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# Media Use and Global Warming Perceptions

## A Snapshot of the Reinforcing Spirals

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This study used the reinforcing spirals model to investigate the mutual influence between individuals' media use and their global warming perceptions. Data from the science module of the 2006 General Social Survey were analyzed using structural equation modeling. Results offered support for the reinforcing spirals model's predictions. Media use mediated the effects of age, race, and education on perceived knowledge about global warming. Perceived knowledge and concern over global warming also predicted future information seeking about the polar regions.

**Keywords:** *global warming; reinforcing spirals; information seeking; indirect effects*

Two long-standing traditions in mass communication scholarship are media effects research and audience activity research. Media effects research focuses mostly on the social, psychological, and behavioral impact of media content on the audiences (Bryant & Zillmann, 2002). Research on audience activity, on the other hand, focuses mostly on the characteristics, motivations, and involvement of audience members as they consume the media (Levy & Windahl, 1985). Despite their apparent connections and the intermittent calls for integration (Rosengren & Windahl, 1972; Rubin, 2002; Windahl, 1981), these two lines of research have evolved largely independently over the years.

A recent attempt at a comprehensive model of audience activity and media effects is the reinforcing spirals framework (Slater, 2007). According to this framework, audience selectivity (a form of audience activity) and media effects represent two intertwined and mutually reinforcing processes. These processes, if unmitigated by countervailing external influences, may result in both increased use of the selected media content and the maintenance or strengthening of the attitude or behavior in question. In addition to these individual-level outcomes, the mutual reinforcement between the two processes is also believed to have effects on the supra-individual level that may influence social identity and perceptions of attitudinal and behavioral norms.

Initial evidence for the central hypotheses of the reinforcing spirals model is encouraging but still limited (Slater, Hayes, & Ford, 2007; Slater, Henry, Swaim, &

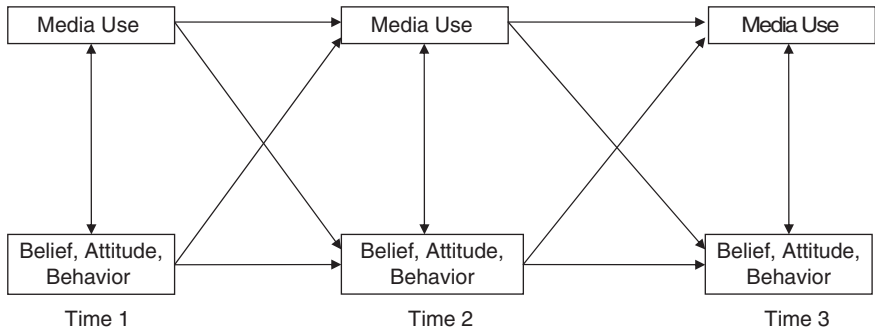
Anderson, 2003; Slater & Rasinski, 2005). The present study hopes to add to this emerging literature by testing the key propositions of the reinforcing spirals model in the context of global warming, using the 2006 General Social Survey (GSS) data. Given its relative newness and the much controversy it has aroused, global warming appears to be an ideal context in which to examine the interplay between media use and individual-level issue perceptions. Because the GSS data are cross-sectional, this study will not be able to test the reinforcing spirals model in its entirety. Instead, it will take a snapshot of the reinforcing processes and focuses its attention on (a) the role of media use as a mediator between exogenous variables and global warming perceptions, and (b) the effect of global warming perceptions on the likelihood of future issue-specific information seeking.

## Literature Review

### The Reinforcing Spirals Model

The reinforcing spirals model seeks to offer a dynamic and holistic understanding of the interaction between mass media and their audiences (Slater, 2007). By integrating the processes of media effects and audience selectivity, it acknowledges both the media's potential to influence and the audience's potential autonomy in seeking or avoiding such influence. The mass communication literature contains abundant evidence for the effects of media use on a variety of social- and individual-level outcomes (see Bryant & Zillmann, 2002). Consumption of media content has been shown to shape public agenda (McCombs & Shaw, 1972), mold conceptions of social reality (Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002), enable behavioral acquisition through vicarious learning (Bandura, 1977), and facilitate the dissemination of technological innovations (Rogers, 2003). At the same time, mass communication researchers have also noted that the audiences are not always passive in their consumption of the media. Instead, their media use is often purposeful, driven by specific interests and motivations (Blumler & Katz, 1974), guided by selective attention to content of choice (Zillmann & Bryant, 1985), and sometimes involving the expenditure of substantial time and resources (e.g., cancer information seeking; Shim, Kelly, & Hornik, 2006). The reinforcing spirals model argues that these two perspectives on the relationship between the media and their audiences are not incompatible. In fact, they should be synthesized to provide a comprehensive view of the dynamics of mediated communication. The key to such synthesis, according to Slater, is to understand that mediated communication is not a static phenomenon but a continuously unfolding interaction. The contour and nature of mediated communication are shaped over time by two intertwined and mutually reinforcing processes—the impact of audience characteristics on media choice and the effects of media use on audience attitudes and behaviors. These mutually influencing processes, Slater argues, are best viewed as two paired and complementary

**Figure 1**  
**A Minimal Path Representation of the Reinforcing Spirals Model**



Source: Slater (2007, p. 284). © 2007 International Communication Association. Reproduced with permission of Blackwell Publishing Ltd.

spirals, which, in their simplest form, can be visually diagrammed as a three-step, cross-lagged path model (Figure 1).

