

ORIGINAL ARTICLE

**Social Media, Network Heterogeneity,
and Opinion Polarization**Jae Kook Lee¹, Jihyang Choi¹, Cheonsoo Kim¹, & Yonghwan Kim²¹ School of Journalism, Indiana University, Bloomington, IN 47405, USA² Department of Telecommunication and Film, University of Alabama, Tuscaloosa, AL 35487, USA

Employing a national probability survey in 2012, this study tests relationships between social media, social network service (SNS) network heterogeneity, and opinion polarization. The results show that the use of social media is a positive predictor of the level of network heterogeneity on SNSs and that the relationship is mediated by several news-related activities, such as getting news, news posting, and talking about politics on SNSs. Testing the association between SNS network heterogeneity and polarization, this study considers 3 different dimensions of opinion polarization: partisan, ideological, and issue. The findings indicate that political discussion moderates the relationship between network heterogeneity and the level of partisan and ideological polarizations. The implications of this study are discussed.

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A few days before the U.S. presidential election in 2012, a contrast of red and blue seems to cover the entire country. It does not take long to spot concerns about highly polarized politics between Republicans/conservatives and Democrats/liberals. On November 4, 2012, *The New York Times* reported “the country is now dominated by solidly Democratic states on the coasts and solidly Republican ones in the interior and in much of the South” (Liptak, 2012). The bipolar clusters of red and blue are observed in virtual spaces as well as on geographic maps. Online space is found divided into left-leaning and right-leaning clusters on the blogosphere (Adamic & Glance, 2005) and on Twitter (Conover et al., 2011). Nonetheless, the question remains whether public opinion has been indeed polarized and whether it will be, despite the contrasting colors of maps on paper and on the screen (Fiorina & Abrams, 2008; Nivola & Brady, 2006).

Confounding the problem is the proliferation of new spheres of communication; the most recent example being the social media. Do social media facilitate or attenuate polarization? Concerning the impacts of the new spheres, two competing hypotheses provide fairly different predictions. The first states that individuals are

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more likely to expose themselves to likeminded points of view while avoiding dissimilar perspectives, leading them to form more extreme opinions in the direction of their original inclinations, thanks to the characteristics of online space, such as more choices in media sources and networks and more effective filtering tools (Sunstein, 2001; Van Alstyne & Brynjolfsson, 2005). The other hypothesis predicts that new media will enable individuals to encounter more diverse views and thus to have more moderate positions on political matters (Bimber, 2004; Papacharissi, 2002). The Internet provides “a flexible and adaptable set of opportunities for communication” (Bimber, 2004, p. 31). Among these opportunities, the essence is the ability of the Internet to bring “people from different cultural backgrounds, states, or countries to virtual political discussions in a matter of minutes, often expanding each other’s horizons with culturally diverse viewpoints” (Papacharissi, 2002, p. 23).

Both the predictions broadly consist of two-step arguments: from individual exposure to (likeminded or diverse) communication networks and to (de)polarization. The goal of this study was to test the competing hypotheses about polarization in each of the two steps by shifting our focus from offline networks to social media networks. Social network services (SNSs) provide an ideal ground for investigation of the relationships between exposure to communication networks and polarization, in that the SNS is, by definition, a space for information exchange and discussion (Park, Kee, & Valenzuela, 2009). Along this line, studies have examined how use of social media such as Facebook is associated with exposure to dissimilar viewpoints and discussion network heterogeneity (Kim, 2011; Kim, Hsu, & Gil de Zúñiga, 2013). Such research leads to the next phase of discussion on the relationships between the use of new media, communication networks, and polarization. First, beyond the relationship between general SNS use and network heterogeneity, it is necessary to investigate the roles played by different types of SNS usages. Literature has demonstrated that distinctive patterns or types of media use often lead to differing political consequences (Wojcieszak & Mutz, 2009). Thus, it is likely that multidimensional activities on SNSs have varying associations with diversity level of networks. In this sense, we explore whether and how certain SNS activities (i.e., posting comments, getting news, and talking about politics on SNSs) mediate the relationship between SNS use and network heterogeneity. Second, we attempt to reveal links between network heterogeneity and opinion polarization in the context of social media, investigating a conditioning variable in the connection. Empirical findings about the links have been fairly mixed (Parsons, 2010; Taber & Lodge, 2006). Such results are, to some extent, attributable to variables that moderate the relationship. Given the definition of social media as a ground of communication exchange, it is probable that political discussion plays such a moderating role in the association between network heterogeneity and opinion polarization. Thus, we test the possible conditioning of political discussion.

This study investigates the relationships among the individual use of SNS, network heterogeneity, and opinion polarization. Employing a national probability

survey, we first examine the associations of people's SNS use activities with network heterogeneity of their SNS and then explore the relationship of the SNS network heterogeneity with opinion polarization. Findings will contribute to extending the understanding of interplays between online communication networks and the level of opinion polarization.

Social media and network heterogeneity

Since the rise of the Internet and subsequent formation of the new media environment, contrasting predictions have been put forth with regard to individuals' media selection, which in turn could relate to the public's opinion formation. Some argue that individuals will be more selectively exposed to likeminded information, which is compatible with their existing belief system, thanks to heightened availability and selectivity of information (Sunstein, 2001). Still others contend that individuals will have more chances to come across diverse information and viewpoints in the new information system (Papacharissi, 2002).

