

Porous chambers, echoes of valence and stereotypes: A network analysis of online news coverage interconnectedness following a nationally polarizing race-related event

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## Abstract

Selective exposure to one-sided news coverage, especially of controversial geopolitical events, may contribute to growing social polarization. Existing research on “echo chambers”—fragmented information environments that amplify homogeneous perspectives—focuses on the degree to which individuals and social media platforms shape informational segregation. Here, we explore whether news organizations directly contribute to echo chambers through the hyperlinks they embed in online articles. Using network and text analysis, we examined coverage of the 2014 shooting of Michael Brown in Ferguson, Mo., and found that online news media exhibited weak community structure and high connectivity across news outlets. However, analyses also indicated that media sources were more likely to link to coverage that was similar to their own in terms of emotional valence and stereotype-relevant aspects of the events. While hyperlinking to diverse news sources may ameliorate fragmented information environments, selectively linking to similar coverage may contribute to growing polarization.

*Keywords: selective exposure, news media, polarization, echo chambers, network analysis, text analysis*

Porous chambers, echoes of valence and stereotypes: A network analysis of online news coverage interconnectedness following a nationally polarizing race-related event

Social psychologists have long studied the phenomenon of selective exposure to information consistent with individuals' pre-existing attitudes (for a review, see Smith, Fabrigar, & Norris, 2008). While recent work has focused on the role of individual preferences and motivations in seeking ideologically consistent information and avoiding exposure to contradicting information (e.g., Frimer, Skitka, & Motyl, 2017; Galdi, Gawronski, Arcuri, & Friese, 2012; Sawicki et al., 2013), social psychologists have also played a key role in illuminating situational factors of the information environment that increase exposure to like-minded perspectives beyond individual choice (Fischer, Schulz-Hardt, & Frey, 2008; Freedman & Sears, 1965; Johnston, 1996; Smith, Fabrigar, Powell, & Estrada, 2007). For example, in early work, Freedman and Sears (1965; 1967) stressed that it is not individual consumers alone who shape their exposure, but also that people tend to be exposed to more attitude-congruent information simply by nature of how this information is marketed and communicated (i.e., *de facto selective exposure*, such as political advertisements targeting neighborhoods already more likely to support the advertised candidate). In this paper, we aim to update the field's understanding of how the organization of the modern news environment may shape *de facto* selective exposure beyond consumers' choices and preferences, particularly in response to polarizing geopolitical events.

Recent research and the popular press suggest that selective exposure to like-minded news coverage is growing, with national news media consumption becoming increasingly polarized (Pariser, 2011; Pew Research Center, 2014a). In particular, researchers and journalists have suggested that individuals increasingly operate within online "echo chambers," fragmented

information environments that promote selective access to one-sided news coverage aligned with users' pre-existing attitudes and beliefs (e.g., Iyengar & Hahn, 2009). Given that continued exposure to like-minded perspectives in echo chamber-like environments can reinforce individuals' attitudes and make them more extreme in their views (DiFonzo et al., 2013), the proliferation of such media environments could exacerbate growing social and political polarization in America and across the world (Moody & Mucha, 2013; Westfall, Van Boven, Chambers, & Judd, 2015). The consequences of fragmented information environments for social polarization may be particularly severe in the context of charged geopolitical events where there are multiple interpretations of what happened. In these cases, selective exposure to one-sided media may not only strengthen users' attitudes, but also result in a different understanding of the basic facts of the event (Shapiro & Bloch-Elkon, 2008).

Despite increased attention to the potential effects of echo chambers, the degree to which information fragmentation in news media actually exists is unclear. Much of the work in this area has focused on social media platforms and users (Aiello & Barbieri, 2017; Bakshy, Messing, & Adamic, 2015; Barberá et al., 2015; Sharma, Hofman, & Watts, 2015), finding mixed results as to whether social media has increased or decreased exposure to cross-cutting content. However, researchers have yet to examine whether online news outlets directly contribute to the formation of segregated information environments—in other words, whether these news sources promote *de facto* selective exposure (Freedman & Sears, 1965; Sears & Freedman, 1967).

We propose that one way in which news media sources could reinforce or mitigate echo chambers is through hypertextuality: hyperlinks embedded within the text of online news articles that allow users to click through to another article or website (Deuze, 2003). Hypertextuality is a prominent feature of online news media (Deuze, 2003). Users not only notice and use hyperlinks

to access additional information in online news articles, but the presence of hyperlinks even affects the way individuals cognitively process online news, increasing attention, memory, and information-seeking (Borah, 2014; Wise, Bolls, & Schaefer, 2008). Informed by previous research on political blogs (Adamic & Glance, 2005), we suggest two routes by which news media organizations could directly contribute to echo chambers through the hyperlinks they choose to embed. First, media outlets may habitually link to articles from a limited and consistent set of other sources, and rarely link to content from sources outside this set. If this were the case, a user clicking on links to access additional information would be passively confined to articles from a narrow segment of the news media—the “chamber.” Second, media organizations may specifically link to like-minded sources that cover news events in a similar manner. In this case, the link-clicking user would not only be corralled within the chamber, but would also be consistently exposed to thematically homogenous editorial takes and presentations of underlying facts—the “echo.” Alternatively, news outlets could mitigate information fragmentation by linking to a wide variety of sources with diverse perspectives.

The question of how online news media are organized, absent social media or individual intervention, is important for several reasons. Digital news will soon be the dominant platform for information seeking, already overtaking television as the primary news source among adults under 50 (Mitchell et al., 2014), and research suggests that the majority of online news consumption occurs through direct browsing (as opposed to social media newsfeed or news aggregator recommendations; Flaxman, Goel, & Rao, 2016). Prior work in social psychology suggests that people’s selective exposure—and thus perhaps their resulting polarization—is driven by the interaction of their information environments and individual motivations (Freedman & Sears, 1965; Smith et al., 2007). Yet, despite the growing prominence of direct-

browse online news media in people's daily lives, very little is understood about its organization and role in promoting or mitigating selective exposure through information fragmentation. A full understanding of the causes and effects of selective exposure requires knowledge of the situational factors that could affect individuals' information-seeking behavior and the information to which they are exposed. In addition, research indicates that users take advantage of hyperlinking in online news articles most frequently in times of unusual (rather than routine) political occurrences, and are particularly likely to click on content related to crime, death, and violence (Boczkowski & Mitchelstein, 2012; Tenenboim & Cohen, 2015). This research suggests that the choices news media organizations make that influence consumer browsing—such as when and how to embed hyperlinks—may be particularly important to understand in the context of acute geopolitical events involving violence.

To this end, we focused our analysis on news media coverage of the widely publicized shooting of Michael Brown (an unarmed black teenager) by Darren Wilson (a white police officer) in Ferguson, Mo., and subsequent protests, in August, 2014. This event was followed by high attitudinal polarization regarding underlying causes and implications of the shooting (particularly concerning the role of race), as well as the basic facts of how and why Michael Brown was shot (Pew Research Center, 2014b). Using a combination of network and text analytical approaches, we conducted a pre-registered analysis to determine whether a collection of top online news media outlets exhibited echo chamber-like tendencies (i.e., organization into distinct groups of sources presenting like-minded perspectives) in their coverage of the Ferguson shooting. We operationalized like-minded perspective as similarity across psychologically and politically meaningful dimensions, specifically political leaning of sources, linguistic sentiment, and language related to race. Prior work has found that political orientation and sentiment shape

how individuals consume and share news (e.g., Brady, Wills, Jost, Tucker, & Van Bavel, 2017; Frimer et al., 2017; Himelboim et al., 2016). Our goal in examining these measures was thus to understand whether online news sources contribute to political and affective information segregation by linking to other sources with similar ideological and affective bent.

