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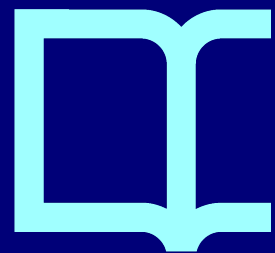
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## Emotions, Public Opinion and U.S. Presidential Approval Rates:

### A 5 year Analysis of Online Political Discussions

#### Abstract

This paper 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 the emotions of the public over a period that includes two U.S. presidential elections, the attacks of September 11, 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. Our contribution is twofold: we show that online discussions contain information that is representative of public opinion trends; and we provide evidence that emotions can be used as consistent indicators of political attitudes on a societal scale.

*Keywords:* agenda setting, priming, public opinion, emotions, political discussions, online interactions, sentiment analysis, approval rates

## Introduction

Public opinion is a proxy for the way citizens perceive political issues and react to current affairs. Scandals or 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, 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 paper 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.

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES

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2  
3 Unlike polls and surveys, this strategy provides real time information of how the public  
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5 responds to current affairs and changes in the political landscape.  
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9 This paper emerges at the intersection of two research strands. The first, agenda  
10  
11 setting, studies the connection between the salience of issues in the public agenda and the  
12  
13 formation of political evaluations (Gitlin, 1980; Iyengar & Kinder, 1987; McCombs & Shaw,  
14  
15 1972; Shaw & McCombs, 1977). The second research strand, captured by appraisal and  
16  
17 affective intelligence theories, focuses on the cognitive effects of emotions and their impact in  
18  
19 shaping opinions and behavior (Lazarus, 1991; Lazarus & Lazarus, 1994; Marcus, Neuman,  
20  
21 & MacKuen, 2000). While agenda setting explores how the higher visibility of certain issues  
22  
23 in news media – or the tone in which they are reported – affect opinion formation, affective  
24  
25 intelligence research focuses attention on the direct effects that emotions have on cognition  
26  
27 and behavior, in line with a well established research tradition that sees in emotions a  
28  
29 fundamental driving force of human action (Elster, 1999; Frank, 1988; Frijda, 1986; Turner &  
30  
31 Stets, 2006). This study builds a connection between these two areas of research by tracking  
32  
33 opinions on issues that are salient in the public agenda, and extracting the emotions that those  
34  
35 opinions convey, which we use as an approximation to individual-level reactions to political  
36  
37 events. The question we want to answer is whether, once aggregated, those emotional  
38  
39 reactions are significantly associated with political evaluations; evidence in favor of that  
40  
41 association would suggest that emotions can be used as an explanatory mechanism that is  
42  
43 consistent with research on political psychology, which can help understand what moves  
44  
45 aggregated opinion trends.  
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54 The paper proceeds as follows. First, we review previous research on agenda setting,  
55  
56 priming and opinion formation, and we link those findings with political psychology research  
57  
58 on how emotions mediate information processing and attentiveness to political events. We use  
59  
60 this discussion to draw our research questions on how emotions shape opinion formation. We

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2  
3 then present our data, which tracks tens of thousands of internet-based political discussions  
4  
5 spanning a five-year period, and we discuss the method employed to extract scores on three  
6  
7 emotional dimensions: valence, arousal, and dominance. We examine trends in the three  
8  
9 dimensions and how they are affected by salient political events, and we assess whether  
10  
11 emotions help explain shifts in aggregated political evaluations, here measured in the form of  
12  
13 approval rates. The paper ends with a discussion of our findings, which offer a novel  
14  
15 empirical approximation to mechanisms often implied in public opinion research.  
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### 23 **Agenda Setting, Public Opinion, and Emotions**

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26 Public opinion broadly refers to the views held by the majority of people. Which  
27  
28 issues are more salient to their attention – and therefore more influential in shaping their  
29  
30 views – is what agenda setting research aims to uncover. The main claim of agenda setting  
31  
32 theory is that the transfer of salience from news reporting to public opinion affects both what  
33  
34 to think about and how to think about it (McCombs & Shaw, 1972; Shaw & McCombs,  
35  
36 1977). There are two mechanisms involved in the association between public communication  
37  
38 and opinion formation: the first, priming, relies on the psychological principle that more  
39  
40 salient issues are also more likely to be accessed, or retrieved from memory, when forming  
41  
42 opinions (Iyengar & Kinder, 1987); the second mechanism, framing, is concerned with how  
43  
44 issues are reported (Gitlin, 1980; Iyengar, 1991) and it has been referred to as second level  
45  
46 priming because it focuses not only on the salience of issues (first level) but also on the  
47  
48 salience of certain attributes of a given issue (Weaver, 2007). The tone that the media use to  
49  
50 report on political news (positive or negative) is one of the examples of how second level  
51  
52 priming can influence public opinion (Sheafer, 2007). Either way, priming assumes that the  
53  
54 media agenda affects how people evaluate political actors by making certain issues or  
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56 characteristics more central to their evaluations.  
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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 (Adams & Moody, 2007; 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.

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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

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 7

1  
2  
3 evaluation of situations and issues (Lazarus, 1991; Lazarus & Lazarus, 1994). Early studies  
4  
5 on the political consequences of emotions find evidence of their impact on presidential  
6  
7 evaluations and vote disposition (Conover & Feldman, 1986; Marcus, 1988; Marcus &  
8  
9 MacKuen, 1993; Way & Masters, 1996). This early work derived into the formulation of a  
10  
11 more coherent theory, affective intelligence, which sees in emotions heuristic devices used to  
12  
13 gather and process information (Marcus, et al., 2000; Neuman, Marcus, Crigler, & MacKuen,  
14  
15 2007; Redlawsk, 2006). The core of the argument is that negative emotions like anxiety or  
16  
17 anger motivate people to search for more and better information, whereas positive emotions  
18  
19 like enthusiasm tend to reinforce political choices.  
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26 According to this stream of research, emotions shape public opinion by making people  
27  
28 more alert to new information or more reliant on their preconceptions; in other words, it  
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30 suggests that the connection between issue salience and opinion formation depends not only  
31  
32 on priming (i.e. the evaluation of political actors in line with the issues and attributes  
33  
34 highlighted by news media) but also on how emotions mediate attention and judgment, which  
35  
36 varies with each individual response to political news and events. The affective tone of news  
37  
38 reporting and the emotional reactions of the public are likely to be associated, but they refer to  
39  
40 different stages of the agenda setting process, and point to different mechanisms; when it  
41  
42 comes to explaining political evaluations, the emotional reactions of the public are more  
43  
44 directly connected to judgment and decision making than the affective tone of the news they  
45  
46 read.  
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52 A study in the context of the Iraq war, for instance, found that both anger and anxiety  
53  
54 increased attention to news related to the conflict but that the two emotions had opposite  
55  
56 effects on support: anger increased approval of the invasion while anxiety reduced it (Huddy,  
57  
58 Feldman, & Cassese, 2007). A related study on perceived terrorism risk found that fear  
59  
60 increased threat estimates and support for precautionary policies but anger generated the

