election.

We next examined patterns in posting and commenting behavior by users and across the subreddits. Most users have posted or commented in only one or a small number of subreddits—the average number of political subreddits posted to is 1.50—while a few submit to many—the maximum is 80. Similarly, most subreddits have a modest number of users, typically a few thousand, while a few have more than 10,000 unique contributing users. The maximum number of users in a particular subreddit is 443,741 (r/The_Donald), with an average of 10,294 unique contributing users in each subreddit. The uneven distribution of user submission behavior is important to account for when creating ideological estimates. Users differ significantly in their propensity to submit to subreddits in general, and subreddits differ significantly in the extent to which they attract users to contribute. Therefore, the model we use accounts for these factors when estimating the latent ideological measure.

Method

We approach the estimation of ideological positions of users of political subreddits using the logic of latent space models in social networks (Barberá et al., 2015). The method uses ideas from item response theory to measure a latent variable from a set of

behavioral indicators. A key assumption of the application of such models to data from social media is that users form connections in homophilic ways (McPherson et al., 2001)—users prefer to form connections to entities that are similar politically. That is, we expect that users who are ideologically similar will tend to form connections to similar subreddits, and those who are ideologically distant will tend to not form connections. In our case, we expect that users will tend to post and comment in subreddits that they perceive will attract users who are similar in ideology to themselves and tend to refrain from posting or commenting in subreddits that they perceive to attract users who are ideologically dissimilar. Previous work has shown that large-scale, online networks such as Twitter (Barberá et al., 2015) and Facebook (Bond & Messing, 2015) exhibit political homophily in a similar fashion.

More formally, suppose that we have N Reddit users who choose whether or not to submit to J subreddit forums. Let y_{ij} denote the decision by user i to submit to subreddit j and that $y_{ij} = 1$ ($y_{ij} = 0$) indicates that user i has (has not) posted or commented in the subreddit, where $i = 1, \ldots, N$ and $j = 1, \ldots, J$. With this framework, we can describe the ideal point model for users and subreddits as

$$y_{ij}^* = \alpha_i + \beta_j - \left\| x_i - z_j \right\|^2 + \epsilon_{ij} \,..$$

in which $\|\cdot\|$ represents the Euclidean norm, and ϵ_{ij} is the error term (Barberá et al., 2015). The ideal point for Reddit user i is x_i and for subreddit j is z_j. The logic of the model is that as the distance between a user and a subreddit increases, the likelihood that a user will make a post in that subreddit decreases. The ideal points for both users and subreddits are simultaneously estimated so that the ideological positions of users and subreddits are similar if the users post in the subreddit. That the model estimates parameters for both the users and the subreddits means that by estimating the model, we are able to measure ideal points (ideology estimates) for both users and subreddits on the same scale. The model enables us to account for the varying propensities of users to submit to multiple subreddits and for subreddits to attract varying numbers of users through the model parameters α_i and β_j, respectively. The inclusion of the α_i and β_j parameters in the model is analogous to including fixed effects for each user and each subreddit in a regression model. The model recovers ideal points that are unrelated to the users' and subreddits' underlying propensities to submit across subreddits and for subreddits to attract more or fewer users.

The model above includes separate parameters for all users and all subreddits. Because of this, the model quickly becomes quite complex. Fortunately, researchers have produced algorithms that enable the estimation of the model through approximation. To estimate the model, we use the network item response theory estimation procedure that uses expectation maximization to substantially more quickly estimate the model described by Imai, Lo, and Olmsted (2016) and implemented in the emIRT package in *R*. We then standardize the resulting measures such that they have a mean of 0 and a standard deviation of 1, making the scale easier to interpret. For example, a user with a value of 1 would be one standard deviation to the right (more conservative) of the average user.

Results

Validation

The nature of the underlying scale the model estimates is unknown without validation. Because of this, it is particularly important to investigate the ideological estimates the model produces and to compare them to users' stated political preferences. We also note that, although the model assumes that people make decisions about which subreddits to post in, we make no assumptions about the patterns of conversation within or across the subreddits. That is, we assume that people select which subreddits they prefer to submit to. However, the model does not use data from patterns of interaction between users.