We chose to examine linguistic framing of race in coverage because there was high polarization in the degree to which individuals believed race played a role in Wilson shooting Brown (Pew Research Center, 2014b). If news organizations directed readers to sources with thematically similar perspectives on race through hyperlinks, this could contribute to the observed polarization. We identified three aspects of linguistic framing theoretically related to racial attitudes in prior research. First, we examined sources' *focus on race* (i.e., used race-related words). Prior work suggests that avoiding the discussion of race is correlated with colorblind ideology on an individual level (Norton, Sommers, Apfelbaum, Pura, & Ariely, 2006). More recent work suggests that exposure to colorblind news coverage of prior shootings of Black Americans (e.g., Trayvon Martin) predicts a lower likelihood of believing race was a factor compared to coverage that discusses race (Lawrence, 2014), suggesting that news media could be a key contributor to attitudinal polarization about the role of race. Second, we examined evidence for sources clustering by *linguistic intergroup bias*—the use of abstract language to discuss negative characteristics and concrete language to discuss positive characteristics of racial out-group members (Maass et al., 1989)—in articles. This linguistic pattern is associated with implicit bias and perpetuation of racial stereotypes (e.g., Gorham, 2006; Von Hippel, Sekaquaptewa, & Vargas, 1997). Finally, we examined whether sources linked to other outlets that used similar *language related to stereotypes*. Specifically, we examined the extent to which sources focused on (a) Michael Brown's youth when he was killed, or (b) the petty crime he was

reported to have committed prior to the shooting (i.e., stealing cigarillos from a local store). Prior work shows that people often perceive Black boys as older, bigger, and less innocent than White children, in line with stereotypes about Black males as threatening (Goff, Jackson, Di Leone, Culotta, & DiTomasso, 2014). Other work shows that news media often focuses on the crimes of Black subjects (e.g., Sommers, Apfelbaum, Dukes, Toosi, & Wang, 2006), which propagates the stereotype of Blacks as criminals among media audiences (e.g., Dixon, 2007; Dixon & Maddox, 2005). Thus, we suggest that increased focus on Brown's youth would be consistent with counterstereotypic coverage, whereas increased focus on the cigarillo theft would be consistent with stereotypic coverage. Selective hyperlinking along these concepts would be consistent with the idea that news media organizations may themselves contribute to polarization in attitudes and beliefs, specifically those about race (Pew Research Center, 2014b), via de facto selective exposure.

### **Methods**

This research is part of a larger ongoing project exploring how news media covered the 2014 shooting of Michael Brown in Ferguson, Mo. We registered a pre-analysis plan detailing this work on the Open Science Framework. Departures from this plan and additional methodological details are discussed in the *Supplementary Material*.

### **Data Collection**

Articles about the Ferguson shooting were collected from the top overall 51 online media sources and top 18 online African American-oriented media sources, identified by Pew Research Center (2015) based on number of unique visitors in January, 2015. Using the search engines of sources' websites and Google search functions, we obtained all articles containing the keyword "Ferguson" published by these sources from the day Michael Brown was shot, August 9th, to



August 19th, 2014. This date range was strategically selected to correspond with the initial period of protest in Ferguson. All search results were screened by research assistants to ensure that the article referred to the correct “Ferguson.” The research team extracted the contents of each article that met this criterion. After accounting for overlap in these sources and sites without any relevant articles, our final sample included 3,284 articles from 66 online news sources.

**Hyperlink Network**

During data collection, we manually annotated each article to record all hyperlinks embedded in the text. All but two sources, Boston Globe and MSN, included hyperlinks in the text of collected articles. A total of 13,516 hyperlinks were identified (see Table 1 for breakdown by source). Of these, 7,928 (2,701 external and 5,227 internal) were between two sources in our sample and thus were included in the network.

As in similar hyperlink analyses (Adamic & Glance, 2005; Leskovec et al., 2007; Meusel et al., 2014), we constructed a network representing each source in our sample as a single node and hyperlinks between sources as connections between these nodes (i.e., edges; for an introduction to network analysis for social-personality psychologists, see Clifton & Webster, 2017). The result (Figure 1) is a directed, weighted hyperlink network. Edge weights correspond to the number of times articles of the originating source linked to articles of the target source.

Table 1  
*Number of articles and hyperlinks of sources in final sample*

Source	Category	Articles	External Links	Internal Links
ABC	Top Overall	36	21	135
AL	Top Overall	40	55	47
BBC	Top Overall	49	49	9
BET	Top African American	26	80	85
BlackAmericaWeb	Top African American	22	19	7
BlackEnterprise	Top African American	10	24	25

Source	Category	Articles	External Links	Internal Links
BleacherReport	Top Overall	2	4	0
Bossip	Top African American	40	29	59
Boston	Top Overall	10	19	13
Boston Globe	Top Overall	14	0	0
BusinessInsider	Top Overall	83	247	146
Buzzfeed	Top Overall	45	111	52
CBS	Top Overall	71	57	423
ChicagoTribune	Top Overall	44	28	74
Chron	Top Overall	31	76	50
ClutchMag	Top African American	11	24	0
CNET	Top Overall	7	19	14
CNN	Top Overall	89	120	119
DailyBeast	Top Overall	51	60	19
DailyMail	Top Overall	161	105	0
DallasMorningNews	Top Overall	28	11	6
DetroitFreePress	Top Overall	34	12	10
Ebony	Top African American	18	196	3
EliteDaily	Top Overall	3	23	6
Engadget	Top Overall	1	11	0
Essence	Top African American	12	19	2
EurWeb	Top African American	43	36	30
Examiner	Top Overall	68	255	189
FoxNews	Top Overall	95	48	24
Gawker	Top Overall	61	227	83
Grio	Top African American	18	34	33
Guardian	Top Overall	89	386	621
HelloBeautiful	Top African American	9	97	25
HuffPost	Top Overall	240	1208	439
Independent	Top Overall	42	24	32
LATimes	Top Overall	103	75	177
MadameNoire	Top African American	18	56	10
Mashable	Top Overall	42	199	57
Mic	Top Overall	23	201	34
Mirror	Top Overall	14	2	23
Mlive	Top Overall	9	7	6
MSN	Top Overall	3	0	0
NBC	Top Overall	108	97	279
NewsOne	Top African American	35	74	11
NJ	Top Overall	2	1	3
NPR	Top Overall	71	132	57
NYDailyNews	Top Overall	54	27	9

Source	Category	Articles	External Links	Internal Links
NYPost	Top Overall	47	14	41
NYTimes	Top Overall	80	292	192
Salon	Top Overall	74	402	34
SFGate	Top Overall	5	0	6
Slate	Top Overall	41	175	39
TechCrunch	Top Overall	2	14	2
Telegraph	Top Overall	43	9	20
TheAtlantic	Top Overall	27	164	20
TheBlaze	Top Overall	73	111	79
TheRoot	Top African American	58	221	50
Time	Top Overall	92	244	132
Upworthy	Top Overall	8	19	0
USAToday	Top Overall	155	227	153
USNews	Top Overall	30	128	26
Vice	Top Overall	33	195	65
Vox	Top Overall	44	117	129
WashingtonPost	Top Overall	269	1045	749
Yahoo	Top Overall	111	281	36
YBF	Top African American	7	26	8
Total		3284	8289	5227

*Note.* Number of articles and total count of external hyperlinks (linking to an article from a different source) and internal hyperlinks (linking to an article from the same source) embedded in articles of 66 online news media sources in final sample ( $n = 52$  top overall outlets;  $n = 14$  top African American-oriented outlets).