The question of whether people will be exposed to more diverse communication networks poses significant ramifications to the future of democracy. If individuals are increasingly exposed to only likeminded information sources, it is likely that the society will be more fragmented into pieces and more polarized into two extreme positions (Nie, Miller, Golde, Butler, & Winneg, 2010; Stroud, 2010). The progress of fragmentation and polarization will be a serious threat to the functioning of democracy, because the society will have less common ground and the public will be less tolerant to opposing opinions (Sunstein, 2001).

The two competing arguments first differ in their positions about the process of individual exposure to communication networks. Research has identified mechanisms of the exposure to likeminded information sources, such as cognitive dissonance (Festinger, 1957; Klapper, 1960). Studies have shown that people are more likely to select information sources consistent with their partisan political predisposition (Iyengar & Hahn, 2009; Stroud, 2008, 2010) and selectively seek out information about public affairs issues that they think are personally important (Kim, 2009). Nevertheless, there also are findings which indicate that individuals still do not avoid uncongenial information sources and thus often come across opposing points of view (Garrett, 2009; Garrett, Carnahan, & Lynch, 2011). Though individuals tend to seek out information consistent with their own pre-existing opinions (Knobloch-Westerwick & Meng, 2011; Stroud, 2008, 2010), they do not actively and systematically sacrifice contact with challenging opinions (Garrett, 2009; Gentzkow & Shapiro, 2011). People are still likely to encounter political differences, even when they have no intention of seeking political information in groups where both political and apolitical activities coexist (Wojcieszak & Mutz, 2009). Such exposure to diverse points of view is reinforced and augmented, in particular, by structural characteristics of the new media environment. "Blurred and porous boundaries between websites" facilitate inadvertent exposure to political perspectives from the other side of the ideological hallway (Brundidge, 2010, p. 685).

It seems that the “porous boundaries” have become much more dense on social media, due to the algorithms by which one can deliberately choose with whom to interact. For example, many SNSs provide functions to filter out nonlikeminded people by blocking contact with them such as “unfriending.” For this reason, some view social media as a huge echo chamber (Aiello *et al.*, 2012; Conover *et al.*, 2011). However, others suggest that boundaries on SNSs are still porous enough to facilitate exposure to uncongenial perspectives. On social media, one can maintain larger networks with less investment (Ellison, Steinfield, & Lampe, 2007) and expand their daily networks beyond the immediate boundaries of their family or local communities (McLeod & Lee, 2012). Indeed, it was found that the use of SNSs expands the number of social ties (Hampton, Goulet, Rainie, & Purcell, 2011), which may correlate with heterogeneity of networks (Huckfeldt, Mendez, & Osborn, 2004). In addition, political orientation is not the only criterion people deploy to decide whether to make friends with someone, because individuals use SNSs to gratify diverse needs such as socializing, entertaining, self-status seeking, and information seeking (Park *et al.*, 2009; Quan-Haase & Young, 2010). Recent research has reported that people do not systematically weed out interaction with dissimilar others on SNSs (Bisgin, Agarwal, & Xu, 2010). When they disagree with opinions posted on social media, most SNS users (66%) say they typically ignore the posts, while relatively few people (18%) have actually blocked, defriended, or hidden the contacts (Rainie & Smith, 2012).

As a subspace of the Internet, the SNSs share the structural characteristics that reinforce the encountering of diverse perspectives. Further, the structural characteristics and various individual motivations work together to lead SNS users to a networked space where both political and apolitical activities occur. These characteristics are, subsequently, likely to facilitate people’s exposure to information that is not necessarily consistent with their existing belief system (Brundidge, 2010; Wojcieszak & Mutz, 2009). In fact, studies have found a positive relationship between social media use and network heterogeneity. The more individuals use SNSs, the more likely they are to know people with a variety of occupations (Hampton, Lee, & Her, 2011). Political use of SNSs was found to significantly predict probability of encountering political information challenging their predisposition (Kim, 2011). In addition, social media use (*i.e.*, Facebook and Twitter) has a positive association with discussion network heterogeneity (Kim *et al.*, 2013). Drawing on findings of previous research, we expect that social media use will be positively associated with the level of network heterogeneity on SNSs (H1).

Mediating social media use to network heterogeneity

Frequent SNS users are likely to have more heterogeneous networks on SNSs, because they engage in activities that facilitate interactions with diverse individuals, such as exchanging information and expressing their opinions (Brundidge, 2010; Valenzuela, Arriagada, & Scherman, 2012). As a new space for communication, SNSs enable citizens to participate in a number of different activities from information exchange to socializing to entertainment seeking (Quan-Haase & Young, 2010). Among various

activities, informational use of social media (i.e., reading news, posting messages, and joining political discussion) could play a mediating role in the relationship between individuals' general use of the SNSs and network heterogeneity. The mechanism could be explained with a sequence of two paths. First, given that SNSs function as information hubs that allow users to share and exchange news or information, frequent users of social media tend to be more involved in the informational activities on SNSs (Valenzuela, Arriagada, et al., 2012). This is because news or public affairs information constitutes the majority of content circulated in social media, and SNS users can easily engage in discussion with others about various issues using unique features of SNSs, for example, clicking the "like" buttons and commenting on friends' posts (Kwak, Lee, Park, & Moon, 2010). Second, such informational activities on SNSs may have associations with individuals' network heterogeneity. Frequent posting of informational content and participation in political discussion online lead to more heterogeneous networks, because those activities increase inadvertent contacts with diverse others (Brundidge, 2010; Kim, 2011). When posting comments regarding social issues, SNS users are likely to be exposed to diverse opinions from various people.

