Tracking Issue Attention: Specifying the Dynamics of the Public Agenda

Author(s): Gary T. Henry and Craig S. Gordon

Source: *The Public Opinion Quarterly*, Summer, 2001, Vol. 65, No. 2 (Summer, 2001), pp. 157-177

Published by: Oxford University Press on behalf of the American Association for Public Opinion Research

Stable URL: https://www.jstor.org/stable/3078800

TRACKING ISSUE ATTENTION
SPECIFYING THE DYNAMICS OF THE PUBLIC AGENDA

GARY T. HENRY
CRAIG S. GORDON

Abstract While interest in issues shifts daily, tracking these changes is currently done by multiple surveys, which are conducted months apart. In this article, we adapt political tracking poll methods to model the functional form of issue attention changes through three phases, including equilibrium, developing interest, and decline. We find that opinions do follow discernible cycles. Further, we test and find strong support for the "boredom" explanation that reactions to external events that are brought to the attention of the public through the media are much greater during the developing interest phase than the saturation phase. The evidence gathered from the newly adapted method has implications for modeling the issue-attention cycle and testing the effects of media coverage and external events on public interest in issues.

Introduction

Day-to-day, public interest in issues shifts, sometimes subtly, sometimes dramatically. Events, issue competition, carrying capacity of the mass public, and activities in other arenas such as the media or one of the three branches of government influence the rise, fall, and revival of issues on the public agenda. Competing explanations for the rise and fall of issue interest are quite subtle, distinct, and plausible, which raises many interesting questions for empirical research. Is the carrying capacity limited by education (McCombs and Zhu 1995), by attention (Zhu 1992), or by constraints on surplus compassion (Hilgartner and Bosk 1988)? Do public issues compete with all other

GARY T. HENRY and CRAIG S. GORDON are at the Andrew Young School of Policy Studies and the Department of Political Science at Georgia State University. The authors gratefully acknowledge the financial support of the Environmental Protection Division of the Georgia Department of Natural Resources in conjunction with the Environmental Economics Center, Andrew Young School of Policy Studies, Georgia State University. The authors wish to thank Charlotte Steeh, Vincent Price, and three anonymous reviewers for helpful comments on an earlier draft of this article. An earlier paper on a similar topic coauthored by Gary T. Henry and Richard E. Chard was presented at the 1999 AAPOR conference.

Public Opinion Quarterly Volume 65:157–177 0033-362X/2001/6502-0001$02.50

information for interest and attention (Hilgartner and Bosk 1988) or do they compete for a zero-sum allocation among themselves (McCombs and Zhu 1995; Zhu 1992)? Is it the cost and sacrifices of proposed solutions that drive issues off the agenda (Downs 1972) or boredom (Hilgartner and Bosk 1988; Kingdon 1995)? Empirically testing these propositions has been limited by the data available for analysis and the methodologies used.

The dynamic nature of issue attention and the static nature of most existing research designs make ruling out rival hypotheses challenging when effects are found and ruling out timing or the length of the interval between surveys as a plausible explanation for the lack of a discernible effect. Most evidence of the change in mass opinions comes from comparing data across multiple cross-sectional surveys (McCombs and Zhu 1995; Monroe 1998; Mutz and Soss 1997; Page and Shapiro 1992), from splitting single surveys before and after a suspected cause has occurred (Krosnick and Kinder 1990), panel studies (Krosnick and Brannon 1993), or from experiments (Iyengar and Kinder 1987). When the intent is to examine the effects of changing interest on other attitudes, such as political evaluations or policy actions, the limitations of data from these sources are less severe.

However, when researchers want to know how, why, for whom, and the timing with which issue importance shifts occur, data must support the specification of the functional form of interest over time and have the capability to test alternative explanations for the changes. Each of the methods that is currently in the literature may have potentially untenable assumptions that can reduce its validity or usefulness. For example, artificially dividing a cross-sectional design into before and after an external event occurred opens the possibility that uncovered effects are a function of the uneven distribution of respondents between the two periods, such as those who are easy to reach and hard to reach. Participants in a panel study receive implicit or explicit cues regarding the subject matter. These cues potentially bias the findings, making it plausible that the difference in responses across waves is due to reactivity to the measurement process. Potentially, the most limiting aspect of current methods is the assumption that the functional form of the issue attention cycle is captured by linear functions, which Neuman (1990) has shown not to be the case (p. 169). Because interest is a function of time as well as media coverage, individual characteristics, and elite responses, static measurements may or may not capture the effects of change depending upon the timing of the administration of the surveys. For the most often used methods, multiple cross-sectional surveys, it is difficult to ascertain if the gap between surveys has been sufficiently long for the effects to occur or too long, allowing boredom (Kingdon 1995; Neuman 1990), the costs of proposed solutions (Downs 1972), or the constraints on surplus compassion (Hilgartner and Bosk 1988) to set in. As Kosicki (1993) pointed out, agenda-setting research lacks sufficient specification of the time dimension and the dynamic nature of the theories is undermatched by the static nature of the measures:

"Researchers studying agenda setting tend to discuss it as a dynamic process, focusing on the continuous fluctuation of media agendas, and their subsequent impact on audience agendas. . . . A major problem is that often the conceptual and operational definitions do not match. . . . While most of the language used by agenda-setting authors discusses an active, constructive approach to these issues, it is normally studied with rather static notions of the issue agenda" (p. 106).

