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Emotions, Public Opinion, and U.S. Presidential Approval Rates: A 5-Year Analysis of Online Political Discussions

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This article examines how emotional reactions to political events shape public opinion. We analyze political discussions in which people voluntarily engage online to approximate the public agenda: Online discussions offer a natural approach to the salience of political issues and the means to analyze emotional reactions as political events take place in real time. We measure shifts in emotions of the public over a period that includes 2 U.S. presidential elections, the 9/11 attacks, and the start of military action in Afghanistan and Iraq. Our findings show that emotional reactions to political events help explain approval rates for the same period, which casts novel light on the mechanisms that mediate the association between agenda setting and political evaluations.

Public opinion is a proxy for the way citizens perceive political issues and react to current affairs. Scandals, controversial policies, natural disasters, or international conflicts, can all provoke shifts in the opinions of the public and cast shadows over the authority of their representatives. Public opinion impacts on the political process by means of electoral accountability, but also by means of propaganda and media manipulation (Glynn, Herbst, O'Keefe, & Shapiro, 1999; Jacobs & Shapiro, 2000; Lewis, 2001). This opens a two-way mode of communication that is central to the democratic process and to the legitimacy of policy making (Lippmann, 1922). Citizens can use public opinion to articulate their interests and reward or punish their representatives; political leaders, in turn, can adapt their discourse to the interests of their constituents by monitoring, or trying to shape, their views (Delli Carpini & Keeter, 1996; Hutchings, 2005). Knowing what the people think and what affects their political preferences is therefore a core element of democratic governance.

Several barometers are designed to track shifts in public opinion. Approval ratings, for instance, offer monthly measures of support to government; and several sample surveys gauge public opinion around a range of controversial issues like abortion,

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arms control, or gay rights (Althaus, 2003; Erikson, MacKuen, & Stimson, 2002; Stimson, 1998, 2004). While approval rates offer a continuous but shallow measure of what the public thinks, surveys are richer in scope but usually designed to capture long-term dynamics on very specific areas of public concern. In this article, we propose an alternative approach to the study of public opinion that aims to complement these previous efforts and move forward our understanding of how the public thinks. The novelty of our approach is twofold. We analyze what the public decides to discuss about, as opposed to their opinions on a battery of predetermined topics; and we extract the emotional content of those discussions to capture reactions to political events. Unlike polls and surveys, this strategy provides real-time information of how the public responds to current affairs and changes in the political landscape.

This article emerges at the intersection of two research strands. The first, agenda setting, studies the connection between the salience of issues in the public agenda and the formation of political evaluations (Gitlin, 1980; Iyengar & Kinder, 1987; McCombs & Shaw, 1972; Shaw & McCombs, 1977). The second research strand, captured by appraisal and affective intelligence theories, focuses on the cognitive effects of emotions and their impact in shaping opinions and behavior (Lazarus, 1991; Lazarus & Lazarus, 1994; Marcus, Neuman, & MacKuen, 2000). While agenda setting explores how the higher visibility of certain issues in news media—or the tone in which they are reported—affect opinion formation, affective intelligence research focuses attention on the direct effects that emotions have on cognition and behavior, in line with a well-established research tradition that sees in emotions a fundamental driving force of human action (Elster, 1999; Frank, 1988; Frijda, 1986; Turner & Stets, 2006). This study builds a connection between these two areas of research by tracking opinions on issues that are salient in the public agenda, and extracting the emotions that those opinions convey, which we use as an approximation to individual-level reactions to political events. The question we want to answer is whether, once aggregated, those emotional reactions are significantly associated with political evaluations; evidence in favor of that association would suggest that emotions can be used as an explanatory mechanism that is consistent with research on political psychology, which can help understand what moves aggregated opinion trends.

The article proceeds as follows. First, we review previous research on agenda setting, priming, and opinion formation, and we link those findings with political psychology research on how emotions mediate information processing and atten-tiveness to political events. We use this discussion to draw our research questions on how emotions shape opinion formation. We then present our data, which tracks tens of thousands of Internet-based political discussions spanning a 5-year period, and we discuss the method employed to extract scores on three emotional dimensions: valence, arousal, and dominance. We examine trends in the three dimensions and how they are affected by salient political events, and we assess whether emotions help explain shifts in aggregated political evaluations, here measured in the form of approval rates. The article ends with a discussion of our findings, which offer a novel empirical approximation to mechanisms often implied in public opinion research.

Agenda setting, public opinion, and emotions

Public opinion broadly refers to the views held by the majority of people. Which issues are more salient to their attention—and therefore more influential in shaping their views—is what agenda setting research aims to uncover. The main claim of agenda setting theory is that the transfer of salience from news reporting to public opinion affects both what to think about and how to think about it (McCombs & Shaw, 1972; Shaw & McCombs, 1977). There are two mechanisms involved in the association between public communication and opinion formation: The first, priming, relies on the psychological principle that more salient issues are also more likely to be accessed, or retrieved from memory, when forming opinions (Iyengar & Kinder, 1987); the second mechanism, framing, is concerned with how issues are reported (Gitlin, 1980; Iyengar, 1991); this has been referred to as second-level priming because it focuses not only on the salience of issues (first level) but also on the salience of certain attributes of a given issue (Weaver, 2007). The tone that the media use to report on political news (positive or negative) is one of the examples of how second-level priming can influence public opinion (Sheafer, 2007). Either way, priming assumes that the media agenda affects how people evaluate political actors by making certain issues or characteristics more central to their evaluations.

The most common research design in agenda setting involves a combination of news media content analysis and public opinion surveys (Rogers, Dearing, & Bregman, 1993). Studies on the consequences of agenda setting have systematically found correlations between issue salience and the opinions that people form about those issues and about political actors (Weaver, McCombs, & Shaw, 2004). These findings connect with a related area of research that analyses how opinions and policy debates change over time (Erikson et al., 2002; Page & Shapiro, 1992). Examples include policies about education, race, welfare, or health care, but also gun control, capital punishment, or abortion, all of which generate public debates that change in salience and intensity over the years (Althaus, 2003; Carmines & Stimson, 1989; Layman, 2001; Schuman, Steech, & Bobo, 1985; Stimson, 2004; Wolbrecht, 2000). Research on these domains of public opinion qualifies agenda setting theory by noting that most issues are not a priority for the vast majority of the public, whose knowledge about policy discussions is consistently low anyway (Delli Carpini & Keeter, 1996). What this means is that news media might create an agenda of the relevant topics to think about, but people still vary in their perception of which issues are more relevant. This calls for new ways to measure the public agenda that assess more directly the issues that are central to the public, and allow exploring the mechanisms that, triggered by attention to those issues, end up shaping political evaluations. Emotions, and their cognitive and heuristic effects, offer one such mechanism.