Indeed, research has reported evidence for certain online activities connecting general use and other variables. Expression of political opinions and online messaging mediate the association between online news use and political network heterogeneity (Brundidge, 2010). In a study of political engagement, three forms of activities on Facebook—using Facebook for news, expressing opinions, and socializing with friends—were found to mediate the relationship between Facebook use and protest activities (Valenzuela, Arriagada, et al., 2012). Furthermore, online political messaging mediates the connection between political use of social media and exposure to political differences (Kim, 2011).

These findings suggest that frequent use of social media leads to higher levels of network heterogeneity on SNS, because they are more engaged in certain information-related activities on SNSs. Therefore, we hypothesize that the informational usage pattern of the social media—that is, getting news, posting news, and talking about politics on the SNSs—will mediate the relationship between social media use and the level of the SNS network heterogeneity (H2).

Network heterogeneity and polarization

Discussions about the relationship between new media use and opinion polarization often involve whether certain media use is associated with exposure to likeminded or diverse viewpoints and communication networks as a linkage: the more (or less) individual exposure to diverse perspectives, the lower (or the higher) the level of polarization. In the current environment, citizens are exposed to broader and more diverse social connections in online spaces like social media, and the political consequences prompted by such changes have begun to draw much scholarly attention (Kim, 2011; Valenzuela, Kim, et al., 2012). In this sense, it deserves thorough investigation and should be put to the test by examining how network heterogeneity is associated with polarization in the social media setting.

Much of polarization literature has focused on individuals' political predispositions, such as partisan affiliation (Abramowitz & Saunders, 2008; DiMaggio, Evans, & Bryson, 1996), and their media use patterns (Nie et al., 2010; Stroud, 2007, 2010) as determinants of polarization. Another line of research has emphasized the structure of social networks as a factor that has significant effects on the level of polarization (Mutz, 2002; Sunstein, 2000). The structure of social networks is deemed important in explaining attitude polarization mainly because it tends to function as individuals' information environment, where various political messages are diffused (Huckfeldt & Sprague, 1987, 1995; Huckfeldt et al., 2004). Given that individuals located within heterogeneous networks (where people from diverse backgrounds exchange information) are more likely to be exposed to diverse perspectives and, accordingly, are more likely to become familiar with politically dissimilar views.

The political consequences of exposure to dissimilar views have long been a subject of polarization research, but findings are largely mixed. A group of deliberation theorists have argued that exposure to diverse communication networks may have depolarizing effects. They posit that the presence of political disagreements tends to stimulate critical thinking or deliberation (Delli Carpini, Cook, & Jacobs, 2004), thus encouraging individuals to take opposite views into consideration, foster understanding of diverse perspectives, and ultimately induce consensus among citizens through modification of their views toward those favored by others (Gutmann & Thompson, 1996; Habermas, 1989 [1962]). Empirical research, indeed, has revealed that exposures to opposite views tend to increase political tolerance and awareness of the legitimate arguments underlying opposing perspectives (Mutz & Mondak, 2006; Price, Cappella, & Nir, 2002). Furthermore, heterogeneous social networks depolarized people's attitude toward political candidates by increasing negative emotions toward the in-party candidate and positive emotions toward the out-party candidate (Parsons, 2010).

On the other hand, it is contended that exposures to diverse political views amplify pre-existing political predilections and produce more extreme positions in the direction of one's original positions. Studies have found that encounters with dissimilar views indeed result in more extreme attitudes about such topics as affirmative action and gun control (Taber & Lodge, 2006), same-sex marriage and sexual minority rights (Wojcieszak & Price, 2010), stem cell research (Binder, Dalrymple, Brossard, & Scheufele, 2009), homosexuality (Munro & Ditto, 1997), and attitudes toward political candidates (Meffert, Chung, Joiner, Waks, & Garst, 2006). *Biased information processing* is suggested as the reason for that (Taber & Lodge, 2006). One of the information-processing mechanisms is called confirmation bias, by which individuals give unequal attention and weights to information that supports their own position (Nickerson, 1998; Taber & Lodge, 2006). Such motivated information processing is thought to explain why encountering dissimilar opinions further exacerbates strong predilections (Wojcieszak & Price, 2010). Further, some people end up with more extreme positions even after they actively seek out dissimilar or disagreeable political information. This process is labeled as motivated skepticism

(Ditto & Lopez, 1992; Taber & Lodge, 2006) or disconfirmation bias (Edwards & Smith, 1996), by which people scrutinize information that is inconsistent with their prior positions more thoroughly in order to counter argue and reinforce their own prior perspectives.

The conflicting observations and findings suggest that the relationship may also depend on the value of a third variable, such as political discussion. It is likely that political discussion works as a moderator of the relationship between network heterogeneity and polarization, because studies have suggested that the extent of exposure to dissimilar views within social networks and the frequency of political discussion tend to work interactively in building citizens' opinions. Those who have a higher degree of exposure to political disagreement and take part in discussions more frequently tend to have the largest "argument repertoire," which refers to the range of arguments people hold both in support of and against their position on a political issue (Price *et al.*, 2002). Given that an understanding of the arguments underlying supporting and opposing perspectives is an essential component in determining the direction and strength of people's opinions, it can be inferred that the structure of social networks when combined with discussions of political issues would have a distinctive association with the polarization of opinions. Moreover, the structure of the network and political discussion are closely linked with each other such that having more diverse discussion partners tends to lead citizens to participate in the discussion of political issues more actively (Blau, 1977; McLeod *et al.*, 1999).