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 8

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2  
3 opposite outcomes (Lerner, Gonzalez, Small, & Fischhoff, 2003). Anxiety has also been found  
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5 to be behind public opposition to immigration (Brader, Valentino, & Suhay, 2008) and of vote  
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7 choice (Ladd & Lenz, 2008). Positive emotions, on the other hand, can motivate participation  
8  
9 and activate existing loyalties, as experimental evidence has suggested in the context of  
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11 political advertising (Brader, 2005). Research on the response to the attacks of September 11  
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13 has also provided evidence that positive emotions like pride and hope can influence political  
14  
15 opinion, in this case in the form of greater confidence in institutions (Gross, Brewer, & Aday,  
16  
17 2009). Put together, this research suggests that the same political events trigger emotional  
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19 reactions on different dimensions, and that each of these might have a different impact on  
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21 opinion formation, depending on the issue at hand.  
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28         Research on affective intelligence contributes to previous work on opinion formation  
29  
30 by providing consistent evidence of one channel by which emotions impact on opinions,  
31  
32 namely by triggering (or not) the motivation to gather more information. This mechanism is  
33  
34 different from second level priming, which treats the emotional tone of news reporting as one  
35  
36 of the heuristic shortcuts that people use in forming their evaluations (Sheafer, 2007); what  
37  
38 affective intelligence research suggests is that emotions have an indirect effect on opinions by  
39  
40 causing citizens to be more thorough in their search for information. Research on the  
41  
42 cognitive effects of emotions, however, does not give much insight into the sources of those  
43  
44 emotions (Brader, 2006) or into how the same stimuli might trigger different reactions, as has  
45  
46 been suggested before (Conover & Feldman, 1986); agenda setting research, on the other  
47  
48 hand, provides ample evidence of the nature of those stimuli (McCombs, 2004). Building on  
49  
50 these two research streams, this study assumes that the salience and framing of issues affect  
51  
52 political evaluations by triggering emotions at the individual level, which offers the  
53  
54 mechanism to link changes in aggregated trends. Instead of focusing on the media agenda –  
55  
56 on which most first and second level priming studies are based (Son & Weaver, 2005;  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES

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3 Sheafer, 2007; Tan & Weaver, 2010) – this study analyzes the public agenda, as  
4  
5 approximated using the political discussions in which people voluntarily engage online. We  
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7 assume that those discussions, and the emotions they convey, contain relevant information  
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9 about the motivations and predispositions of the public – and hence of the factors behind  
10  
11 aggregated political evaluations.  
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16 Previous research exploring the connection between agenda setting, emotions and  
17  
18 opinion formation has mostly focused on single issues (like the economy, immigration,  
19  
20 terrorism, or military conflict) and they have elicited emotions using either experiments or  
21  
22 surveys; this means that, even when panel data is used, these previous studies have intrinsic  
23  
24 limitations to analyze longitudinal dynamics and shifts in prevalent emotions. Inferences  
25  
26 about the influence of emotions in opinion formation are also constrained by the timing and  
27  
28 the nature of the issues that each study considers. Our approach is based on a wider range of  
29  
30 issues – those that are salient in the public agenda at any given time – and on real time  
31  
32 reactions to those issues. Our approach also provides richer longitudinal data to assess the  
33  
34 durability and effects of the emotions that political events trigger. Earlier work has shown that  
35  
36 news media coverage correlates with the issues discussed in online forums (Roberts, Wanta,  
37  
38 & Dzwo, 2002) and with search behavior (Weeks & Southwell, 2010); search queries have  
39  
40 also been used to infer agenda setting dynamics (Scharkow & Vogelgesang, 2011). However,  
41  
42 none of these studies explicitly explores the association between agenda setting, emotions,  
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44 and opinion formation; this is the focus of the analyses that follow.  
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53 This study is inevitably constrained by the type of emotions that can be measured in  
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55 written communication; it is also constrained by the nature of aggregated data, which can only  
56  
57 assume the psychological mechanisms that are at play. However, it is standard in agenda  
58  
59 setting research to use aggregated measures of public opinion (for instance, Son & Weaver,  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 10

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2  
3 2005) and other measures of generalized emotions have been used before to explain political  
4  
5 evaluations, as when the Index of Consumer Sentiment is used to predict approval rates  
6  
7 (Kriner & Schwartz, 2009). Moreover, using online political discussions can cast novel light  
8  
9 on how opinions are simultaneously shaped by agenda setting and the emotions stirred in the  
10  
11 process. The aim of the following analyses is to determine if, as the literature just reviewed  
12  
13 suggests, emotions are significantly associated with political evaluations. Even though the  
14  
15 association is assessed on the aggregate, it still points to individual level mechanisms that are  
16  
17 consistent with recent research on how emotions influence political judgment.  
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## 25 Data and Methods

### 26 Online Political Discussions

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31 The data we use tracks political discussions in the online forum Usenet, a distributed  
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33 discussion system that has been active for over three decades (Hauben & Hauben, 1997; Lueg  
34  
35 & Fisher, 2003). We use the dataset Netscan (Smith, 2003; Smith & Kollock, 1999), a  
36  
37 sample of Usenet that contains about 350 thousand discussion groups. The dataset was  
38  
39 obtained upon request from the Microsoft research team that compiled it; although this dataset  
40  
41 and its web application are no longer publicly available, the same data is now archived and  
42  
43 managed by Google Groups.  
44  
45  
46  
47  
48