Compared to agenda setting, there is relatively little research on the emotional foundations of political opinion (Kinder, 1998). There is enough evidence, however, to infer that emotions trigger cognitive reactions that cannot be reduced to second-level priming. Psychologists have long differentiated the effects of "feeling" and

''thinking'' in information processing (Zajonc, 1980), and they have highlighted the role that emotions have in the evaluation of situations and issues (Lazarus, 1991; Lazarus & Lazarus, 1994). Early studies on the political consequences of emotions find evidence of their impact on presidential evaluations and vote disposition (Conover & Feldman, 1986; Marcus, 1988; Marcus & MacKuen, 1993; Way & Masters, 1996). This early work derived into the formulation of a more coherent theory, affective intelligence, which sees in emotions heuristic devices used to gather and process information (Marcus et al., 2000; Neuman, Marcus, Crigler, & MacKuen, 2007; Redlawsk, 2006). The core of the argument is that negative emotions like anxiety or anger motivate people to search for more and better information, whereas positive emotions like enthusiasm tend to reinforce political choices.

According to this stream of research, emotions shape public opinion by making people more alert to new information or more reliant on their preconceptions; in other words, it suggests that the connection between issue salience and opinion formation depends not only on priming (i.e., the evaluation of political actors in line with the issues and attributes highlighted by news media) but also on how emotions mediate attention and judgment, which varies with each individual response to political news and events. The affective tone of news reporting and the emotional reactions of the public are likely to be associated, but they refer to different stages of the agenda-setting process, and point to different mechanisms; when it comes to explaining political evaluations, the emotional reactions of the public are more directly connected to judgment and decision making than the affective tone of the news they read.

A U.S. study in the context of the Iraq war, for instance, found that both anger and anxiety increased attention to news related to the conflict but that the two emotions had opposite effects on support: Anger increased approval of the invasion while anxiety reduced it (Huddy, Feldman, & Cassese, 2007). A related study on perceived terrorism risk found that fear increased threat estimates and support for precautionary policies but anger generated the opposite outcomes (Lerner, Gonzalez, Small, & Fischoff, 2003). Anxiety has also been found to be behind public opposition to immigration (Brader, Valentino, & Suhay, 2008) and of vote choice (Ladd & Lenz, 2008). Positive emotions, on the other hand, can motivate participation and activate existing loyalties, as experimental evidence has suggested in the context of political advertising (Brader, 2005). Research on the response to the 9/11 attacks has also provided evidence that positive emotions like pride and hope can influence political opinion, in this case in the form of greater confidence in institutions (Gross, Brewer, & Aday, 2009). Put together, this research suggests that the same political events trigger emotional reactions on different dimensions, and that each of these might have a different impact on opinion formation, depending on the issue at hand.

Research on affective intelligence contributes to previous work on opinion formation by providing consistent evidence of one channel by which emotions impact on opinions, namely by triggering (or not) the motivation to gather more information. This mechanism is different from second-level priming, which treats the emotional tone of news reporting as one of the heuristic shortcuts that people

use in forming their evaluations (Sheafer, 2007); what affective intelligence research suggests is that emotions have an indirect effect on opinions by causing citizens to be more thorough in their search for information. Research on the cognitive effects of emotions, however, does not give much insight into the sources of those emotions (Brader, 2006) or into how the same stimuli might trigger different reactions, as has been suggested before (Conover & Feldman, 1986); agenda-setting research, on the other hand, provides ample evidence of the nature of those stimuli (McCombs, 2004). Building on these two research streams, this study assumes that the salience and framing of issues affect political evaluations by triggering emotions at the individual level, which offers the mechanism to link changes in aggregated trends. Instead of focusing on the media agenda—on which most first- and second-level priming studies are based (Son & Weaver, 2005; Sheafer, 2007; Tan & Weaver, 2010)—this study analyzes the public agenda, as approximated using the political discussions in which people voluntarily engage online. We assume that those discussions, and the emotions they convey, contain relevant information about the motivations and predispositions of the public—and hence of the factors behind aggregated political evaluations.

Previous research exploring the connection between agenda setting, emotions, and opinion formation has mostly focused on single issues (like the economy, immigration, terrorism, or military conflict) and they have elicited emotions using either experiments or surveys; this means that, even when panel data is used, these previous studies have intrinsic limitations to analyze longitudinal dynamics and shifts in prevalent emotions. Inferences about the influence of emotions in opinion formation are also constrained by the timing and the nature of the issues that each study considers. Our approach is based on a wider range of issues—those that are salient in the public agenda at any given time—and on real-time reactions to those issues. Our approach also provides richer longitudinal data to assess the durability and effects of the emotions that political events trigger. Earlier work has shown that news media coverage correlates with the issues discussed in online forums (Roberts, Wanta, & Dzwo, 2002) and with search behavior (Weeks & Southwell, 2010); search queries have also been used to infer agenda-setting dynamics (Scharkow & Vogelgesang, 2011). However, none of these studies explicitly explores the association between agenda setting, emotions, and opinion formation; this is the focus of the analyses that follow.

This study is inevitably constrained by the type of emotions that can be measured in written communication; it is also constrained by the nature of aggregated data, which can only assume the psychological mechanisms that are at play. However, it is standard in agenda-setting research to use aggregated measures of public opinion (for instance, Son & Weaver, 2005) and other measures of generalized emotions have been used before to explain political evaluations, as when the Index of Consumer Sentiment is used to predict approval rates (Kriner & Schwartz, 2009). Moreover, using online political discussions can cast novel light on how opinions are simultaneously shaped by agenda setting and the emotions stirred in the process. The aim of the following analyses is to determine if, as the literature just reviewed suggests, emotions are significantly associated with political evaluations. Even though the

association is assessed on the aggregate, it still points to individual level mechanisms that are consistent with recent research on how emotions influence political judgment.

Data and methods

Online political discussions

The data we use tracks U.S. political discussions in the online forum Usenet, a distributed discussion system that has been active for over 3 decades (Hauben & Hauben, 1997; Lueg & Fisher, 2003). We use the dataset Netscan (Smith, 2003; Smith & Kollock, 1999), a sample of Usenet that contains about 350,000 discussion groups. The dataset was obtained upon request from the Microsoft research team that compiled it; although this dataset and its web application are no longer publicly available, the same data is now archived and managed by Google Groups.