To validate the measures, we rely on "user flair." On Reddit, users may display flair with their posts. In many subreddits, authors may create a text string that appears next to their username when they create a post in the subreddit. Flair helps to communicate to other users some aspect of the posting user's identity. For example, a user's flair might read, "AZ—Trump supporter—MAGA," in which case the user is likely signaling the state in which they reside (Arizona), that they support Donald Trump, and they have used the campaign slogan of then-candidate Trump ("MAGA" stands for "Make America Great Again"). Many users self-identify using politically relevant author flair in the subreddits that we observe. We make use of this by searching for commonly used terms that should be predictive of a user's political ideology. We collected flair from all users who used author flair at least once ($n = 113,541$). Although users who make use of author flair account for 16.4% of the total set of users in the data, they made 55.3% of the total number of submissions. This suggests that users who make use of author flair constitute a relatively active set, and may also be relatively sophisticated.

Figure 2 shows the average ideology as measured from posting behavior of users who included certain keywords in their author flair.[2] As the figure shows, users who include conservative terms (e.g., "trump," "maga," "conservative") are on the right end of the scale, while those with liberal terms (e.g., "communist," "democrat," "socialist") are on the left. Terms related to political moderation (e.g., "moderate," "centrist," "independent") are relatively central. The results suggest the scale is successful at identifying the political positions of users. However, it is noteworthy that the order of the average ideological estimates is not perfectly aligned with expectations (e.g., "centrist" is to the right of "republican"). Although we are unable to know precisely why this is, it is possible that some terms are more likely to be used sarcastically, or that certain moderate terms (such as "centrist") are more likely to be adopted by those who avoid partisan labels but nonetheless are ideologically more extreme.

The Ideological Structure of Conversations on Reddit

Using the ideological scale we created above, we investigated the extent to which the conversations on Reddit about politics are between ideologically similar Reddit users. To do so, we examined a common and visible pattern in communication on the site:
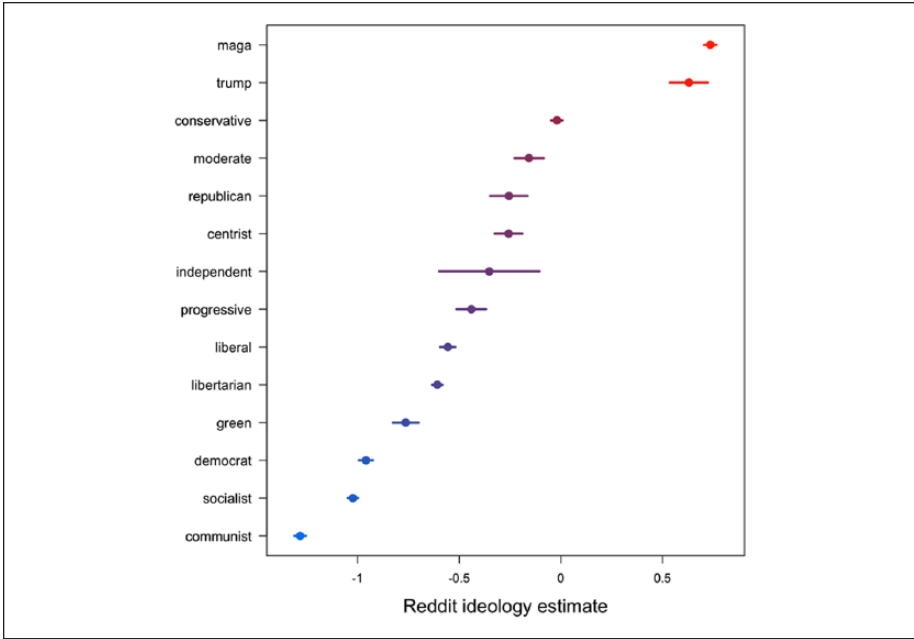
Figure 2. Validation of user-level ideology estimates.
Note. The average ideology of users displaying each term in their user flair. Each point represents the average ideology of users who use each term in their user flair. Lines represent the 95% confidence intervals of the averages. The color of the points is on a scale from blue to red that is related to each group's average ideology. The category "maga" is short for "Make America Great Again," the campaign slogan for Donald Trump's 2016 presidential campaign.

comments on the submissions made by others. The structured way in which users comment on the submissions made by others enables us to understand when a user is commenting on a post made by another user, a subsequent user comments on the comment made by a user, and so on.

