Broadening Exposure, Questioning Opinions, and Reading Patterns with Reflext: a Computational Support for Frame Reflection

Eric P. S. Baumer , Claire Cipriani , Mitchell Davis , Gary He , James Kang , Jaclyn Jeffrey-Wilensky , Jinjoo Lee , Justin Zupnick & Geri K. Gay

Broadening Exposure, Questioning Opinions, and Reading Patterns with Reflext: a Computational Support for Frame Reflection

Eric P. S. Baumer
Claire Cipriani
Mitchell Davis
Gary He
James Kang
Jaclyn Jeffrey-Wilensky
Jinjoo Lee
Justin Zupnick
Geri K. Gay

ABSTRACT. Vast amounts of political coverage are generated daily online. Some tools have been developed to help keep track of what is being said, but fewer efforts focus on how things are being said, i.e., how issues are framed. This article presents a study of Reflext, an interactive visualization tool that leverages computational linguistic analysis to support reflection on the framing of political issues. This system was deployed in a field study, during which the tool was used by regular readers of political news coverage during the 2012 U.S. election campaign. The results describe the tool's support for a variety of activities related to frame reflection, how users integrated tool use with their existing reading

Eric P. S. Baumer is a research associate in the Communication Department at Cornell University. His research interests lie at the nexus of computer science and the social sciences.

Claire Cipriani holds a B.S. in information science from Cornell University. Her research interests include information science and interaction design.

Mitchell Davis holds an M.P.S. in information science from Cornell University. His research interests include information science and machine learning.

Gary He is an undergraduate researcher in Electrical and Computer Engineering at Cornell University. His research interests include computer science and computer engineering.

James Kang holds a B.S. in Communication from Cornell University. His research interests include social media and online engagement.

Jaclyn Jeffrey-Wilensky is an undergraduate researcher in linguistics and computer science at Cornell University. Her research interests include computational linguistics and cognitive science.

Jinjoo Lee is an undergraduate researcher in Policy Analysis and Management at Cornell University. Her research interests include new media and journalism.

Justin Zupnick is a post-baccalaureate researcher at Cornell University. His research interests include interaction design and digital art.

Geri K. Gay is Kenneth J. Bissett Professor and Chair of Communication at Cornell University. Her research interests include mobile heath, new media, and sentiment design.

Address correspondence to: Eric P. S. Baumer, Cornell University, Information Science Department, 219 Gates Hall, Ithaca, NY 14853 (E-mail: ericpsb@cornell.edu).

practices, and broader issues in how participants interpreted the computational analysis and visualization. These findings contribute to our understanding of how algorithmically based interactive systems might mediate both the practical experiences of and situated interpretation of framing in political content.

Increasingly, coverage and discussion of political news and issues occurs via online media (Drezner & Farrell, 2008; Mitchell, Rosenstiel, & Christian, 2012; Pew Research Center, 2012). Commentators and researchers have documented numerous ramifications of this shift, among them the availability of vast amounts of content covering an overwhelming breadth of topics and issues from almost any imaginable perspective or opinion (Garrett, 2009; Hargittai, Gallo, & Kane, 2008). The possibilities offered by this ecosystem promise democratic engagement and participation both on a scale and of a kind previously unattainable (Fishkin, 2009; Mutz, 2006; Price, 2009).

The Internet has not, however, led to any radical democratization of political participation. Indeed, much research argues that Internet use tends to further balkanize political discussion, given the ease of finding like-minded individuals and avoiding all others (Garrett, 2009; Hargittai et al., 2008; Lawrence, Sides, & Farrell, 2010).

Such balkanization arises not only from differences in opinion, but often from differences in how issues are framed. Terms such as "tax relief," "racial quotas," "pro-life," "pro-choice," and "death panels," as well as other catchphrases, metaphors, and keywords (Entman, 1993; Gamson & Modigliani, 1989), have rallied citizens by focusing attention on specific aspects of issues that, in reality, are quite complex. How an issue is framed—what counts as a problem, how causes are diagnosed, and what remedies are suggested—can have significant effects on perceptions of an issue and prescriptions for action (Gamson & Modigliani, 1989; Price, Nir, & Cappella, 2005; Snow, Rochford, Worden, & Benford, 1986). Furthermore, when different parties approach an issue with different frames, productive conversations become difficult, if not impossible. One approach to resolving this difficulty is frame reflection (Schön & Rein, 1994), or the process of identifying existing frames for an issue, examining their assumptions, and considering alternative framings. Schön and Rein (1994) argue that frame reflection can effectively resolve seemingly intractable policy controversies.

While conceptually appealing, such frame reflection is no mean feat. Even identifying existing frames—both your own and others'— can be quite challenging, let alone examining those frames critically or considering alternatives. To address this difficulty, we are developing *computational supports for frame reflection*—tools that draw attention to, and promote critical thinking and reflection about, the ways in which issues are framed. We do so by leveraging the patterns of language that evidence framing and the wealth of daily-produced political content and coverage, combined with recent developments in natural language processing and computational linguistics (e.g., Blei, 2012; Pang & Lee, 2008; Resnik, 1993; Steyvers & Griffiths, 2007). Here, we adapt those techniques to identify patterns of language relevant to framing. Importantly, the tools we are developing do not identify frames per se; framing is an interpretive process that exists neither wholly in the text nor wholly in the reader but in the relationship between the two (Benford, 1997). Thus, we seek instead to expose for conscious examination that interpretive process by drawing out certain linguistic patterns to use as a scaffold in supporting reflection on the process of framing.

This article presents a study of one such computational support for frame reflection, called Reflext, that visualizes computationally

identified patterns of association among groups of words. To be clear, while the ultimate goal is to foster more thoughtful, reflective public dialogue, the system presented here is but a first step along that path. The first portion of this article describes the implementation of the tool, noting how both the data analysis and visualization design reflect sociological and political communication theories on framing. The second portion of the article reports on a field study where readers of political news used the tool for six weeks as part of their regular news reading practice. The results show not only how study participants integrated Reflext into their daily reading practices but also the ways in which it supported various types of frame reflective uses. Thus, the article contributes not only to an exploration of how algorithmically based systems might mediate political communication, but also to developing an understanding of what frame reflection looks like in practice.

RELATED WORK

Framing and Frame Reflection

To make sense of their interactions, people frame their experiences (Goffman, 1974). Framing helps people "locate, perceive, identify, and label" (Entman, 1993, p. 52), i.e., organize and give meaning to information about experiences in the world. A frame combines "keywords, stock phrases" (Entman, 1993, p. 52), "metaphors, exemplars, catchphrases" (Gamson & Modigliani, 1989, p. 3), and other devices to form an interpretive lens or "package" (cf. Entman, 1993) through which to make sense of facts or events. Frames function to define what counts as a problem, to diagnose a problem's causes, to make moral judgments about those involved, and to suggest solutions to those problems. In short, frames are a way of organizing our world.

Framing can significantly impact perceptions of political issues. Nuclear power, for example, has been framed at different times in such various ways as social progress to improve quality of life, as a Frankenstein's monster that is out of control, or as promoting national security by reducing dependence on foreign energy (Gamson & Modigliani, 1989). In each case, the framing was used to argue for or against the development of nuclear power. There is not, however, a one-to-one mapping between framings and positions on an issue; different positions can invoke the same frame, and different framings can be used to support the same position (Gamson & Modigliani, 1989). In the context of group discussions, framing gay civil unions as homosexual marriage providing special rights led participants to take more extreme, polarized positions than framing it as a civil union providing equal rights (Price et al., 2005). Recent work has also explored the impacts of exposure to multiple frames, noting that the relative strengths of each frame (Chong & Druckman, 2007), as well as the relative order in which frames are seen and how much choice participants have in selecting frame-laden articles (Druckman, Fein, & Leeper, 2012), can significantly impact the effects of those frames. Frames also play a variety of roles in the definition, legitimation, and mobilization of social movements, from uniting disparate groups under a single vision to transforming problematic events into rallying cries (Snow et al., 1986). Importantly, frames are not objects that exist in an external reality. Rather, framing is a sociological process of interpretation that facilitates meaning making (Benford, 1997).