Netscan tracks Usenet discussions for the period September 1999 to February 2005. Our analyses focus on the discussions held within the groups that contained the word "politics" in their hierarchy (hierarchies are used to organize newsgroups in nested categories); this totaled 935 groups for the period considered. These groups are quite diverse in terms of their ideological position, which can be inferred using the hierarchy tags (i.e. alt.politics.democrat, alt.politics.republican). Out of the newsgroups that have explicit ideological references in their names, 21% are left leaning and 12% right leaning; the rest, 67%, are miscellaneous (i.e. talk.politics.misc). Cross-posting in these discussions is quite frequent: The percentage of messages that are simultaneously sent to more than one newsgroup remains between 63% and 85% for the full period, creating discussions that span across several groups. This means that most users do not see newsgroups as closed boundaries for political talk but rather as distribution channels they activate to engage a diversity of users in the same discussion. When preparing the data for the analyses, we excluded the discussions that did not have at least three messages in order to avoid spam and nonsignificant discussions.

These discussions involved about 800,000 unique participants. Less than 30%, however, remained active for more than a month, which means that the signal of public opinion captured by this data is very diverse: It is based on the contributions of a high number of users with a fast turnaround. On average per month, around 7,000 unique users contributed around 30,000 discussion topics. Despite of the large numbers, these users are still not a representative sample of the population: Representativeness is undermined not only by the digital divide (particularly important toward the beginning of the period, when Internet penetration rates were lower) but also by the self-selecting nature of these groups: The discussants we track are likely to be more interested in politics than an average person; they are, after all, a minority (of hundreds of thousands) sufficiently engaged in politics to be active in these forums. The topics they choose to discuss about, however, are still a good approximation to the public agenda—certainly a more direct approach to the mind of the public than news reporting by the media.

We choose to analyze political discussions in Usenet because they allow us to reconstruct patterns over a longer period than more recent social media like Facebook or Twitter, although recent work also tracking emotions in written communication is using those platforms (Bollen, Pepe, & Mao, 2009; Kramer, 2010; Paltoglou & Thelwall, in press; Golder & Macy, 2011). Usenet data allows us to consider a time window that includes some prominent events like the attacks of 9/11 or the invasion of Iraq; this allows us to connect our findings with previous research exploring emotional reactions to those events (i.e. Huddy, Feldman, & Cassese, 2007; Gross et al., 2009; Lerner et al., 2003). Agenda-setting research assumes that news media are the principal connectors between the events that take place in the world and the picture the public gets of those events in their minds. We propose using online political communication to move one step ahead and characterize the emotional nature of that impression. The range of issues prioritized in the public agenda might not fully overlap with the priorities of the media agenda, so this study differs from previous attempts to analyze the evaluative tone of news reporting (Sheafer, 2007); the analyses that follow extract affective language directly from what the public decides to discuss about.

Measures of emotion

We extract the emotional content of the discussions using the Affective Norms for English Language Words (ANEW), a list of words with emotional scores given by human subjects (Bradley & Lang, 1999). The ANEW list contains about 1,000 words that receive a rating on a 9-point scale in three dimensions: valence, arousal, and dominance. The valence dimension measures the extent to which words make subjects feel happiness, satisfaction, and hope (stronger feelings as they get closer to 9), or their opposites: sadness, dissatisfaction, and despair (stronger as they get closer to 1). The arousal dimension captures the association of words with feelings of excitement, anger, or frenzy, and their opposites; dominance, in turn, focuses on feelings of domination or being in control versus feelings of submission or awe. This list of words and their scores give an empirical measure of affective evaluations and, in the context of this study, of how the public reacts to salient political events. Our working assumption is that we can approximate the prevalent feelings of the public by measuring the emotional content of the words used in the discussions of those events.

The algorithm to extract emotional scores from the discussions follows the method proposed by Dodds and Danforth (2010), and it is summarized in Figure 1. For every sample of discussion headers, which we aggregated monthly, we identified and counted the number of occurrences of ANEW words. Panel 1 in Figure 1 contains a few empirical examples of discussion topics. The discussion under the heading "U.S. could be free from oil dependence" has one ANEW word ("free"); the discussion under the subject line "The war is fraud" has two ANEW words ("war" and "fraud"). We then matched every word with their scores in the three emotional dimensions and we calculated, in a third step, the monthly averages as well as their standard deviations, taking into account not only the scores but also the frequency of words:
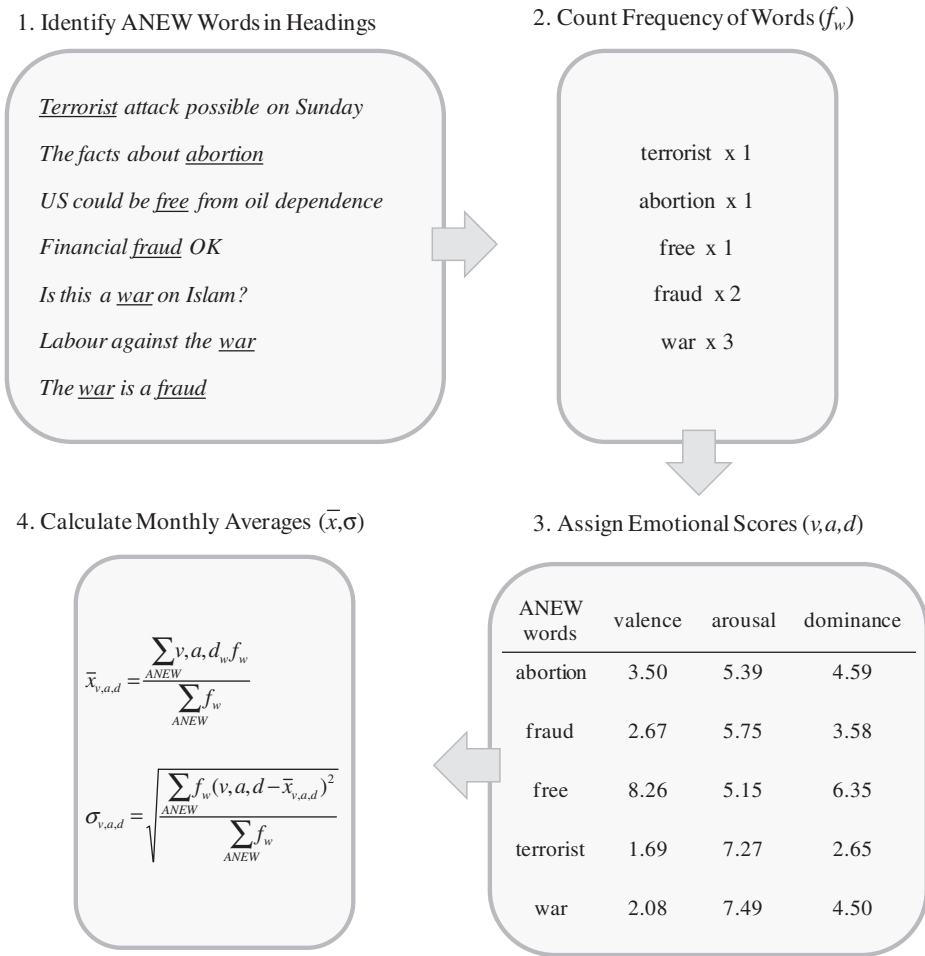
1. Identify ANEW Words in Headings

Terrorist attack possible on Sunday

The facts about abortion

US could be free from oil dependence

Financial fraud OK

Is this a war on Islam?