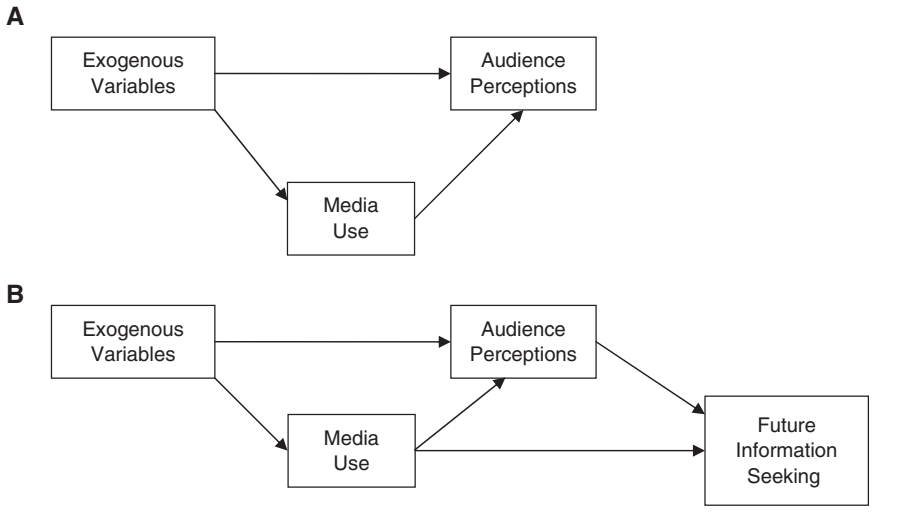
As is shown in Figure 1, the traditional focus of media effects research is reflected in the paths from media use at an earlier point in time to belief, attitude, and behavior at a subsequent point in time; the traditional focus of audience selectivity research is reflected in the paths from belief, attitude, and behavior at an earlier point in time to media use at a subsequent point in time. Although these paths suggest nothing new when viewed in isolation, their integration in the reinforcing spirals model has led to new and important insights that Slater (2007) summarizes in two key propositions:

*Proposition 1:* In most media effects contexts, the role of media can be modeled as endogenous, mediating, or partially mediating the effect of other individual-difference variables on the outcomes of interest. (p. 282)

*Proposition 2:* Cognitive or behavioral outcomes of media use also influence media use, particularly when the cognitions or behaviors are related to personal or social identity. (p. 283)

Clearly, the best test of the reinforcing spirals model and its propositions demands longitudinal data. In a four-wave panel survey on violent media content and adolescent aggressiveness, Slater and his colleagues found both concurrent and lagged effects of violent media use on aggressiveness; they also found concurrent effects of aggressiveness on violent media use, although the predicted lagged effects did not appear (Slater et al., 2003). In another two-wave national panel survey, evidence emerged for cross-lagged effects between news attention and elaboration on the one hand and political knowledge on the other (Eveland, Shah, & Kwak, 2003).

**Figure 2**  
**Mediation Processes Examined in (a) Slater and Rasinski**  
**(2005) and (b) the Current Study**



Although both these studies preceded the formal proposal of the reinforcing spirals model, their hypotheses and results were consistent with the model's predictions. Taken together, the evidence from these longitudinal studies has been largely supportive of the reinforcing spirals model.

Although longitudinal data are most ideal for testing the reinforcing spirals model, cross-sectional data, when properly treated and analyzed, can also be used to test some of the model's stipulations. For example, in an earlier study on social risk judgments, Slater and Rasinski (2005) tested the mediating role of media use as specified by Proposition 1 (see Figure 2a). Using techniques suggested by Baron and Kenny (1986), the authors found that media exposure and attention partially mediated the effects of exogenous variables such as demographics and personal experience on alcohol-related risk judgments. These findings were consistent with the reinforcing spirals model's predictions. Most of these findings were also replicated by a recent risk judgments study using an adolescent sample (Slater et al., 2007).

The current study continues to test the reinforcing spirals model using cross-sectional data. However, it also extends previous research in two important ways. First, it tests the model in a new context, focusing on the complex relationship between people's media use and their global warming perceptions. As will be shown later, global warming is an issue domain wherein the interplay between the media and the public appears to be particularly active and consequential. Second and more

important, this study seeks to offer a fuller test of the reinforcing spirals model compared to previous cross-sectional research. In Slater and Rasinski's study (2005), for example, only the first proposition of the model was tested. The mediation process consisted of only two steps, first from exogenous variables to media use, then from media use to audience perceptions. This study seeks to test Propositions 1 and 2 simultaneously. To do so, a final endogenous variable—that is, future issue-specific information seeking—is added to represent a new phase of media use. After this addition, the previous two-step mediation process is extended to three steps, with influence flowing from exogenous variables to media use, then to audience perceptions, then to future information seeking. This extended mediation process is diagrammed in Figure 2b. Comparing Figures 1 and 2, it is not difficult to see that the extended mediation process offers a much closer approximation of the full model than the earlier two-step process.

### Information Seeking

The addition of the information-seeking variable to the mediation process is consistent with the conceptual underpinnings of the reinforcing spirals model. As the model suggests, the effects of prior media use, such as increase in issue salience, should in turn influence subsequent media use (see Proposition 2). Following the reinforcing spirals analogy, and barring suppressing external influences, we would expect the newer wave of media use to reflect a higher level of audience selectivity. Active seeking of issue-relevant information, thus, is a likely media use outcome during this stage.

Treating information seeking as an outcome of audience perceptions is also consistent with the information-seeking literature. Much of the current work on information seeking has focused on identifying the cognitive and affective antecedents of information seeking (e.g., Afifi & Weiner, 2004; Brashers, 2001; Griffin, Neuwirth, Dunwoody, & Giese, 2004; Johnson, 1997; Rimal, 2002). Although theoretical formulations vary, most researchers agree that issue interpretation and appraisal are important determinants of information seeking. The theory of uncertainty management, for example, posits that appraisal of issue uncertainty is the primary source of motivation for subsequent behavioral responses, including information seeking (Brashers, 2001). The theory of motivated information management similarly considers issue interpretation the beginning phase of the psychological process underlying decisions to seek information (Afifi & Weiner, 2004). These theories all point to issue perceptions as important antecedents of information seeking.