Framing has also been shown to play a significant role in online media. Zhou and Moy (2007) used a conflict in China between the wife of a businessman and a peasant couple to examine the interplay between framing in media coverage and framing in online discussion. Their findings provide evidence for mutual influence between the two, but they also argue that framing online was both more diverse and less influenced by media coverage than expected. Similarly, Johnston (2011) analyzed the framing of religious issues online, finding both systematic similarities with and differences from the framing of religion in print media. In comparing two online sources, Tian and Stewart (2005) also found mostly similar framing of SARS in articles on the Web sites of CNN and the BBC, though the two sources evidenced key

differences in framing. Such work pertains to the present article for two reasons. First, it demonstrates the importance of considering framing in online media. Second, it suggests that comparing framing among different sources may help support frame reflection, described further below.

In a related vein, some work has considered methods of ameliorating framing effects. Previous work found that, in decision making, positively framed situations led participants to avoid risk, whereas negatively framed situations led participants to seek risk (Kahneman & Tversky, 1984). Later research suggests that this bias can be reduced using various techniques that require participants to map the decision alternatives in some canonical representation that showed the benefits and tradeoffs of each (Hodgkinson, Bown, Maule, Glaister, & Pearman, 1999; Hodgkinson, Maule, Bown, Pearman, & Glaister, 2002; Wright & Goodwin, 2002). Such interventions arguably derive their efficacy by circumventing the heuristic, largely unconscious processes that give rise to frame effects, thereby allowing for more conscious, intentional decision making. We suggest that such techniques may also provide an effective means for facilitating frame reflection.

This article builds on this previous work, but rather than investigating the effects of any given framing, the research presented here involves promoting awareness of, and reflection upon, framing. Complex policy debates can become intractable when the parties involved approach the situation using different frames (Schön & Rein, 1994). For example, a decade-long controversy over homelessness in Massachusetts resulted in part from differences among three dominant frames: social welfare, market access, and social control. Each framing emphasized different aspects of the issue, made value judgments about those involved, and provided different prescriptions for action; the social welfare framing emphasized caring for the homeless as a disadvantaged population, the market access framing cast homelessness as an economic problem that could be addressed by ensuring access to the housing market, and the social control frame cast the homeless as deviants and suggested that homelessness be treated as tantamount to criminal behavior.

The controversy was finally resolved through a reframing that synthesized key elements from each of these three frames. Thus, Schön and Rein (1994) argue that such frame reflection, through critical consideration of the various framings of an issue, can enable productive discussion and resolution of such complex debates.

Political Opinions Online

In attempting to address the balkanization of online discussion noted above, some work has been done on systems for exposing users to a variety of political opinions. Using an interface that intentionally mixes proportions of like-minded and opposing news coverage in a user's news feed, Munson and Resnik (2010) found that individual differences—whether a user was diversity-seeking or challenge-averse—led to differences in perceptions of the interface's utility. ConsiderIt (Kriplean, Morgan, Freelon, Borning, & Bennett, 2012) and the Living Voters Guide (Freelon, Kriplean, Morgan, Bennett, & Borning, 2012), in which users articulate arguments for and against proposed ballot measures, helped users both better understand their own positions and take into account arguments against their positions.

In some cases, though, the simple classification of coverage as either agree or disagree, as is common in the selective exposure literature (cf. Garrett, 2005, 2009; Garrett, Carnahan, & Lynch, 2011), does not fully capture the complexity of perspectives. Opinion Space (Faridani, Bitton, Ryokai, & Goldberg, 2010) attempts to address this complexity by asking users to rate their dis/agreement with five political viewpoints leading to a visualization that projects the resulting data using principal components analysis into a two-dimensional "space" of opinions. Another study, which focused on readers of political blogs, suggested that typical party or ideological boundaries do not adequately capture the subtleties in the variety of readers' political views (Baumer, Sueyoshi, & Tomlinson, 2011). As described above, different sources have been found to frame the same issue differently (Johnston, 2011; Tian & Stewart, 2005; Zhou & Moy, 2007), and the frame(s) to which an individual is initially exposed may shape her or his subsequent information seeking

(Druckman et al., 2012). Thus, different ways of framing an issue may represent another way of transcending agree/disagree or ideological binaries when considering exposure to political opinions.

Visualization of Text Analysis

While previous work has been done in the space of online political engagement and text-based visualizations, none has focused specifically on framing or promoting frame reflection. One of the most widely known online visualization tools, ManyEyes (Viégas, Wattenberg, van Ham, Kriss, & McKeon, 2007), provides a variety of ways to visualize textual data. Most of these use relatively straightforward word counts or co-occurrence data.

Some systems employ more complex text analysis. The Stanford Dissertation Browser (Chuang, Ramage, Manning, & Heer, 2012) uses topic modeling to create a visual interface to the university's archive of dissertations, showing both similarities among individual dissertations and similarities among university departments. In the political arena, Many Bills (Assogba, Ros, DiMicco, & McKeon, 2011) uses machine learning to create topical classifications of proposed legislation before the U.S. Congress. The system is designed to identify both what a bill is about at a high level and to facilitate identifying sections of a bill that may not seem pertinent to the bill's primary focus.

Most such previous work uses text analysis to show *what* people are saying but not *how* they are saying it, i.e., how concepts are framed. One exception, metaViz (Baumer, Sinclair, & Tomlinson, 2010), uses computational metaphor identification to identify potential metaphors in political blogs. The metaViz system has a design and goals that are similar to our system, both in its focus on critical thinking and reflection and in that metaphor is one aspect of framing (Gamson & Modigliani, 1989). However, the system presented here is less prescriptive; rather than telling people what metaphors are being invoked, it identifies and draws attention to certain patterns of language.

As suggested in previous work (Hodgkinson et al., 1999, 2002; Wright & Goodwin, 2002),

techniques that circumvent the usual heuristic processes by which frame effects occur may help to mitigate such effects by promoting more conscious, intentional reasoning. We suggest here that techniques to promote such non-heuristic reasoning may be effective means of promoting frame reflection, i.e., conscious reflection on the framing of an issue. We further suggest that visualizations of text analysis represents one such technique. Computational text analysis revolves around identifying patterns of language. Visualizations can help draw attention to, and provide unusual juxtapositions of, those patterns. Doing so isolates these linguistic patterns from their context of use, potentially circumventing heuristic readings and thus helping to encourage more conscious, thoughtful consideration of the framing of issues connoted by language. Such thoughtful reflection represents the kind of reasoning that computational supports for frame reflection aim to encourage.

The Politics of Algorithms and Algorithms of Politics

While such computational tools offer exciting possibilities, they also introduce the potential for a number of complexities. Systems and techniques for text analysis have encoded in them decisions not only about what types of linguistic patterns are interesting or important but also about what those patterns mean. Recent research has begun to consider the implicit value judgments and assumptions designed into such systems, and how those implicit details play out in the context of use (Ananny, 2011; Anderson, 2011; Chuang et al., 2012; Gillespie, in press). For example, Ananny (2011) describes the sociological and political ramifications that resulted when Google's recommender system suggested that Grindr, a dating app for gay men, was related to a sex offender search app. The interesting questions, Ananny argues, are not in why the system made this connection but in how various stakeholders, from Google engineers to smartphone users to gay rights activists, explained the relationship and what it meant.

Similar analyses have considered the sociological and political interpretation of algorithmic systems including Twitter's trending topics

(Gillespie, 2011), journalistic audience-based agenda setting (Anderson, 2011), and others. While this article focuses primarily on understanding how computational tools can support frame reflection, we also consider how such reflection relates to the conceptualization and interpretation of these algorithmically based systems.