We tested H1 by examining the correlation between the ideology of a user who makes a submission and the ideology of a user who comments on the initial user's submission. The overall correlation is positive and significant ($r = .58$, $p < .01$),[3] which supports H1. Across all submissions, 70.80% of commenters had a difference in estimated ideology of one standard deviation or less. Clearly there is positive selection in ideological posting, but the correlation is not so high that users are interacting only with like-minded others.

To test H2, we separately calculated the correlation in ideology for each day in the 18-month period, shown in Figure 3. Note that over the entire period, the correlation is always positive. This suggests that there is substantial political homophily in the commenting network across time. The date with the highest correlation is January 17, 2016 ($r = .82$, $p < .01$), when 87.20% of interactions were between users with a
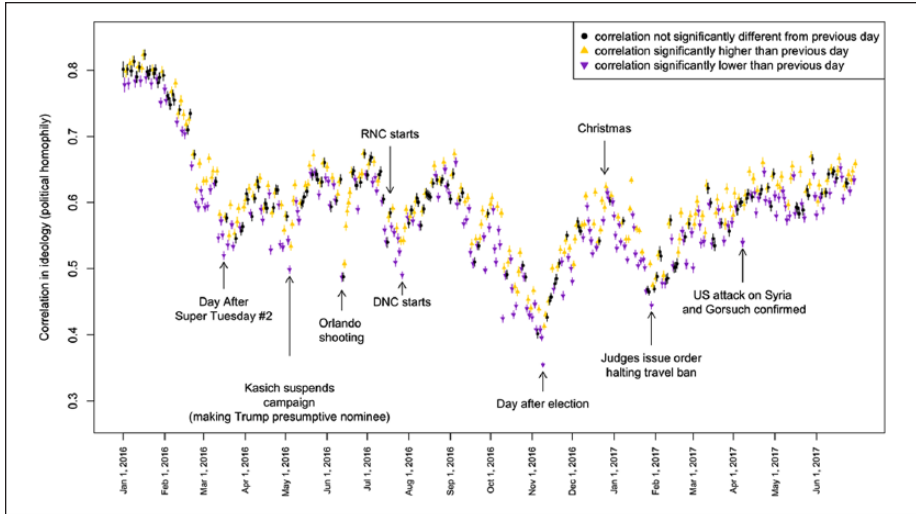
Figure 3. Correlation in ideology of post author and post commenter over time.
Note. Points indicate the correlation coefficient for the day and lines are the 95% CI of the estimate. CI = confidence interval.

difference in ideology of less than one standard deviation. The date with the lowest correlation is November 9, 2016 ($r = .35$, $p < .01$), the day after the U.S. presidential election, when only 56.40% of interactions were between users with a difference in ideology of less than one standard deviation. The figure suggests that on days in which there are political events, the correlation in ideology between users decreases.

We next compared each day's correlation with the previous day's correlation using Fisher's Z test for comparing two correlations (Fisher, 1925) and implemented in R by Diedenhofen and Musch (2015). Overall, we found that on 35.3% of days there was a significant decrease in correlation from the previous day, on 36.9% of days there was a significant increase in correlation from the previous day, and on 27.8% of days the correlation was not significantly different from the previous day, at the $\alpha = .05$ level. There are only two instances in which the correlation increases or decreases significantly for more than four consecutive days.[4] Although there is significant variability from day to day, overall trends are also clear. For example, in the weeks leading up to the 2016 general election, the trend is for decreasing correlation values and in the weeks following the election the trend is for increasing correlation values.

To further test H2, we performed an autoregression analysis in which the correlation observed on each day is predicted by the previous day's correlation (i.e., r_{t-1}) and the correlation from 7 days prior (i.e., r_{t-7}), and an indicator variable for whether a political event occurred on the day or on the previous day.[5] The results show that there is a significant negative relationship between political events and the correlation in ideology between interacting users on a given day ($B = -0.01$, $p < .01$; see Online

Appendix for more details). As described in the theoretical development of H2, we highlight two processes that may account for the decrease in correlation surrounding political events: increased breadth of posting activity and that new users may be attracted to converse about politics. In the Online Appendix, we detail post-hoc tests of these mechanisms, the results of which suggest that both processes occur.