Responding to the need for dynamic models that include the rise and fall of issue interest, McCombs and Zhu (1995) estimated the functional form of the issue attention cycle using historical survey data to specify a curvilinear function. By modeling the changes in responses to the "most important problem" item from the Gallup surveys administered since 1954, McCombs and Zhu (1995) demonstrated that a theoretically meaningful, second-order polynomial curve fits the rise and fall of responses over time. Modeling responses to this particular item, which stands as the best available barometer of issue interest among the American public over time (Smith 1985), is probably unique in terms of availability and degree of comparability over time. In addition, the form of the item fits the zero-sum game assumption of agenda-setting theory (Zhu 1992). However, the data used in their models subject their analysis to extraneous factors that may reduce the comparability of the responses over time. For example, the lack of even intervals between surveys and the inability to disaggregate the series as well as changes in question wording, survey administration, and response coding (Smith 1985) restrict the ability to rule out rival hypotheses. McCombs and Zhu (1995) adroitly attacked the plausibility of several rival explanations through sensitivity analyses and confirmatory tests on other available data sets, but, as they note, the available data limit researchers' abilities to move from description to testing explanations. Their work reinforces the need to address the challenge posed by Hilgartner and Bosk (1988) to develop "more sophisticated measures and indices of the level of attention that problems receive" in order to answer "more sophisticated structural questions about the competitive process" (p. 73). Rogers, Dearing, and Bregman (1993) made a similar call for better measures.

In this article, we contribute to the process of developing better measures by attacking two problems. The first problem is to map the ebb and flow of the issue attention cycle; the second is to test the extent to which expected external events or activities cause perturbations in the model in the expected way. If researchers can fit a curve corresponding to the rise, fall, and revival of interest in an issue over time, then the resulting descriptive model can provide a useful base for testing significant perturbations in the expected pattern. Once the base is established, we are able to test theoretically generated propositions about the causal relationships underlying the data patterns. In this article, we examine the proposition that the audience becomes inured to messages after the phase in which interest builds up. In other words, lack of novelty in the messages causes boredom and disregard of the same messages

that a few days before had caused interest to spike. We test this proposition by examining the differences in responses to reports of external events during the build-up and decline of interest phases, using a survey method, which we adapted to track issue attention.

We appropriated a survey methodology, commonplace in other circumstances, for studying issue interest. For over 20 years, campaign tacticians and the news media have valued real time estimates of public opinion sufficiently to fund daily campaign tracking polls (John 1989; Moore 1999; Rhee 1996). Tracking polls rely on rolling samples, which mix easy and hard to reach respondents, thereby allowing the survey population's attitudes to be estimated each day. One can view survey responses daily or aggregate over a few days to assess shifts in attitudes. For tracking polls, this is done to assess trends in the public's preferences for candidates, especially important in key races and in the last days of a campaign (Moore 1999; Rhee 1996). But the method has the potential to be applied to daily, weekly, or monthly tracking of attitudes, specifically to measure the public interest in issues.

To evaluate the potential of what we call rolling sample surveys (RSS), we conducted a rolling sample survey over 153 days. In this article, we present evidence from this survey relevant to the rolling sample surveys methodology and their utility in tracking issue attention over time. Specifically, we (1) examine the feasibility of collecting rolling sample survey time series data; (2) compare results with simulated cross-sectional surveys results; (3) model the functional form of the issue attention cycle; and (4) test an explanation of change in the level of interest. We begin with a brief description of the survey.

The Rolling Sample Survey

The purpose of the rolling sample survey (RSS) was to generate a long, thin time series to examine the dynamics of attitude change. The underlying logic is based on obtaining a sufficient number and mix of respondents to justify the use of each day's respondents as an independent sample of the target population. The critical feature of the rolling sample surveys is that each day's respondents are independent samples of the survey population. Consistent survey administration in terms of item wording, item order, respondent identification, training of interviewers, hours of operation, and the myriad other procedures that govern telephone survey administration eliminated most of the extraneous sources of variation that could cause shifts in issue importance. We interviewed respondents once, eliminating reactivity to measurement as a plausible explanation for differences in response over time. Because the samples are generated through standard random digit dialing procedures and the stimuli are naturally occurring, biases associated with some experimental designs are minimized as plausible explanations of attitude changes found in

the RSS design. While cost and the ability to anticipate external events and the media coverage of these events may limit the use of rolling sample surveys, they do reduce some known biases of other survey methods and may provide a useful complement to panel studies and cross-sectional designs.

The data from RSS provide a plethora of analysis choices. We can aggregate the rolling survey sample for multiple days and treat the data as a cross-sectional design by conducting individual-level analyses. Daily estimates accumulate quickly, allowing for the use of sophisticated time series analysis. Additional time series data, such as external events or media coverage, can be added for analytical purposes, as we demonstrate in this study. Data for specified periods can be aggregated and compared to other periods using a variety of less sophisticated techniques common in election coverage (Moore 1999). Variables that are expected to mediate or moderate the levels of issue importance can be added to the survey and their relationships with issue importance or other attitudes tested. In other words, rolling sample surveys have great potential for adding to what we know about the dynamics of public opinion since they can be used to describe attitudinal changes over time and test alternative explanations of those changes.

SAMPLE CHARACTERISTICS

From May 1, 1998, to September 30, 1998, trained staff interviewed 4,902 residents of a 13-county region surrounding Atlanta, Georgia. The period of the survey is significant for tracking the importance of air quality, the issue of primary interest in this analysis and one of the issues originally considered by Downs (1972) and, subsequently, by many other analysts. Beginning May 1 each year, air pollution emerges as an important problem in the Atlanta metropolitan region as heat catalyzes a chemical reaction that results in high concentrations of ground-level ozone. During significant portions of the summer, officially lasting through September 30, ground-level ozone exceeds standards set by the U.S. Environmental Protection Agency. For days when ground-level ozone is predicted to exceed .12 parts per million, alerts are sounded through the media and reinforced by electronic highway signs throughout the region on the preceding day. Messages are passed to employers and the public about the dangers of air pollution and methods of reducing it, such as driving less. We expected that the importance of air quality would rise as these alerts began but decrease over time as the public became bored with repeated air quality alerts. During the survey period, 35 alerts were sounded beginning on May 15. The predictability of the deterioration of the air quality during the summer and early fall, coupled with prior knowledge of the intention to announce the ozone alerts, provided an opportunity to test the utility of rolling sample surveys in tracking differences in personal concerns about air quality.