ЯEFLEXT—SYSTEM DESIGN

This article presents a qualitative field study of Reflext, an interactive visualization of computationally identified linguistic patterns that was developed by the authors and designed to support reflection about framing in political content. A previous article describes a controlled experimental study of a Reflext-like prototype (Baumer, Polletta, Pierski, Celaya, Rosenblatt, & Gay, 2013), demonstrating that the tool's capacity for frame reflection on a specific issue interacted with a user's prior views on that issue. This article considers the types of frame reflective practices that such a tool might support in real-world settings. This section describes the collection and analysis of the text data, as well as the design of the visualization.

Text Data

The text analyzed by Reflext come from a collection of 42 political blogs and 11 mainstream media outlets. These were selected due to their prominence in the political blogosphere, as indicated by Technorati authority (http://technorati. com), or due to their use in previous work (Hargittai et al., 2008). Sources vary across the political spectrum, including expressly partisan Republican or Democratic blogs, more general conservative or liberal blogs, some bipartisan blogs, and some third party or nonpartisan blogs. The mainstream news outlets were selected based on either their prominence in political coverage or upon recommendation from study participants (as described below). Content was collected once an hour from these source's RSS feeds; if the RSS feed did not include the full text of the article, the text was scraped from the permalink contained in the RSS feed. After stripping HTML tags, the content of each

article was parsed using the Stanford typed-dependencies parser (De Marneffe, MacCartney, & Manning, 2006), a utility in the Stanford Natural Language Processing library (http://nlp. stanford.edu/software/) that identifies pair-wise grammatical relations.
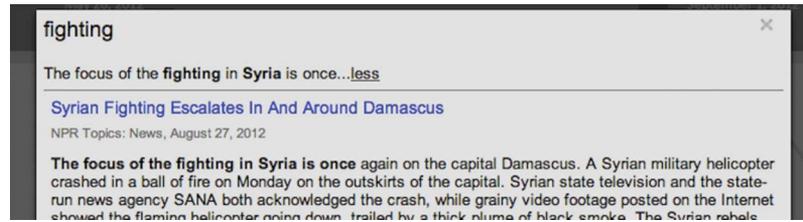
Framing is often instantiated by patterns of associations among words, such as catch-phrases, metaphors, and others (Entman, 1993; Gamson & Modigliani, 1989; Price et al., 2005). Thus, for the nouns with the highest frequency relative to general English (Kilgarriff, 1996), we use the typed dependencies produced by the parser to calculate selectional preferences (Resnik, 1993), which quantify relationships between groups of words. For example, "Medicare" tends to appear with, or *selects for*, the verbs "end," "overhaul," "preserve," "cut," and "save" among others, primarily as the direct object of these verbs. These selectional preferences indicate the types of things one might do to Medicare. Reflext uses a topic-modeling approach that represents selectional preferences as probabilistic distributions over groups of relations and arguments for which each noun selects (Ritter, Mausam, & Etzioni, 2010). This approach provides more subtlety and accuracy than simple co-occurrence counts. While selectional preferences may not capture every linguistic device related to framing, the patterns identified can suggest different ways in which complex issues such as Medicare are framed.

Selectional preferences are calculated for each blog and news source, as well as four aggregate corpora: all blogs, all news, all Republican blogs, and all Democratic blogs. Analyses are based on the most recent 250,000 words from each source, ensuring both sufficient data to generate meaningful results and results based on the most recent content. Currently, Reflext shows results updated on a weekly basis. One-week intervals were chosen in part to allow time to run the computational analyses and in part because some blogs only publish a few posts each week.

Visualization Design

These selectional preference results are presented through a Web-based visualization built using the D3 visualization library (http://d3js.

org/). The initial view displays the top 250 relatively frequent words across all selected sources in the "cloud view," or all relatively frequent nouns in the "list view." In the cloud view (Figure 1a), nouns are scaled by a logarithmic function of their relative frequency with the largest placed closer to the center. The cloud feature is generated using a Javascript D3 implementation of Feinberg's Wordle algorithm (http://static.mrfeinberg.com/bv_ch03.pdf) modified to be non-random, i.e., the same words always appear in the same place. The relative-frequency–based word cloud was chosen as a familiar and easily interpretable way of finding *what* is being said, i.e., an overview first (Shneiderman, 1996). The user can zoom using a mousewheel or trackpad gesture and can pan using click-and-drag. Typing in the search box (Figure 1b) will filter the cloud as each character is typed based on string prefix matching. The list view (not pictured) presents all relatively frequent nouns from every selected source in alphabetical order with similar logarithmic scaling. In both views, each noun is color-coded based on the source from which it comes. If a noun is present in multiple sources, it takes on the color of the source in which it has the highest relative frequency. Users can select and deselect

specific sources or groups of sources, such as all blogs, using the left sidebar (Figure 1c).

When the page first loads, the user is shown the visualizations from the most recent analysis. Using the time slider (Figure 1d), he or she can step back or forward in one-week increments or drag the slider to the desired date, enabling the user to examine changes over time.

Clicking on a noun (e.g., "syria") triggers an animated transition from the cloud or list view to a radial tree showing that noun's selectional preferences (Figure 1e). Words for which the chosen noun selects are grouped first by source, which is also used to color code associated words. They are then grouped by relations (Ritter et al., 2010); words on the same "branch" of the radial tree tend to appear in similar grammatical relationships with the chosen noun. These associated words are also sized according to a logarithmic transform of the strength with which the chosen noun selects for them. As before, users can select and deselect sources to add or remove results from that source, adjust the date slider, and pan and zoom. This portion allows a user to zoom and filter (Shneiderman, 1996), and it provides a sense of *how* common terms are being used in different contexts.

FIGURE 1. Composite collage of the Reflext visualization, showing (a) the word cloud, (b) the search box, (c) the list of sources grouped by type with Newsstand expanded, (d) the date slider, and (e) the radial tree showing selectional preferences.

FIGURE 2. Lightbox with fragments showing associations in context and the source text from which they come.

Clicking one of the associated words in the radial tree opens a light box with sentence fragments that demonstrate examples of this association in context, i.e., providing details on demand (Shneiderman, 1996). A user can click "more" to see the full text of the article in which that example appeared with the example fragment in bold type (Figure 2); clicking the article title links to the original source.

This design may help to mitigate some of the impacts of ordering effects noted in framing research (e.g., Druckman et al., 2012). Rather than present one frame or another first, the circular layout imposes limited ordering on the linguistic associations being visualized and thus may allow equal possibility of perceiving different frames as more or less salient. This design also reflects the idea that visualizing patterns of language can help promote frame reflection by circumventing the usual heuristic processes by which frame effects occur (cf. Hodgkinson et al., 1999, 2002; Wright & Goodwin, 2002). The radial tree (Figure 1e) visualizes identified linguistic patterns, presenting them both out of context and juxtaposed with one another. This approach is intended to encourage more thoughtful consideration of the relationships between the associated words rather than reading solely for content or comprehension. Furthermore, clicking through to see an instance of a pattern highlighted in its context of use (Figure 2) provides the opportunity to apply that same thoughtful consideration back to the original text.

To reiterate, unlike computational analytic techniques used by researchers (Conway, 2006; Lind & Salo, 2002; Matthes & Kohring, 2008), Reflext does not identify frames *per se*. The literature on framing describes in general the types of linguistic and conceptual devices associated with framing (Entman, 1993; Gamson &

Modigliani, 1989; Price et al., 2005), but it does not provide strict guidance as to when specific phrases are or are not related to framing. Since metaphor is one such device, and metaphor is sometimes associated with selectional preferences (Fass, 1991; Mason, 2004), we suggest this as one potentially framing-relevant linguistic pattern. Furthermore, framing theorists argue that frames do not exist objectively in a text; rather, framing is a dynamic interpretive accomplishment (Benford, 1997) evidenced only in part by the texts that instantiate it. Neither does Reflext identify bias; it will not tell a user whether, e.g., Fox News is more or less biased than NYT.com. The tool identifies and draws attention to potentially informative patterns of language, but it intentionally provides interpretive flexibility in allowing users to make meaning from those patterns. By going beyond simply telling a user what frames are at work or identifying a conservative or liberal bias, Reflext may be a useful tool in facilitating frame reflection.