Importantly, the number of unique users who submit on a given day is highly correlated with the number of submissions made on a day. The degree to which posting behavior on the site exhibits a high degree of partisan homophily is predicted by the number of users conversing about politics. On days when little political news has occurred, users who are relatively dedicated to discussing politics submit to the site, and do so in a highly homophilic way. On days when important political events occur, many users who otherwise do not submit to the political subreddits come to the site to discuss the day's events and, crucially, discuss the events with a relatively diverse set of other users. Although the positive selection of like-minded conversation partners persists—on days of relatively low correlation in ideology between conversation partners, the correlation is above .35—the effect is diminished.

We investigated RQ1 by examining the degree to which political homophily exists throughout levels of commenting. That is, User A may make a post that is commented on by User B. User B's comment may be commented on by User C, and so on. To examine whether a post may set off a cascade of similar posting, we examine the correlation between the ideology of a user who makes a submission and the ideology of those who comment on the submission (commenter Level 1, the correlation between User A and User B as well as User B and User C), the ideology of a user who makes a submission and the ideology of those who comment on the comments on that submission (commenter Level 2, the correlation between User A and User C), and so on, for up to six levels of separation between the original user and subsequent commenters. The results of this analysis are presented in Figure 4. We found that the initial commenters on a post are highly likely to have a similar ideology ($r = .75$, $p < .01$). Subsequent commenters also have similar ideologies to the initial poster, but with each subsequent step in the commenting chain, the correlation in ideology with the initial poster decreases. By the sixth level of commenting, the correlation in ideology between the initial poster and the commenter is much lower, though still positive and significant ($r = .36$, $p < .01$).

The figure suggests that the extent to which chains of commenters have similar ideologies varies across the ideological spectrum. Both liberals and conservatives show strong evidence of positive selection into like-minded conversations. Conservatives appear to have more diverse interactions, though the diversity is across the conservative end of the ideological spectrum, as evidenced by the degree to which observations spread across the full conservative spectrum (the upper right of each panel). Liberals show stronger evidence of positive selection even within the liberal end of the ideological spectrum (the lower left of each panel). This suggests that, although both groups show strong evidence of political homophily, conservatives show less evidence of political homophily within their ideological in-group. However,
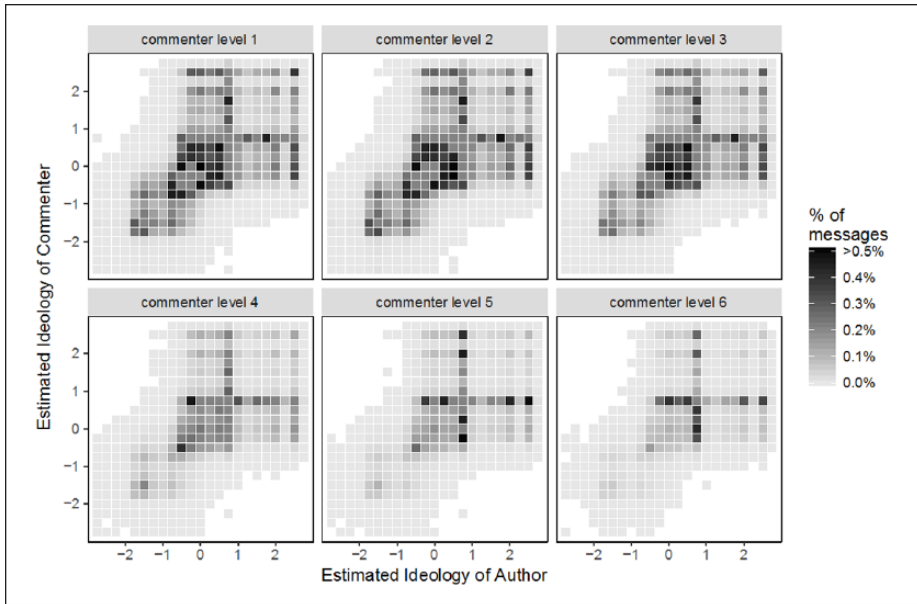
Figure 4. Political homophily in commenting on posts in political subreddits.
Note. The intensity of the shading of each cell corresponds to the percentage of comments on posts by users with estimated ideology scores of *x* and commenters with ideology *y*. Political homophily would be maximized if all posts were along the diagonal.

the ideological similarity as subsequent users join the conversation is stronger for a post started by a conservative user than for a post started by a liberal user.