The overall response rate (1) was 54 percent for the entire survey and the

cooperation rate (1) was 64 percent, as shown in table 1.[1] One hundred and nineteen sampling replicates of between 83 and 150 telephone numbers were introduced over the 153 days during which the survey was conducted. The replicates were obtained from a commercial vendor of telephone numbers generated through standard random digit dialing procedures. The goal of the methodology was to produce approximately 30 completed interviews each day. As numbers were needed every day or two, a new replicate was introduced and made available for interviewers to dial. The numbers from previous days that had not been eliminated as either completed interviews or nonsample were retained in order to add hard to reach respondents into the daily sample. As table 1 shows, interviewers called respondents an average 6.67 times each. Numbers that in the end were classified as noncontacts (no specific respondent was identified) were called an average of 22 times.

By mid-June, the replicate size stabilized at 125 numbers per day, which was sufficient to produce an average of approximately 33 interviews each day from that point to the end of the survey. Figure 1 shows the count of completed interviews by day over the period. While the linear trend of completed interviews was essentially flat over the study period, the polynomial fit shows that the number of completes trended upward during May and June, peaked in July, and declined in August and September. The ramp-up at the beginning corresponds to the time when the pool of numbers available for dialing was increasing rapidly. In September, the practice of adding replicates was slowed, resulting in fewer completed surveys. We also smoothed the daily completed interview count using a 2-week moving average to the series, which, as seen in figure 1, shows three periods when the completed interviews were either above or below the curvilinear trend line. For periods in both June and August, the demand for interviewer time was relatively low with little competition from other surveys but in July heavy competition for interviewer time due to other surveys being in the field seems to have resulted in slightly fewer than expected completed interviews. Response rates ranged from 32.1 percent to 71.9 percent for individual replicates, with the exception of one outlier.[2]

SURVEY ITEMS

Interviewers asked 30 behavioral and attitudinal items and 12 items concerning respondent demographic information and household characteristics. The average length of an interview was 7.1 minutes. Of greatest interest to this study were 10 items that asked about community and personal concern for five issues: public schools, air quality, the environment, ground-level ozone, and jobs and the economy. Adopting the wording of items asked by Mutz and

1. All rates were calculated using the AAPOR standard definitions.
2. Presumably this occurred because the numbers in this replicate were a block of unassigned telephone numbers.

Soss (1997), interviewers asked, "I would like to know how important you think certain issues are to other people in the Atlanta metropolitan area, regardless of how you might feel personally. How about air quality? Leaving aside your own views, how important do you think this issue is to people in the Atlanta metropolitan area [scale repeated as needed] on a 1-to-10 scale, where 1 means not at all important and 10 means very important?"

Each of the five issues listed in the text above was substituted in the question

Table 1. Survey Administration Summary for Rolling Sample Survey (1998)

	Rates (%)	*N*	Average Number of Calls
Total sample size		13,780	9.43
Valid sample		9,078	12.06
Response rate 1	54.14	4,902	6.67
Refusal rate 1	20.55	1,861	15.62
Noncontacts		1,407	22.08
Other		860	19.16
Unknown housing		48	5.46
Nonsample		4,702	4.35
Average length (minutes)		7.13	
Cooperation rate 1	64.31		
Contact rate 1	84.19		
Beginning date		May 1, 1998	
Ending date		September 30, 1998	
Completed interviews per day		32.04	

NOTE.—Partial completions are treated as refusals. Categories are per American Association for Public Opinion Research (1998) Standard Definitions.

in a random order. Air quality was chosen for this example since we were most interested in the interest in this issue. This was the first set of substantive items on the survey. Next interviewers asked, "Now I'd like to find out how personally worried or concerned you are about a number of issues. If you aren't really personally concerned about some of these matters, please don't hesitate to say so. On a scale of 1 to 10, where 1 means not at all concerned and 10 means very concerned, how personally concerned are you about air

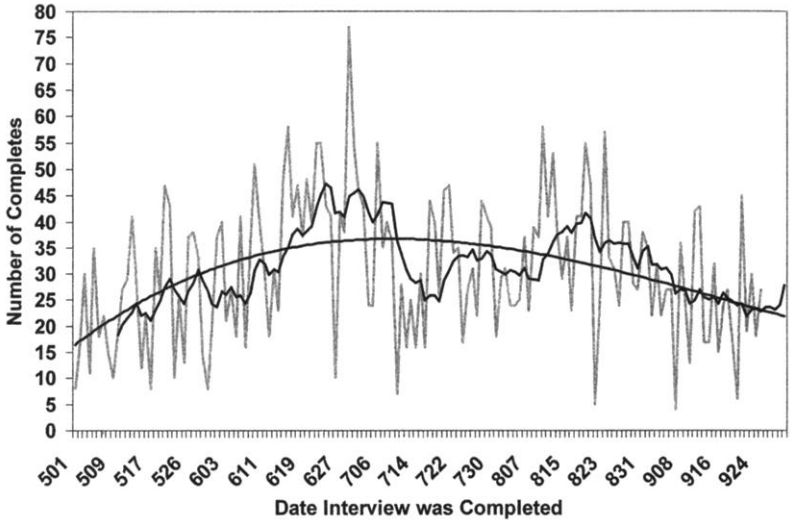

Figure 1. Rolling sample survey: Completed interviews per day

quality?" Again, ratings for all five issues were requested. In the analysis that follows, we focus on the responses to the personal importance of air quality item, although other items produce similar results.

ADDITIONAL DATA

For analytical purposes, 13 additional variables were added to the data set. First, the time variable was centered using the midpoint day (day 77) as the center, which produced a variable ranging from −76 to +76. Although the survey period lasted 153 days, no surveys were conducted on two holidays, Memorial Day and July 4. Data were imputed for those two days in order to maintain a consistent progression of days in the data series.[3] In addition, the day of the week that each response was obtained was added for all observations. Also, the number of calls that had been attempted to reach the respondent was added for each completed interview. For each day, the number of completed interviews and the average number of calls to complete the

3. Using an Expectation-Maximization algorithm in Statistical Package for the Social Sciences 10 for missing data analysis, we imputed the .8 percent of missing data on the personal salience issue in the individual data set using all available data. Then, we estimated the daily responses based on data weighted with sampling and poststratification weights. The weights were based on 1997 census estimates for age, race, income, gender, and education. Finally, for the two holidays when surveys were not administered, we used an EM algorithm to impute their values using all available data.

interviews were calculated. The day of the week, average number of calls needed to obtain the responses each day, and the number of completed interviews were needed to control for artifacts of the method that could affect the observed changes in issue attention over time.