FIELD STUDY

The tool described above enables us to consider a number of research questions related to frame reflection and how computational systems might support it:

RQ1. What patterns of use arise with computational supports for frame reflection when used regularly over a period of time?

RQ2. Are different types or aspects of frame reflection more or less supported by such tools?

RQ3. How do people interpret and make meaning of computational text analyses and visualizations thereof in a real-world setting?

To explore these questions, Reflext was deployed in a field study conducted from June through October 2012.

Participants were recruited via large e-mail lists, such as chi-announcements@listserv.acm.org and air-l@listserv.aoir.org, as well as snowball sampling via local department e-mail lists. Recruitment e-mails called for both self-proclaimed "political junkies" and people averse to politics to try out a tool for "understanding political news and discussion by visualizing patterns of language." This recruitment strategy was meant to target primarily those individuals who we assumed would be most likely to use such a tool as Reflext, i.e., those who are knowledgeable, tech-savvy, and politically engaged.

A total of 21 participants completed an initial interview during June or July 2012. These initial interviews, conducted via Skype or in-person, included questions about participants' existing online reading practices (e.g., Where and how often do you read political news and discussion? When and how did you start reading these sources? If you only had 10 minutes, how would you decide what to read?), perceptions and attitudes about political issues (e.g., Which issues are most important to you and why? How did you form your opinions on those issues? How do your views compare with predominant societal views?), and online news reading and political engagement (e.g., Do the sources you read mostly align or conflict with your views? Do you ever notice differences in language used to describe different issues?). These interviews established a baseline against which users' accounts of their practices after using Reflext could be compared. At the end of the initial interview, the researcher spent 5–10 minutes introducing the participant to Reflext, describing it as a tool that identified patterns of language in news and blogs to help users understand different perspectives on current issues. When possible, Skype screen sharing was used. Participants were then asked to use the tool as a part of their regular political news-reading practice.

Between 6 and 12 weeks later (M = 8.3, Mdn = 8), depending on participant availability, a second interview was conducted with each participant, which focused mainly on their use of the tool (e.g., How have you been using Reflext over the past several weeks? Are there situations in which Reflext is more or less useful? Have you discussed the tool with anyone else?) and how it may have impacted their reading practices or perceptions of issues (e.g., Are there issues of which you are now more or less aware or about which you think differently? Has using Reflext affected the sources you read or your attitude towards different sources? Has it impacted the way you read political news?). When possible, the participants used screen sharing to show the interviewer their use of the tool. Of the 21 initial participants, 16 completed the second interview; the other five did not respond to e-mail requests to schedule a second interview. Six participants, who had indicated interest in optional subsequent interviews, were contacted for a third interview in late October or early November; the U.S. election occurred on November 6, 2012.

During the field study, the results displayed by the tool were updated weekly; every Monday, results through the previous Saturday were posted. On November 8, all participants received an e-mail asking if they would like to continue to receive notifications of updates. Seven participants indicated that they would like to be notified of major updates or new features, two of whom requested to continue receiving notifications of weekly analysis updates.

Based on participant feedback, some small modifications were made to the tool. The most significant change was the addition of the time slider (Figure 1d) on July 17. Other changes included deactivating less commonly viewed sources (July 24); adding new sources by popular demand, e.g., *The Economist*'s U.S. coverage, *The Atlantic*'s Politics section, and *Al Jazeera* English (July 24); hyperlinking article titles to the original sources (July 24); and adding the name of the source to the example pane (September 1). These modifications, which were also mentioned in the weekly e-mails to participants, did not change the core experience or design of the tool over the course of the field study.

All participants' interviews were transcribed, and transcripts were analyzed using open coding followed by axial coding (Lofland & Lofland, 1995). We analyzed the first and second round

of interviews separately but according to similar, standard qualitative methods. Each set of interviews was read iteratively to generate themes that described the participants, their existing reading practices, their previous experiences with political news and online engagement, and, in the second round, their use of and experiences with Reflext. The transcripts were subsequently coded for these themes, and served as the basis for the results presented here.

Profile of Participants

Initial interviews were conducted with 21 participants (12 female, 8 male, 1 queer) ages 19 to 60 (M = 36.7, Mdn = 35). Several (7) worked either in the technology sector (Web designer, usability analyst), and several identified as students (9) and/or researchers (4). With respect to nationality, 16 were U.S. citizens (one living abroad), two were Canadian (one living in Canada, one in the U.S.), one was Belgian, one was Portuguese, and one was Chinese living in Britain. With one exception, all participants either self-identified as political "junkies" or described being relatively politically informed. Thus, our recruitment strategy succeeded in finding tech-savvy, politically engaged participants.

When asked their political affiliation, responses were not always straightforward. While two participants identified as Republicans and eight as Democrats, the other 11 articulated ideological leanings in more varied, subtle ways, such as "liberal republican" or "fairly centrist on economic issues [but] left/middle-left on social issues." While these self-descriptions use common terms, such as liberal, conservative, or progressive, participants generally hesitated to ascribe to such labels, as in similar previous work (Baumer et al., 2011). Participants noted that "labels kind of pigeon-hole things," thereby facilitating misconceptions.

Reading of political content was often described as interest-driven title-skimming. The process starts with skimming titles on the front page of a news site—some participants set their browser's home page to such sites as NYT.com—followed by clicking on stories that either involved issues about which the participant already cared or promised to present novel information with which the participant was unfamiliar. Ten participants explicitly mentioned that their reading process involved seeking out a variety of news sources, including viewpoints in opposition to their own, as a means of balancing out their political news source "diet." Six participants predominantly read sources aligned with their own existing views; reasons varied from avoiding frustration to avoiding objectionable political agendas. Another two participants described reading mostly sources with which they disagreed, one saying he could not see the point of "reading reinforcing something you already know."

Just as participants take into consideration how their own biases might influence their selection and interpretation of political news, they also consider how a given source's bias may influence its coverage. Participants made two different types of distinctions in this regard: objective vs. subjective and objective vs. fair.

On the one hand, 10 participants wanted news coverage to be neutral, i.e., objective, with a strictly separate space designated for opinions or subjective material. The news, according to this view, should consist entirely of facts. On the other hand, six participants were less concerned whether opinions were mixed with the news, arguing that news should be "not objective, but fair." That is, opinions should be disclosed honestly and explicitly, and space should be provided for voicing multiple divergent viewpoints. Some went so far as to say it was impossible to remove all opinion or bias from news coverage, aligning with the assertion that all information is framed (Entman, 1993).

When asked, all 21 participants had a sense of differences in language between different sources or different opinions (cf. Johnston, 2011; Tian & Stewart, 2005; Zhou & Moy, 2007), but few could articulate the nature of these differences. As an example, one participant described how the same person could be called either a "freedom fighter" or a "terrorist," and that these different labels carried vastly different connotations. Despite the pervasive sense of the importance of language, this was the closest any participant came in his or her initial interview to describing anything resembling framing or to engaging in something resembling frame reflection.

RESULTS

Results emerging from the analysis of the interviews are organized into three sections, each of which explores one of the research questions described above. First, we provide a general description of how participants engaged with the system (RQ1). Second, we describe how participants' use of Reflext aligned with potential indicators of frame reflection (RQ2). Finally, we take advantage of the opportunity afforded by these data to consider broader questions about the interpretation of algorithmically based systems (RQ3).

For many of the themes below, we list one or more exemplar quotes, each of which serves as a representative of a larger pattern. Also, where possible, we note the numbers of participants whose experiences align with each theme. However, these numbers should be interpreted carefully for at least two reasons. First, although our participants resemble the population of potential users of tools such as Reflext, we used convenience sampling, which is not necessarily representative. Second, since the interviews followed a semi-structured protocol, and since the analysis was done after completion of the interviews, not all participants were asked about every theme. Thus, a participant not mentioning a given theme does not necessarily imply that their experiences did not align with that theme. Nonetheless, we include numbers where possible to provide a sense of the predominance of each theme or pattern discussed below.