Labour against the war

The war is a fraud

2. Count Frequency of Words (f_w)

terrorist x 1

abortion x 1

free x 1

fraud x 2

war x 3

4. Calculate Monthly Averages ($\bar{x}, \sigma$)

$$\bar{x}_{v,a,d} = \frac{\sum_{ANEW} v,a,d_w f_w}{\sum_{ANEW} f_w}$$

$$\sigma_{v,a,d} = \sqrt{\frac{\sum_{ANEW} f_w (v,a,d - \bar{x}_{v,a,d})^2}{\sum_{ANEW} f_w}}$$

3. Assign Emotional Scores (v,a,d)

ANEW words	valence	arousal	dominance
abortion	3.50	5.39	4.59
fraud	2.67	5.75	3.58
free	8.26	5.15	6.35
terrorist	1.69	7.27	2.65
war	2.08	7.49	4.50

Figure 1 Method to extract emotional scores from discussion topics (adapted from Dodds & Danforth, 2010).

In this example, the word ''war'' (which has an average valence of 2.08 and average arousal of 7.49) is counted three times; the word ''fraud'' is counted twice and the rest, only once.

We only used the discussion headers because we did not have access to the content of the messages. Previous research has shown that headers are representative of the rest of the thread, and it has become standard in research to use them as such (see, for instance, Broder, Fontoura, Josifovski, & Riedel, 2007; Chakrabarti, Agarwal, & Josifovski, 2008). Most importantly, discussion topics offer a natural measure of issue salience: The most visible issues are more likely to trigger a discussion, and these issues are summarized in the subject line. In total, we analyzed about 380,000 subject lines, so even though headers offer a limited account of the content of the discussions,

they still offer rich enough data to extract continuous measures of emotions. The subject lines contained a total of 2.3 million words; of these, about 6% ($N \sim 140,000$) are part of the ANEW list. This percentage might seem low because the vast majority of words used in written communication are articles, pronouns, prepositions, and other neutral words not contained in the ANEW lexicon. The names of persons, institutions or countries are also not covered by the lexicon as the emotional reaction toward these terms (and their salience) varies in time.

The ANEW list offers just one of multiple possibilities to measure emotions in written communication, exemplified by a growing area of research (Asur & Huberman, 2010; Bollen, Mao, & Zeng, 2010; Kramer, 2010; O'Connor, Balasubramanyan, Routledge, & Smith, 2010; Paltoglou & Thelwall, in press; Golder & Macy, 2011). There is no research to date that compares the ANEW list vis-a-vis other machine-learning algorithms for sentiment analysis. In any case, although these algorithms offer alternatives to our chosen method, all of them have weaknesses on their own (Paltoglou, Gobron, Skowron, Thelwall, & Thalmann, 2010). We opted for the ANEW list because it has already been used to infer emotional states at a population level using various large-scale text corpuses (Dodds & Danforth, 2010) and because its lexicon has been tested and replicated in other languages (Redondo, Fraga, Padron, & Comesana, 2007), which adds a comparative dimension to the analyses by potentially allowing measurements across linguistic communities.

Figure 2 shows lists of the 20 most popular ANEW words aggregated per year in the form of tag clouds: The size of each word corresponds to the square root of its number of occurrences in discussion headings. The series at the top of the figure tracks the total number of discussions that were initiated on a monthly basis. The relative count of words in the discussions can be interpreted as a first approximation to issue salience: they give a sense of which topics were more visible to the public at each point in time and deemed important enough to spur a higher number of discussions. As the figure shows, there is a clear shift in the visibility of certain topics: After 9/11, "war" becomes the most prominent issue, clearly outweighing the attention paid to the discussion of other topics. That this shift takes place is not surprising given the significance of post-9/11 events and their domination of the political life of this period; what is less clear is how the public responds to the salience of these events, a question that the following analyses consider.

In line with psychological research, we distinguish emotions from mood (mood does not require a triggering event, emotions do) and also from sentiment (which refers to emotions that turn into generalized long-term beliefs, see Frijda, Manstead, & Bem, 2000; also Frijda, 2007). By tracking emotional reactions over time, our approach gives an empirical criterion to assess when emotions crystallize into generalized sentiment, how susceptible they are to political shocks, and how long it takes for their effects to decay. Most importantly, it offers a point of connection between agenda-setting research, and the analysis of how salient issues affect opinion formation, and political psychology research, which focuses on the effects of emotions on political judgment.
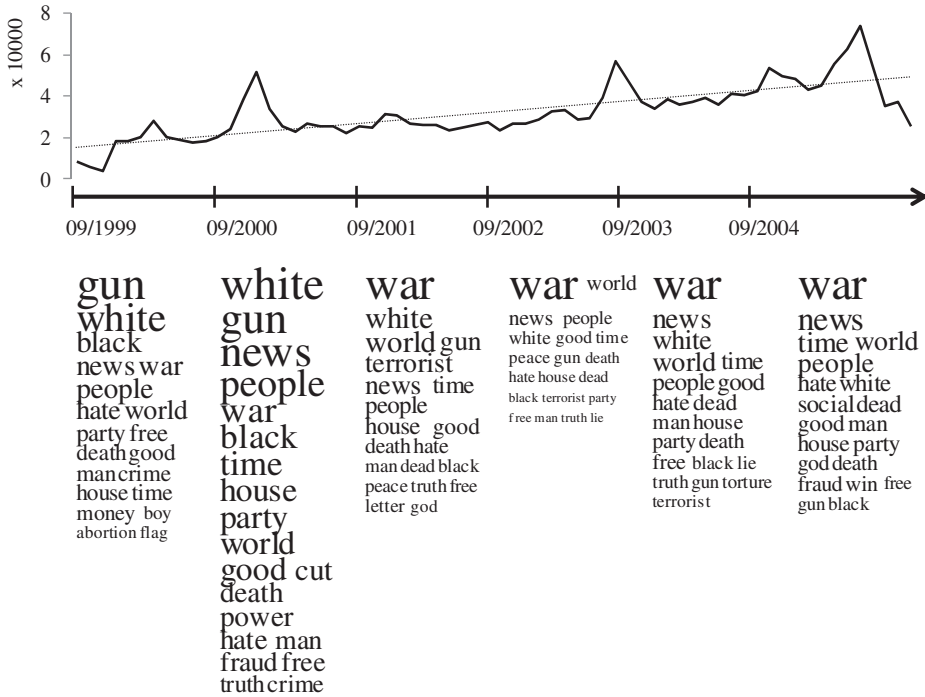
Figure 2 Number of discussions and most popular ANEW words used over time.