## Methods of Analysis

**Community Detection.** We used the Spinglass community detection algorithm (Reichardt & Bornholdt, 2006) to examine network structure, per established guidelines for detecting communities in networks containing fewer than 1,000 nodes (Yang, Algesheimer, & Tessone, 2016). In the context of this study, the presence of robust communities would indicate that online news media is segregated into defined clusters of sources that link to one another frequently, and more rarely link to sources outside their cluster (a “chamber”-like structure; Adamic & Glance, 2005). To determine whether news sources were partitioned into defined communities based on their hyperlinks, we bootstrapped our original network 10,000 times with replacement, reassessing community membership in each bootstrap replicate while recording the

number of times each pair of sources was assigned to the same community (“comembership”). We obtained final community assignments by running the Spinglass algorithm on the comembership matrix (Lusseau, Whitehead, & Gero, 2009).

We assessed the overall robustness of these communities by calculating the community assortativity coefficient,  $r_{com}$ , which represents the degree of overlap between the communities of the observed network and those derived from the 10,000 bootstrap replicates (Shizuka & Farine, 2016). The authors of this method suggest that an  $r_{com}$  value greater than 0.5 provides evidence for robust community structure, with values approaching 1 indicating higher confidence in the reliability of identified communities (Shizuka & Farine, 2016, p. 241). Finally, we estimated network modularity ( $Q_{est}$ ), a measure of the strength of network division into distinct groups (Newman & Girvan, 2004), by calculating the mean of modularity coefficients derived from 10,000 iterations of Spinglass community detection on the original data.

**Assortativity.** We examined assortativity (Newman, 2003), a network-level metric that, in this context, reflects the tendency of sources to selectively link to other similar sources. Assortativity coefficient ( $r$ ) values range from -1, indicating a perfectly disassortative network (in this context, for example, where the political leanings of each pair of sources connected via hyperlink are perfectly negatively correlated), to 0, indicating a non-assortative network (the political leanings of each pair of sources connected via hyperlink are not correlated), to 1, indicating a perfectly assortative network (the political leanings of each pair of sources connected via hyperlink are perfectly positively correlated; Noldus & Van Mieghem, 2015; Newman, 2003). To examine whether the Ferguson news hyperlink network was significantly more or less assortative than what would be expected under a null model, we used a two-tailed node permutation test with 10,000 randomizations of the network, where exact  $p$ -values are

calculated as the proportion of times assortativity coefficients generated from random networks were greater than the absolute value of the observed assortativity coefficient (e.g., Williamson, Franks, & Curley, 2016; Farine & Whitehead, 2015).

### **Similarity Measures**

We first examined the degree to which sources selectively linked to other sources with a similar political leaning. To examine selective linking to thematically similar content, we extracted two categories of measures of articles' textual content: sentiment and framing of race.

**Political leaning.** Political leaning of sources was operationalized as the political orientation of their audiences, as in previous research (e.g., Gentzkow & Shapiro, 2011). To estimate political leaning, we used data collected in another study in which 1,556 participants reported their political orientation and how much they trusted news information from online media sources (see *Supplementary Material*). Data was available for 64 of 66 sources in our sample.

**Sentiment.** Sentiment analysis is a way to measure the positivity, negativity, or general emotionality of text. We calculated *emotionality*—the overall sentiment expressed regardless of positive or negative valence—by computing the proportion of words in articles that appeared in either the LIWC positive or negative emotion dictionaries (Pennebaker, Booth, & Francis, 2007). Higher values of this metric indicate that the text contains a higher proportion of emotion-laden terms generally (Godbole, Srinivasaiah, & Skiena, 2007).

Next, we calculated two metrics of *valence*, or the direction of emotionality expressed in articles (i.e., positive or negative). For the first, we used LIWC to calculate the proportion of positive emotion words out of total emotion words. To calculate the second metric of valence, we used VADER, a more sophisticated context-aware sentiment analysis tool that takes into

account contextual factors such as intensifying words and negations (Hutto & Gilbert, 2014). For both of these metrics, higher values indicate positive sentiment and lower values reflect negative sentiment.

**Linguistic framing of race.** We investigated three linguistic components of Ferguson coverage related to past research on framing of race and race-related issues: focus on race, linguistic intergroup bias, and stereotype-relevant language.

**Focus on race.** Each source's focus on race was measured using Word2Vec latent word embeddings in dictionary-like methods (Garten et al., 2017). This method relies on distributed word representations that emerged from neural networks (Mikolov et al., 2013). We represented the concept of race as the average of the word vectors for "black," "white," "race," "ethnicity," and "diversity."

**Linguistic intergroup bias.** A source's linguistic intergroup bias (Maass, Salvi, Arcuri, & Semin, 1989) was operationalized as the correlation between concreteness and emotional valence of language (calculation described above) used in each of that source's articles. The concreteness for a given article was computed by averaging concreteness ratings for all words in the article that appeared in a lexicon of approximately 40k English words scored from concrete to abstract via crowd-sourcing (Brysbaert, Warriner, & Kuperman, 2014). A positive correlation indicated that articles tended to use concrete and positive language together, and abstract and negative language together—a pattern consistent with conceptualizations of linguistic intergroup bias. This correlation was computed for all sources containing more than two articles about Ferguson ( $n = 62$ ).

**Stereotype-relevant language.** We used Word2Vec to measure the extent to which news media depicted Michael Brown in a stereotypic (focus on criminality, i.e., his theft of cigarillos)

versus counterstereotypic (youth at time of shooting) way. We used the seed words “cigarillo,” “cigar,” and “cigarette” to measure focus on crime, and “youth,” “young,” “child,” “teenager,” “graduation,” and “school” for focus on youth.

**Source-level estimation.** Whenever source-level estimates of a metric were needed, we fit a multilevel Bayesian model in which each estimated source-specific intercept were so-called “random effects,” in order to account for the nested data structure (see *Supplementary Material*). We used the mean of the posterior distribution for each source as the source-level estimate.