To control for other influences that might affect issue interest, additional data sources were tapped, and variables from those sources were added to the time series. First, newspaper coverage was measured by searching the archives of the *Atlanta Journal and Constitution* for the study period and recording the number of articles that included the words "air quality," "air pollution," "smog," or "ozone" (the harmful ingredient in smog) by day. Only articles that were included in the version of the paper circulated throughout the entire region were counted. The search produced 70 articles, mainly in the paper's local section and on the editorial pages. Five variables were added to the data set: articles appearing (1) on the front page, (2) in the metro section, (3) on the editorial pages, (4) in the business section, and (5) the summed number of articles from all of the preceding pages.

Finally, four variables were added to test the impact of actual weather conditions or air quality on the public's interest in air quality. First, the high temperature for the day as recorded by the U.S. Weather Service and the average dew point for the day were collected. The dew point combines the effects of heat and humidity to form a variable that may relate to the perceived "mugginess" of the day. Either heat or mugginess could directly influence the public's concern about air quality. A third variable was the average wind speed for each day. Wind speed can also influence the perception of air quality. Also, higher wind speeds drive the offending emissions from the region's air and can reduce smog as well as ground-level ozone. The final variable is the actual average of the amount of ground-level ozone between 8 A.M. and 8 P.M. as measured at the Fulton County measuring site. The actual city of Atlanta resides mainly within Fulton County. While ground-level ozone is invisible and odorless, it is the harmful component of visible smog. If issue interest is highly correlated with actual air pollution, then we can expect that issue interest will increase on days when ozone levels are high. It is important to note that air quality alerts are imperfectly correlated with days when the actual air quality is above acceptable standards. For example, of the 35 alert days, only 13 days actually exceeded the EPA standard for poor air quality. On 22 days when alerts were called, ozone levels did not exceed standards. Furthermore, on nine days, ozone levels exceeded the standards, but an air quality alert had not been called. Thus, the differences in the days when alerts are issued and the days when ozone exceeds the standard allow for both to be tested in the models. This allows us to test whether individuals respond to objective measures of reality—ozone levels—or on the basis of the air quality alerts.

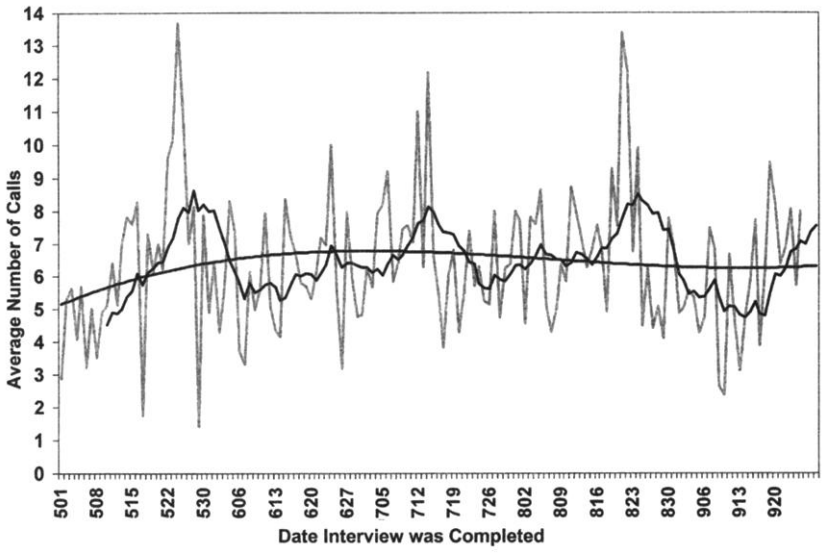

Figure 2. Average number of attempts to complete an interview by day

Evaluation of the Survey Responses

One of the major issues with which rolling sample surveys must contend is whether the sample of responses collected on a given day can be treated as an independent sample of the target population. John (1989) identified this as one of the most important issues for tracking polls and indicated that the mix of hard to reach and easy to reach respondents was critical to the viability of the method. The unique nature of the RSS relies on the numbers from each replicate remaining in the system and receiving multiple calls to obtain a final disposition. Each day, the completed surveys contained a mix of easy to reach and hard to reach respondents, except during the start up and end of the period.

One method of evaluating the success of the mix is to examine the average number of phone calls attempted for the responses obtained on each day of the survey period. For the daily responses to be treated as independent samples, there should be a constant number of attempts for each completed interview throughout the survey period. If replicates are added unevenly or if the probability of obtaining responses from hard to reach individuals begins to increase as they continue to be called throughout the survey period, the mix of respondents could change systematically and reduce the plausibility of findings produced by the method. Figure 2 shows the average number of calls per day in order to obtain the interviews completed that day. We fit a polynomial trend to the average number of calls to complete an interview series, which

shows almost no systematic increase in the average number of calls. This indicates a reasonably constant effort in obtaining responses from hard to reach households and individuals. We also fit a 2-week moving average to the data, which oscillated between five and eight attempts to complete an interview. Overall, the number of attempts to complete an interview averaged about 6.7, and the fluctuations were reasonably constrained. However, because the averages did vary from one day to the next, for both number of completes and average number of attempts, they are both used as controls in the multivariate models.