49 Netscan tracks Usenet discussions for the period September 1999 to February 2005.  
50  
51 Our analyses focus on the discussions held within the groups that contained the word  
52  
53 'politics' in their hierarchy (hierarchies are used to organize newsgroups in nested categories);  
54  
55 this totaled 935 groups for the period considered. These groups are quite diverse in terms of  
56  
57 their ideological position, which can be inferred using the hierarchy tags (i.e.  
58  
59 alt.politics.democrat, alt.politics.republican). Out of the newsgroups that have explicit  
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1  
2  
3 ideological references in their names, 21% are democrat and 12% republican; the rest, 67%,  
4  
5 are miscellaneous (i.e. talk.politics.misc). Cross-posting in these discussions is quite frequent:  
6  
7 the percentage of messages that are simultaneously sent to more than one newsgroup remains  
8  
9 between 63% and 85% for the full period, creating discussions that span across several  
10  
11 groups. This means that most users do not see newsgroups as closed boundaries for political  
12  
13 talk but rather as distribution channels they activate to engage a diversity of users in the same  
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15 discussion. When preparing the data for the analyses, we excluded the discussions that did not  
16  
17 have at least three messages in order to avoid spam and non-significant discussions.  
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25           These discussions involved about 800 thousand unique participants. Less than 30%,  
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27 however, remained active for more than a month, which means that the signal of public  
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29 opinion captured by this data is very diverse: it is based on the contributions of a high number  
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31 of users with a fast turnaround. On average per month, around seven thousand unique users  
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33 contributed around thirty thousand discussion topics. In spite of the large numbers, these users  
34  
35 are still not a representative sample of the population: representativeness is undermined not  
36  
37 only by the digital divide (particularly important towards the beginning of the period, when  
38  
39 Internet penetration rates were lower) but also by the self-selecting nature of these groups: the  
40  
41 discussants we track are likely to be more interested in politics than an average person; they  
42  
43 are, after all, a minority (of hundreds of thousands) sufficiently engaged in politics to be  
44  
45 active in these forums. The topics they choose to discuss about, however, are still a good  
46  
47 approximation to the public agenda – certainly a more direct approach to the mind of the  
48  
49 public than news reporting or the media agenda.  
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56           We choose to analyze political discussions in Usenet because they allow us to  
57  
58 reconstruct patterns over a longer period than more recent social media like Facebook or  
59  
60 Twitter, although recent work also tracking emotions in written communication is using those

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 12

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3 platforms (Bollen, Pepe, & Mao, 2009; Kramer, 2010; Georgios Paltoglou & Thelwall, 2011;  
4  
5 Golder & Macy, 2011). Usenet data allows us to consider a time window that includes some  
6  
7 prominent events like the attacks of 9/11 or the invasion of Iraq; this allows us to connect our  
8  
9 findings with previous research exploring emotional reactions to those events (i.e. Huddy,  
10  
11 Feldman, & Cassese, 2007; Gross, et al., 2009; Lerner, et al., 2003). Agenda setting research  
12  
13 assumes that news media are the principal connectors between the events that take place in the  
14  
15 world and the picture the public gets of those events in their minds. We propose using online  
16  
17 political communication to move one step ahead and characterize the emotional nature of that  
18  
19 impression. The range of issues prioritized in the public agenda might not fully overlap with  
20  
21 the priorities of the media agenda, so this study differs from previous attempts to analyze the  
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23 evaluative tone of news reporting (Sheafer, 2007); the analyses that follow extract affective  
24  
25 language directly from what the public decides to discuss about.  
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### 34 **Measures of Emotion**

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37 We extract the emotional content of the discussions using the Affective Norms for  
38  
39 English Language Words (ANEW), a list of words with emotional scores given by human  
40  
41 subjects (Bradley & Lang, 1999). The ANEW list contains about a thousand words that  
42  
43 receive a rating on a 9 point scale in three dimensions: valence, arousal, and dominance. The  
44  
45 valence dimension measures the extent to which words make subjects feel happiness,  
46  
47 satisfaction and hope (stronger feelings as they get closer to 9), or their opposites: sadness,  
48  
49 dissatisfaction and despair (stronger as they get closer to 1). The arousal dimension captures  
50  
51 the association of words with feelings of excitement, anger or frenzy and their opposites;  
52  
53 dominance, in turn, focuses on feelings of domination or being in control versus feelings of  
54  
55 submission or awe. This list of words and their scores give an empirical measure of affective  
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57 evaluations and, in the context of this study, of how the public reacts to salient political  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 13

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3 events. Our working assumption is that we can approximate the prevalent feelings of the  
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5 public by measuring the emotional content of the words used in the discussions of those  
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7 events.  
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10  
11 The algorithm to extract emotional scores from the discussions follows the method  
12  
13 proposed by Dodds and Danforth (2009), and it is summarized in Figure 1. For every sample  
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15 of discussion headers, which we aggregated monthly, we identified and counted the number  
16  
17 of occurrences of ANEW words. Panel 1 in Figure 1 contains a few empirical examples of  
18  
19 discussion topics. The discussion under the heading “U.S. could be free from oil dependence”  
20  
21 has one ANEW word (‘free’); the discussion under the subject line “The war is fraud” has two  
22  
23 ANEW words (‘war’ and ‘fraud’). We then matched every word with their scores in the three  
24  
25 ANEW words (‘war’ and ‘fraud’). We then matched every word with their scores in the three  
26  
27 emotional dimensions and we calculated, in a third step, the monthly averages as well as their  
28  
29 standard deviations, taking into account not only the scores but also the frequency of words:  
30  
31 in this example, the word “war” (which has an average valence of 2.08 and average arousal of  
32  
33 7.49) is counted three times; the word “fraud” is counted twice and the rest, only once.  
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38 --- Figure 1 about here ---  
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43 We only used the discussion headers because we did not have access to the content of  
44  
45 the messages. Previous research has shown that headers are representative of the rest of the  
46  
47 thread, and it has become standard in research to use them as such (see, for instance, Broder,  
48  
49 Fontoura, Josifovski, & Riedel, 2007; Chakrabarti, Agarwal, & Josifovski, 2008). Most  
50  
51 importantly, discussion topics offer a natural measure of issue salience: the most visible issues  
52  
53 are more likely to trigger a discussion, and these issues are summarized in the subject line. In  
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55 total, we analyzed about 380 thousand subject lines, so even though headers offer a limited  
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57 account of the content of the discussions, they still offer rich enough data to extract  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 14