## Results

### Community Structure

Using the previously described bootstrapping approach, we detected four distinct communities of news sources based on hyperlink connectivity, reported in Table 2 and pictured in Figure 1. This approach yielded modest evidence that these communities were robust ( $r_{com} = .55$ , just over the .5 threshold). However, modularity was low ( $Q_{est} = .022$ ). This suggests that while there were four statistically reliable clusters of interconnected sources in this network, segregation was generally weak, and there were still many links across group divisions. In fact, excluding internal links, 23.1% of hyperlinks were between sources of the same community, while 76.9% of hyperlinks cut across community divisions.

Table 2. *Community membership results.*

Community 1	Community 2	Community 3	Community 4
AL	ABC	BlackAmericaWeb	BET
BBC	BleacherReport	BlackEnterprise	BostonGlobe
Bossip	DallasMorningNews	ChicagoTribune	BusinessInsider
Boston	Time	Chron	ClutchMag
Buzzfeed	Vice	EliteDaily	CNET
CBS	WashingtonPost	Engadget	CNN
DailyMail		Guardian	DailyBeast
DetroitFreePress		HelloBeautiful	Essence
Ebony		Mic	EurWeb
Gawker		Mirror	Examiner
Grio		NewsOne	FoxNews
HuffPost		NYDailyNews	LATimes
Independent		Salon	NJ
MadameNoire		TheAtlantic	NPR
Mashable		Upworthy	Slate
Mlive		USAToday	TechCrunch
MSN		Yahoo	Telegraph
NBC		YBF	
NYPost			
NYTimes			
SFGate			
TheBlaze			
TheRoot			
USNews			
Vox			
<i>n</i> = 25	<i>n</i> = 6	<i>n</i> = 18	<i>n</i> = 17

*Note.* Membership results derived from hyperlink connectivity using bootstrapping method with Spinglass community detection algorithm.



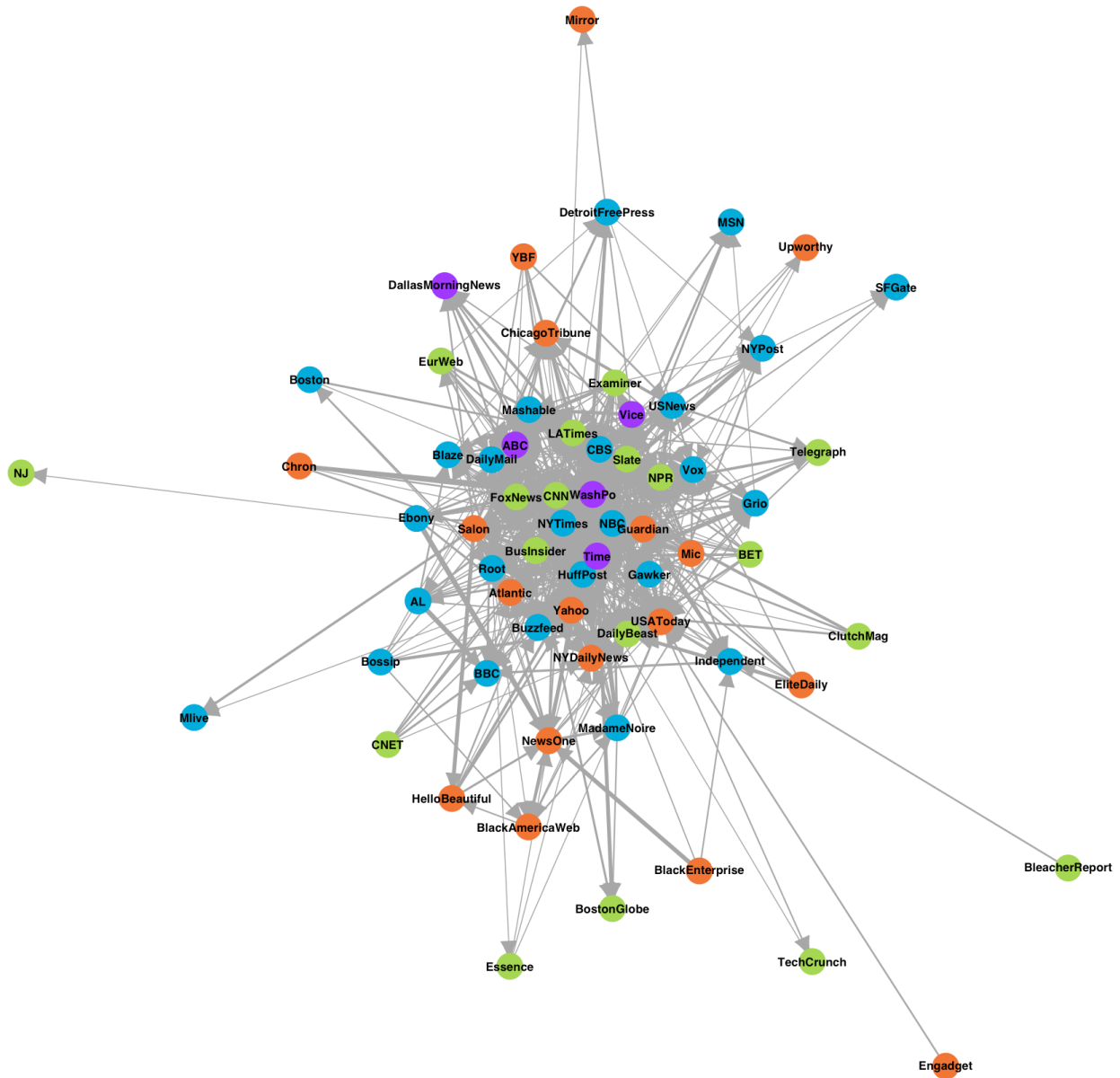


Figure 1. Visualization of full Ferguson shooting news hyperlink network ( $N_{sources} = 66$ ;  $N_{links} = 7,928$ ), colored by community membership. Internal hyperlinks (an article linking to another article from the same source) are not pictured. See *Supplementary Material* for information on how to access a three dimensional, interactive version of this network visualization.

### Assortativity

We first analyzed assortativity by source political leaning. For the subset of sources for which we were able to obtain estimates of source users' political preferences, ( $n_{sources} = 64$ ;

$n_{links} = 7,826$ ; see Figure 2), we find that the network was assortative by political leaning ( $r_{lean} = .12$ ), but assortativity was not greater than would be expected under the null ( $p = .98$ ). In other words, while the 64 sources were more likely to link to other sources with similar rather than dissimilar political leanings, the observed correlation between political leanings of sources connected by hyperlinks did not exceed the correlation expected by chance.