Comparison of the Rolling Sample Survey with Static Estimates of Issue Interest

In the two preceding sections, we indicated that the rolling sample surveys are both feasible and obtain a stable mix of hard to reach and easy to reach respondents. In this section, we will try to answer the question, why bother with a new survey method? We will illustrate the outstanding problem of the major alternative design, using one or more cross-sectional surveys to understand the shifts in issue importance. Because public attitudes about issue importance shift constantly in response to a variety of stimuli, it is impossible to ascertain a priori if opinions at a given time are at equilibrium or have been jostled by a stimulus, such as an event, media reports, or a court ruling. The flux of opinion makes the selection of the baseline as well as the poststimulus survey period very important. Wanta (1997, p. 14), in reviewing the literature, estimates that 4 weeks is the most logical time lag between pre- and poststimulus surveys, but researchers have used periods as short as a week and as long as 9 months between surveys. For example, Mutz and Soss (1997) used a pre-Christmas baseline, then follow-ups at 5-, 4-, and 4-month intervals, respectively, for their analysis of changes in issue importance stimulated by a sustained campaign of advocacy journalism.

An example of the importance of timing for drawing inferences about attitudinal shifts can be simulated from the rolling sample survey results. Using the rating of personal salience of air quality as the example, we divided the actual RSS survey period into 22 overlapping 3-week periods, essentially 3-week moving averages. Each of the periods contained from 653 to 1,133 responses. The results from each simulated survey are directly comparable to the results obtained from a cross-sectional survey using the same interviewing and sampling methods for a 3-week period. The 3-week period was chosen as a reasonable approximation of the length of time a survey organization might spend with a cross-sectional survey in the field.

We estimated the means and intervals[4] for the personal salience of air quality

4. Based on two standard errors.

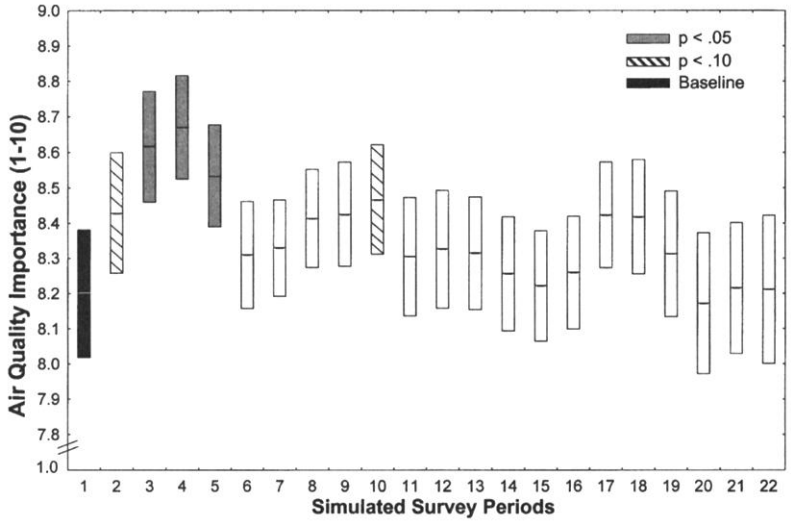

Figure 3. Simulated survey comparisons: Means and confidence intervals. The denoted bars represent significant differences from the baseline simulated study.

for 22 3-week periods. The results are graphed in figure 3. The means fluctuate throughout the period. The first 3-week survey was conducted at the beginning of the season when air quality alerts began to be issued throughout the metropolitan area. The first survey, which was used as the baseline for figure 3, was significantly different from five of the other surveys (three with $p < .05$, two with $p < .10$). Only conducting back-to-back surveys beginning in the first week and then in the fourth week would have revealed the maximum change in personal importance of air quality that occurred during the summer cycle. Surveys starting in weeks 6, 7, 8, or 9 would not have produced statistically significant differences from the first simulated survey. Thus, only the first lag proposed by Wanta (1997) would have shown statistically significant differences. Longer lags in this example would completely miss the initial rise and fall of issue importance. Overall, 28 percent of the means from the simulated surveys constructed from the actual data were significantly different from one another at the $p < .05$ level. An additional 12 percent of the means were different at the $p < .10$ level.

The variability in means indicates the difficulty of reaching confident conclusions from cross-sectional surveys about changes in attitudes. This analysis highlights the need to control for other sources of changes that may have occurred prior to a baseline survey. An event before the baseline survey might

raise issue attention and never be taken into account in the analysis of differences between the baseline and subsequent surveys. Selecting the appropriate gap between cross-sectional surveys, as figure 3 shows, may be the most crucial decision made in planning the studies of opinion change. However, using rolling sample surveys to model the functional form of attitudinal shifts, as we show in the next section, holds promise for allowing better estimates of short-term impacts of events on issue importance and the staying power of issues in the minds of the public over a longer term.

Modeling the Functional Form of the Time Series

Downs (1972) proposed a five-stage model of the issue-attention cycle that began with low attention during the pre-problem stage and continued with a dramatic rise in interest and concern in the second and third stages when the issue was under active consideration on the public agenda. As proposed solutions for the problem encountered difficulties, interest would decline (fourth stage) and eventually return to its pre-problem level. After an issue runs its course, it may rise again to the public agenda or remain at an equilibrium for some time. While others debate the reasons behind the phenomena, most postulate a rise, fall, and subsequent revival of issue interest (Hilgartner and Bosk 1988; McCombs and Zhu 1995). For modeling purposes, the phases can be broken down into three for most issues: developing or rising interest, declining interest, and an equilibrium level of interest that is subject to only mild fluctuations. Of course, a plateau of interest above the equilibrium level could be expected for certain types of issues (Neuman 1990) or issues that have exceptionally long staying power, such as McCombs and Zhu (1995) found with two issues—money as well as government and politics—on the most important issues list.