Issue perceptions can include a wide spectrum of cognitive and affective reactions. In information-seeking research, however, much attention has been focused on the extent to which the issue in question is perceived to be problematic, threatening, and worthy of concern. This research focus is likely inherited from the broader behavioral theories that are often used to guide information-seeking research. Many

behavioral theories acknowledge the key role elevated risk perceptions play in engendering new behavior or behavior change. In the health belief model, perceived susceptibility to a health problem and perceived severity of the problem are considered two of the most important determinants of subsequent health behavior (Becker, 1974). Similar behavioral determinants are also identified in protection motivation theory (Rogers, 1983). In the theory of reasoned action (Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1991), behavioral attitude is believed to be shaped by both the likelihood and the desirability of potential behavioral consequences. The desirability of such consequences, in turn, is often decided by the perceived seriousness of the problem that the behavior seeks to address. These behavioral theories all have profound influence on information-seeking research. A clear example of such influence can be found in the health communication domain, where risk perceptions are often viewed as a primary source of motivation for health information seeking (e.g., Rimal, 2002).

Overall, it appears that focusing on information seeking is justifiable as we extend the reinforcing spirals into a new audience selectivity phase. At the same time, special attention needs to be paid to issue-related concern both as an outcome of previous media use and as a key motivator of subsequent information seeking.

### **Global Warming, Public Perceptions, and the Polar Regions**

Global warming is currently a prominent topic in public discourse both in the United States and worldwide. Unlike many other social issues with which the public may have first-hand experience, global warming is an issue that many come to learn about through the media. The primary source of mediated information about global warming is the news. Indeed, as Nelkin (1995) noted, “[I]n areas of science and technology where readers have little direct information or preexisting knowledge to guide an independent evaluation . . . , the press, as the major source of information, defines the reality of the situation for them” (pp. 68-69). Other forms of media also appear to have played important roles in fostering public interest in this domain, prominent examples including the Oscar-winning documentary *The Inconvenient Truth* and the blockbuster thriller *The Day After Tomorrow*.

The surge of interest in global warming undoubtedly has deeper scientific, social, economic, and political roots. The United States, with only 5% of the world’s population, is responsible for 25% of the world’s greenhouse gas emissions (Marland, Boden, & Andres, 2007). The environmental, economic, and political ramifications of global warming, as well as the potential consequences of inaction or drastic action, have made the issue extremely complex. Although these issue characteristics fundamentally determine public opinion on global warming, they enter public awareness primarily through the mediation of television, newspapers, radio, and other media outlets. How the public attends and responds to mediated information about global warming, consequently, becomes an important question to ask as we

seek to understand the evolution of public opinion surrounding this issue. The fact that global warming is a relatively new and controversial issue also suggests that the interaction between the media and the public in this domain is likely to be particularly active (Dunwoody, 1999). As such, this issue provides an ideal environment in which to test the central tenets of the reinforcing spirals model.

The phrase *global warming* first entered public discourse in 1988, when National Aeronautics and Space Administration climatologist James Hansen stated before Congress “with 99 percent confidence” that global warming had already begun (Dilling & Moser, 2007). Today, polls show that most of the American public is aware of global warming. Most Americans also believe that global warming is real, and that human activity is a contributing factor in global warming. Despite these perceptions, however, the American people still think of global warming as an issue of low priority. Furthermore, they believe that the ill effects of global warming are not likely to affect themselves, but people in remote regions of the world and nonhuman nature (Leiserowitz, 2005, 2007).

The public’s concern over the effects of global warming is an important driver of individual action and public policy. In this study, concern over global warming constitutes the primary audience perception variable. The behavioral outcome, as mentioned earlier, is future issue-relevant information seeking. This is a behavioral outcome that is both likely and important, given that much confusion still exists in public understanding of global warming (Bostrom, Morgan, Fischhoff, & Read, 1994; Leiserowitz, 2005, 2007). Mental models research on global warming has shown that melting polar ice, sea-level rise, and the extinction of polar animals are some of the most salient images American people harbor about global warming (Leiserowitz, 2005, 2007). The public concern and information seeking variables in this study, therefore, will both focus on the polar regions. The public concern variable gauges people’s apprehension of the detrimental effects of global warming on the polar regions. The information-seeking variable assesses the likelihood that people would purposefully gather information about the polar regions in the future.

## **Mechanisms of Media Influence**

Consistent with the reinforcing spirals model, this study predicts that concern over the effects of global warming on the polar regions is influenced by media use. Two mechanisms seem to be particularly important in the materialization of this influence. The first has to do with the media’s general function as an information purveyor. The second is more unique to the global warming context, focusing on the media’s impact on perceived scientific agreement about the reality and causes of global warming. The first mechanism is based on the fundamental assumption that people can learn from the media (Bandura, 1977). Indeed, knowledge growth, whether intentional or unintentional, equitable or inequitable, appears to be an important outcome of media use (Tichenor, Donohue, & Olien, 1970). Given the