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3 continuous measures of emotions. The subject lines contained a total of 2,3 million words; of  
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8 these, about 6% (N~140,000) are part of the ANEW list. This percentage might seem low  
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17 because the vast majority of words used in written communication are articles, pronouns,  
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19 prepositions and other neutral words not contained in the ANEW lexicon. The names of  
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21 persons, institutions or countries are also not covered by the lexicon as the emotional reaction  
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23 towards these terms (and their salience) varies in time.  
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30 The ANEW list offers just one of multiple possibilities to measure emotions in written  
31  
32 communication, exemplified by a growing area of research (Asur & Huberman, 2010; Bollen,  
33  
34 Mao, & Zeng, 2010; Kramer, 2010; O'Connor, Balasubramanyan, Routledge, & Smith, 2010;  
35  
36 Georgios Paltoglou & Thelwall, 2011; Golder & Macy, 2011). There is no research to date  
37  
38 that compares the ANEW list vis-a-vis other machine-learning algorithms for sentiment  
39  
40 analysis. In any case, although these algorithms offer alternatives to our chosen method, all of  
41  
42 them have weaknesses on their own (Paltoglou, Gobron, Skowron, Thelwall, & Thalmann,  
43  
44 2010). We opted for the ANEW list because it has already been used to infer emotional states  
45  
46 at a population level using various large-scale text corpuses (Dodds & Danforth, 2009) and  
47  
48 because its lexicon has been tested and replicated in other languages (Redondo, Fraga,  
49  
50 Padron, & Comesana, 2007), which adds a comparative dimension to the analyses by  
51  
52 potentially allowing measurements across linguistic communities.  
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59 --- Figure 2 about here ---  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 15

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Figure 2 shows lists of the twenty 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, 2000:55; 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.

### 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,

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 16

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3 which aggregates polls conducted by several news and opinion poll organizations, including  
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5 Gallup. The data tracks responses to variations of the question “Do you approve or disapprove  
6  
7 of the way the incumbent President is handling his job?” Each data point corresponds to  
8  
9 monthly averages and is based on a different cross-section sample of the population, which  
10  
11 helps minimize random measurement error. Table 1 presents some descriptive measures of  
12  
13 the data. Although the average approval for the two incumbent presidents during this period  
14  
15 (Bill Clinton and George W. Bush) remains around 60%, the variance is higher for the Bush  
16  
17 presidency, which spans most of the data points in the period we consider. Both the maximum  
18  
19 and minimum scores were reached during his time in office: they coincide, respectively, with  
20  
21 the attacks of 9/11 (when support for the President reached a historical maximum) and the  
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23 Abu Ghraib scandal.  
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30 --- Table 1 about here ---  
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33 We use approval rates as a measure of political evaluation because it is more  
34  
35 responsive to what the public thinks than surveys on more specific issues. Approval polls use  
36  
37 more or less identical questions for long periods, yielding a measure of opinion that can be  
38  
39 compared across time. The evaluation of the President offers a good pulse of how the public  
40  
41 perceive the management of the nation and the issues that most concern them at any given  
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43 moment. Although this measurement does not go into the reasons why respondents approve  
44  
45 (or not) the job of their representatives, it is measured frequently enough to help identify  
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47 inertias that systematically appear during the life cycle of all administrations. Some of those  
48  
49 inertias include the systematic higher rates of the first months in office (the ‘honeymoon’  
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51 period); the attrition that follows the act of governing; and the surges in approval during  
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53 military conflicts (Clarke, Stewart, Ault, & Elliott, 2004; Kriner & Schwartz, 2009; Mueller,  
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55 1973). Research on approval rates assumes that the public is well informed, that they follow  
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3 closely political events and react to them as a thermostat reacts to room temperature. The  
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5 analyses presented here use emotions as the temperature to which approval rates react.  
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## 10 11 12 13 14 15 **Research Questions and Models**

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18 There are two types of questions we want to answer with this data: (1) how do  
19 emotions co-evolve with political events and changes in issue salience? And (2) are emotional  
20 reactions associated to changes in political evaluations? By answering these questions we aim  
21 to contribute to previous work in political psychology, particularly in its intersection with  
22 agenda setting research. As discussed above, recent research has provided consistent evidence  
23 of the cognitive impact of emotions; however, which stimuli or events are more consequential  
24 when triggering emotional reactions is still an underexplored area. By analyzing the  
25 emotional content of discussions around topics that are primed by the public, we cast light on  
26 one empirical point of connection between agenda setting and political psychology research.  
27 Our analyses also help assess to what extent online political communication can be used as a  
28 proxy to changes in the opinions of the public.  
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45 Given that our research questions focus on time trends, we decided to carry our  
46 analyses in two stages. First, we fit linear models to analyze the significance of trends and the  
47 relative impact of salient events on the six emotional series under consideration, which  
48 correspond to the monthly averages and standard deviations of valence, arousal, and  
49 dominance. The models follow the form:  
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$$56 \quad e_t = \alpha_0 + \alpha_1 t + \alpha_2 d_{1,t} + \dots + \alpha_m d_{m,t} + z_t \quad (\text{Eq. 1})$$

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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 18

Where  $e_t$  refers to one of the six emotional series,  $\alpha_0$  is the intercept parameter,  $\alpha_1$  estimates the effect of time  $t$ , and  $\alpha_2 \dots \alpha_m$  estimate the impact of salient political events, captured as dummy variables  $d_{1,t} \dots d_{m,t}$ . 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 (1) 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. Since the linear models account for the non-stationary 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:

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

In this model the dependent variable  $a_t$  is the approval rates series; the coefficient  $\alpha$  captures the autocorrelation, or how much influence past values  $a_{t-1}$  have on rates at time  $t$ . The emotional series  $e_1 \dots e_m$  are included as part of a linear regression fitted to the error series  $z_t$ . If the coefficients  $\alpha_2 \dots \alpha_m$  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 (2), 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 grey vertical bars identify some of the most prominent events in this period: the two presidential elections (in November 2000 and November 2004), the attacks of September 11, 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 about here--