We hypothesized that the importance of air quality would rise, peak, fall, and potentially rise again before settling back to an equilibrium level some time after the summer smog season. Using data from the entire 153-day period, we modeled personal issue salience as a function of time. The dependent variable is the mean of the personal importance of air quality responses obtained on each day, where the means were weighted for the differential probability of selection and using poststratification weights (see note 3 above). We assumed that the issue attention cycle would exhibit one or two humps characteristic of an alternating series and eventually converge to the long-term mean of the series, the equilibrium. We tested for one and two interest cycles during the summer and found that personal salience followed the form:

$$\text{Salience (Air Quality)} = \Sigma_1^5 D_{(t)}^i + \epsilon,$$

where $D_{(t)}$ is the day of the series centered to zero, in our case running from −76 to 76. We postulated that the polynomial would be of a fifth order and was estimated as an autoregressive model with an exact maximum-likelihood estimator. The first-order autoregressive coefficient was insignificant, .120 (.082), p = nonsignificant.

The results of the autoregressive model are displayed in table 2, as are the results from the three additional models.[5] As shown in table 2, both the second-order and fourth-order terms were highly significant predictors of salience and with opposite signs, as anticipated. The opposite signs result in the hypothesized dampening function. The centered moving-average estimates of the personal salience regarding air quality are shown in figure 4. The daily values ranged from a low of just below 7.75 (on the 10-point scale) to just about 9.0. The smoothed function overlaid on figure 4 is estimated from the polynomial equation. Salience rises quickly with the onset of the air pollution season. At the first and highest peak, the effects of time added over one-third point to the personal salience of air quality. Also striking is how quickly the issue became salient, 29 days from the minimal to maximal point, especially relative to its decay. From the zenith of the first peak, it took 55 days to reach the nadir. The first cycle lasted a total of 83 days. The second cycle took 48 days to reach its peak and added an estimated .13 to the salience of air quality at its high point. The rolling sample survey ended before the second cycle was able to run its course, though we estimated that it would take 30 days to reach the initial equilibrium point. Given the seasonal nature of smog, punctuated by occasional spikes in ground-level ozone, we would anticipate that the issue would remain at equilibrium until the following spring. While the sample size for each day was small, the theoretically meaningful model of personal importance over time illustrates the insights about the dynamic nature of the attention cycle that can be obtained from rolling sample surveys.

Testing an Explanation of Change Using the Series

In order to test explanations of the changes in issue salience, three additional models were estimated. First, we added controls for external factors and artifacts of the RSS method to test their impacts on changes in issue salience. Second, an expected cause of the change in issue salience, the air quality alerts were added to the equation that included the controls. Finally, we tested the boredom or "worn out" hypothesis offered by Neuman that predicts less response to the same stimulus during periods of declining issue interest. In order to control for changes in the overtime variance of number of attempts to complete a call and completed calls per day among other potential influ-

5. The log likelihood was −90.37, the Akaike's information criterion was 194.73, and the Schwarz's Bayesian criterion was 215.95.

Table 2. Four Regression Models of the Issue Attention Cycle

	Autoregressive Model		Polynomial Model with Controls		Action Day Model		Up/Down Cycle Alerts Model	
Variables	Regression Coefficient	*T*-Score	Regression Coefficient	*T*-Score	Regression Coefficient	*T*-Score	Regression Coefficient	*T*-Score
Polynomials:								
Fifth order	.028∗E8	.07	.008∗E8	.21	.022∗E8	.62	.027∗E8	.77
	(.041∗E8)		(.036∗E8)		(.036∗E8)		(.035∗E8)	
Fourth order	−.464∗E6	2.94***	−.028∗E6	2.05**	−.028∗E6	2.01**	−.023∗E6	1.67*
	(.158∗E6)		(.014∗E6)		(.014∗E6)		(.014∗E6)	
Third order	.575∗E4	.21	−.001∗E4	.06	−.007∗E4	.33	−.007∗E4	.32
	(2.748∗E4)		(.022∗E4)		(.022∗E4)		(.022∗E4)	
Second order	.022∗E2	2.62***	.015∗E2	2.12**	.013∗E2	1.82*	.009∗E2	1.29
	(.008∗E2)		(.007∗E2)		(.007∗E2)		(.007∗E2)	
First order	−.004	.86	−.001	.46	−.001	.32	−.002	.57
	(.004)		(.003)		(.003)		(.003)	
Action day (AD)					.236	2.57***		
					(.092)			
Up cycle, AD							.464	3.46***
							.134	
Down cycle, AD							.195	2.17**
							.090	
Front page			.197	2.03**	.266	2.57***	.313	3.99***
			(.097)		(.103)		(.078)	

Editorial			−.114	1.95*	−.113	2.18**	−.099	2.33**
			(.058)		(.052)		(.042)	
Temperature			.008	.74	−.004	.33	−.005	.48
			(.011)		(.012)		(.011)	
Dew point			.008	.95	.006	.75	.002	.16
			(.009)		(.008)		(.008)	
Wind speed			.045	2.05**	.070	2.99***	.081	3.55***
			(.022)		(.023)		(.023)	
Average ozone			2.766	1.52	1.633	.90	−.772	.44
			(1.825)		(1.810)		(1.752)	
Completes			.000	.16	.000	.10	.001	.64
			(.003)		(.002)		(.002)	
Attempts			.009	.43	.008	.45	.003	.21
			(.020)		(.019)		(.016)	
Constant	8.264	106.1***	6.453	7.26***	7.520	7.48***	8.053	8.25***
	(.078)		(.889)		(1.005)		(.976)	

NOTE.—The autoregressive model is an AR(1) model with an exact maximum likelihood estimator. The remaining three models are multiplicative heteroscedastic regression models. These models were estimated as fixed effects models, with the days of the week as the fixed effects (reference = Monday). None of the fixed effects was significant. Standard errors are in parentheses.

* $p < .10$.