General Patterns and Practices of Use

Reading, searching, and browsing

The usage that participants described most commonly resembled information gathering, usually following one or more of three different forms.

First, five participants described treating Reflext as a news aggregator to find articles or read stories on topics or issues of interest. For example, participants interested in the conflict in Syria would click on "Syria" or "Damascus" or "Aleppo" from the word cloud. Second, nine participants used Reflext more as a search tool.

These participants would read about a particular topic or issue elsewhere and then come to the tool to find out more about it. The third type of use more closely resembled browsing. Eight participants described at times opening Reflext without anything particular in mind and would skim the word cloud and the radial trees to see if anything interesting grabbed their attention. These latter two approaches, searching and browsing, differed from the first, reading, in that they generally did not involve reading the full text of any one article but rather looking at portions of many articles.

Integration with and alteration of existing practices

Use of Reflext was shaped by the different ways participants positioned the tool in relation to their existing news reading practices. For example, eight participants viewed the tool as a supplement: "I still go to all of my news sources first and read those and read whatever people post on Facebook and that all has priority over this [Reflext]." These participants most often followed the searching pattern described above, looking for coverage about a particular issue or wanting to read specific stories.

For four participants, though, Reflext became a primary news source. One participant had previously relied heavily on Reddit's r/politics. However, "Since starting using Reflext . . . I just removed r/politics from my like frontpage because it was getting obnoxious, and I actually find Reflext a lot cleaner." Such participants tended to follow the reading and, to a lesser extent, browsing usage patterns described above.

Frame Reflective Uses

Due to limited previous work studying frame reflection, few prescriptions are available as to what sorts of activities should be considered indicative of frame reflection. However, several possibilities can be drawn from previous research on framing (Benford, 1997; Entman, 1993; Goffman, 1974; Lau & Schlesinger, 2005; Mutz, 2006; Price et al., 2005; Schlesinger & Lau, 2000; Snow et al., 1986). Here, we enumerate three potential indicators of frame reflection.

First, significant work has argued for the value of exposure to a wide array of opinions and viewpoints, particularly those that differ from one's own (e.g., Mutz, 2006; Price et al., 2005). Similarly, frame reflection likely requires broad exposure to and consideration of a variety of sources providing different perspectives on an issue (cf. Johnston, 2011; Tian & Stewart, 2005; Zhou & Moy, 2007). Second, simply being exposed to diverse sources and opinions may not be enough. Frame reflection likely involves engaging with and reasoning about different political opinions, including understanding others' opinions, questioning one's own opinions, or adopting new opinions (Benford, 1997; Entman, 1993; Snow et al., 1986). Third, just as previous work has suggested thinking across different policy domains as an important type of political reasoning (Lau & Schlesinger, 2005; Schlesinger & Lau, 2000; Snow et al., 1986), frame reflection may facilitate noticing connections or patterns among seemingly disparate issues.

This subsection considers the extent to which each of these three types of behavior was or was not evidenced in the qualitative analysis of the interview transcripts. These results demonstrate not only the extent to which Reflext facilitated frame reflection but *what kinds* of frame reflective activities were most supported.

Broadening exposure

We found evidence that Reflext broadened participants' exposure in three specific ways. First, seven participants described seeing material from sources they might not have encountered otherwise. For example, one participant recounted finding a number of interesting and useful articles only to discover that they came from the BBC, a source she would not usually even consider consulting. Another participant mentioned having a similar experience with Al Jazeera, a source that she had assumed would include an anti-Isreali bias. "But I'll read a story about the Middle East and later realize . . . that it came from Al Jazeera.. . . When I go to see where it came from I'll be like 'Wow, really, that came from there? Hmm they're better [less biased] than I thought they were.'" We only counted as broadened

exposure cases where participants specifically noted reading sources they would not have read previously, as opposed to those participants who mentioned in their initial interview reading diverse sources. Interestingly, such exposure often occurred because participants could not tell from exactly which source a particular association had come, since it was at times difficult to tell which colors on the list of sources matched colors of associated words in the visualization. Thus, what might be considered a usability problem helped broaden participants' exposure (cf. Greenberg & Buxton, 2008).

Second, six users mentioned that Reflext exposed them to topics or issues they might not otherwise have encountered. For example, when one participant clicked on Syria, she found many of the associations—shoot, conflict, kill, rebel—unsurprising. However, one association, "leave," was not expected. Clicking on this term, she found discussions about refugees "leaving" Syria for Turkey, drawing attention to another aspect of the conflict there that she had not previously considered.

Third, five participants described encountering more diverse sets of opinions than they would have otherwise. For example, one participant appreciated getting "a different perspective on Western involvement in the Middle East," in part because of exposure to a source that "doesn't come up in Google News usually."

Understanding, questioning, and noticing opinions

This exposure to diverse ideas and opinions through Reflext had two primary ramifications. First, it helped participants form a better understanding of opinions that differed from their own. "Especially when it comes to the Middle East, . . . I'm better informed about what the other side thinks." Second, in some cases, it led participants to question their own opinions. For example, one participant, a self-described "liberal Republican," had assumed that she would vote for Mitt Romney, the Republican presidential candidate. However, after reading coverage about Romney's personal takes, her resolve began to waver. "I haven't jumped ship entirely, but I'm beginning to start looking around and saying that I'm going to need to find more

information on both candidates." Crucially, she encountered this coverage from a source she would not otherwise have consulted but found only as a result of using Reflext. As in this example, no study participants drastically altered their opinion on a given issue, but, also as in this example, many became more thoughtful and reflective, examining those opinions more closely.

In a few cases, though, participants still focused on information that supported their previous opinions. As one participant recalled reading, "There's a division within the tea party and the regular republicans . . . and it's like, oh that's interesting. And sort of gleefully enjoy that but I enjoyed it in a gleefully partisan way." This experience resonated with his previous views of Republicans as factious and disorganized.

Finally, during the initial interviews, participants saw important distinctions between factual news and opinions, similar to the objective/subjective distinction described above. However, with Reflext, participants more often noted how even purportedly factual coverage or "straight news" could cast an issue in certain ways. One participant noted, even in the context of "straight news . . . sometimes I will see the bias creep in and then I can tell . . . it's either Al-Jazeera or BBC, I can't quite tell but it's gotta be one of the two of those." This acknowledgment resonates with a core tenet of framing theory, that all information is framed and there is no such thing as an unframed fact (Entman, 1993), though no participant went so far as to suggest that all news reporting evidences some type of framing.

Reading for patterns (or not)

Issues are not framed through single isolated phrases but rather via large, repeated patterns that may span numerous documents and contexts. Although the associations visualized in Reflext may be seen as an example of one such pattern, only four participants mentioned that they had begun to reshape their reading practices around such patterns. One participant, focusing on countries, started noticing similarities between India and Brazil, prompting her to consider how the two might be similar and attending more closely to the language associated with

each. "[I]t's changing the way I'm reading the news . . . . I used to read for the plotline, I'd see the headline and then I'd see the plotline that went with the headline. But now, I'm reading it specifically for connections."

While these changes suggest intriguing possibilities, such reading for patterns was one place where Reflext was not as successful at fostering frame reflection. Our analysis also revealed one other key way in which participants were not as frame reflective as they could have been. When using the tool, participants often wanted a specific answer to questions such as which source was more biased or, in general, what a given linguistic pattern in the visualization meant. Such a desire, however, runs contrary to the design's intent for open-endedness and flexibility of interpretation. This tension draws attention back to the importance of considering how algorithmically based systems are interpreted and made meaningful.

On the Interpretation of Algorithms

Recent work has drawn attention to the importance of how users interact with and interpret systems that incorporate techniques from topic modeling, recommender systems, sentiment analysis, and other complex computational analyses (Ananny, 2011; Anderson, 2011; Chuang et al., 2012; Gillespie, in press). This subsection applies a similar lens to our data, describing participants' processes of interpretation when using Reflext. It also provides a deeper look at the relationship between the frame reflective uses described above and the computational underpinnings of the system.