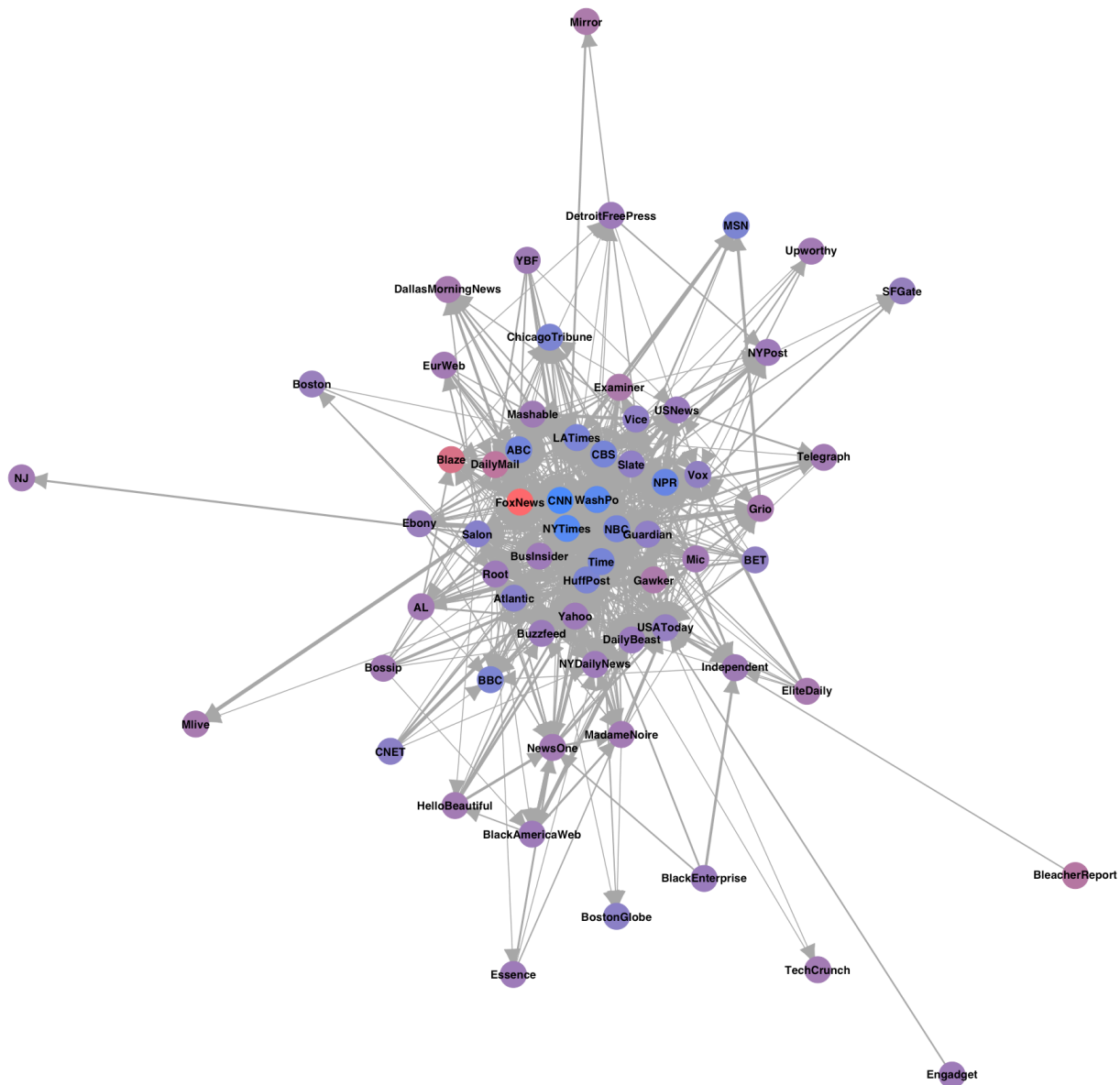


Figure 2. The sub-network of 64 sources for which political leaning data was available, colored by proportion of conservative users from red (highest proportion of conservative users) to blue (lowest proportion of conservative users). Internal hyperlinks (an article linking to another article from the same source) are not pictured, nor are hyperlinks from or to sources outside the 64-source subset.

We next turned to assortativity analyses based on the linguistic metrics calculated for each of the sources. Figure 3 displays the correlations between the linguistic measures used in our analyses, plus source political leanings. To determine whether the network showed evidence of assortativity by sentiment, we first examined emotionality. Assortativity by emotionality would indicate that sources that used emotional language—whether positively or negatively valenced—in their coverage of the Ferguson shooting tended to link to other sources that also used emotional language. Analyses did not reveal significant assortativity by emotionality ( $r_{emo} = .15, p = .23$ ). However, analyses of assortativity by valence revealed that the network was significantly more assortative by valence than would be expected by chance using both the LIWC method ( $r_{val-L} = .19, p = .04$ ), and the context-aware VADER method ( $r_{val-V} = .19, p = .01$ ). These results indicate that sources tended to link to other sources that covered the shooting with a similar valence (i.e., *either* positively *or* negatively).

Analyses on linguistic framing of race revealed no significant assortativity by sources' use of race-related words in articles about the events in Ferguson ( $r_{race} = .14, p = .39$ ) or by our operational measure of linguistic intergroup bias—the correlation between article text concreteness and valence—using either valence measure (LIWC:  $r_{LIB-L} = .15, p = .28$ , VADER:  $r_{LIB-V} = .17, p = .09$ ). However, the network was significantly more assortative by focus on both Brown's criminality (i.e., stealing cigarillos;  $r_{crime} = .21, p = .01$ ) and his youth ( $r_{youth} = .18, p = .03$ ) than would be expected by chance. These results indicate that news sources tended to link to other sources that had similarly stereotypic or counterstereotypic coverage.