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

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3 dimensions. The estimated coefficients are shown in Table 2. There are three main findings  
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5 worth capturing from this table. First, the time trends identified are statistically significant for  
6  
7 valence and dominance: the average scores for both dimensions go down as time passes,  
8  
9 signalling increasing levels of unhappiness and uneasiness; also in both cases deviation  
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11 around the mean goes up, meaning that with time more discussions tended to fall closer to the  
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13 two extremes of the emotional scales. The two arousal series have an upward trend, but once  
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15 the autocorrelation of the error terms is taken into account (using the GLS estimation), the  
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17 trends are not significant.  
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25           Second, the most salient political event of this period, in terms of magnitude and  
26  
27 significance across emotional dimensions, is the invasion of Iraq. Figure 3 showed that after  
28  
29 9/11 political communication became more negative and aroused, but also more polarized  
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31 around average emotions; the regression models show that the estimated coefficients for this  
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33 event go in the expected direction, but that for the most part they do not reach statistical  
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35 significance when time trends are controlled for. And third, presidential elections do not have  
36  
37 any significant effects in any of the series, with the exception of dominance: deviation around  
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39 the mean in this emotional dimension goes significantly up with the 2004 election, an effect  
40  
41 that is likely to be related with the “War on Terror” discourse that dominated the campaign.  
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52           -- Table 2 about here—  
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### 55 **The Impact of Emotions on Political Evaluations** 56 57

58           The evolution of approval rates vis-a-vis the emotional series is shown in Figure 4.  
59  
60 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

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 21

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3 it generated a response in approval rates, which go up shortly after military action starts – in  
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5 line with the public reaction in times of war (Mueller, 1973). This military intervention  
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7 coincides with the lowest point in the valence series, that is, the moment with the unhappiest  
8  
9 general sentiment; it also coincides with a peak in arousal: when the war started, discussions  
10  
11 adopted the angriest expressions of the period we consider. If we just measure public opinion  
12  
13 using approval rates, this war did not bring such an extreme reaction in the public as the  
14  
15 attack of 9/11 had done; but it definitively stirred more antagonistic feelings. One reason for  
16  
17 the different emotional reaction to these two events has to do with the unexpectedness of the  
18  
19 attack. The possibility of a war was salient in the media, and in the mind of the public, for a  
20  
21 longer period, which gave them more time to digest the news (and their feelings) and have a  
22  
23 response ready when the war finally started. The figure also qualifies previous research on  
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25 emotional reactions to the war (Huddy, Feldman & Cassese, 2007): anger might have  
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27 increased support, and Figure 4 suggests that the average feeling was indeed that of increased  
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29 anger; but it also shows that there was quite a lot of divergence around that general feeling.  
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39 -- Figure 4 about here --  
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44 To test whether these visual associations are statistically significant, and determine  
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46 which, if any, of the six emotional dimensions has more explanatory power, we fitted a series  
47  
48 of AR(1) models following Equation 2. The findings, summarized in Table 3, indicate that  
49  
50 only valence and arousal have statistically significant effects on approval rates, once  
51  
52 autocorrelation is controlled for. Valence has a negative effect, which means that as the  
53  
54 general levels of happiness decrease, a positive evaluation of the president increases, and vice  
55  
56 versa. Arousal has a positive and stronger effect: the higher the prevalent emotions are in this  
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58 scale (i.e. the angrier the public grows) the better the evaluations become; this effect is  
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3 particularly strong for the series tracking deviations around the mean. The effects of these  
4  
5 emotions, however, are only statistically significant when each dimension is considered  
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7 separately. According to the AIC and the likelihood test, the best models to explain approval  
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9 rates are those that incorporate the arousal series.  
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12  
13 -- Table 3 about here --  
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## 18 **Discussion**

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21 The analyses above show that the time period we consider can be characterized by  
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23 declining trends in valence and dominance, and by rising levels in arousal, which is most  
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25 significantly driven by issues related to the military conflict in Iraq. The findings also show  
26  
27 that arousal (and the implied emotion of anger) is the most significant dimension when  
28  
29 explaining approval rates. These findings fall in line with previous studies, in particular those  
30  
31 analyzing the emotional reactions to the attacks of 9/11 and the Iraq war: they show that anger  
32  
33 makes people less inclined to see military action as risky and therefore more likely to support  
34  
35 it (Huddy, Feldman & Cassese, 2007). We interpret these findings as evidence that the same  
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37 cognitive mechanisms identified by political psychology research are at play; however, we  
38  
39 also find that deviations around average arousal (which we take as an indication of increased  
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41 polarization) is a stronger explanatory factor, which means that the reasons behind public  
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43 support for the president are probably more varied than usually acknowledged.  
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53 The nature of our data and methods imposes some limitations to the comparability of  
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55 our results with previous research. First, the emotional dimensions that we consider do not  
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57 map exactly onto the emotions that have been analyzed before. The negative impact of  
58  
59 valence on approval rates, for instance, goes against the finding that positive emotions  
60  
increase confidence in institutions (Gross, Brewer, & Aday, 2009); however, the valence

## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 23

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3 dimension cannot be reduced to the emotions of pride and hope that this previous study  
4  
5 considers. Likewise, previous research has found that anger has – contrary to what we find – a  
6  
7 negative effect on government evaluation, but that study elicited emotions in the narrower  
8  
9 context of personal economic situations (Conover & Feldman, 1986). Moreover, our data  
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11 works with aggregated emotions and tracks them for a longer period than most previous  
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13 studies; this means that we are capturing the average effects of the public’s response to a  
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15 wider range of issues – whichever happened to be salient at any given time— than previously  
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17 considered.  
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25         Second, we assume that the words used to refer to salient events approximate well the  
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27 affective impact that those events have on people. Although this assumption relates back to  
28  
29 the agenda setting claim that news reporting, and second level priming, contributes to imprint  
30  
31 a picture of the world on people’s minds, it departs from the usual analytical approach in  
32  
33 political psychology, which employs survey questions to elicit emotional states, often in a  
34  
35 retrospective way. The advantage of using surveys is that the cognitive mechanisms can be  
36  
37 inferred more directly by asking the same respondents about their political preferences or  
38  
39 behavior; the advantage of using online communication, on the other hand, is that it captures  
40  
41 the response of the public in a more reactive manner, that is, as events take place, and on a  
42  
43 continuous scale over time. Our findings show, for instance, that while approval rates tend to  
44  
45 equilibrate in the long run (back to an equilibrium of about 50 per cent, Stimson, 2004: 145),  
46  
47 shifts in the emotional series are more resistant to the weight of time. This aspect has gone  
48  
49 mostly unnoticed by survey research because of the limitations of panel data, but has  
50  
51 important repercussions for our understanding of how the public forms their opinions.  
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58 However, it also limits the comparability of our findings with previous research.  
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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 24