Finally, we investigated H3—the relationship between the ideology of the author of a submission and the author of subsequent comments in forums outside of political subreddits. We collected all submissions that were made by a user for whom we had a measure of ideology and the post was commented on by another user for whom we had an ideology measure in nine popular subreddits.[6] We filtered these to only include submissions that included the names of the last names of the 2016 presidential candidates ("Trump" and "Clinton") or the names of the two major political parties ("Republican" and "Democrat"). Although this is a conservative method for identifying political posts, we feel confident that such posts concern politics. We read a random sample of the submissions and all of those that we read referenced politics. In total, we collected 129,905 additional submissions containing these terms made by these users between January 1, 2016, and June 30, 2017. We created heatmaps, shown in Figure 5, that visually display the relationship between author and commenter ideology across these nine subreddits.

The correlations in the ideology of the author of a submission and a commenter on that submission across all nine subreddits are very weak. The subreddit in this set with the highest correlation was r/movies ($r = .04$, $p < .01$). This suggests that there is some
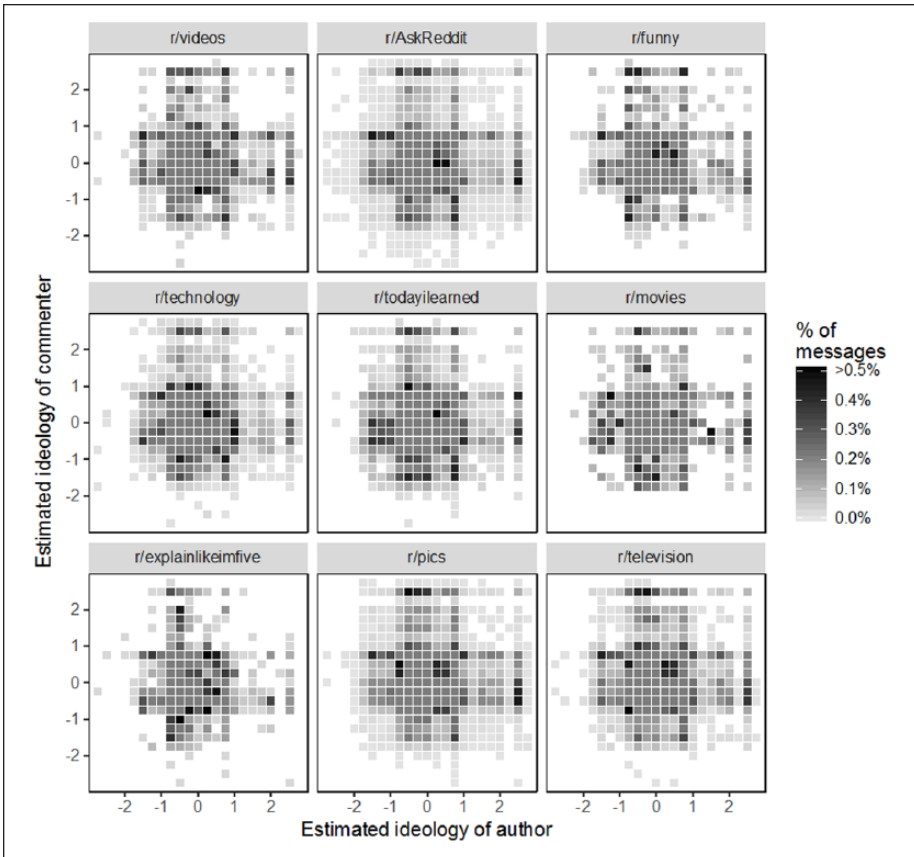
Figure 5. Political homophily in commenting on posts in nonpolitical subreddits.
Note. The intensity of the shading of each cell corresponds to the percentage of comments on posts by users with estimated ideology scores of *x* and commenters with ideology *y*. Political homophily would be maximized if all posts were along the diagonal.

positive selection in the r/movies subreddit, but that in others there is little such effect. Indeed, in both r/funny ($r = -.04, p < .01$) and r/videos ($r = -.04, p < .01$), there is suggestive evidence of heterophily, or the tendency to interact with those who are politically different. All other subreddits had correlations between $-.02$ and $.03$. The difference between interaction patterns in political subreddits and nonpolitical subreddits is substantial—when politics is not the main topic of the forum, the positive selection effect disappears.