Another reason for the moderation of political discussion is that the effects of the information that one obtains from social networks may depend on the level of people's discussions with others. Simply being exposed to diverse political views does not necessarily mean that the information is seriously considered in determining one's political opinions. Instead, the process of discussion in which people try to make sense of new ideas encountered in their social networks may stimulate reflective thinking (McLeod *et al.*, 1999), thus yielding the blending of diverse opinions through the interpersonal give-and-take of political talks. In fact, political discussion tends to facilitate citizens to process newly obtained information more meaningfully (Scheufele, 2001). Further, the frequency of such discussion affects the usefulness of the information encountered within individuals' network, as people tend to process new information more carefully when they anticipate discussion with others whose political views differ from their own (Hardy & Scheufele, 2005). If this is the case, the relationship between network heterogeneity and opinion polarization will be dependent on the frequency of the discussions that individuals have in their everyday life.

When coupled with more frequent discussions, the exposure to heterogeneous networks enhances awareness of rationales for both oppositional and congenial positions (Mutz, 2002; Price *et al.*, 2002). This means that discussion is likely to negatively moderate the association between network heterogeneity and polarization. However, it is also possible that the combination of the exposure and discussion leads to less-balanced and more polarized opinions because arguing one's own

position requires more unified understanding of conflicting information obtained in the networks (Guerin & Innes, 1989). In either case, the extant research indicates that political discussion would play a conditioning role in the relationship. Thus, we expect that political discussion will moderate the association between the SNS network heterogeneity and opinion polarization (H3).

Method

Data

This study used a national survey to test the hypotheses. The survey was administered to adults across the United States from May 3, 2012, to May 10, 2012. Respondents were selected using probability sampling and invited to be part of a nationally representative panel maintained by a professional organization, Clearvoice Research Panel. For a more accurate representation of the U.S. population, this national sample was based on two U.S. Census variables: gender and age. Respondents consisted of 1,032 adult Americans and the response rate was 17.3%. While the response rate was relatively low, it was within the acceptable range for panel web-based surveys (Sax, Gilmartin, & Bryant, 2003). In order to increase data quality, we used list-wise deletion to address missing cases largely found in party ID and ideology. This method is known to estimate approximately unbiased regression coefficients (Little, 1992).

Measurement

Social media network heterogeneity

Based on previous studies (Brundidge, 2010; Scheufele, Hardy, Brossard, Waismel-Manor, & Nisbet, 2006), the SNS network heterogeneity is measured by a battery of questions asking respondents about the frequency of communication exchanges with various groups of people. The groups include “people of different gender,” “people with extreme right views,” “people with extreme left views,” “people who are Democrats,” “people who are Republicans,” “people of a different race or ethnicity,” and “people of different religion.” For each group, we asked, “On social network sites, how often do you talk to people listed below?” An index was built by summing up the seven variables ($M = 13.66$, $SD = 5.15$, range = 0–21, Cronbach’s $\alpha = 0.90$).

Polarization

In order to measure the individual level of polarization, this study used four different variables of partisan, ideological, and two issue-based measures, following Wojcieszak and Rojas (2011). We use absolute values of responses to questions about political parties, political ideology, and issues, based on previous research (Mutz, 2002; Stroud, 2010). Partisan polarization is measured by the difference between the feeling thermometer index of political parties of Democrat and Republican, which ranges from 0 to 100. The Republican thermometer scores were subtracted from the Democrat scores and then absolute values were calculated ($M = 36.47$,

$SD = 31.68$, range = 0–100). Ideological polarization is measured by the folded value of respondents' answer to a question of political ideology ($M = 0.77$, $SD = 0.73$, range = 0–2). If the answer is “moderate,” “somewhat conservative (liberal),” and “very conservative (liberal),” then one's score is 0, 1, and 2, respectively. To measure opinion polarization about specific issues, we used two questions asking favorability about same-sex marriage ($M = 3.13$, $SD = 1.48$, range = 1–5) and the health care reform ($M = 2.87$, $SD = 1.40$, range = 1–5). Again, the absolute values of responses to the 5-point Likert scale questions are used for polarization measures (same-sex marriage: $M = 1.21$, $SD = 0.86$, range = 0–2; health care: $M = 1.17$, $SD = 0.79$, range = 0–2).

Social media use

Social media use and more specific SNS use types were measured based on previous studies (Valenzuela, Arriagada, et al., 2012). Social media use is measured by a single item, asking for amount of time spent using social network sites ($M = 2.35$, $SD = 2.06$, range = 0–7). Different patterns of social media use are measured at three dimensions: getting news, posting news, and talking about politics on SNSs. Each variable is measured by a single item, which asks frequency of such actions on SNSs (getting news: $M = 1.70$, $SD = 0.99$, range = 0–3; posting news: $M = 1.25$, $SD = 1.01$, range = 0–3; talking politics: $M = 1.31$, $SD = 1.03$, range = 0–3).

Political discussion

This study uses a question asking frequency of general discussions about politics and current events to measure political discussion ($M = 1.82$, $SD = 0.88$, range = 0–3).