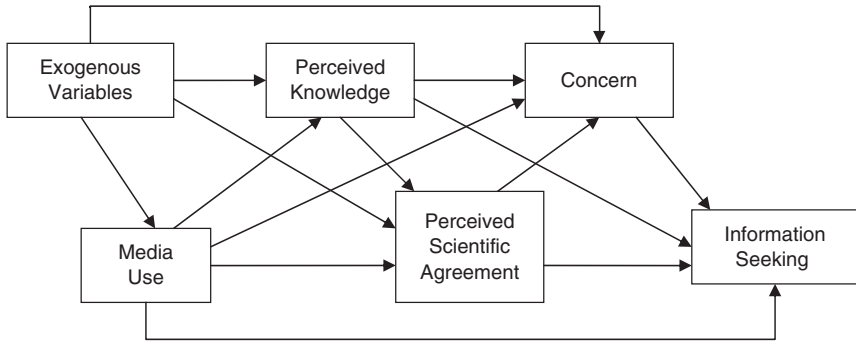
relatively newness of the global warming issue, public concern in this domain, at least in part, is driven by knowledge gained through exposure to mediated information. The GSS data used in this study do not contain a measure of actual knowledge about global warming; however, a measure of perceived knowledge is available. The perceived knowledge measure should suffice as a surrogate to help us explore the mediating role of knowledge in the relationship between media use and people's concern over the effects of global warming on the polar regions.

The effect of media use on knowledge or perceived knowledge is well documented in the science communication literature (Gerbner, Gross, & Signorielli, 1981; LaFollette, 1990; Nelkin, 1995). In general science literacy research, there is evidence that exposure to science media is positively associated with factual and procedural scientific knowledge (Nisbet et al., 2002). Specific to global warming, there is also evidence that information from media sources has contributed positively to audience knowledge in this domain (Stamm, Clark, & Eblacas, 2000). The effect of media use on perceived knowledge has also been shown to have further consequences. A recent experimental study found that exposure to science news increased perceived understanding of science, which in turn motivated conversation with others about science (Southwell & Torres, 2006). This last finding is particularly relevant to the current study. Indeed, to the extent that interpersonal conversation about science indicates an elevated level of interest or concern, this finding can be considered as demonstrating a mediating effect of perceived knowledge that is similar to the one hypothesized in this study.

While media use may foster concern over global warming through enhancing perceived knowledge, it may simultaneously suppress such concern through its effect on perceived scientific agreement. Perceptions of scientific agreement over global warming have attracted much research attention recently. On the one hand, the consensus is established in the scientific community that global warming is indeed occurring and that human activities have made clear contributions to it (Intergovernmental Panel on Climate Change, 2007; Oreskes, 2004). On the other hand, national surveys and polls continue to show that many people still do not believe that scientists have reached agreement over these issues (Nisbet & Myers, 2007). A parallel line of research shows that the U.S. media have adhered to the convention of balanced reporting when covering global warming (Boykoff, 2008; Boykoff & Boykoff, 2004). This leads researchers to speculate that this particular pattern of media coverage may have misguided public perceptions as it assigns equal weight to the minority of naysayers and the vast majority of scientists in agreement. However, as reasonable as this speculation sounds, empirical data are lacking to show that media use is indeed negatively associated with the public's perceptions of scientific agreement. This study will seek to offer direct evidence for this hypothesized connection.

It is not difficult to see how perceived scientific controversy may dissipate concern over the effects of global warming. Scientists, for most people, represent credible sources of information. When scientists are believed to have reached consensus over a serious problem, apprehension about the ill effects of the problem is likely to

**Figure 3**  
**Working Model for the Current Study**



intensify. Conversely, when scientists are perceived to hold inconsistent views over the problem, anxiety over the problem is likely to atrophy. Perceived scientific agreement, thus, may serve as an avenue through which media use negatively influences concern over global warming.

The relationship between media use and concern over global warming, thus, is expected to contain two potentially countervailing mediators, perceived knowledge and perceived scientific agreement. But what complicates matters even more is that perceptions of scientific agreement may also be influenced by perceived knowledge. Indeed, balanced reporting is not likely to be the only thing that people notice in the media. When people do gain factual knowledge from the media, the likelihood that they would perceive scientific consensus over global warming should increase. Thus, in this study, media use, perceived knowledge, perceived scientific agreement, and concern over global warming form a complicated sequence of mediation. Media use is expected to have a direct positive effect on perceived knowledge but a direct negative effect on perceived scientific agreement. Perceived knowledge, then, is expected to positively influence both perceived scientific agreement and concern over global warming. Finally, perceived scientific agreement is also expected to positively influence concern.

### Working Model for the Current Study

Incorporating the global warming variables into the theory-based mediation process (Figure 2b), we obtain a working model for this study (see Figure 3). According to this model, exogenous variables such as demographics and party affiliation influence global warming perceptions both directly and through the mediation of media

use. Media use influences concern over global warming both directly and through the mediation of perceived knowledge and perceived scientific agreement, with perceived knowledge also influencing perceived scientific agreement. Concern over global warming then leads to future information seeking about the polar regions.

Although the model allows perceived knowledge and perceived scientific agreement to influence information seeking through the mediation of concern, it is conceivable that these variables may also motivate information seeking through other unspecified mechanisms. For example, people who consider themselves well informed may want to seek more information to keep their knowledge up to date; people who perceive a lack of scientific consensus may also seek information because they want to monitor the "debate." To account for these possibilities, perceived knowledge and perceived scientific agreement are allowed to influence information seeking directly in the model, above and beyond their indirect effects mediated by concern over global warming. Finally, the model allows current media use to have a direct influence on information seeking, which in itself is a highly specialized, future-oriented media use variable.

## Method

The working model for this study was tested using the 2006 GSS data. The GSS is a national probability sample survey conducted by the National Opinion Research Center (NORC), currently fielded once every 2 years. The GSS contains a standard core of demographic and attitudinal questions, plus topic modules of special interest. In its 2006 data collection, the GSS added a science module, which included questions on global warming and the polar regions. These questions provided data for the current analysis.