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3 The time trends we identify show that some emotional reactions – like the sudden drop  
4  
5 in valence or climb in arousal that followed 9/11 – end up crystallizing into generalized  
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7 sentiment, that is, into longer term emotional shifts: none of these two emotional series go  
8  
9 back to the average values they showed before the attack. This casts some doubts about the  
10  
11 direction of causality from media agenda to political evaluations, and begs the question of  
12  
13 whether news reporting responds also to background shifts in the emotions of the public. A  
14  
15 recent study has found that emotions are central in the social transmission of news: using data  
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17 from the online edition of a newspaper, the study finds that content that triggers high levels of  
18  
19 arousal (either positive or negative) is more viral than content that does not activate those  
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21 emotions (Berger & Milkman, forthcoming). If the news that activate certain emotions are  
22  
23 read by more people, then emotions are also an important factor in shaping the media agenda:  
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25 after all, it is in the interest of news providers to go viral and they might adapt the tone of  
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27 their reporting to maximize their chances.  
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34 Our focus on the issues that the public decides to discuss about also suggests that  
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36 issues normally not considered as politically relevant might influence political evaluations as  
37  
38 well. Another recent study has shown that events that are irrelevant for the political process  
39  
40 but consequential for individuals' affective state, like football game outcomes, have a  
41  
42 significant influence on political evaluations: being in a good mood makes citizens more  
43  
44 reconciled with the status quo and more positive about incumbent candidates or parties  
45  
46 (Healey, Malhotra & Mo, 2010). This gives an additional reason to shift the empirical focus  
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48 from the media agenda to the issues that are important to the public: emotions exert their  
49  
50 influence through channels that are not necessarily political or acknowledged as relevant in  
51  
52 traditional surveys and polls.  
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59 Focusing on the public agenda, in any case, opens a more direct point of connection  
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with political psychology research because it measures directly the priorities of the public and



## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES 25

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3 the emotional tone they use when discussing about political issues. In their classic work,  
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5 Iyengar and Kinder took the association between agenda-setting and political evaluations as a  
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7 demonstration of the effects of priming (Iyengar and Kinder, 1987). Making issues or  
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9 attributes salient, and therefore more likely to be used when forming opinions, has important  
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11 effects in the views of the public; but there are other mechanisms, driven by the emotional  
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13 reactions that salient events activate, that are also at play in opinion formation (Marcus,  
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15 Neuman, & MacKuen, 2000). Our measurement of the public agenda opens a more direct  
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17 connection to those individual-level mechanisms and therefore to previous research on how  
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19 emotions shape political judgment. More research is needed to further qualify the nature and  
20  
21 effects of emotions, and to devise better tools for extracting affect from written  
22  
23 communication; but our findings suggest that pursuing this line of research can improve our  
24  
25 understanding of how public opinion is formed.  
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33 The findings presented here also build a case to use online discussions and internet-  
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35 enabled communication as sources of public opinion data. Online discussions, our data  
36  
37 suggest, are representative of public opinion trends even though they are not demographically  
38  
39 representative of the population. The analytical strategy we propose does not allow us to  
40  
41 make the usual demographic breakdowns (this information is usually absent from digital  
42  
43 data), and it can only identify patterns of correlation rather than the actual causal mechanisms  
44  
45 driving opinion formation; but it sheds new light into how individual emotional reactions  
46  
47 aggregate and evolve over time. Emotions have been an elusive target for analysis on a large,  
48  
49 societal scale; we can now advance in this line of research by implementing new methods that  
50  
51 pay attention to the opinions that people are willing to express, or to their reactions to the  
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53 opinions expressed by other people. Although the method we employ is only robust when  
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55 large samples of written communication are used, it still provides a faster and cheaper  
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57 alternative to surveys, and it spans a wider range of topics that can possibly be covered by  
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3 opinion polls. The speed at which online information can be processed also means that public  
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5 officials can use it to respond faster to issues of public concern, and ultimately improve the  
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7 channels for democratic governance.  
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## Conclusions

This paper 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.

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## EMOTIONS, PUBLIC OPINION AND U.S. PRESIDENTIAL APPROVAL RATES

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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=3002.

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Table 2. Linear models of emotional series as a function of time and salient events

	OLS						GLS					
	valence		arousal		dominance		valence		arousal		dominance	
	$\bar{x}$	$\sigma$	$\bar{x}$	$\sigma$	$\bar{x}$	$\sigma$	$\bar{x}$	$\sigma$	$\bar{x}$	$\sigma$	$\bar{x}$	$\sigma$
intercept	<b>98.18</b>	<b>-195.00</b>	<b>-85.33</b>	<b>-75.20</b>	<b>64.19</b>	-46.52	<b>103.26</b>	<b>-184.27</b>	-50.03	-70.25	<b>64.19</b>	-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	<b>-0.0005</b>	<b>0.0010</b>	<b>0.0004</b>	<b>0.0004</b>	<b>-0.0003</b>	<b>0.0002</b>	<b>-0.0005</b>	<b>0.0009</b>	0.0003	0.0004	<b>-0.0003</b>	<b>0.0002</b>
	(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	<b>0.4192</b>	-0.0472	0.1607	-0.0221	-0.0442	-0.0231	<b>0.4192</b>
	(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	<b>0.2761</b>	-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	<b>-0.5863</b>	<b>0.3883</b>	<b>0.6387</b>	<b>0.6473</b>	-0.2378	<b>-0.5554</b>	<b>-0.4065</b>	0.2086	<b>0.2848</b>	<b>0.2643</b>	-0.2378	<b>-0.5554</b>
	(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	<b>-0.3707</b>	<b>0.3465</b>	0.2003	-0.1092	<b>-0.4148</b>	0.1607	<b>-0.3026</b>	0.2127	<b>0.2200</b>	-0.0322	<b>-0.4148</b>	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 <sup>2</sup>	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
logLik							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.