Control variables

Other variables were included as control, because literature has shown their relationships with polarization (Brundidge, 2010; Stroud, 2010). They are demographics (age: $M = 39.8$, $SD = 16.4$; gender: male = 51.6%; race: White = 77.2%; income: $M = \$45,500$, $SD = \$25,000$; education: $M = 11$ years of schooling), news media use (amount of time spent, range = 0–5, print newspapers: $M = 1.34$, $SD = 1.34$; TV news: $M = 2.80$, $SD = 1.58$; radio news: $M = 1.50$, $SD = 1.45$; Internet news: $M = 2.27$, $SD = 1.49$), and other individual characteristics (party ID: $M = 3.18$, $SD = 1.55$, range = 1–5, Republican to Democrat; Political ideology: $M = 2.80$, $SD = 1.04$, range = 1–5, conservative to liberal; Interest: $M = 2.28$, $SD = 1.22$, range = 0–4; knowledge: $M = 2.55$, $SD = 1.70$, range = 0–5, Cronbach's $\alpha = 0.74$). Considering its relationship with network heterogeneity (Huckfeldt, Johnson, & Sprague, 2004), we also included SNS network size (the number of friends) into analysis as a control ($M = 229.84$, $SD = 459.22$, range = 0–10,000).

Results

This study first specified an ordinary least squares (OLS) regression model to estimate the relationship between social media use and individual variations of the

Table 1 Regression Analysis of Social Media Network Heterogeneity, *unstandardized (SE)^a*

Predictor	SNS Network Heterogeneity
Age	−0.09 (0.02)***
Gender (being male)	−0.23 (0.41)
Education	0.10 (0.03)
Income	0.07 (0.10)
Race (being White)	0.50 (0.51)
Interest	0.57 (0.23)*
Knowledge	−0.20 (0.15)
Party ID	−0.13 (0.15)
Ideology	0.47 (0.24)*
Political discussion	0.65 (0.32)*
Newspaper	0.21 (0.17)
TV news	0.06 (0.15)
Radio news	−0.01 (0.16)
Online news	0.19 (0.17)
Social media network size	0.00 (0.00)
Social media use	0.51 (0.12)***

^a $N = 543$, list-wise. $R^2 = 0.22$.

* $p < .05$. ** $p < .01$. *** $p < .001$.

SNS network heterogeneity. Some demographic and control variables were found to have a significant relationship with the dependent variable. Age was found negatively associated with the SNS network heterogeneity, indicating that older individuals are more likely to have less diverse social media network. Table 1 summarized the findings.

Turning back to the proposed hypothesis, H1, that frequency of social media use will predict the network heterogeneity on SNSs, was supported. In Table 1, social media use was found to have a significant relationship with the SNS network heterogeneity, controlling for demographic and other variables of individual characteristics, and media use in the model ($B = 0.51$, $t = 4.38$, $p < .001$). The finding indicated that the more time an individual spends on social media such as Facebook and Twitter, the more likely that one has more diverse networks on the SNSs. The result is consistent with previous research, supporting H1.

We hypothesized that the relationship between general social media use and the network heterogeneity on SNSs will be mediated by variables representing specific usage patterns on social media, such as getting news, posting news, and talking about politics on SNSs (H2). To test the mediation hypothesis, this study employed a bootstrapping technique (Preacher & Hayes, 2004). This technique directly tests a mediating relationship, whereas traditional methods indirectly test it by looking at changes in magnitudes of associations between variables of interest (Preacher & Hayes, 2004). It has a number of advantages: for instance, testing of multiple mediators at

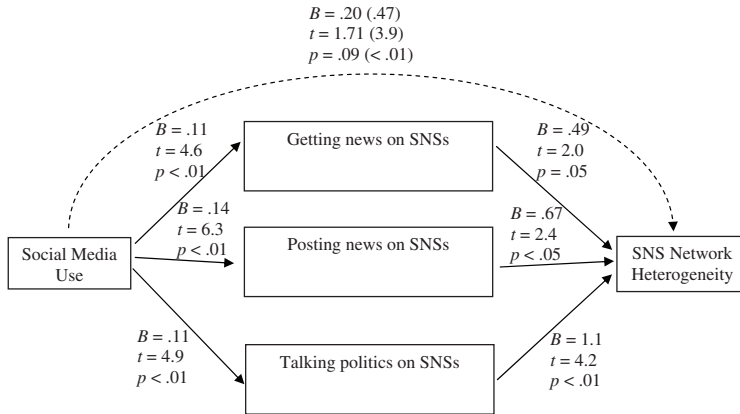


Figure 1 The relationship between social media use and network heterogeneity is mediated by the variables: getting news, posting news, and talking about politics on social media. The numbers in the parentheses are statistics before adding the mediators into the equation.

the same time and controlling for relationships between mediators. Because three mediators are hypothesized here, we performed the multiple mediation analysis. This study analyzed the 95% confidence intervals associated with the indirect effects of the three variables—getting news, posting news, and talking about politics on SNS—on the variations of the SNS network heterogeneity. When these confidence intervals do not include zero, this is evidence of significant mediation by theorized variables. The test results showed that effects of general social media use on the SNS network heterogeneity were relayed through specific SNS usage patterns: getting news on SNSs (95% bias-corrected and accelerated bootstrap confidence interval for the total indirect effect using 5,000 bootstrap samples = [0.0016–0.1252]), posting news on SNSs (confidence interval = [0.0247–0.1839]), and political discussion on SNSs (confidence interval = [0.0559–0.2092]). Figure 1 illustrates the mediating relationships. Three types of activities on SNSs emerged as significant mediators of the relationship, even after controlling for demographics, media use, and other individual characteristics. After inclusion of the mediators into the model, the direct effect of general SNS use on the network heterogeneity was found not significant ($B = 0.22$, $p > .05$), which indicated that variables of getting news, posting news, and talking politics fully mediate the relationship. The results support H2.