The 2006 GSS was administered using computer assisted personal interviewing (CAPI). A total of 4,510 adults completed the interview. The response rate was 77.3% based on the Response Rate 5 (RR5) formula as defined by the American Association for Publication Opinion Research (AAPOR; 2006).<sup>2</sup> For more methodological details of the GSS, readers are referred to the GSS codebook available on the NORC Web site (<http://www.norc.org/GSS+Website/Codebook/>).

## Sample

Because the 2006 GSS contained a number of different modules, respondents were randomly assigned to answer questions from one or more modules. The total number of respondents assigned to answer the global warming questions was 928. Of these only 453 also answered the media use questions that were embedded in other parts of the GSS. These respondents constituted the working sample for this study. Characteristics of this sample are summarized in Table 1.

**Table 1**  
**Sample Characteristics**

Variable	Percentage
Age	
18-30	20.9
31-40	19.3
41-50	20.0
51-60	19.1
61 and above	20.7
Gender	
Male	43.5
Female	56.5
Race	
White	75.7
Black	14.6
Other	9.7
Education	
Less than high school	11.0
High school	51.0
Junior college	8.6
Bachelor	20.8
Graduate	8.6
Party affiliation	
Democrat	33.4
Independent near Democrat	12.1
Independent	20.4
Independent near Republican	8.5
Republican	25.6

Note: Percentages do not always add up to 100% because of missing values.

## Measures

*Media use.* Respondents reported their use of television, newspapers, and the World Wide Web in the GSS. Television use was assessed by asking “On the average day, about how many hours do you personally watch television?” Answers ranged from 0 to 24 hours but the vast majority of the respondents (92.7%) reported watching television for less than 7 hours. Respondents reporting watching television for 7 or more hours were collapsed into a single category (7 hours) to reduce the influence of outliers ( $M = 2.87$ ,  $SD = 1.87$ ).

The newspaper use question was “How often do you read the newspaper—every day, a few times a week, once a week, less than once a week, or never?” This variable was reverse coded (such that 1 = *never* and 5 = *every day*) before entering analysis ( $M = 3.50$ ,  $SD = 1.48$ ).

The Web-use question asked “Not counting e-mail, about how many hours per week do you use the Web? (Include time you spend visiting regular Web sites and

time spent using interactive Internet services like chat rooms, Usenet groups, discussion forums, bulletin boards, and the like)." A large portion of the respondents (39.1%) reported no Web use at all and the rest of them reported using the Web anywhere between 1 and 70 hours per week. Based on their reports, respondents were categorized into four groups: nonusers (0 hour, 39.1%), light users (1-4 hours, 28%), medium users (5-10 hours, 17.7%), and heavy users (above 10 hours, 14.3%). This recoded variable was used in data analysis ( $M = 1.07$ ,  $SD = 1.07$ ).

*Perceived knowledge.* Respondents were asked how informed they were about global warming. Answers were given on a 5-point scale (1 = *very informed* to 5 = *very uninformed*). The variable was reverse coded before data analysis ( $M = 3.42$ ,  $SD = 1.09$ ).

*Perceived scientific agreement.* Respondents were asked to indicate the extent to which environmental scientists agreed among themselves about the existence and causes of global warming. They responded on a 5-point scale (1 = *near complete agreement* to 5 = *no agreement at all*). This variable was also reverse coded prior to analysis ( $M = 3.38$ ,  $SD = 1.09$ ).

*Concern over global warming in the polar regions.* Five potential effects of global warming on the polar regions were presented to respondents and they were asked to indicate the extent to which each of the effects would bother them. These effects include the following: "By 2020, polar bears may become extinct," "Sea level may rise by more than 20 feet, flooding coastal areas," "Arctic seals may be threatened," "Inuit and other native peoples may no longer be able to follow their traditional way of life," and "The northern ice cap may completely melt." Responses were given on a 4-point scale (1 = *a great deal* to 4 = *not at all*). All items were reverse coded and then averaged into an overall index ( $M = 3.29$ ,  $SD = 0.70$ ,  $\alpha = .83$ ).

*Information seeking.* The information-seeking measures were preceded by a brief note informing respondents that 2007-2008 has been designated the International Polar Year. They were also told that many scientific and educational organizations would be making efforts during that period to increase public awareness of the polar regions. After receiving this information, respondents were asked how likely it would be for them to watch a television program, read a newspaper article, read a magazine article, go to a museum to see an exhibit, watch a feature film, read a book, visit a Web site, and attend a live lecture by a scientist about the polar regions. Respondents answered the questions on a 4-point scale (1 = *very likely* to 4 = *very unlikely*). Their responses were reverse coded and then averaged into an information-seeking index ( $M = 2.42$ ,  $SD = 0.74$ ,  $\alpha = .87$ ).

*Exogenous variables.* The exogenous variables used in this research included gender, race (recoded as White vs. non-White), age (in actual years), education (in

**Table 2**  
**Correlation Matrix**

	Sex	Age	Race	Education	Party	TV	Newspaper	Web	Knowledge	Agreement	Concern
Age	-.02										
Race	-.12	.15									
Education	-.11	-.04	.13								
Party	-.12	-.01	.31	-.05							
TV	.13	.12	-.18	-.27	-.09						
Newspaper	-.06	.22	-.01	.24	-.04	-.10					
Web	-.09	-.23	.12	.36	.01	-.16	.05				
Knowledge	-.14	-.06	.11	.25	.03	-.06	.16	.19			
Agreement	.04	-.03	-.03	.10	-.13	-.08	.07	.02	.10		
Concern	.00	.01	.17	.14	-.05	-.11	.07	.09	.30	.22	
Seeking	-.16	.04	.07	.21	-.04	-.13	.17	.16	.43	.10	.36

Note: *N* = 453. Correlations above .09 are significant at the .05 level (two-tailed).

actual years of education completed), and party affiliation (7-point scale ranging from 1 = *strong Democrat* to 7 = *strong Republican*). We included party affiliation in this group of exogenous variables because recent polls showed it to be strongly associated with global warming perceptions (Maibach, Roser-Renouf, & Weber, 2008; Pew Research Center, 2007). Other potential exogenous variables, such as income, marital status, and employment status were also considered in preliminary analysis but later dropped for their lack of effect on the media use and global warming perception variables.