Political evaluation

We use presidential approval rates as a measure of political evaluation. In particular, we use the combination of polls published by the Roper Center for Public Opinion Research, which aggregates polls conducted by several news and opinion poll organizations, including Gallup. The data tracks responses to variations of the question "Do you approve or disapprove of the way the incumbent President is handling his job?" Each data point corresponds to monthly averages and is based on a different cross-section sample of the population, which helps minimize random measurement error. Table 1 presents some descriptive measures of the data. Although the average approval for the two incumbent presidents during this period (Bill Clinton and George W. Bush) remains around 60%, the variance is higher for the Bush presidency, which spans most of the data points in the period we consider. Both the maximum and minimum scores were reached during his time in office: They coincide, respectively, with the attacks of 9/11 (when support for the President reached a historical maximum) and the Abu Ghraib scandal.

We use approval rates as a measure of political evaluation because it is more responsive to what the public thinks than surveys on more specific issues. Approval polls use more or less identical questions for long periods, yielding a measure of opinion that can be compared across time. The evaluation of the President offers a

Table 1 Public Approval of U.S. Presidents (1999–2005)

	Mean approval	Max approval	Min approval
Sept 1999 to Jan 2001 (Clinton)	60.2	65.4	57.7
Feb 2001 to Feb 2005 (Bush)	59.8	86.5	45.9

Source: Roper Center for Public Opinion Research. Percentages are based on a combination of monthly polls (Pew, Fox/OpinDynamics, NBC/WSJ, Gallup/CNN/USA, Harris, Yank/TIME/CNN, Gallup, CBS, Newsweek, ABC, CBS/NYT, LATimes, Tarrance/Lake, ABC/WP, Marist, Tarrance/Voter.com, Battleground, Democracy Corps). Sizes for each cross-sectional sample vary between $N = 100$ and $N = 3,002$.

good pulse of how the public perceive the management of the nation and the issues that most concern them at any given moment. Although this measurement does not go into the reasons why respondents approve (or not) the job of their representatives, it is measured frequently enough to help identify inertias that systematically appear during the life cycle of all administrations. Some of those inertias include the systematic higher rates of the first months in office (the "honeymoon" period); the attrition that follows the act of governing; and the surges in approval during military conflicts (Clarke, Stewart, Ault, & Elliott, 2004; Kriner & Schwartz, 2009; Mueller, 1973). Research on approval rates assumes that the public is well informed, that they follow closely political events and react to them as a thermostat reacts to room temperature. The analyses presented here use emotions as the temperature to which approval rates react.

Research Questions and Models

There are two types of questions we want to answer with this data: (a) how do emotions coevolve with political events and changes in issue salience? And (b) are emotional reactions associated to changes in political evaluations? By answering these questions we aim to contribute to previous work in political psychology, particularly in its intersection with agenda-setting research. As discussed above, recent research has provided consistent evidence of the cognitive impact of emotions; however, which stimuli or events are more consequential when triggering emotional reactions is still an underexplored area. By analyzing the emotional content of discussions around topics that are primed by the public, we cast light on one empirical point of connection between agenda-setting and political psychology research. Our analyses also help assess to what extent online political communication can be used as a proxy to changes in the opinions of the public.

Given that our research questions focus on time trends, we decided to carry our analyses in two stages. First, we fit linear models to analyze the significance of trends and the relative impact of salient events on the six emotional series under consideration, which correspond to the monthly averages and standard deviations of valence, arousal, and dominance. The models follow the form:

$$e_t = \alpha_0 + \alpha_1 t + \alpha_2 d_{1,t} + \cdots + \alpha_m d_{m,t} + z_t \tag{1}$$

where e_t refers to one of the six emotional series, α_0 is the intercept parameter, α_1 estimates the effect of time t, and $\alpha_2 \ldots \alpha_m$ estimate the impact of salient political events, captured as dummy variables $d_{1,t} \ldots d_{m,t}$. The error term is captured by z_t. We compare Ordinary Least Squares (OLS) to Generalized Least Squares (GLS) estimations, which are more reliable as they control for the autocorrelation of the data. These analyses allow us to answer research question (a) and identify long-term dynamics in the prevalent emotions of the public.

In a second stage, we applied stationary time series models using the residuals of the linear models. As the linear models account for the nonstationary components of the series, the residuals do not contain noticeable trends, but they are still correlated in time. We use first order autoregressive models AR(1) of the form:

$$a_t = \alpha a_{t-1} + z_t, \text{where } z_t = \alpha_1 + \alpha_2 e_{1,t+} \cdots +\alpha_m e_{m,t} + w_t \qquad (2)$$

In this model the dependent variable a_t is the approval rates series; the coefficient α captures the autocorrelation, or how much influence past values a_{t-1} have on rates at time t. The emotional series $e_1 \ldots e_m$ are included as part of a linear regression fitted to the error series z_t. If the coefficients $\alpha_2 \ldots \alpha_m$ in this regression are significant it means that the emotional series help improve the predictive power of the model by adding information that is not captured by the autocorrelation term—that is, by the recent history of approval rates. The tests we perform with these models allow us to answer research question (b), and identify which emotional dimension is more relevant, if any, to explain approval rates in this period. These models do not allow us to infer causality, and given the nature of our data we can only assume the psychological mechanisms linking emotions with opinion formation. However, the proposed models allow us to determine the significance of the association, and infer whether emotional reactions can be used as consistent indicators of political attitudes.