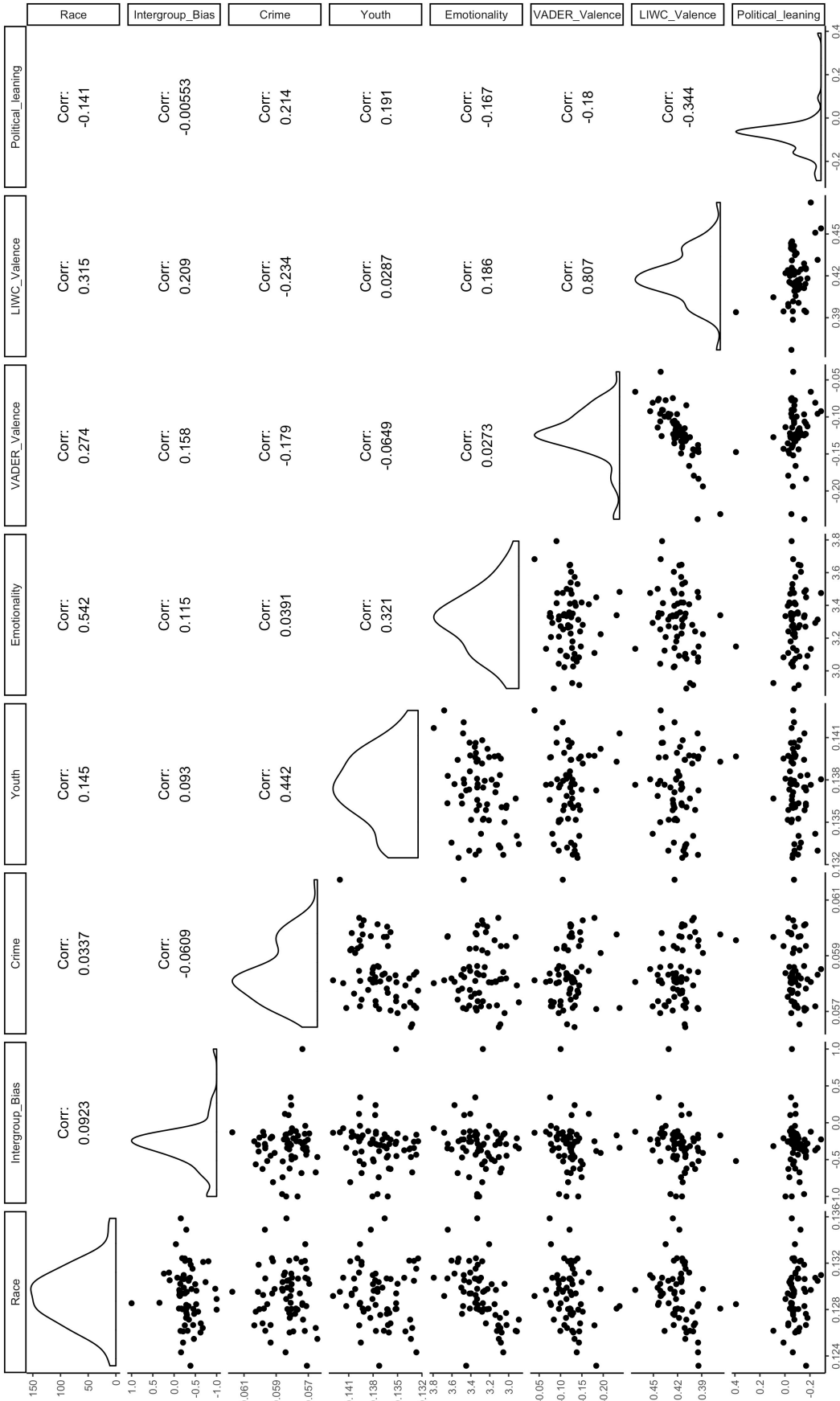


Figure 3. Correlation matrix for each of the linguistic metrics measured at the source level. “Intergroup Bias” refers to the correlation between concreteness and valence (VADER measure).

### Discussion

In this research, we sought to illuminate modern situational factors contributing to selective exposure by documenting the ways in which online news media may directly shape and segment the information to which individuals are exposed. Specifically, we examined a hyperlink network of news articles about the 2014 shooting of Michael Brown in Ferguson to determine whether media organizations contribute to potential “echo chambers” by (1) selectively embedding links to a finite set of other sources, limiting the potential for users to click through to sources outside the “chamber,” and, further, (2) selectively embedding links to sources that cover national—especially nationally polarizing—events in thematically similar ways (the “echo”). Results indicated, first, that although the network divided into statistically reliable subgroups of interconnected sources, the overall division of the network into distinct, segregated groups was low, and sources frequently linked to other news outlets outside of their own communities. Second, we found that sources tended to link to other sources that covered the Ferguson events with a similar valence (i.e., positive or negative emotionality), and with similar emphasis on Brown’s criminality and youth. We did not find selective linking between sources that had similar political leanings, use of race-related words, or language consistent with linguistic intergroup bias.

Our finding that news sources linked to other sources that covered the Ferguson events with a similar emotional valence is consistent with previous work that found assortativity by valence in political dialogue among Twitter users (Himmelboim et al., 2016). Our work demonstrates that this “valence sorting” extends to hyperlink decisions made by media organizations, creating a digital structure that may support and reinforce the tendency to engage with others who have the same emotional take on political events. In particular, given that

individuals tend to seek out affective information that matches their own beliefs (Swann et al., 1992), selective hyperlinking by valence similarity may ensure that consumers are exposed to information matching their particular affective attitude toward a given event from both the first news source they visit and from subsequent articles to which they are directed. This repeated exposure may strengthen their attitudes and beliefs about the event, heightening affective polarization (Petty, Haugtvedt, & Smith, 1995). This could translate to increased ideological polarization, given work suggesting that political and moral judgments are frequently driven by affective response (Graham, Meindl, & Beall, 2012; Valdesolo & DeSteno, 2006). As such, valence assortativity in hyperlinking could provide one explanation for growing ideological polarization (Moody & Mucha, 2013; Pew Research Center, 2014a).

Further, this research suggests that news media may facilitate selective exposure to racial stereotypes through hyperlinking decisions. Sources emphasizing Brown's theft of cigarillos—consistent with the stereotype of Black Americans as criminals (Dixon & Maddox, 2005)—were more likely to link to other sources that also emphasized this aspect of the narrative. Similar sorting emerged in emphasis on Brown's youth, a focus counter to the stereotype-driven tendency to regard Black boys as older and less innocent than they are (Goff et al., 2014). This suggests that, depending on where individuals enter a news cycle, they may be differentially exposed to pockets of stereotypic or counterstereotypic coverage. This could have profound implications for endorsement of racial stereotypes, and societal movement toward improved race relations and equality more broadly. Exposure to stereotypic information perpetuates stereotypes (Hilton & von Hippel, 1996), and stereotypes in the media specifically can strengthen real-world stereotype endorsement and prejudice, and decrease support for policies that may help the stereotyped group (Ramasubramanian, 2007). Exposure to such information in echo chamber-

like environments may strengthen these effects (DiFonzo et al., 2013), increasing societal polarization in racial stereotype endorsement depending on where one gets one's news.

This work paves the way for future research examining how structural factors shaping access to thematically different information interact with individuals' motivations to confirm pre-existing attitudes and avoid inconsistent information (Smith et al., 2008). Previous work suggests that attitudinal polarization is partly driven by biased assimilation, where individuals perceive attitude-confirming information as more convincing than attitude-disconfirming information (Lord, Ross, & Lepper, 1979). For example, individuals with negative attitudes toward a social group are more likely to believe stereotype-consistent information than counterstereotypic information about that group, strengthening their original attitudes (Munro & Ditto, 1997). Our work suggests that the organization of online news media, in promoting selective exposure (for example, to stereotypic versus counterstereotypic news coverage), may facilitate attitude polarization, exacerbating the effects of individual attitudinal and information-seeking processes. Directly examining how the themes and organization of coverage observed here affect individual attitudes and selective exposure is a critical next step.

This research also suggests a need for future work on the motivations behind and consequences of journalistic decisions to link to other sources. Although we have focused on implications for news consumers—i.e., de facto selective exposure—there are also people behind online news hyperlinking decisions, and the psychology of these individuals is important to understand considering the potential influence (however unintentional) of their decisions on selective exposure and attitude polarization. A greater understanding of these decisions could also shed light on how “chambers” emerge in online news media. While results of this analysis suggested that there were reliable groups of sources that tended to link to one another, these

communities were relatively weak, and we detected no obvious source characteristics that could be driving the observed divisions. Future work could illuminate presently unobserved variables that explain these groupings, such as timing (i.e., media sources that publish first influence what other sources decide to cover, and the themes they use in their coverage; Golan, 2006) or corporate partnerships (e.g., NBC and MSN may have incentive to link to one another because of their corporate relationship). Linking decisions could also be dependent on the type of news being covered. For example, perhaps hyperlink decisions in coverage of a presidential campaign depend more on ideological alignment (potentially leading to more ideological segregation in the news network) given that news sources may actively endorse candidates, whereas linking decisions in coverage of an unexpected geopolitical event such as Brown's shooting rely more on timing, regardless of ideological compatibility (leading to weaker segregation). This is also an important consideration for generalizability of the findings described here, as a hyperlink network of coverage of a different event could have revealed different findings.