For investigation of the relationship between social media and polarization, we specified four regression models with OLS estimates, because we used four dependent variables to measure the level of polarization: partisanship, ideology, same-sex marriage, and health care reform. Results of the regression analysis are reported in Table 2.

We hypothesized that political discussion will moderate the relationship between the SNS network heterogeneity and the level of polarization (H3). As shown in Table 2, the interaction term of political discussion and the SNS network heterogeneity was

Table 2 Regression Analysis of Polarization, *unstandardized (SE)*^a

Predictor	Partisanship	Ideology	Same-sex Marriage	Health care Reform
Age	0.12 (0.11)	−0.00 (0.00)	−0.00 (0.00)	0.00 (0.00)
Gender (being male)	−6.50 (2.80)*	−0.11 (0.06) [†]	−0.21 (0.08)**	−0.01 (0.06)
Education	−1.12 (1.09)	−0.03 (0.02)	0.03 (0.03)	−0.00 (0.03)
Income	0.52 (0.68)	0.02 (0.02)	−0.00 (0.02)	0.00 (0.02)
Race (being White)	4.77 (3.49)	0.08 (0.08)	0.03 (0.10)	0.07 (0.08)
Party ID	0.84 (1.00)	0.01 (0.02)	0.04 (0.03)	−0.02 (0.02)
Ideology	1.81 (1.64)	−0.18 (0.04)***	−0.06 (0.05)	−0.09 (0.04)*
Interest	4.89 (1.61)**	0.05 (0.04)	0.05 (0.05)	0.09 (0.04)*
Knowledge	1.75 (1.04) [†]	0.04 (0.02)	0.07 (0.03)*	0.11 (0.02)***
Political discussion	0.53 (2.19)	0.11 (0.05)*	0.11 (0.06) [†]	0.10 (0.05)*
Newspaper	−0.68 (1.19)	−0.00 (0.03)	−0.03 (0.03)	0.03 (0.03)
TV news	1.39 (1.01)	0.02 (0.02)	−0.03 (0.03)	−0.02 (0.03)
Radio news	−1.12 (1.13)	0.05 (0.03)*	−0.03 (0.03)	−0.03 (0.03)
Online news	−1.26 (1.16)	−0.07 (0.03)**	0.00 (0.03)	−0.02 (0.03)
Social media use	−0.05 (0.86)	−0.00 (0.02)	0.04 (0.03)	0.01 (0.02)
SNS network heterogeneity	−0.47 (0.32)	0.00 (0.01)	0.01 (0.01)	0.01 (0.02)
Discussion × SNS network heterogeneity	0.82 (0.33)*	0.02 (0.01)*	−0.01 (0.01)	0.01 (0.01)
R ²	0.11	0.16	0.08	0.18

SNS = social network service.

^aN = 499, list-wise.[†]p < .10. *p < .05. **p < .01. ***p < .001.

found significantly associated with two variables of polarization level, partisanship polarization ($B = 0.82$, $t = 2.52$, $p < .05$) and ideological polarization ($B = 0.02$, $t = 2.48$, $p < .05$). More details of the interaction effects are shown in Figure 2. A striking contrast was found: The higher level of SNS diversity led to more partisanship polarization for individuals participating in more political discussions whereas it had almost no effects on partisanship polarization for those joining fewer political discussions. It showed a similar pattern for ideological polarization. Figure 2 also shows that the higher the SNS network heterogeneity, the more polarized in ideology, for people who talk about politics more often, whereas the higher SNS network heterogeneity has only minimal connection with ideological polarization for those who talk about politics less often. Indeed, the SNS network heterogeneity matters as long as political discussion is taken into consideration in terms of its relationship with polarization of partisanship and ideology. However, the same pattern was not observed for other two dependent variables of polarization. There were no significant moderation effects of political discussion for attitude polarization about same-sex marriage and health care issues.

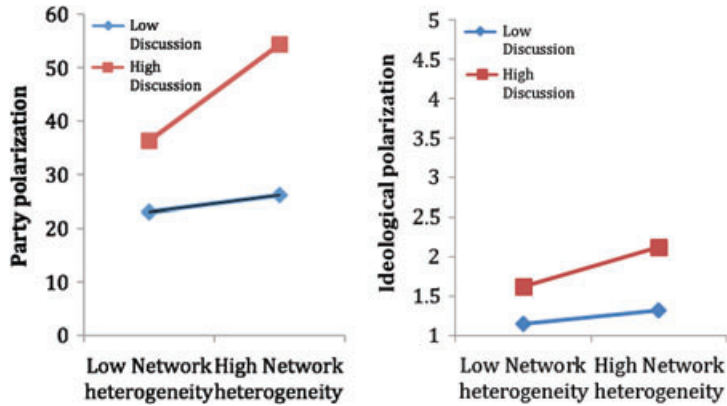


Figure 2 Interaction effects of political discussion and SNS network heterogeneity on partisanship and ideological polarization. SNS, social network service.