What's interesting?

At the simplest level, we wanted to know how well the selectional preference patterns identified by Reflext aligned with users perceptions of what was interesting or warranted further examination. Most of the associations that participants found interesting and explored further were described as unexpected, confusing, or "funny" in some way. In a few cases, the funny ones ended up being spurious artifacts. For example, many participants were intrigued why the term "junkie" appeared so prominently in the

word cloud, only to discover that a blog called "Political Junkie" included the word multiple times in many of its posts.

However, according to six participants, these unexpected associations became the most useful. The example described above about the association between "syria" and "leave" demonstrates how expected results were often ignored while unexpected results wound up being interesting and informative. One participant stopped clicking on the names of people, instead focusing on countries, which tended to have more unexpected or confusing associations. Another participant, who clicked on "troops," noted, "There's the words 'leave' 'use' 'play' 'see' 'fight' and 'force,' and I thought there, 'play' kind of jumped out at me . . . are the troops playing over there? . . . When I actually click on it, it's going to something about troops playing a key role. . . . So that's another example where of I look at this [Reflext] as a tool for going deeper into something." While expected associations may help confirm that the system is working as intended, the unexpected associations were found most interesting and informative.

Transparency and meaning

Several participants, both those with and without a technical background, described wanting more transparency, either about how the system worked or about what the results meant.

At various times, 10 participants made conjectures or sought explicit explanations about the functioning of the technology behind the system. Such questions dealt with aspects ranging from how Reflext acquired content from Web pages, to how exactly it identified patterns and associations in text, to how the identified associations were translated into the visualization. One participant mentioned, "I would kind of like to know how these visualizations are being created because, again, I'm really hesitant to kind of allow the tool to give me this picture of what's going on in the world because I don't know how it's going out picking out these words." In many cases, these considerations were prompted by misalignments between a participant's expectations and what Reflext showed. For example, when one participant "tried looking for Aurora, Colorado . . . I finally found a

really tiny Aurora somewhere on the list . . . I thought, well, it should've probably been bigger because it was such a hot story." The fact that participants developed or sought explanations of how the system worked is not necessarily surprising.

In addition to these questions about functionality, though, participants also raised questions about interpretation. Seven participants sought at some point prescriptive explanations of what the results in the visualization *meant*, either from Reflext itself or, in some cases, from the researcher conducting the interview. When the explanation of selectional preferences was given (e.g., that "Syria" tends to appear as the direct object of "leave"), participants often seemed unsatisfied. For example, one participant clicked on "America," then said, "What I'm assuming is in the context of the concept America the words that are most present in the discussion are the words president, brotherhood, individual, make.. . . So I'm wondering what do you make of that?" Another participant, clicking on "datum," said, "There's just a lot of things that are connected to datum. But I'm still kind of wondering like . . . I still kind of want a number or something on there, that would let me know. . . ."

This desire for a prescriptive interpretation represents, as mentioned above, one way in which participants' use of Reflext demonstrated less frame reflection. Furthermore, it runs contrary to the goal of allowing users to interpret the identified patterns' meanings and our approach of designing for interpretive flexibility (cf. Pinch & Bijker, 1987). This is not to say that the details of the system's inner workings should be shrouded in mystery. Transparency could involve providing a detailed technical account of how the results and visualization are produced, but we suggest that it should not involve providing a prescriptive interpretation of what those results. Doing so might make a system seem easier to use, but it may also reduce the system's capacity to promote reflection.

Preconceptions and algorithmic veracity

As noted above, participants at times felt that the results presented in Reflext conflicted

with their previous assumptions, with five participants noting disconnected results between their expectations and what the visualization showed. For example, one participant, comparing the aggregated Democratic blogs and Republican blogs, clicked on "Medicaid" and noted, "I see words like expansion and medicare, system, security, coverage. Those are all fine but . . . I don't see words on here like socialism, ethics, poverty. . . . I'm actually kind of surprised looking up medicaid that the word 'socialism' doesn't appear here somewhere in the Republican words." In another example, a participant described selecting Fox News and New York Times and then choosing to see their associations with "Obama." "So I have one left leaning and one right leaning, and I figured that there would be some more unpleasanter [sic] words from the right leaning paper about Obama and more nice words from the NYTimes." However, the associations in the visualization showed that the two sources used mostly similar language when discussing the President.

However, rather than suggest that the system was somehow in error, this participant instead questioned his own assumption: "[It] makes me think a little differently about that particular news source [Fox]." These remarks also resemble those described above that participants had made about perceptions of bias in such sources as Al Jazeera or the BBC. Not only does this example further demonstrate the kinds of self-questioning supported by Reflext, but it also raises an important question about the perceived veracity of the system. Previous work has suggested attending to situations in which and the sociological processes by which we decide that an algorithm is wrong (Ananny, 2011; Gillespie, 2011). These results point to the importance of also considering situations in which we let an algorithm tell us that we are wrong, i.e., when we let the results of computational analysis challenge or even change our preconceptions.

DISCUSSION AND FUTURE WORK

The above results describe the various ways that participants engaged, or at times did not engage, in frame reflection. Here, we consider how these results speak to various ongoing discussions in the literature, both with respect to framing and frame reflection, as well as broader issues of selective exposure bias and political deliberation.

Aspects of and Impacts of Frame Reflection

The results presented above showed varying degrees of evidence for each of the three potential indicators of frame reflection we suggested. Here, we consider each of those aspects in more detail, as well as their significance to and connections with ongoing discussions from previous work.

First, participants' accounts of broadened exposure most clearly connect with previous work on selective exposure bias, i.e., seeking out content that aligns with their views and avoiding conflicting content (Garrett, 2005; Lawrence et al., 2010; Mutz, 2006). Much of this previous work has suggested that exposure bias may not be as totalizing or pervasive as some (e.g., Sunstein, 2007) might have feared (Garrett et al., 2011; Hargittai et al., 2008; Munson & Resnick, 2010). In the results presented here, the novel sources participants encountered via Reflext—be it *Al Jazeera*, the BBC, the Huffington Post, Fox News, or *The New York Times*—had previously been avoided less because of differing opinions and more because they were seen as biased sources. These findings align with prior work that has examined how the source of information often impacts perceptions of bias (e.g., Feldman, 2010).

Furthermore, we suggest that framing may provide a novel approach to thinking about selective exposure. Rather than considering whether an individual is exposed to opinions with which she or he disagrees, one might instead look at the number or variety of frames to which an individual is exposed. Indeed, previous analyses have found differences in how the same issue is framed across sources (Johnston, 2011; Tian & Stewart, 2005; Zhou & Moy, 2007). Thus, participants in our study who read more varied sources also likely encountered more varied frames, which may also have helped promote some of the frame reflection we observed.

Second, our analysis found increased engagement with and consideration of diverse opinions. Beyond simply seeing opposing viewpoints, as with the case of broadened exposure, participants actually engaged with, and considered as potentially viable, competing arguments. The participant who, after using Reflext, began to question her decision to vote for Romney provides one example. These results resemble in some ways those of Freelon et al. (2012) and Kriplean, Toomin, Morgan, Borning, and Ko (2011), who found evidence that users of the Living Voters Guide often took into account arguments from differing points of view, though they rarely changed their opinions drastically. Similarly, our participants rarely described changing their opinions on an issue. However, even if it does not result in opinion change, this process of considering arguments that conflict with one's prior views is itself valuable (Cappella, Price, & Nir, 2002).

Finally, we saw some evidence that participants noticed patterns and connections among diverse issues. These findings relate most clearly to previous work on policy metaphors (Lau & Schlesinger, 2005; Schlesinger & Lau, 2000). Lau and Schlesinger (2005) suggest that an important mode of reasoning for both political elites and general citizens involves making inferences across different policy domains. However, of the three potential indicators, our analysis produced the least evidence for this aspect of frame reflection.