Analysis

The impact of political events on emotional reactions

Figure 3 tracks the emotional load of online discussions in the three dimensions: valence, arousal, and dominance. The figure plots averages (left y-axis) and standard deviations (right y-axis) as they change over time. The gray vertical bars identify some of the most prominent events in this period: the two presidential elections (in November 2000 and November 2004), the 9/11 attacks, the invasion of Iraq, and the abuses of Abu Ghraib. These series clearly show the before and after marked by the 9/11 attacks, which prompted a fall in the average values of valence and, to a lesser extent, dominance, and a rise in the scores of arousal. The invasion of Iraq and the scandals associated to the conflict generated the lowest peaks in valence and the highest peaks in arousal. After 9/11, the standard deviation around mean valence scores goes up significantly, signaling increasing levels of emotional polarization.
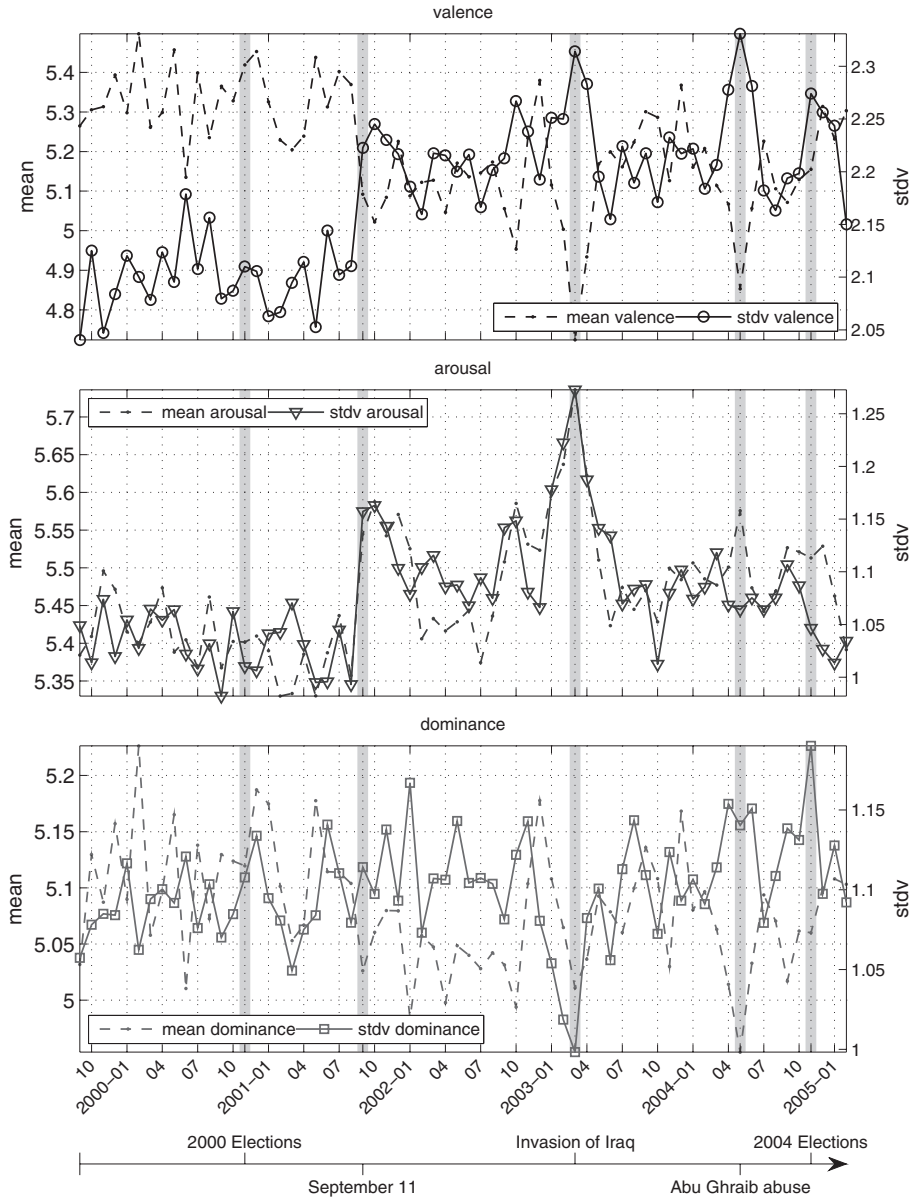
Figure 3 Changes in mean and standard deviation of valence, arousal, and dominance.

To test for the significance of these trends, and the relative impact of the most salient events on the emotions of the public, we run a series of linear models following Equation 1. For ease of interpretation, the six emotional series were rescaled so that they are all bounded between 0 and 1; this means that the effects will be smaller in magnitude than if we had preserved the original scales, but we can compare them

directly across the emotional dimensions. The estimated coefficients are shown in Table 2. There are three main findings worth capturing from this table. First, the time trends identified are statistically significant for valence and dominance: The average scores for both dimensions go down as time passes, signaling increasing levels of unhappiness and uneasiness; also in both cases deviation around the mean goes up, meaning that with time more discussions tended to fall closer to the two extremes of the emotional scales. The two arousal series have an upward trend, but once the autocorrelation of the error terms is taken into account (using the GLS estimation), the trends are not significant.

Second, the most salient political event of this period, in terms of magnitude and significance across emotional dimensions, is the invasion of Iraq. Figure 3 showed that after 9/11 political communication became more negative and aroused, but also more polarized around average emotions; the regression models show that the estimated coefficients for this event go in the expected direction, but that for the most part they do not reach statistical significance when time trends are controlled for. And third, presidential elections do not have any significant effects in any of the series, with the exception of dominance: Deviation around the mean in this emotional dimension goes significantly up with the 2004 election, an effect that is likely to be related with the ''War on Terror'' discourse that dominated the campaign.

The impact of emotions on political evaluations
The evolution of approval rates vis-a-vis the emotional series is shown in Figure 4. The attacks of 9/11 brought up a sudden and simultaneous reaction in all the series; the start of the Iraq war, however, generated highs and lows in the three emotional dimensions before it generated a response in approval rates, which go up shortly after military action starts—in line with the public reaction in times of war (Mueller, 1973). This military intervention coincides with the lowest point in the valence series, that is, the moment with the unhappiest general sentiment; it also coincides with a peak in arousal: When the war started, discussions adopted the angriest expressions of the period we consider. If we just measure public opinion using approval rates, this war did not bring such an extreme reaction in the public as the attack of 9/11 had done; but it definitively stirred more antagonistic feelings. One reason for the different emotional reaction to these two events has to do with the unexpectedness of the attack. The possibility of a war was salient in the media, and in the mind of the public, for a longer period, which gave them more time to digest the news (and their feelings) and have a response ready when the war finally started. The figure also qualifies previous research on emotional reactions to the war (Huddy, Feldman, & Cassese, 2007): anger might have increased support, and Figure 4 suggests that the average feeling was indeed that of increased anger; but it also shows that there was quite a lot of divergence around that general feeling.