**Analysis Strategy**

The working model for this study was tested using structural equation modeling. The statistic package used was Amos 7.0 and the test was carried out using maximum likelihood estimation. The intercorrelations of the key variables in the model are presented in Table 2. Model fit was evaluated primarily using comparative fit index (CFI) and root mean square error of approximation (RMSEA). Following recommendations in the literature (Byrne, 2001; Kline, 1998), CFI above .90 and RMSEA below .08 were taken as indicators of adequate model fit. The likelihood ratio statistic ( $\chi^2$ ) will also be reported, but it was not used as a criterion to assess model fit due to its sample-dependent limitations (Bentler & Bonett, 1980; Hu & Bentler, 1999).

Although many of the variables contained in the model were single-item observed measures, two of the variables (concern and information seeking) were measured with multiple-item scales. To control for measurement error, these variables were specified as latent composite variables in the model (Bollen, 1989; Stephenson & Holbert, 2003). For each of the variables, the latent variable had only one composite indicator, that is, the averaged index. The path from the latent variable to the indicator was given a fixed weight of 1 and the error variance for the indicator was fixed to  $(1 - \alpha)$  multiplied by the indicator’s variance.

An important assumption for maximum likelihood estimation is that the data should be multivariate normal (Chou & Bentler, 1995; West, Finch, & Curran, 1995). Prior to analysis, variables in the model were inspected for distributional problems. Univariate skewness and kurtosis were found to be within reasonable range for each of the variables based on standards suggested by previous research (i.e.,  $|\text{skewness}| < 2$ ,  $|\text{Kurtosis}| < 7$ ; West et al., 1995). The multivariate distribution of the variables also showed no signs of significant nonnormality (Mardia's normalized coefficient = 1.30, *ns*). The multivariate normality assumption is thus satisfied in the current analysis.

The exogenous variables in the model (i.e., sex, age, race, education, and party affiliation) were allowed to covary with one another. In preliminary analysis, these variables were each specified to have unique influence on the media use and perception variables (see Figure 3). Because effects of individual exogenous variables were not explicitly hypothesized, nonsignificant paths in preliminary analysis were dropped from the final model. The paths among the other variables in the model were all retained in the final analysis, however, because they were specifically predicted based on theory and previous research.

The working model was estimated first to see if the proposed model structure was consistent with the data. As mediation is explicitly hypothesized in the reinforcing spirals framework, significance tests of specific indirect effects were conducted after model estimation. The product of coefficients approach was used in the mediation tests, and standard errors for indirect effects were calculated using Sobel's formula (1982).<sup>3</sup>

## Results

Estimation of the proposed model produced the following fit indices:  $\chi^2 (24, N = 453) = 27.66$ ,  $p = .28$ , CFI = .99, RMSEA = .02 (90% CI = .00-.04). The CFI and RMSEA values indicated that the model fit the data very well. Having obtained evidence of overall fit, this study then proceeded to answer its research questions by examining individual paths in the model and conducting mediation tests.

The first question this study sought to answer was whether media use would mediate the effects of exogenous variables on global warming perceptions. The effects relevant to this question are summarized in Table 3. As is shown in the table (top panel), many of the exogenous variables had significant effects on media use. Respondents who were older ( $\beta = .14$ ,  $p = .003$ ), male ( $\beta = .09$ ,  $p = .05$ ), non-White ( $\beta = -.16$ ,  $p < .001$ ), and less educated ( $\beta = -.24$ ,  $p < .001$ ) reported watching more television. Respondents who were older ( $\beta = .23$ ,  $p < .001$ ) and better educated ( $\beta = .25$ ,  $p < .001$ ) reported greater newspaper reading. Web use was more prevalent among respondents who were younger ( $\beta = -.22$ ,  $p < .001$ ), White ( $\beta = .11$ ,  $p = .02$ ), and had higher education ( $\beta = .34$ ,  $p < .001$ ).

**Table 3**  
**Media Use as Mediator Between Exogenous Variables**  
**and Global Warming Perceptions**

	TV	Newspaper	Web	Perceived Knowledge	Perceived Scientific Agreement	Concern
Effects of exogenous variables on media use and global warming perceptions						
Age	.14***	.23****	-.22****	—	—	—
Sex	.09**	—	—	-.11***	—	—
Race	-.16****	—	.11**	—	—	.18****
Education	-.24****	.25****	.34****	.19****	—	—
Party	—	—	—	—	-.14***	-.10**
Effects of media use on global warming perceptions						
TV	—	—	—	.03	-.08	-.06
Newspaper	—	—	—	.11**	.05	.01
Web	—	—	—	.11**	-.01	.01
Significant indirect effects of exogenous variables on global warming perceptions through the mediation of media use (total effects in parentheses)						
Age via newspaper	—	—	—	.02** (.003)	—	—
Age via Web	—	—	—	-.03** (.003)	—	—
Race via Web	—	—	—	.01* (.01)	—	—
Education via newspaper	—	—	—	.02** (.25)	—	—
Education via Web	—	—	—	.04** (.25)	—	—

Note: Path coefficients are standardized regression weights. Dashes in the top panel indicate nonsignificant paths dropped after preliminary analysis. Significance for indirect effects was ascertained using the Sobel test. \* $p < .1$ . \*\* $p < .05$ . \*\*\* $p < .01$ . \*\*\*\* $p < .001$ .