This point raises the question: Why might evidence for these indicators of frame reflection vary? We suggest that these three indicators represent increasingly difficult types of frame reflection. Simply broadening exposure by reading material one would not otherwise encounter requires neither significant expenditure of cognitive energy nor massive changes to one's reading practices. Thus, this aspect may be the easiest of the three. Seriously considering the differing opinions one finds in those sources, though, likely requires more effort, especially if it involves questioning your own views. The visualization tool studied here seemed to provide adequate support for these first two indicators. Finally, although reasoning by comparison across policy domains may be a common form of understanding political issues (Lau &

Schlesinger, 2005; Schlesinger & Lau, 2000), drawing to conscious attention and reflecting on those connections may be rather more difficult, making this third indicator the most challenging. In most cases in our data, the linguistic patterns shown in the visualization did not adequately support this indicator of frame reflection. Future work should explore the relative difficulties of these frame reflective behaviors, as well as whether various types of tools can help ameliorate those difficulties.

Limitations

While this article provides an important exploration of frame reflection in a real-world setting, several limitations should be kept in mind when interpreting the results.

First, due to the in-depth, qualitative nature of the analysis, we did not include large numbers of diverse participants. We chose this approach because of our work's exploratory nature and the limited amount of previous research on frame reflection. This choice limits our ability to make inferences about the broad applicability or efficacy of such tools. However, this choice also made it tractable to gather data rich data about how the use of tools such as Reflext unfold in real-world settings over a period of one and one-half to three months. We suggest that the duration of the field study and richness of the data collected balance, at least to some extent, the limitations arising from the relatively modest number of participants.

On a related note, participants in this study may not represent the broader population of individuals among whom researchers might be interested in promoting frame reflection. Many of our participants were moderately to highly tech-savvy, fairly well educated, and self-described political "junkies." Previous work, though, has found that frame effects can differ based on individual factors such as political knowledge, level of political engagement, education, etc. (Chong & Druckman, 2007; Lau & Schlesinger, 2005), which raises two important points. First, as described above, we employed theoretically motivated sampling; politically engaged and tech-savvy individuals are, we suggest, more likely to use tools such

as Reflext, so the results from this study provide insights about the population of interest. Second, understanding how less informed or engaged individuals, or those with less technical knowledge, might use and interpret such tools represents an important area for future work.

Second, all the data that we collected for this study come from self-report. On the one hand, this might be seen as a weakness. We cannot objectively verify, e.g., that people were actually exposed to more diverse sources than they would have been otherwise. However, in the context of frame reflection, what is important is not *that* participants are exposed to more diverse sources and opinions but that they *say* they are exposed to more diverse sources and opinions. Here, participants' accounts of their own encounters with and reasoning about political issues are the object of study, making self-report a valuable method of data collection.

Finally, this work focused on instances of frame reflection as exhibited by individuals. However, as argued above, frame reflection has the most potential for impact in the context of group discussions. Future work should examine the various roles that tools such as Reflext might play in deliberative settings. Such work could take a similar approach, with tools that help deliberators understand different perspectives in a corpus of text. Alternatively, such tools might be aimed inward, i.e., used to analyze transcripts of deliberative sessions, thereby allowing those involved to come to a greater understanding of their own framings of an issue.

CONCLUSION

This article describes a qualitative field study of Reflext, an interactive visualization that leverages computational linguistic analysis to support reflection about framing in political coverage. Through this field study, we found that users engaged in a variety of activities related to frame reflection (Schön & Rein, 1994), effectively integrated use of Reflext with their existing reading practices, and experienced a range of both successes and difficulties in interpreting results shown by the system. While not every participant used the tool in a frame reflective manner at all times, the changes in both reading

practices and perceptions of political issues we observed during the study seem promising. These results speak to a number of ongoing discussions, not only about framing but also about selective exposure bias, political deliberation, and the sociological interpretation of computational systems. Thus, the work presented here helps advance the larger endeavor of facilitating more thoughtful, reflective engagement with political issues.

REFERENCES

Ananny, M. (2011, April). The curious connection between apps for gay men and sex offenders. *The Atlantic*. Retrieved from http://www.theatlantic.com/technology/archive/2011/04/the-curious-connection-between-apps-for-gay-men-and-sex-offenders/237340/

Anderson, C. W. (2011). Deliberative, agonistic, and algorithmic audiences: Journalism's vision of its public in an age of audience transparency. *International Journal of Communication*, 5, 529–547.

Assogba, Y., Ros, I., DiMicco, J., & McKeon, M. (2011). Many bills: Engaging citizens through visualizations of congressional legislation. *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems* (pp. 433–442). New York: ACM Press.

Baumer, E. P. S., Polletta, F., Pierski, N., Celaya, C., Rosenblatt, K., & Gay, G. K. (2013). Developing computational supports for frame reflection. *Proceedings of the iConference*. Fort Worth, TX.

Baumer, E. P. S., Sinclair, J., & Tomlinson, B. (2010). "America is like Metamucil": Fostering critical and creative thinking about metaphor in political blogs. *Proceedings of the ACM CHI Conference on Human*

Factors in Computing Systems (pp. 1437–1446). New York: ACM Press.

Baumer, E. P. S., Sueyoshi, M., & Tomlinson, B. (2011). Bloggers and readers blogging together: Collaborative co-creation of political blogs. *Computer Supported Cooperative Work (CSCW)*, *20*(1–2), 1–36.

Benford, R. D. (1997). An insider's critique of the social movement framing perspective. *Sociological Inquiry*, *67*(4), 409–430.

Blei, D. M. (2012). Probabilistic topic models. *Communications of the ACM*, *55*(4), 77–84.

Cappella, J. N., Price, V., & Nir, L. (2002). Argument Repertoire as a Reliable and Valid Measure of Opinion Quality: Electronic dialogue during campaign 2000. *Political Communication*, *19*(1), 73–93.

Chong, D., & Druckman, J. N. (2007). Framing theory. *Annual Review of Political Science*, *10*(1), 103–126.

Chuang, J., Ramage, D., Manning, C. D., & Heer, J. (2012). Interpretation and trust: Designing model-driven visualizations for text analysis. *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems* (pp. 443–452). New York: ACM Press.

Conway, M. (2006). The subjective precision of computers: A methodological comparison with human coding in content analysis. *Journalism & Mass Communication Quarterly*, *83*(1), 186–200.

De Marneffe, M. C., MacCartney, B., & Manning, C. D. (2006). Generating typed dependency parses from phrase structure parses. *Proceedings of The International Conference on Language Resources and Evaluation*. Genoa, Italy.

Drezner, D. W., & Farrell, H. (2008). The power and politics of blogs. *Public Choice*, *134*(1–2), 15–30.

Druckman, J. N., Fein, J., & Leeper, T. J. (2012). A source of bias in public opinion stability. *American Political Science Review*, *106*(2), 430–454.

Entman, R. M. (1993). Framing: Toward clarification of a fractured paradigm. *Journal of Communication*, *43*(4), 51–58.

Faridani, S., Bitton, E., Ryokai, K., & Goldberg, K. (2010). Opinion space: A scalable tool for browsing online comments. *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems* (pp. 1175–1184). New York: ACM Press.

Fass, D. (1991). Met*: A method for discriminating metonymy and metaphor by computer. *Computational Linguistics*, *17*(1), 49–90.

Feldman, L. (2010). Partisan differences in opinionated news perceptions: A test of the hostile media effect. *Political Behavior*, *33*(3), 407–432.

Fishkin, J. S. (2009). Virtual public consultation: Prospects for Internet deliberative democracy. In T. Davies & S. P. Gangadharan (Eds.), *Online deliberation: Design, research, & practice* (pp. 23–36). Palo Alto, CA/Chicago, IL: Center for the Study of Language and Information/University of Chicago Press.

Freelon, D. G., Kriplean, T., Morgan, J., Bennett, W. L., & Borning, A. (2012). Facilitating diverse political engagement with the Living Voters Guide. *Journal of Information Technology & Politics*, *9*(3), 279–297.