Discussion

This study investigated the relationships between social media use, the network heterogeneity on the social media, and opinion polarization, using a national probability survey in the United States. We examined how individual use of social media is associated with the heterogeneity of one's network on SNSs and tested mediation hypotheses about the relationship. We also tested political discussion as a possible moderator of the relationship between the SNS network heterogeneity and polarization. The findings first confirmed that general use of social media is positively associated with the SNS network heterogeneity, even after controlling for demographics and other key variables of individual characteristics. Consistent with previous research, the results indicated that individuals who frequently use social media such as Facebook or Twitter are likely to have more diverse networks on SNSs. The findings add evidence for rather optimistic predictions about the impacts of social media on exposure to diverse information sources. The rapid development of communication technologies has brought a variety of projections about influences that new media may have on the future of democracy. One of the pessimistic arguments in this matter is that people will be increasingly exposed to likeminded social networks and thus will be more fragmented and polarized, due to enhanced selectivity of the new media (Sunstein, 2001). However, this study points to the opposite direction as long as it is concerned with the network heterogeneity on social media. It is likely that social media indeed facilitates an individual's exposure to diverse perspectives when she is on Facebook, Twitter, or other social media sites.

Activities on social media are not one dimensional; therefore, it is warranted to provide more detailed mapping of the relationship between social media use and the network heterogeneity. This study showed parts of this map, by identifying mediating variables of individual activities on SNSs: getting news, posting news, and talking about politics. The findings demonstrated that such specific activities relating to

the informational use of social media fully mediate the relationship between social media use and the individual variation of the SNS network heterogeneity. These findings are consistent with previous studies demonstrating that the informational uses of media can contribute to desirable outcomes such as expanding one's social boundaries, networks, and participatory activities (Brundidge, 2010; Valenzuela, Arriagada, et al., 2012). What matters for the network heterogeneity turns out to be news- and information-related activities on social media.

Overall, findings about the connection between social media and the SNS network heterogeneity shed some light on the question about the future of public life in the changing media environment. This study suggests that rapidly expanding social media is very likely to facilitate higher diversity of individuals' SNS network, which may lessen the concerns about the so-called echo chamber effect on the Internet. As long as they are frequently on social media sites such as Facebook or Twitter, users will have more diverse social networks on the SNSs rather than flocking to groups with only likeminded people/individuals. At this point, the next question is about the kinds of activities one does on the SNSs. The mediation identified in this study clearly demonstrates the importance of news-related activities about public affairs in the process where the social media use is linked to the network heterogeneity.

Nevertheless, the heightened heterogeneity of the social media networks does not necessarily mean that individuals become more open-minded and moderate in their attitudes toward political matters. In fact, evidence is less clear in terms of the relationship between the SNS network heterogeneity and the level of opinion polarization. This study found no direct association of the SNS network heterogeneity with four different measures of opinion polarization. Regardless of whether it is about political party, ideology, or issues, the network heterogeneity on social media was not found to predict the level of polarization.

However, further investigation revealed that the link between the SNS network heterogeneity and attitude polarization is regulated by political discussion. As in Figure 2, citizens' discussion about public affairs was found to moderate the relationship. For individuals who join political discussions more often, the higher SNS heterogeneity is associated with more polarized opinion about party and ideology. On the other hand, for the people who participate in fewer discussions, the higher SNS heterogeneity is not so much related to polarized opinion. The findings of interaction effects are consistent with previous research, in that political discussion may regulate the relationship between media use and online activities (Wojcieszak, 2010) and may have direct association with opinion extremity (Binder et al., 2009). The network heterogeneity indeed matters in the process of polarization of opinion about party and ideology.

We speculate that the interaction effect is in part due to conditional activation of *biased information processing*—that is, confirmation bias and disconfirmation bias (Ditto & Lopez, 1992; Taber & Lodge, 2006). It is possible that the mechanism of the biased information processing is more likely to be activated for people with higher frequency of political discussion, because they have more chances and higher

expectations to explain and justify their own views. Indeed, people who are supposed to transmit information are likely to pay unequal attention to supportive information and, consequently, have more polarized opinions. The reason is that specific cognitive organization helping to form clearer and more unified thoughts tends to be activated when one expects to present his or her own views (Guerin & Innes, 1989).

In this case, despite diverse information available in their networks, they may selectively focus, through the biased mechanism, on subsets of the entire information, which are to be used in their future discussions. On the other hand, the mechanism might be less likely to work for people who participate in political discussions less frequently. In fact, political discussion involves more meaningful, careful consideration of information (Hardy & Scheufele, 2005; Scheufele, 2001) and thus would closely relate to the biased information processing. If an individual is more active in political discussions, she is likely to carefully process information gained from her social media networks due to her high chances and expectations of future discussions. The careful consideration of information is likely to be fairly selective, which in turn boosts the probability of biased processing of information. Relating to this point, research also has demonstrated that people tend to discuss politics and public affairs with likeminded others (Huckfeldt & Sprague, 1995) and that the most frequent interactions in networks are likely to occur with the most homogenous discussion partners (Mutz & Martin, 2001). It is, therefore, quite probable that people who frequently talk about politics would process information more selectively and have discussions with likeminded people, which is associated with the formation of more polarized attitudes through the activation of the biased information processing. However, the current data did not measure details about how one processes information acquired inside online social networks and how she uses it during discussions, which limits us from testing the speculation. This issue should be addressed in future research.