Between media use and global warming perceptions (see Table 3, middle panel), two effects emerged significant—greater newspaper reading ( $\beta = .11, p = .02$ ) and greater Web use ( $\beta = .11, p = .02$ ) were associated with greater perceived knowledge. The effect of television viewing on perceived knowledge was not significant; neither were the effects of the media use variables on perceived scientific agreement and concern over global warming. Mediation tests (see Table 3, bottom panel) revealed several significant and marginally significant indirect effects of exogenous variables on perceived knowledge. These included the indirect effects of age through the mediation of newspaper reading ( $\beta = .02, p = .04$ ) and Web use ( $\beta = -.03, p = .04$ ), the indirect effect of race through the mediation of Web use ( $\beta = .01, p = .06$ ), and the indirect effects of education through the mediation of newspaper reading ( $\beta = .02, p = .04$ ) and Web use ( $\beta = .04, p = .02$ ). Overall, respondents who were White and better educated perceived themselves as being well informed about global warming partly because they had read newspapers and used the Web more often. Age had a more intricate relationship with perceived knowledge, however. Older people read more newspapers but were less likely to use the Web. These tendencies

appeared to have offset each other and resulted in a negligible total effect of age on perceived knowledge ( $\beta = .003$ ).

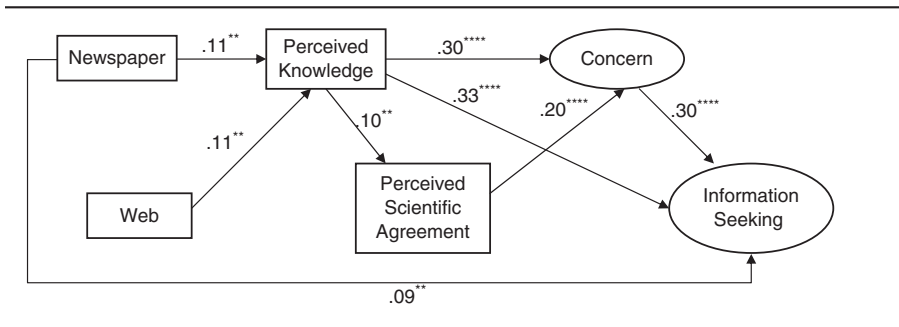
Also of note in Table 3 is that some of the exogenous variables had significant direct effects on global warming perceptions. Male respondents reported less knowledge about global warming than female respondents ( $\beta = -.11, p = .01$ ). White respondents reported greater concern over global warming than non-White respondents ( $\beta = .18, p < .001$ ). Education had a direct positive effect on perceived knowledge ( $\beta = .19, p < .001$ ) above and beyond its indirect effect through the mediation of media use. Finally, party affiliation negatively predicted perceived scientific agreement ( $\beta = -.14, p = .004$ ) and concern over global warming ( $\beta = -.10, p = .05$ ). Respondents leaning toward the Republican Party were much less likely than those leaning toward the Democratic Party to perceive scientific consensus and feel concerned over the effects of global warming in the polar regions.

This study also predicted that the effect of media use on concern over global warming would be mediated by perceived knowledge and perceived scientific agreement. The effect of media use on perceived scientific agreement was also predicted to be mediated by perceived knowledge. Finally, media use and global warming perceptions were predicted to influence future information seeking. Results related to these predictions are presented in Figure 4 and Table 4. For the sake of clarity, effects of exogenous variables and nonsignificant paths are not included in the Figure.

As is shown in Figure 4, perceived knowledge was positively associated with both perceived scientific agreement ( $\beta = .10, p = .04$ ) and concern over global warming ( $\beta = .30, p < .001$ ). Perceived scientific agreement was also positively associated with concern ( $\beta = .20, p < .001$ ). The indirect relationship between perceived knowledge and concern over global warming through the mediation of perceived scientific agreement was marginally significant ( $\beta = .02, p = .07$ , see Table 4). This pattern of relationships was consistent with the prediction. Furthermore, as only perceived knowledge was significantly related to any of the media use variables (see Table 3), it became the only pathway through which media use influenced the other perception variables. As is shown in Table 4, the mediated effects of newspaper reading ( $\beta = .03, p = .03$ ) and Web use ( $\beta = .03, p = .03$ ) on concern over global warming were both positive and significant. The mediated effects of newspaper reading ( $\beta = .01, p = .13$ ) and Web use ( $\beta = .01, p = .12$ ) on perceived scientific agreement, however, failed to reach statistical significance.

The final endogenous variable in the model was information seeking. As Figure 4 shows, information seeking was significantly predicted by three variables: newspaper reading ( $\beta = .09, p = .04$ ), perceived knowledge ( $\beta = .33, p < .001$ ), and concern over global warming ( $\beta = .30, p < .001$ ). Those reading more newspaper, reporting greater knowledge and greater concern about global warming were more likely to seek out information about the polar regions in the future. Television viewing ( $\beta = -.07, p = .14$ ) and Web use ( $\beta = .07, p = .14$ ) did not directly influence information seeking; neither did perceived scientific agreement ( $\beta = -.002, p = .97$ ). However, through the mediation of perceived knowledge, newspaper reading ( $\beta = .04, p = .03$ )

**Figure 4**  
**Model Estimation Results**



Note: CFI = comparative fit index; RMSEA = root mean square error of approximation; CI = confidence interval.  $\chi^2 (24, N = 453) = 27.66, p = .28, CFI = .99, RMSEA = .02 (90\% CI = .00-.04)$ . Ovals represent latent composite variables. Exogenous variables are not included (see Table 2 and text). Nonsignificant paths are not included (see text). Path coefficients are standardized regression weights.  
 \*\* $p < .05$ . \*\*\*\* $p < .001$ .