** $p < .05$.

*** $p < .01$.

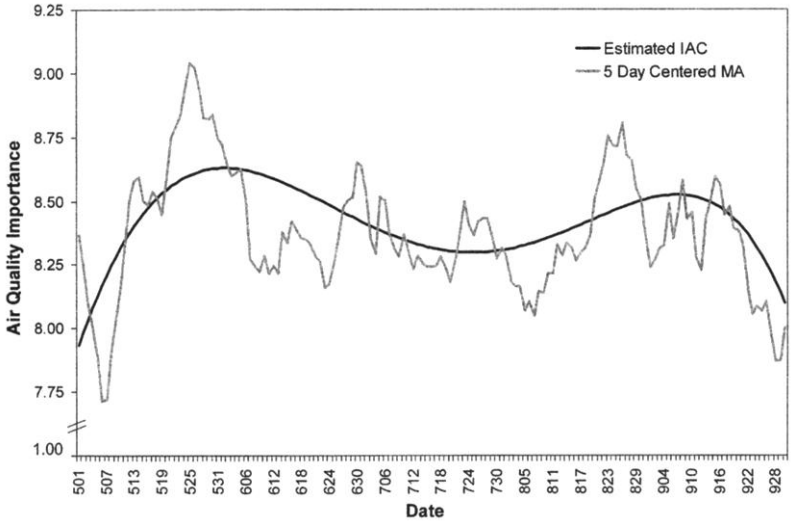

Figure 4. Time series of personal importance of air quality

ences, we estimated a multiplicative heteroscedastic model with robust standard errors.[6]

CONTROLLING FOR EXTRANEOUS INFLUENCES

In table 2, the results of the model that includes eight influences other than the alerts are presented. This model was first estimated with the total number of newspaper articles that mentioned air quality as an independent variable. The newspaper coverage was insignificant, so we tried an alternative specification, the number of articles about air quality on the front page of the paper and the number of editorials or op-ed pieces about air quality. As expected, the front-page articles significantly and positively influenced the perception of issue salience. However, editorials were associated with decreases in issue salience. Quite possibly, the negative effect, rather than no effect, is explained by the timing of editorials, which often followed front-page coverage. Of the variables measuring the weather conditions and the actual levels of ground-level ozone, only wind speed was significantly related to issue attention. On

6. A multiplicative heteroscedastic model estimates an OLS model with normal disturbances and multiplicative heteroscedasticity in the form of: $Y_i = m_i + s_i * e_i$, where m_i equals $E(Y_i) = b_0 + b_1x_{1i} + \ldots + b_nx_{ni}$ and $\mathrm{VAR}(e_i) = \exp(g_0 + g_1z_{1i} + \ldots + g_mz_{mi}) = v_i$. Therefore, Y_i has a mean of m_i and a variance of v_i. We then estimate the vector of x_i's on Y_i to estimate the beta coefficients, and we simultaneously estimate the vector of z_i's on the log-variance of Y_i to estimate the variance model. For a more detailed discussion, see Greene (1993) and Harvey (1976).

windier days, issue salience climbed. The presence of harmful air on a particular day or heat and muggy conditions did not affect issue salience. Because ground-level ozone is invisible and hot, humid days are almost a constant throughout the summers in Atlanta, the lack of any effect was not entirely unexpected.

Neither the number of completes for the day nor the average number of attempts needed to obtain the completed interviews were systematically related to the issue salience for the day. However, the simultaneous estimates of potential violations of heteroscedasticity indicate that the variance associated with days in which a smaller number of completes was obtained is higher than days when the number of completes is larger. With the daily samples averaging around 30 cases, this is nearly true by definition, since the number of cases $(n - 1)$ is in the denominator of the variance estimator. The distribution of high and low response days throughout the sample period, as seen in figure 1, mitigates against any systematic errors of interpretation from this result. To capture other effects that may influence the model, we included the fixed effects of the days of the week (reference = Monday) in the model. None of the variables was significant.

ESTIMATING THE IMPACT OF ALERTS

We estimated the same polynomial model with controls again, this time adding an intervention term, the issuance of an air quality alert. The results for the polynomials and control variables were quite similar to those found in the previous equation, as shown in table 2. The coefficient for the alert was found to be significant ($p < .01$) and suggests that the alerts drove the salience up by nearly one-quarter point on the 10-point scale.

Boredom or public saturation with the issue predicts different responses to the alerts during periods of developing interest and periods of declining interest. During the build-up phase, alerts would be expected to punctuate interest and contribute to driving the overall interest higher. During the declining phase, the same messages would have less impact. The messages have exhausted public interest, and they have been "worn out" by the repetition (Neuman 1990). We expected the same message to have a different response in the two phases. The introduction of the single intervention term into the model implicitly assumes that the intervention has a constant effect on salience throughout the cycle. We tested the more nuanced hypothesis by creating two intervention variables. The "up cycle" variable was coded one if an intervention occurred during a period of rising salience and zero otherwise. The "down cycle" variable was coded one if an intervention occurred during a period of falling salience and a zero otherwise.

The results of this fourth model are shown in table 2, alongside the other model. The interventions that occurred during the "up cycle" added nearly one-half point to salience of air quality ($p < .01$). During the "down cycle"

the alerts added .20 point ($p < .05$). The effect found here is consistent with the boredom expectation. McCombs and Zhu (1995) found that environmental issues were the shortest lived of all the issues that rose to the top of the most important issue list over a 40-year period. It is quite possible that differences in sustainability result from the "crisis" categorization of environmental issues. Many other issues are generated and regenerated by longer running institutional or real world processes, for example, impeachment or Vietnam, which have developments that culminate in "new" messages to forestall audience boredom. The importance of environmental issues may spike when a crisis occurs, but the repetition of the crisis without immediate consequences or high-visibility attention within democratic institutions is not sufficient to maintain interest in the issue.

Conclusions

Taking advantage of a seasonal occurrence (smog) and predictable messages being delivered to the public (air quality alerts), we were able to model the form of issue interest changes over time. Across the 153-day period, interest undulated, resembling a dampening cycle. We were also able to test the differences in responses to messages during periods of rising and falling interest. The public reacts less to messages during periods of overall declining interest. The results are important for consideration in future theory construction but they also may be used to help inform the implications of timing decisions when using cross-sectional surveys to measure dynamic events and responses. Our theories of the issue attention cycle are not yet sufficiently precise to specify when interest is likely to rise, fall, plateau for a period, and settle into an equilibrium posture. Mistimed surveys may result in missed effects, but the lack of effect may be attributed to the intervention rather than the method. Rolling sample surveys may augment our knowledge of the dynamics of issue attention and provide clues to the specifying lags between cross-sectional surveys that may be most likely to capture short-term as well as long-term alterations.