Gamson, W. A., & Modigliani, A. (1989). Media discourse and public opinion on nuclear power: A constructionist approach. *The American Journal of Sociology*, *95*(1), 1–37.

Garrett, R. K. (2005). *Exposure to controversy in an information society* (Doctoral dissertation). University of Michigan, Ann Arbor, MI.

Garrett, R. K. (2009). Politically motivated reinforcement seeking: Reframing the selective exposure debate. *Journal of Communication*, *59*(4), 676–699.

Garrett, R. K., Carnahan, D., & Lynch, E. K. (2011). A turn toward avoidance? Selective exposure to online political information, 2004–2008. *Political Behavior*, *35*(1), 113–134.

Gillespie, T. (2011). Can an algorithm be wrong? Twitter trends, the specter of censorship, and our faith in the algorithms around us. Culture Digitally. Retrieved October 19, 2011, from http://culturedigitally.org/2011/10/can-an-algorithm-be-wrong/.

Gillespie, T. (in press). The relevance of algorithms. In T. Gillespie, P. Bockzkowski, & K. Foot (Eds.), *Media Technologies*. Cambridge, MA: MIT Press.

Goffman, E. (1974). *Frame Analysis*. Cambridge, MA: Harvard University Press.

Greenberg, S., & Buxton, B. (2008). Usability evaluation considered harmful (some of the time). *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems* (pp. 111–120). New York, NY: ACM Press.

Hargittai, E., Gallo, J., & Kane, M. (2008). Cross-ideological discussions among conservative and liberal bloggers. *Public Choice*, *134*(1–2), 67–86.

Hodgkinson, G. P., Bown, N. J., Maule, A. J., Glaister, K. W., & Pearman, A. D. (1999). Breaking the frame: An analysis of strategic cognition and decision making under uncertainty. *Strategic Management Journal*, *20*(10), 977–985.

Hodgkinson, G. P., Maule, A. J., Bown, N. J., Pearman, A. D., & Glaister, K. W. (2002). Further reflections on the elimination of framing bias in strategic decision making. *Strategic Management Journal*, *23*(11), 1069–1076.

Johnston, L. C. (2011). *Lasting legacies: A framing analysis of religion news online and in legacy media* (Master's thesis). University of Missouri-Columbia, Columbia, MO.

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American Psychologist*, *39*(4), 341–350.

Kilgarriff, A. (1996, March). BNC Word Frequency List. Retrieved September 19, 2011, from http://www.kilgarriff.co.uk/bnc-readme.html.

Kriplean, T., Morgan, J., Freelon, D., Borning, A., & Bennett, L. (2012). Supporting reflective public thought with ConsiderIt. *Proceedings of the ACM Conference on Computer-Supported Cooperative Work* (pp. 265–274). New York: ACM Press.

Kriplean, T., Toomin, M., Morgan, J. T., Borning, A., & Ko, A. J. (2011). REFLECT: Supporting active listening and grounding on the Web through restatement. *Extended Abstracts of the ACM Conference on Computer-Supported Cooperative Work*. New York: ACM Press.

Lau, R. R., & Schlesinger, M. (2005). Policy frames, metaphorical reasoning, and support for public policies. *Political Psychology*, *26*(1), 77–114.

Lawrence, E., Sides, J., & Farrell, H. (2010). Self-segregation or deliberation? Blog readership, participation, and polarization in American politics. *Perspectives on Politics*, *8*(1), 141–157.

Lind, R. A., & Salo, C. (2002). The framing of feminists and feminism in news and public affairs programs in U.S. electronic media. *Journal of Communication*, *52*(1), 211–228.

Lofland, J., & Lofland, L. (1995). *Analyzing social settings: A guide to qualitative observation and analysis*. Belmont, CA: Wadsworth.

Mason, Z. J. (2004). CorMet: A computational, corpus-based conventional metaphor extraction system. *Computational Lingistics*, *30*(1), 23–44.

Matthes, J., & Kohring, M. (2008). The content analysis of media frames: Toward improving reliability and validity. *Journal of Communication*, *58*(2), 258–279.

Mitchell, A., Rosenstiel, T., & Christian, L. (2012). Mobile devices and news consumption: Some good signs for journalism. Project for Excellence in Journalism. Retrieved from http://stateofthemedia.org/print-chapter/?print_id=11552.

Munson, S. A., & Resnick, P. (2010). Presenting diverse political opinions: How and how much. *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems* (pp. 1457–1466). New York: ACM Press.

Mutz, D. C. (2006). *Hearing the other side: Deliberative vs. participatory democracy*. New York: Cambridge University Press.

Pang, B., & Lee, L. (2008). Opinion mining and sentiment analysis. *Foundations and Trends in Information Retrieval*, *2*(1–2), 1–135.

Pew Research Center. (2012). YouTube & news: A new kind of visual journalism. Project for Excellence in Journalism. Retrieved from http://www.journalism.org/node/30171.

Pinch, T. J., & Bijker, W. E. (1987). The social construction of facts and artifacts. In W. E. Bijker, T. P. Hughes, & T. J. Pinch (Eds.), *The social construction of technological systems* (pp. 17–50). Cambridge, MA: MIT Press.

Price, V. (2009). Citizens deliberating online: Theory and some evidence. In T. Davies & S. P. Gangadharan (Eds.), *Online deliberation: Design, research, and practice* (pp. 37–58). Palo Alto, CA/Chicago, IL: Center for the Study of Language and Information/University of Chicago Press.

Price, V., Nir, L., & Cappella, J. N. (2005). Framing public discussion of gay civil unions. *Public Opinion Quarterly*, *69*(2), 171–212.

Resnik, P. (1993). *Selection and information: A class-based approach to lexical relationships* (Doctoral Dissertation). University of Pennsylvania, Philadelphia, PA

Ritter, A., Mausam, & Etzioni, O. (2010). A latent dirichlet allocation method for selectional preferences. *Proceedings of the Annual Meeting of the Association for Computational Linguistics* (pp. 424–434). Uppsala, Sweden: Association for Computational Linguistics.

Schlesinger, M., & Lau, R. R. (2000). The meaning and measure of policy metaphors. *American Political Science Review*, *94*(3), 611–626.

Schön, D. A., & Rein, M. (1994). *Frame reflection: Toward the resolution of intractable policy controversies*. New York: Basic Books.

Shneiderman, B. (1996). The eyes have it: A task by data type taxonomy for information visualizations. In *IEEE Symposium on Visual Languages* (pp. 336–343). IEEE Computer Society: Washington, D.C.

Snow, D. A., Rochford, E. B., Worden, S. K., & Benford, R. D. (1986). Frame alignment processes, micro-mobilization, and movement participation. *American Sociological Review*, *51*(4), 464–481.

Steyvers, M., & Griffiths, T. (2007). Probabilistic topic models. In T. Landauer, D. McNamara, S. Dennis, & W. Kintsch (Eds.), *Handbook of latent semantic analysis* (Vol. 427). Mahwah, NJ: Lawrence Erlbaum Associates.

Sunstein, C. (2007). *Republic.com 2.0*. Princeton, NJ: Princeton University Press.

Tian, Y., & Stewart, C. M. (2005). Framing the SARS crisis: A computer-assisted text analysis of CNN and BBC online news reports of SARS. *Asian Journal of Communication*, *15*(3), 289–301.

Viégas, F. B., Wattenberg, M., van Ham, F., Kriss, J., & McKeon, M. (2007). ManyEyes: A site for visualization at Internet scale. *IEEE Transactions on Visualization and Computer Graphics*, *13*(6), 1121–1128.

Wright, G., & Goodwin, P. (2002). Eliminating a framing bias by using simple instructions to "think harder" and respondents with managerial experience: comment on "breaking the frame." *Strategic Management Journal*, *23*(11), 1059–1067.

Zhou, Y., & Moy, P. (2007). Parsing framing processes: The interplay between online public opinion and media coverage. *Journal of Communication*, *57*(1), 79–98.