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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)	<b>0.850</b>	<b>0.843</b>	<b>0.839</b>	<b>0.849</b>	<b>0.842</b>	<b>0.848</b>	<b>0.850</b>	<b>0.840</b>	<b>0.845</b>	<b>0.849</b>	<b>0.850</b>
	(0.061)	(0.063)	(0.064)	(0.061)	(0.063)	(0.062)	(0.061)	(0.064)	(0.062)	(0.062)	(0.062)
mean valence		<b>-0.187</b>						-0.162			-0.350
		(0.087)						(0.104)			(0.218)
stdev valence			0.138					0.047			-0.063
			(0.091)					(0.106)			(0.134)
mean arousal				<b>0.256</b>					0.127		0.115
				(0.097)					(0.112)		(0.145)
stdev arousal					<b>0.293</b>				<b>0.226</b>		0.168
					(0.092)				(0.108)		(0.130)
mean dominance						-0.049				-0.058	0.234
						(0.067)				(0.072)	(0.139)
stdev 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
logLik	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.

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Figure 1. Method to extract emotional scores from discussion topics

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 ( $\bar{x}, \sigma$ )

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

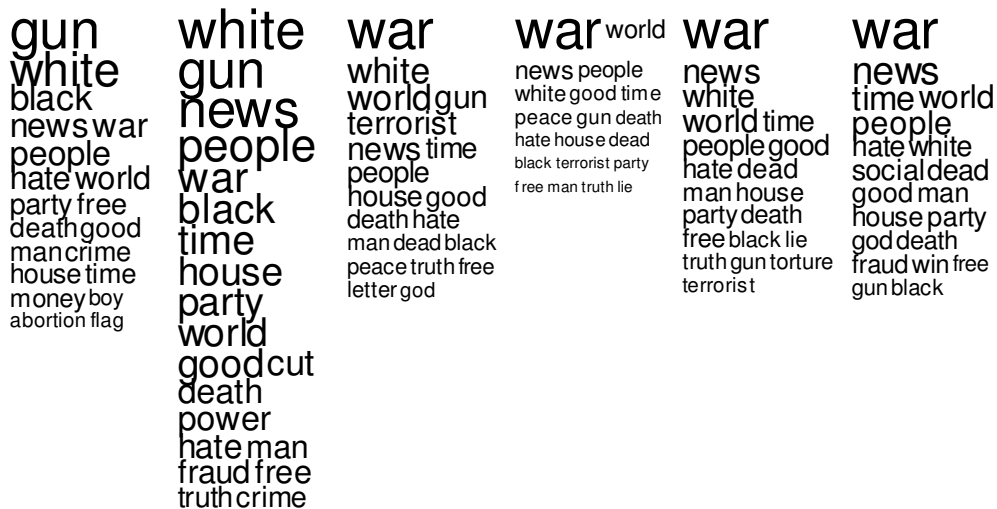
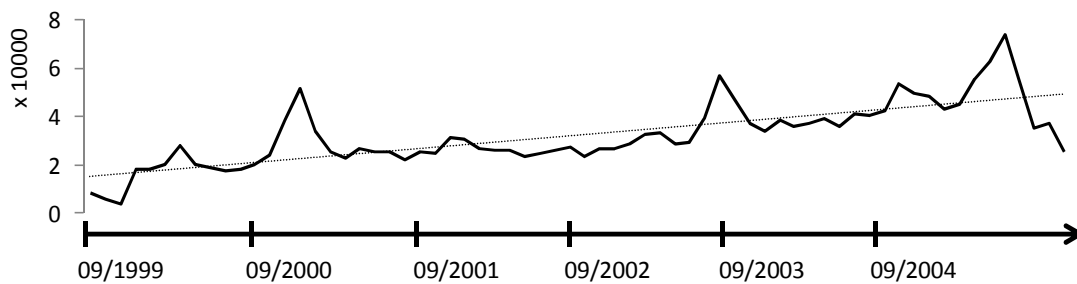
$$\sigma_{v,a,d} = \sqrt{\frac{\sum_{ANEW} f_w (v, a, d - \bar{x}_{v,a,d})^2}{\sum_{ANEW} f_w}}$$

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

Note: Adapted from Dodds & Danforth, 2009

Figure 2. Number of discussions and most popular ANEW words used over time



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Figure 3. Changes in mean and standard deviation of valence, arousal and dominance