In sum, using the "echo chamber" framework, our work shows that there is relatively weak evidence for the existence of "chambers" in the hyperlinking behavior of news organizations on the web. However, there is robust evidence that the hyperlinks embedded in online news articles promote valence and stereotype "echoes" by connecting coverage with similar affect and content related to racial stereotypes. This work highlights the importance of examining structural factors shaping access to certain types of information, particularly in the context of prominent geopolitical events like the Ferguson shooting. This is an increasingly pressing research topic in the context of high social polarization and the constantly connected nature of modern society.



## References

- Adamic, L. A., & Glance, N. (2005). The political blogosphere and the 2004 US election: Divided they blog. In *Proceedings of the 3rd International Workshop on Link Discovery*, 36–43.
- Aiello, L. M., & Barbieri, N. (2017). Evolution of ego-networks in social media with link recommendations. In *Proceedings of the Tenth ACM International Conference on Web Search and Data Mining*, 111–120.
- Bakshy, E., Messing, S., & Adamic, L. A. (2015). Exposure to ideologically diverse news and opinion on Facebook. *Science*, 348(6239), 1130–1132.
- Barberá, P., Jost, J. T., Nagler, J., Tucker, J. A., & Bonneau, R. (2015). Tweeting from left to right: Is online political communication more than an echo chamber? *Psychological Science*, 26(10), 1531–1542.
- Boczkowski, P. J., & Mitchelstein, E. (2012). How users take advantage of different forms of interactivity on online news sites: Clicking, e-mailing, and commenting. *Human Communication Research*, 38(1), 1–22.
- Borah, P. (2014). The hyperlinked world: A look at how the interactions of news frames and hyperlinks influence news credibility and willingness to seek information. *Journal of Computer-Mediated Communication*, 19(3), 576–590.
- Brady, W. J., Wills, J. A., Jost, J. T., Tucker, J. A., & Van Bavel, J. J. (2017). Emotion shapes the diffusion of moralized content in social networks. *Proceedings of the National Academy of Sciences*, 201618923.

- Brysbaert, M., Warriner, A. B., & Kuperman, V. (2014). Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research Methods*, 46(3), 904–911.
- Clifton, A., & Webster, G. D. (2017). An introduction to social network analysis for personality and social psychologists. *Social Psychological and Personality Science*, 8(4), 442–453.
- Deuze, M. (2003). The web and its journalism: Considering the consequences of different types of newsmedia online. *New Media & Society*, 5(2), 203–230.
- DiFonzo, N., Bourgeois, M. J., Suls, J., Homan, C., Stupak, N., Brooks, B. P., ... Bordia, P. (2013). Rumor clustering, consensus, and polarization: Dynamic social impact and self-organization of hearsay. *Journal of Experimental Social Psychology*, 49(3), 378–399.
- Dixon, T. L. (2007). Black criminals and White officers: The effects of racially misrepresenting law breakers and law defenders on television news. *Media Psychology*, 10(2), 270–291.
- Dixon, T. L., & Maddox, K. B. (2005). Skin tone, crime news, and social reality judgments: Priming the stereotype of the dark and dangerous Black criminal. *Journal of Applied Social Psychology*, 35(8), 1555–1570.
- Farine, D. R., & Whitehead, H. (2015). Constructing, conducting and interpreting animal social network analysis. *Journal of Animal Ecology*, 84(5), 1144–1163.
- Fischer, P., Schulz-Hardt, S., & Frey, D. (2008). Selective exposure and information quantity: How different information quantities moderate decision makers' preference for consistent and inconsistent information. *Journal of Personality and Social Psychology*, 94(2), 231–244.
- Flaxman, S., Goel, S., & Rao, J. (2016). Filter bubbles, echo chambers, and online news consumption. *Public Opinion Quarterly*, 80, 298–320.

- Freedman, J. L., & Sears, D. O. (1965). Selective exposure. *Advances in Experimental Social Psychology*, 2, 57–97.
- Frimer, J. A., Skitka, L. J., & Motyl, M. (2017). Liberals and conservatives are similarly motivated to avoid exposure to one another's opinions. *Journal of Experimental Social Psychology*, 72, 1–12.
- Galdi, S., Gawronski, B., Arcuri, L., & Friese, M. (2012). Selective exposure in decided and undecided individuals: Differential relations to automatic associations and conscious beliefs. *Personality and Social Psychology Bulletin*, 38(5), 559–569.
- Garten, J., Hoover, J., Johnson, K. M., Boghrati, R., Iskiwitch, C., & Dehghani, M. (2017). Dictionaries and distributions: Combining expert knowledge and large scale textual data content analysis. *Behavior Research Methods*, 1–18.
- Gentzkow, M., & Shapiro, J. M. (2011). Ideological segregation online and offline. *The Quarterly Journal of Economics*, 126(4), 1799–1839.
- Godbole, N., Srinivasaiah, M., & Skiena, S. (2007). Large-scale sentiment analysis for news and blogs. *ICWSM*, 7(21), 219–222.
- Goff, P. A., Jackson, M. C., Di Leone, B. A. L., Culotta, C. M., & DiTomasso, N. A. (2014). The essence of innocence: Consequences of dehumanizing Black children. *Journal of Personality and Social Psychology*, 106(4), 526–545.
- Golan, G. (2006). Inter-media agenda setting and global news coverage: Assessing the influence of the New York Times on three network television evening news programs. *Journalism Studies*, 7(2), 323–333.
- Gorham, B. W. (2006). News media's relationship with stereotyping: The linguistic intergroup bias in response to crime news. *Journal of Communication*, 56(2), 289–308.

- Graham, J., Meindl, P., & Beall, E. (2012). Integrating the streams of morality research: The case of political ideology. *Current Directions in Psychological Science*, 21(6), 373–377.
- Hilton, J. L., & von Hippel, W. (1996). Stereotypes. *Annual Review of Psychology*, 47(1), 237–271.
- Himmelboim, I., Sweetser, K. D., Tinkham, S. F., Cameron, K., Danelo, M., & West, K. (2016). Valence-based homophily on Twitter: Network analysis of emotions and political talk in the 2012 Presidential election. *New Media & Society*, 18(7), 1382–1400.
- Hutto, C. J., & Gilbert, E. (2014). Vader: A parsimonious rule-based model for sentiment analysis of social media text. In *Eighth International AAAI Conference on Weblogs and Social Media*.
- Iyengar, S., & Hahn, K. S. (2009). Red media, blue media: Evidence of ideological selectivity in media use. *Journal of Communication*, 59(1), 19–39.
- Johnston, L. (1996). Resisting change: information-seeking and stereotype change. *European Journal of Social Psychology*, 26(5), 799–825.
- Lawrence, Stephanie (2014). *The effect of colorblind racial ideology on discussion of racial events: An examination of responses to the news coverage of the Trayvon Martin shooting* (Master's thesis). Retrieved from [http://scholarworks.umass.edu/masters\\_theses\\_2/93](http://scholarworks.umass.edu/masters_theses_2/93)
- Leskovec, J., McGlohon, M., Faloutsos, C., Glance, N., & Hurst, M. (2007). Patterns of cascading behavior in large blog graphs. In *Proceedings of the 2007 SIAM International Conference on Data Mining*, 551–556.

- Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology*, 37(11), 2098–2109.
- Lusseau, D., Whitehead, H., & Gero, S. (2009). Incorporating uncertainty into the study of animal social networks. *arXiv preprint arXiv:0903.1519*.
- Maass, A., Salvi, D., Arcuri, L., & Semin, G. R. (1989). Language use in intergroup contexts: The linguistic intergroup bias. *Journal of Personality and Social Psychology*, 57(6), 981.
- Meusel, R., Vigna, S., Lehmborg, O., & Bizer, C. (2014). Graph structure in the web—revisited: A trick of the heavy tail. In *Proceedings of the 23rd International Conference on World Wide Web* (pp. 427–432).
- Mikolov, T., Sutskever, I., Chen, K., Corrado, G. S., & Dean, J. (2013). Distributed representations of words and phrases and their compositionality. In *Advances in neural information processing systems* (pp. 3111–3119).
- Mitchell, A., Gottfried, J., Barthel, M., & Shearer, E. (2014). The modern news consumer: News attitudes and practices in the digital era. Pew Research Center. Retrieved from <http://www.journalism.org/2016/07/07/pathways-to-news/>
- Moody, J., & Mucha, P. J. (2013). Portrait of political party polarization. *Network Science*, 1(1), 119–121.
- Munro, G. D., & Ditto, P. H. (1997). Biased assimilation, attitude polarization, and affect in reactions to stereotype-relevant scientific information. *Personality and Social Psychology Bulletin*, 23(6), 636–653.
- Newman, M. E. (2003). Mixing patterns in networks. *Physical Review E*, 67(2), 026126. APS.

- Newman, M. E., & Girvan, M. (2004). Finding and evaluating community structure in networks. *Physical review E*, 69(2), 026113.
- Noldus, R., & Van Mieghem, P. (2015). Assortativity in complex networks. *Journal of Complex Networks*, 3(4), 507–542.
- Norton, M. I., Sommers, S. R., Apfelbaum, E. P., Pura, N., & Ariely, D. (2006). Color blindness and interracial interaction playing the political correctness game. *Psychological Science*, 17(11), 949–953.
- Pariser, E. (2011). *The filter bubble: How the new personalized web is changing what we read and how we think*. New York, NY: Penguin Group.
- Pennebaker, J., Booth, R., & Francis, M. (2007). Linguistic inquiry and word count (liwc2007).
- Petty, R. E., Haugtvedt, C. P., & Smith, S. M. (1995). Elaboration as a determinant of attitude strength: Creating attitudes that are persistent, resistant, and predictive of behavior. *Attitude Strength: Antecedents and Consequences*, 4, 93-130.
- Pew Research Center. (2014a). Political polarization in the American public. Retrieved from <http://www.people-press.org/2014/06/12/political-polarization-in-the-american-public/>
- Pew Research Center. (2014b). Stark racial divisions in reactions to Ferguson police shooting. Retrieved from <http://www.people-press.org/files/2014/08/8-18-14-Ferguson-Release.pdf>
- Pew Research Center. (2015). State of the news media, 2015. Retrieved from <http://www.journalism.org/files/2015/04/FINAL-STATE-OF-THE-NEWS-MEDIA1.pdf>
- Ramasubramanian, S. (2007). Media-based Strategies to Reduce Racial Stereotypes Activated by News Stories. *Journalism & Mass Communication Quarterly*, 84(2), 249–264.

- Reichardt, J., & Bornholdt, S. (2006). Statistical mechanics of community detection. *Physical Review E*, 74(1).
- Sawicki, V., Wegener, D. T., Clark, J. K., Fabrigar, L. R., Smith, S. M., & Durso, G. R. O. (2013). Feeling conflicted and seeking information: When ambivalence enhances and diminishes selective exposure to attitude-consistent information. *Personality and Social Psychology Bulletin*, 39(6), 735–747.
- Sears, D. O., & Freedman, J. L. (1967). Selective Exposure to Information: A Critical Review. *The Public Opinion Quarterly*, 31(2), 194–213.
- Shapiro, R. Y., & Bloch-Elkon, Y. (2008). Do the facts speak for themselves? Partisan disagreement as a challenge to democratic competence. *Critical Review*, 20(1-2), 115–139.
- Sharma, A., Hofman, J. M., & Watts, D. J. (2015). Estimating the causal impact of recommendation systems from observational data. In *Proceedings of the Sixteenth ACM Conference on Economics and Computation* (pp. 453–470).
- Shizuka, D., & Farine, D. R. (2016). Measuring the robustness of network community structure using assortativity. *Animal Behaviour*, 112, 237–246.
- Smith, S. M., Fabrigar, L. R., & Norris, M. E. (2008). Reflecting on six decades of selective exposure research: Progress, challenges, and opportunities. *Social and Personality Psychology Compass*, 2(1), 464–493.
- Smith, S. M., Fabrigar, L. R., Powell, D. M., & Estrada, M.-J. (2007). The role of information-processing capacity and goals in attitude-congruent selective exposure effects. *Personality and Social Psychology Bulletin*, 33(7), 948–960.

- Sommers, S. R., Apfelbaum, E. P., Dukes, K. N., Toosi, N., & Wang, E. J. (2006). Race and Media Coverage of Hurricane Katrina: Analysis, Implications, and Future Research Questions. *Analyses of Social Issues and Public Policy*, 6(1), 39–55.
- Swann, W. B., Wenzlaff, R. M., Krull, D. S., & Pelham, B. W. (1992). Allure of negative feedback: Self-verification strivings among depressed persons. *Journal of Abnormal Psychology*, 101(2), 293.
- Tenenboim, O., & Cohen, A. A. (2015). What prompts users to click and comment: A longitudinal study of online news. *Journalism*, 16(2), 198–217.
- Valdesolo, P., & DeSteno, D. (2006). Manipulations of emotional context shape moral judgment. *Psychological Science*, 17(6), 476–477.
- Von Hippel, W., Sekaquaptewa, D., & Vargas, P. (1997). The linguistic intergroup bias as an implicit indicator of prejudice. *Journal of Experimental Social Psychology*, 33(5), 490–509.
- Westfall, J., Van Boven, L., Chambers, J. R., & Judd, C. M. (2015). Perceiving political polarization in the United States: Party identity strength and attitude extremity exacerbate the perceived partisan divide. *Perspectives on Psychological Science*, 10(2), 145–158.
- Williamson, C. M., Franks, B., & Curley, J. P. (2016). Mouse social network dynamics and community structure are associated with plasticity-related brain gene expression. *Frontiers in Behavioral Neuroscience*, 10.
- Wise, K., Bolls, P. D., & Schaefer, S. R. (2008). Choosing and reading online news: How available choice affects cognitive processing. *Journal of Broadcasting & Electronic Media*, 52(1), 69–85.



Yang, Z., Algesheimer, R., & Tessone, C. J. (2016). A comparative analysis of community detection algorithms on artificial networks. *Scientific Reports*, 6.