To test whether these visual associations are statistically significant, and determine which, if any, of the six emotional dimensions has more explanatory power, we fitted a series of AR(1) models following Equation 2. The findings, summarized in Table 3,

Table 2 Linear Models of Emotional Series as a Function of Time and Salient Events

| | OLS | | | | | | GLS | | | | | |
| | Valence | | Arousal | | Dominance | | Valence | | Arousal | | Dominance | |
	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
Intercept	**98.18**	**−195.00**	**−85.33**	**−75.20**	**64.19**	**−46.52**	**103.26**	**−184.27**	−50.03	−70.25	**64.19**	**−46.52**
	(23.96)	(26.05)	(26.37)	(26.14)	(29.46)	(23.35)	(34.09)	(42.72)	(55.65)	(52.58)	(29.46)	(23.35)
Time	**−0.0005**	**0.0010**	**0.0004**	**0.0004**	**−0.0003**	**0.0002**	**−0.0005**	**0.0009**	0.0003	0.0004	**−0.0003**	**0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0001)	(0.0001)
Elections 00	0.1697	−0.0296	−0.0603	−0.1460	0.0679	0.0832	0.0807	0.0313	−0.0151	−0.0874	0.0679	0.0832
	(0.1531)	(0.1664)	(0.1685)	(0.1670)	(0.1882)	(0.1491)	(0.1348)	(0.1320)	(0.1060)	(0.1094)	(0.1882)	(0.1491)
Elections 04	0.0230	0.1447	0.0434	−0.1718	−0.0231	**0.4192**	−0.0472	0.1607	−0.0221	−0.0442	−0.0231	**0.4192**
	(0.1537)	(0.1672)	(0.1692)	(0.1677)	(0.1890)	(0.1498)	(0.1349)	(0.1321)	(0.1061)	(0.1094)	(0.1890)	(0.1498)
11-Sep	−0.2054	0.2632	0.2508	0.3227	−0.2436	0.0940	−0.1589	0.1754	0.1823	**0.2761**	−0.2436	0.0940
	(0.1519)	(0.1651)	(0.1671)	(0.1657)	(0.1867)	(0.1479)	(0.1345)	(0.1318)	(0.1060)	(0.1093)	(0.1867)	(0.1479)
Invasion Iraq	**−0.5863**	**0.3883**	**0.6387**	**0.6473**	−0.2378	**−0.5554**	**−0.4065**	0.2086	**0.2848**	**0.2643**	−0.2378	**−0.5554**
	(0.1521)	(0.1654)	(0.1674)	(0.1659)	(0.1870)	(0.1482)	(0.1345)	(0.1319)	(0.1060)	(0.1093)	(0.1870)	(0.1482)
Abu Ghraib	**−0.3707**	**0.3465**	0.2003	−0.1092	**−0.4148**	0.1607	**−0.3026**	0.2127	**0.2200**	−0.0322	**−0.4148**	0.1607
	(0.1536)	(0.1670)	(0.1691)	(0.1676)	(0.1888)	(0.1497)	(0.1349)	(0.1321)	(0.1061)	(0.1094)	(0.1888)	(0.1497)
R^2	0.45	0.59	0.36	0.34	0.21	0.34						
AIC							−26.35	−23.03	−38.76	−36.79	2.55	−24.90
log Lik							22.18	20.52	28.38	27.39	6.73	20.45

Note: Bold coefficients are significant at the 5% level. The emotional series (mean and standard deviation for valence, arousal, and dominance) are rescaled between 0 and 1 to ease comparison and interpretation. Standard errors in brackets.
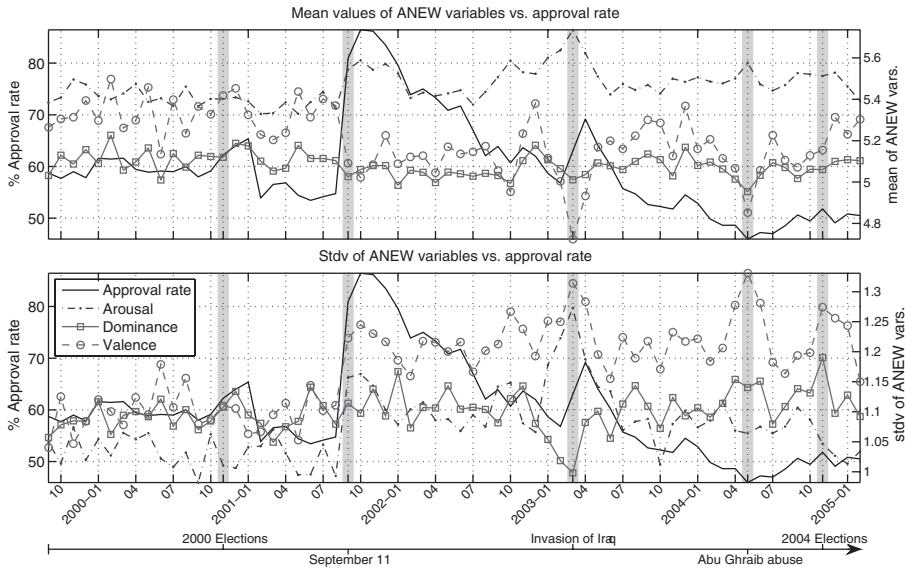
Figure 4 Changes in valence, arousal, and dominance compared to presidential approval rates. *Note*: for better visualization, the standard deviation of valence is offset by −1.

indicate that only valence and arousal have statistically significant effects on approval rates, once autocorrelation is controlled for. Valence has a negative effect, which means that as the general levels of happiness decrease, a positive evaluation of the president increases, and vice versa. Arousal has a positive and stronger effect: the higher the prevalent emotions are in this scale (i.e. the angrier the public grows) the better the evaluations become; this effect is particularly strong for the series tracking deviations around the mean. The effects of these emotions, however, are only statistically significant when each dimension is considered separately. According to the AIC and the likelihood test, the best models to explain approval rates are those that incorporate the arousal series.

Discussion

The analyses above show that the time period we consider can be characterized by declining trends in valence and dominance, and by rising levels in arousal, which is most significantly driven by issues related to the military conflict in Iraq. The findings also show that arousal (and the implied emotion of anger) is the most significant dimension when explaining approval rates. These findings fall in line with previous studies, in particular those analyzing the emotional reactions to the attacks of 9/11 and the Iraq war: They show that anger makes people less inclined to see military action as risky and therefore more likely to support it (Huddy, Feldman & Cassese, 2007). We interpret these findings as evidence that the same cognitive mechanisms identified by political psychology research are at play; however, we also find that deviations

Table 3 Time Series Models of Approval Rates With Emotional Dimensions as External Regressors