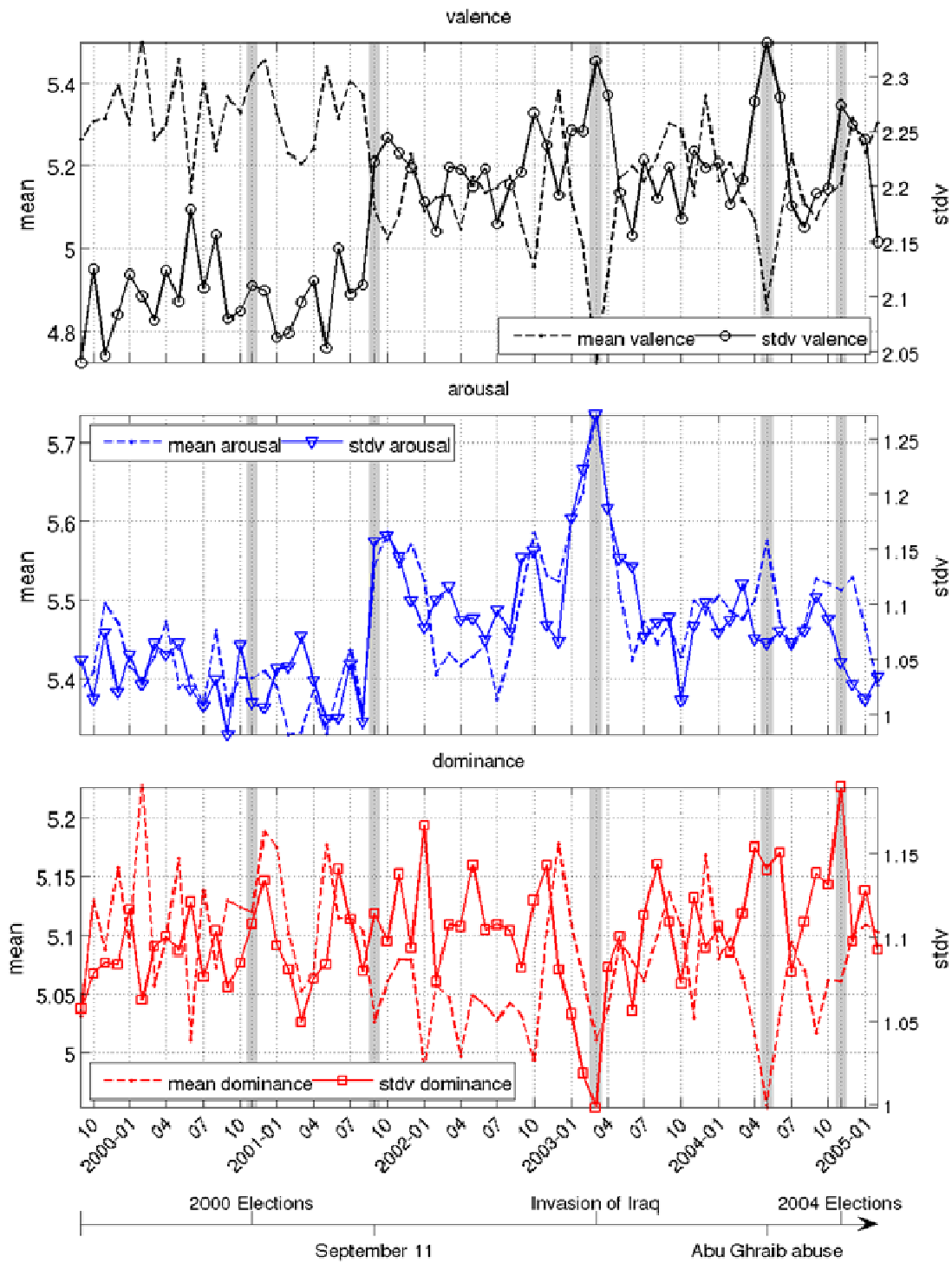
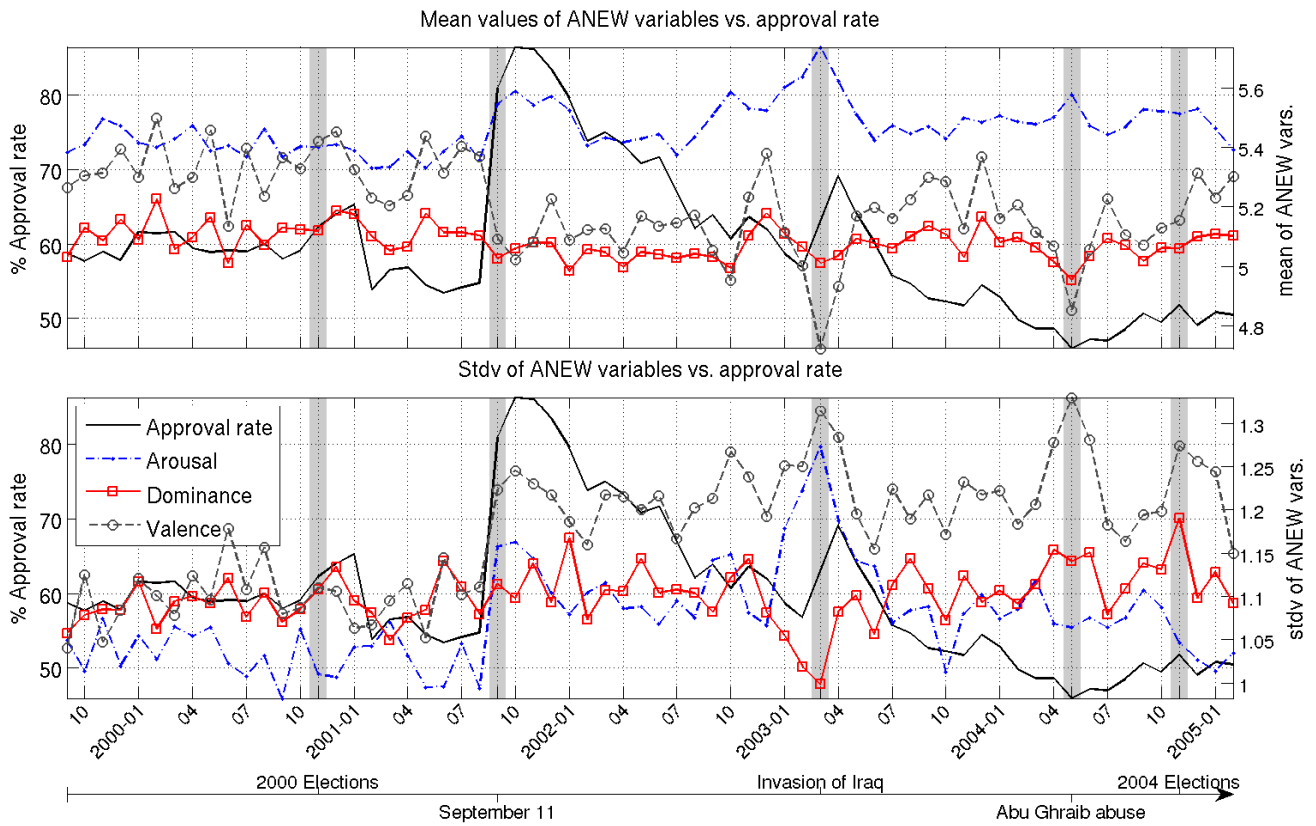


Figure 4. Changes in valence, arousal and dominance compared to presidential approval rates



Note: for better visualisation, the standard deviation of valence is offset by -1