Nevertheless, the findings of this study provide a clue to the mixed results found in existing literature on the relationship between the network heterogeneity and polarization, but there are some additional points to consider. It should be noted that the moderating effects of political discussion were found only for the party and ideological polarization, not for issue-related measures of polarization. This shows that there may be varying dimensions of opinion polarization, as suggested in Wojcieszak and Rojas (2011). The differing findings between party/ideology and issue-related polarization suggest that the underlying mechanism of partisan and ideological polarization is distinct from that of issue-related process. Individual evaluations of the more general objects, that is, party/ideology in this study, are dependent on the frequency of political discussion, but this is not the case for more specific objects of same-sex marriage and health care reform issues here. Hence, we speculate that the specificity of objects is one of the factors driving individual evaluations of public affairs and formation of polarized attitudes.

Though not theorized in this study, findings of knowledge effects show noticeable patterns in the division between party/ideology and issue-related polarization. As in Table 3, knowledge is found to predict the variance of two issue-related measures

of polarization, whereas there is no such association between knowledge and partisan/ideological polarization. This is consistent with previous research that the more knowledgeable are likely to move to more extreme issue positions by counter arguing claims incompatible with their political predisposition (Taber & Lodge, 2006). However, the knowledge effect is less clear in evaluations of more general objects such as presidential candidates (Parsons, 2010), as effects of knowledge were not detected on partisan and ideological polarization in this study. The differing knowledge effects again points to the role of object specificity in the process of attitude polarization.

Some caveats need to be noted in the interpretation of this study's findings. First, due to the nature of cross-sectional data, relationships observed here are not perfectly suitable for causal inferences. It is still possible that attitude polarization may influence patterns of media use or the structure of online networks. As Stroud (2010) articulated, constructs closely related to polarization, such as certainty and confidence, have been considered to predict individual exposure to information (Knobloch-Westerwick & Meng, 2009; Ziemke, 1980). The research suggests that more polarized individuals are likely to seek out uncongenial information, because they are sure of their ability to counter argue it. Also possible is that the less polarized tend to look for more likeminded sources, because they want to strengthen their less certain position. Unfortunately, this study is not allowed to test the direction of causality. And yet, there is some evidence that media use influences attitude polarization, rather than the other way around. In addition to experimental evidence (Knobloch-Westerwick, 2012), a multiwave survey showed that partisan selective exposure affects opinion polarization, although there was also indication, to a lesser extent, for the reverse direction in the findings (Stroud, 2010). Then, the associations found could be cautiously interpreted to indicate that network heterogeneity leads to partisan and ideological polarization. However, the reverse effects, albeit less likely, may also work. What is clear is that, in either causal direction, political discussion plays an important role as a moderator of the association. Nevertheless, for a better understanding of the causality, the relationship should be put to test with appropriate data.

Another point to be noted is that political discussion in this study was measured with the frequency of general discussions about politics, rather than considering the attributes of political discussion. The lack of such detailed measures may limit fuller investigation of moderating roles played by political discussion. As discussed above, the nature and context of political discussion have been found to influence various individual opinions and behaviors. For instance, whether people talk with those who share or challenge their perspectives may have different influences on attitudes and behaviors (Nir, 2005; Valenzuela, Kim, et al., 2012), exposure to dissimilar views contributes to increasing individual awareness of legitimate rationales for oppositional viewpoints, and levels of political tolerance (Mutz, 2002). For more detailed mapping of the moderation mechanism, it is necessary to incorporate various attributes of discussion and characteristics of discussion networks (e.g., frequency and disagreement; Kwak, Williams, Wang, & Lee, 2005; Valenzuela, Kim, et al., 2012).

Also, it should be considered that political discussion on SNSs may have unique characteristics distinct from those offline. Some SNS users (22%) stay away from posting or linking to political content for fear of offending others on their social network (Rainie & Smith, 2012). It is possible that this self-censorship may hinder deliberative function of political discussion occurring on social media, falling short of the ideal of public sphere (Habermas, 1989 [1962]). It may be such that participants in political discussions on SNSs already are more aware of political affairs and hold stronger opinions than others, which may result in further polarization of their attitudes through contacts with others in political discussions. In addition, the unique nature of SNS discussion may also differ by the type of social media: For instance, one may put stronger self-censorship on Facebook than on Twitter. Future studies should pay more attention to these inherent characteristics of discussion on SNSs.

The use of single-item measures was another limitation. For instance, one question for each variable was employed to capture individual variance in social media use and other activities. Although single-item measures have been used in the past, it is clearly time for researchers to shift to multi-item measures of social media use, particularly in light of the psychometric limitations of single-item measures and the substantive need to examine social media use in richer, more detailed ways.

Despite such limitations, this study contributes to further understanding of the heterogeneity of social networks and the process of opinion polarization in the new media environment. We first investigated how the general use of social media relates to the exposure to diverse communication networks. Growing passion and concerns about the impact of social media make it necessary to examine the relationship of social media use with the network heterogeneity. We also tested whether and how specific usage patterns connect the linkage between the frequency of social media use and the heterogeneity of the SNS network, and how the network heterogeneity, interacting with political discussion, is associated with polarization. The findings of mediation and moderation provided fuller pictures about the triangular relationship between social media use, the SNS network heterogeneity, and attitude polarization.

Just as social media has grown rapidly, so too have intensified arguments about its impact on public life. This research sheds some light on this debate by investigating the process from individual use of the social media to exposure to diverse communication networks on the SNSs and to attitude polarization. As the findings showed, the role played by social media in the realm of public opinion is not simply optimistic or pessimistic; rather, it depends on the complex interplay between individual characteristics and the structural nature of the social media. Further investigations will reveal a better understanding of these dynamics.

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