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11
Intercept	−0.019	−0.016	−0.013	−0.013	−0.014	−0.019	−0.019	−0.014	−0.012	−0.020	−0.008
	(−0.088)	(0.082)	(0.082)	(0.084)	(0.079)	(0.087)	(0.089)	(0.081)	(0.079)	(0.087)	(0.080)
AR(1)	**0.850**	**0.843**	**0.839**	**0.849**	**0.842**	**0.848**	**0.850**	**0.840**	**0.845**	**0.849**	**0.850**
	(0.061)	(0.063)	(0.064)	(0.061)	(0.063)	(0.062)	(0.061)	(0.064)	(0.062)	(0.062)	(0.062)
Mean valence		**−0.187**						−0.162			−0.350
		(0.087)						(0.104)			(0.218)
SD valence			0.138					0.047			−0.063
			(0.091)					(0.106)			(0.134)
Mean arousal				**0.256**					0.127		0.115
				(0.097)					(0.112)		(0.145)
SD arousal					**0.293**				**0.226**		0.168
					(0.092)				(0.108)		(0.130)
Mean dominance						−0.049				−0.058	0.234
						(0.067)				(0.072)	(0.139)
SD dominance							−0.008			−0.032	0.049
							(0.081)			(0.086)	(0.088)
AIC	−89.5	−91.97	−89.76	−94.13	−97.12	−87.99	−87.48	−90.17	−96.4	−86.13	−91.41
log Lik	47.74	49.98	48.88	51.06	52.56	48	47.74	50.08	53.2	48.06	54.7

Note: Bold coefficients are significant at the 5% level. The emotional series (mean and standard deviation for valence, arousal, and dominance) are rescaled between 0 and 1 to ease comparison and interpretation. Standard errors in brackets.

around average arousal (which we take as an indication of increased polarization) is a stronger explanatory factor, which means that the reasons behind public support for the president are probably more varied than usually acknowledged.

The nature of our data and methods imposes some limitations to the comparability of our results with previous research. First, the emotional dimensions that we consider do not map exactly onto the emotions that have been analyzed before. The negative impact of valence on approval rates, for instance, goes against the finding that positive emotions increase confidence in institutions (Gross, Brewer, & Aday, 2009); however, the valence dimension cannot be reduced to the emotions of pride and hope that this previous study considers. Likewise, previous research has found that anger has—contrary to what we find—a negative effect on government evaluation, but that study elicited emotions in the narrower context of personal economic situations (Conover & Feldman, 1986). Moreover, our data works with aggregated emotions and tracks them for a longer period than most previous studies; this means that we are capturing the average effects of the public's response to a wider range of issues—whichever happened to be salient at any given time—than previously considered.

Second, we assume that the words used to refer to salient events approximate well the affective impact that those events have on people. Although this assumption relates back to the agenda-setting claim that news reporting, and second-level priming, contributes to imprint a picture of the world on people's minds, it departs from the usual analytical approach in political psychology, which employs survey questions to elicit emotional states, often in a retrospective way. The advantage of using surveys is that the cognitive mechanisms can be inferred more directly by asking the same respondents about their political preferences or behavior; the advantage of using online communication, on the other hand, is that it captures the response of the public in a more reactive manner, that is, as events take place, and on a continuous scale over time. Our findings show, for instance, that while approval rates tend to equilibrate in the long run (back to an equilibrium of about 50%, Stimson, 2004), shifts in the emotional series are more resistant to the weight of time. This aspect has gone mostly unnoticed by survey research because of the limitations of panel data, but has important repercussions for our understanding of how the public forms their opinions. However, it also limits the comparability of our findings with previous research.

The time trends we identify show that some emotional reactions—like the sudden drop in valence or climb in arousal that followed 9/11—end up crystallizing into generalized sentiment, that is, into longer term emotional shifts: None of these two emotional series go back to the average values they showed before the attack. This casts some doubts about the direction of causality from media agenda to political evaluations, and begs the question of whether news reporting responds also to background shifts in the emotions of the public. A recent study has found that emotions are central in the social transmission of news: Using data from the online edition of a newspaper, the study finds that content that triggers high levels of arousal (either positive or negative) is more viral that content that does not activate

those emotions (Berger & Milkman, forthcoming). If the news that activate certain emotions are read by more people, then emotions are also an important factor in shaping the media agenda: After all, it is in the interest of news providers to go viral and they might adapt the tone of their reporting to maximize their chances.

Our focus on the issues that the public decides to discuss about also suggests that issues normally not considered as politically relevant might influence political evaluations as well. Another recent study has shown that events that are irrelevant for the political process but consequential for individuals' affective state, like football game outcomes, have a significant influence on political evaluations: Being in a good mood makes citizens more reconciled with the status quo and more positive about incumbent candidates or parties (Healey, Malhotra, & Mo, 2010). This gives an additional reason to shift the empirical focus from the media agenda to the issues that are important to the public: Emotions exert their influence through channels that are not necessarily political or acknowledged as relevant in traditional surveys and polls.

Focusing on the public agenda, in any case, opens a more direct point of connection with political psychology research because it measures directly the priorities of the public and the emotional tone they use when discussing about political issues. In their classic work, Iyengar and Kinder took the association between agenda-setting and political evaluations as a demonstration of the effects of priming (Iyengar and Kinder, 1987). Making issues or attributes salient, and therefore more likely to be used when forming opinions, has important effects in the views of the public; but there are other mechanisms, driven by the emotional reactions that salient events activate, that are also at play in opinion formation (Marcus, Neuman, & MacKuen, 2000). Our measurement of the public agenda opens a more direct connection to those individual-level mechanisms and therefore to previous research on how emotions shape political judgment. More research is needed to further qualify the nature and effects of emotions, and to devise better tools for extracting affect from written communication; but our findings suggest that pursuing this line of research can improve our understanding of how public opinion is formed.

The findings presented here also build a case to use online discussions and Internet-enabled communication as sources of public opinion data. Online discussions, our data suggest, are representative of public opinion trends even though they are not demographically representative of the population. The analytical strategy we propose does not allow us to make the usual demographic breakdowns (this information is usually absent from digital data), and it can only identify patterns of correlation rather than the actual causal mechanisms driving opinion formation; but it sheds new light into how individual emotional reactions aggregate and evolve over time. Emotions have been an elusive target for analysis on a large, societal scale; we can now advance in this line of research by implementing new methods that pay attention to the opinions that people are willing to express, or to their reactions to the opinions expressed by other people. Although the method we employ is only robust when large samples of written communication are used, it still provides a faster and cheaper alternative to surveys, and it spans a wider range of topics that can possibly

be covered by opinion polls. The speed at which online information can be processed also means that public officials can use it to respond faster to issues of public concern, and ultimately improve the channels for democratic governance.

Conclusions

This article shows that online communication offers new empirical insights into how the public responds to political events. We show that online discussions, although not demographically representative of the population, convey information that is representative of issues that are salient in the mind of the public; we also show that the emotions triggered by those issues help explain political evaluations, here measured in the form of presidential approval. Our approach creates an empirical connection between agenda-setting and political psychology research: We use the topics of online discussions as an empirical approximation to the public agenda, and the emotional load of that communication as an approximation to how the public responds to those issues. This opens an interesting avenue for research where the dynamics of agenda setting and the emotions with which the public responds can be jointly analyzed as determinants of opinion formation.

Acknowledgments

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