Rolling sample surveys may enable researchers to create natural experiments utilizing predictable events and media coverage. Their use may contribute to testing the effects of public information campaigns and advertising messages. The results of such tests could be more precise specification of the timing for replacing the message as the public becomes "worn out" and fails to react to a current ad. They also allow for using serendipitous events that occur during survey administration to be used in theory testing without having the results being tainted by potential sampling biases before and after the event. Rolling sample surveys can be added to other survey methods as a complement for the development of theory because they produce a time series that captures the day-to-day dynamics of public opinion. Rolling sample sur-

veys will allow researchers of the agenda-setting processes to take advantage of an array of time series analysis techniques that are now available, such as Kalman filtering and smoothing (Green and Gerber 1998; Green, Gerber, and DeBoef 1999) and other interrupted time series methods (Mark, Reichardt, and Sanna 2000). While we only presented analyses of responses aggregated by day, these surveys would also permit analyses that go below the aggregate effects on the mass public to test micro-level explanations of changes in issue interest.

While rolling sample surveys require more interviews than cross-sectional surveys, total cost differences may not be too great relative to the benefits. Three cross-sectional surveys would have typically involved 2,400 interviews, compared to about twice as many for the rolling sample survey. Evenly spacing the survey administration results in certain efficiencies in the scheduling and allocation of time in survey labs that off-set some cost differences. Daily completion rates of 30–50 interviews, which were sufficient for the modeling purposes used in this study, are manageable for most survey organizations of medium size or larger, making them feasible for many organizations to conduct. Thus, the rolling sample surveys could be used to compare dynamics of local versus national issues, a subject of much debate and interest in the agenda-setting literature. While only partially tapped in this article, these surveys, if put to use creatively, could speed development of theories and our understanding of the issue attention cycle.

References

American Association for Public Opinion Research. 1998. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for RDD Telephone Surveys and In-Person Household Surveys*. Ann Arbor, MI: AAPOR.

Downs, Anthony. 1972. "Up and Down with Ecology: The 'Issue-Attention Cycle'." *Public Interest* 28:38–50.

Green, Donald P., and Alan Gerber. 1998. "How to Interpret Tracking Polls." *Campaigns and Elections* 19 (August): 23–60.

Green, Donald P., Alan S. Gerber, and Suzanne L. DeBoef. 1999. "Tracking Opinion over Time: A Method for Reducing Sampling Error." *Public Opinion Quarterly* 63:178–92.

Greene, William H. 1993. *Econometric Analysis*. 2d ed. New York: Macmillan.

Harvey, A. C. 1976. "Estimating Regression Models with Multiplicative Heteroscedasticity." *Econometrica* 44:461–65.

Hilgartner, S., and Bosk, C. 1988. "The Rise and Fall of Social Problems: A Public Arenas Model." *American Journal of Sociology* 94(1):53–78.

Iyengar, Shanto, and Donald R. Kinder. 1987. *News That Matters: Television and American Opinion*. Chicago: University of Chicago Press.

John, Kenneth E. 1989. "The Polls: A Report." *Public Opinion Quarterly* 53:590–605.

Kingdon, J. 1995. *Agendas, Alternatives, and Public Policies*. 2d ed. New York: Harper Collins.

Kosicki, Gerald M. 1993. "Problems and Opportunities in Agenda-Setting Research." *Journal of Communication* 43(2):100–127.

Krosnick, Jon A., and Laura A. Brannon. 1993. "The Impact of the Gulf War on the Ingredients of Presidential Evaluations: Multidimensional Effects of Political Involvement." *American Political Science Review* 87(4):963–75.

Krosnick, J. A., and D. R. Kinder. 1990. "Altering the Foundations of Support for the President through Priming." *American Political Science Review*84(2):497–512.

Mark, Melvin M., Charles S. Reichardt, and Lawrence J. Sanna. 2000. "Time Series Designs and Analysis." In *Handbook of Applied Multivariate Statistics and Mathematical Modeling*, ed. H. E. A. Tinsley and S. Brown. San Diego, CA: Academic Press.

McCombs, Maxwell, and Jian-Hua Zhu. 1995. "Capacity, Diversity, and Volatility of the Public Agenda." *Public Opinion Quarterly* 59:495–525.

Monroe, Alan D. 1998. "Public Opinion and Public Policy, 1980–1993." *Public Opinion Quarterly* 62:6–28.

Moore, David W. 1999. "Daily Tracking Polls: Too Much 'Noise' or Revealed Insights?" *Public Perspective*, June/July, pp. 27–31.

Mutz, Diana C., and Joe Soss. 1997. "Reading Public Opinion: The Influence of News Coverage on Perceptions of Public Sentiment." *Public Opinion Quarterly* 61:431–51.

Neuman, W. R. 1990. "The Threshold of Public Attention." *Public Opinion Quarterly* 54:156–76.

Page, Benjamin I., and Robert Y. Shapiro. 1992. *The Rational Public: Fifty Years of Trends in Americans' Policy Preferences*. Chicago: University of Chicago Press.

Rhee, June Woong. 1996. "How Polls Drive Campaign Coverage." *Political Communication* 13: 213–29.

Rogers, Everett M., James W. Dearing, and Dorine Bregman. 1993. "The Anatomy of Agenda-Setting Research." *Journal of Communication* 43(2):68–84.

Smith, Tom. 1985. "America's Most Important Problems: The Polls." *Public Opinion Quarterly* 49 (Summer): 264–74.

Wanta, Wayne. 1997. *The Public and the National Agenda*. Mahwah, NJ: Erlbaum.

Zhu, Jian-Hua. 1992. "Issue Competition and Attention Distraction: A Zero-Sum Theory of Agenda-Setting." *Journalism Quarterly* 69(4):825–36.