Discussion

This article makes several important contributions to the literature on political communication. First, we observed that the overall composition of political conversations

on Reddit is similar to offline political conversations and interactions on other social media in that there is significant homophily, but users encounter users with dissimilar ideologies as well. Furthermore, the degree to which conversation dyads show preference for similarity in political ideology varies considerably over time. In other words, we find that the selective affiliation thesis is conditioned by the prevalence of political events, and enhanced by features of online media particular to Reddit. Specifically, the evidence suggests that in periods of low political activity and interest, users seek to communicate with like-minded individuals. Interestingly, when high-profile political events occur, two important phenomena transpire: (1) many users come to the site, presumably to discuss the events of the day and (2) on such days, users are much *less* likely to comment on the posts made by like-minded fellow users. This is consistent with prior work that showed that ideological segregation online decreased as politically salient events approached (Gentzkow & Shapiro, 2011). Our results show the significant effect that events have on the diversity of conversation from day to day. The sensitivity of the correlation may owe to some degree to how Reddit organizes information. The extent to which politics is discussed and where may be highly responsive to the prominence that such information has on the site. It is possible that diversity-seeking individuals tend to be drawn to participate in political conversations surrounding focusing political events but are less apt to do so overall. It seems plausible that on days in which few important political events take place, that those who discuss politics on the site are more likely to have high degrees of political interest and involvement. Research has shown that such individuals are more polarized in their political views (Fischer & Mattson, 2009), which could result in an increased propensity to seek out similarly polarized conversation partners. Our research suggests that the political conversation networks of relatively highly politically involved individuals on Reddit may be similarly polarized.

Although the subreddit structure of the website significantly affects traffic to pages, one feature of the site may impact how broad the set of users posting on a given topic may be. Reddit features a front page (r/all) that lists the most popular trending threads from all subreddits. The rank ordering of threads on this page is an algorithmic function of the number of "upvotes" and "downvotes"—akin to "likes" on other social media platforms—that a given post receives, relative to the amount of time the thread has been active (Salihefendic, 2015). In this way, users can interact with the algorithmic curation on Reddit to bring to the forefront issues and discussions which they deem to be noteworthy (Thorson & Wells, 2016). On days in which politically focusing events occur, it is likely that some threads from political subreddits appear on this front page. We also found that as events occur new users who had not previously posted in such subreddits do so, potentially increasing the diversity of conversation on these days.

Second, we examined how far the similarity in ideology between a submitting user and subsequent commenters extends. We found that the ideology of an initial user is highly correlated with subsequent commenters' ideologies, but that the relationship deteriorates as commenters are further removed in the comment tree from the initial author. This suggests that comment chains do share a common ideology, but that the ideological diversity of the set of authors engaged in a conversation increases as

subsequent users join the conversation. This helps us to understand the extent to which political homophily not only exists, but also the extent to which it persists throughout evolving conversations. The results suggest that positive selection goes deep into the resulting conversation, but that as it does so, the signal decays.

Third, we found that the relationship between author and commenter ideology was much weaker in subreddits not related directly to politics. Indeed, the contrast between the patterns in Figures 4 and 5 shows how strong the relationship is for subreddits dedicated to political conversations compared with the other subreddits. This finding is similar to previous work showing that political homophily is weaker outside of dedicated political conversations (Barberá et al., 2015; Brundidge, 2010; Munson & Resnick, 2010; Wojcieszak & Mutz, 2009). Reddit also facilitates avoidance of politics, and it appears that this impacts the types of users an individual interacts with. In instances where the active selection of politically like-minded conversation partners is more difficult, politically homogeneous conversations are less likely to form.

Understanding the extent of political homophily and how it varies over time is important for understanding the normative implications that exposure to political views in online networks may have. Prior work has found that some individuals only engage in political talk online (Stromer-Galley, 2014), and that those who engage in online talk prefer diverse conversation partners (Stromer-Galley, 2002). This research suggests that Reddit may offer opportunities for such diverse discussion. Furthermore, research has shown that network heterogeneity is positively related to political participation (M. Kim, 2018; Lu, Heatherly, & Lee, 2016; Min & Wohn, 2018). This research suggests that political events may drive users to interact with a more diverse ideological network, which may in turn have positive effects on political participation. Future research should endeavor to further investigate these relationships.

The approach we use has both advantages and drawbacks. First, the population of Reddit users is not representative of the U.S. population. The user-base overwhelmingly skews young, male, and urban/suburban (Duggan & Smith, 2013). Interestingly, though, the prevalence of racial minorities active on Reddit may prove to be useful for examining intergroup interactions on social media (e.g., Amichai-Hamburger & McKenna, 2006). Looking specifically at users who seek out politically relevant information from the website suggests a less representative sample, as the lack of representativeness intensifies and the prevalence of members of minority groups drops considerably (Barthel, Stocking, Holcomb, & Mitchell, 2016). As demographics correlate significantly with political ideology, the underrepresentation of diverse groups in political discussion on Reddit shapes both the interactions and the content of those interactions on the site.

Our analysis strategy similarly has strengths and weaknesses. For example, our analysis of the effect of political events on homophily assumes that all of the political events we observe have a similar effect on political selection processes and that these effects endure a similar length of time. It is much more likely that some events have a strong influence on homophily and some are weak, and that some endure for longer than others. Similarly, we have a very rough measure of political talk in nonpolitical

threads. It is possible that political talk that occurs in more subtle ways in such threads exhibits higher or lower levels of homophily.

Similarly, the method we use for validation has advantages and drawbacks as well. Author flair is a nonintrusive measure and enables users to self-describe their political beliefs in any way they see fit. One challenge with this measure is that its consistency is unknown. To try to better understand the internal consistency of author flair use, we calculated the overlap in the use of conservative, liberal, and moderate terms in author flair as described above. Overall, 1.4% of authors who used either a liberal or conservative flair used both, 1.5% of authors who used a liberal or moderate flair used both, and 0.5% of authors who used a conservative or moderate flair used both. This indicates that it is unusual for authors to use inconsistent author flairs across subreddits. However, author flair is used by a subset of users who are particularly active on the site. It is possible that the degree to which true political views and our measurement for political views differ among users who have used author flair and those who have not.

Conclusion

Research that combines estimates of political ideology with evidence of communication practices enables us to investigate patterns of communication in vast networks. Our research suggests that, although online political communication does often show significant positive selection into conversations with like-minded individuals, the extent to which that is the case varies across time and the forum in which interaction takes place. As more communication occurs online, having methods and techniques to study such data is of increasing importance. Such media enable users to connect and communicate with a diverse set of other users, and enable researchers to investigate communication practices and impacts at a scale previously not possible.

Declaration of Conflicting Interests

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Notes

1. We identified as many political subreddits as possible and included all such subreddits that had a subscriber base of at least 250 users at the time of data collection.
2. See the Online Appendix for further examinations of the validity of the ideology measure.
3. It is possible that the construction of the measure of ideology through subreddit posting could account for some of the observed correlation. To test for this, we used two procedures. First, we randomly split the full set of subreddits in half, estimated ideology in the

same way as before but only using each half of the data, and calculated the ideology of interacting users in the held-out other half of subreddits. We found significant, positive correlations in ideology in both of the held-out sets of interactions, with correlation coefficients that are substantively similar to the correlation from the full data. Second, we tested this by simulating a null model and found that the observed correlation is significantly higher than in the null model (see the Online Appendix for more details).

4. From June 14, 2016, to June 19, 2016, the correlation increases each day, back toward the baseline level after the Orlando nightclub shooting. From December 12, 2016, to December 16, 2016, the correlation decreases each day.

5. Similar to Hardy and Scheufele (2009), we define political events as significant news or campaign events related to politics. We identified 65 events of significant political importance that drew considerably media attention over the 18-month period (e.g., the Iowa caucuses, presidential debates, James Comey's letter to Congress regarding the investigation of Hillary Clinton, Donald Trump's inauguration). See the Online Appendix for more details and a timeline of these events.

6. We investigate the following subreddits: r/AskReddit (n_{posts} = 47,859), r/explainlikeimfive (n_{posts} = 3,545), r/funny (n_{posts} = 3,853), r/todayilearned (n_{posts} = 8,748), r/videos (n_{posts} = 5,754), r/movies (n_{posts} = 2,040), r/pics (n_{posts} = 33,120), r/technology (n_{posts} = 11,711), and r/television (n_{posts} = 13,365) because they are among the 25 most popular subreddits and because they span a wide array of popular culture.

Supplemental Material

Supplemental material for this article is available online.

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