**Table 4**  
**Other Indirect Effects in the Model**

	Perceived Scientific Agreement	Concern	Information Seeking
Indirect effects of media use			
Newspaper via perceived knowledge	.01 (.003)	.03** (.05)	.04** (.14)
Web via perceived knowledge	.01 (.06)	.03** (.05)	.04** (.12)
Indirect effects of Perceived knowledge			
Via perceived scientific agreement		.02* (.32)	
Via concern			.10**** (.43)
Indirect effect of perceived scientific agreement			
Via concern			.06**** (.06)

Note: Total effects are given in parentheses. Path coefficients are standardized regression weights. Significance for indirect effects was ascertained using the Sobel test.  
 \* $p < .1$ . \*\* $p < .05$ . \*\*\*\* $p < .001$ .

and Web use ( $\beta = .04, p = .03$ ) both had significant indirect effects on information seeking. Perceived knowledge ( $\beta = .10, p < .001$ ) and perceived scientific agreement ( $\beta = .06, p = .001$ ) also had significant indirect effects on information seeking through the mediation of concern over global warming (see Table 4).

Variance explained by the model was 12% for television viewing, 11% for newspaper reading, 18% for Web use, 10% for perceived knowledge, 4% for perceived

scientific agreement, 20% for concern over global warming, and 32% for information seeking.

Although the model proposed in this study provided excellent fit to the data, the possibility exists that alternative models may explain the data equally well or even better. Importantly, as the reinforcing spirals framework is advanced as a synthesis of the traditional audience activity and media effects approaches, it is of theoretical significance to determine whether the proposed model could indeed outperform models based on the two previous approaches. To this end, the proposed model was compared against two alternative models, one based on the traditional audience activity approach, the other the traditional media effects approach. In the audience activity model, the global warming perception variables were moved forward and respecified as exogenous variables predicting media use and information seeking. In the media effects model, media use and information seeking (viewed as another indicator of current patterns of media use) were respecified as exogenous variables predicting global warming perceptions. In both alternative models, the effects of the original exogenous variables in the proposed model remained unchanged.

Because these models were not nested, goodness-of-fit measures based on information theory were used to assess model superiority (Kline, 1998). These include the Akaike Information Criterion (AIC), the Browne-Cudeck Criterion (BCC), and the Bayes Information Criterion (BIC). These indices are interpretable only in comparative terms, with lower values indicating better fit. Comparison of the three models yielded the following results: proposed model: AIC = 135.58, BCC = 138.77, BIC = 357.83; audience activity model: AIC = 148.41, BCC = 152.20, BIC = 411.83; media effects model: AIC = 145.98, BCC = 149.89, BIC = 417.63. These results suggest that the proposed model was indeed superior to the two models based on previous theories.

In addition to these theory-driven alternative models, other logically feasible alternative models were also considered. For example, in one model the path from perceived knowledge to concern was reversed to accommodate the possibility that concern generated by media exposure may increase attention to pertinent media content, resulting in greater knowledge. In another model, the path from perceived knowledge to perceived scientific agreement was reversed to test the scenario that the perceived lack of consensus may undermine people's sense of knowledge on this topic. None of these alternative models fit the data as well as the proposed model (details not reported).

## Discussion

This study used the reinforcing spirals model to investigate the mutual influence between individuals' media use and their global warming perceptions. Although the

reinforcing spirals model has a distinctive time series dimension, proper analysis of cross-sectional data also can shed light on its central propositions. In this study, a portion of the 2006 GSS data were analyzed using structural equation modeling and mediation analyses. The primary interests of the study were the role of media use as a mediator between exogenous variables and global warming perceptions, and the effect of global warming perceptions on future seeking of information related to the polar regions.

The results of this study supported the reinforcing spirals model's predictions. Newspaper reading and Web use mediated the effects of age, race, and education on perceived knowledge about global warming. Perceived knowledge and concern over global warming, in turn, significantly predicted future information seeking. These key findings were consistent with the existing longitudinal and cross-sectional evidence in support of the reinforcing spirals model (Eveland et al., 2003; Slater et al., 2003, 2007; Slater & Rasinski, 2005). Moreover, auxiliary analyses showed that alternative models based on the traditional media effects and audience activity approaches were not able to account for the data as well as the proposed integrative model. These findings add to our confidence in the validity of the reinforcing spirals framework. They also lend credence to the argument that the reinforcing spirals framework represents an important advancement in mass communication theory.

In this study, the mediating effects of media use varied for different demographic variables. Newspaper reading and Web use mediated only a small portion of the effect of education on perceived knowledge. Web use appeared to have mediated most of the effect of race. In the case of age, newspaper reading and Web use displayed countervailing mediating effects. Although both types of media use positively contributed to perceived knowledge, older age was associated with increased newspaper reading but decreased Web use. As a result, the total effect of age on perceived knowledge was miniscule, even though the two indirect effects were both statistically significant.

Variation in the mediating effects of media use is anticipated by the reinforcing spirals framework, which acknowledges that the mediation can be either partial or full in different contexts (Proposition 1, Slater, 2007; also see Slater & Rasinski, 2005). The current finding about age, nevertheless, alerts us to the possibility that the use of different media may transmit different effects to the endogenous variable. When such inconsistency arises, the overall effect of the exogenous variable may become indistinct. This situation, indeed, demonstrates how the reinforcing spirals framework may also enhance our understanding of the impact of exogenous variables. Without its focus on mediation, significant indirect effects of an exogenous variable can be easily overlooked for the lack of a significant total effect.

At this point, it is important to point out that the media use measures in this research were not ideal. Limited by what was available in the GSS, the current analysis only examined respondents' general use of three media—television, newspapers, and the Web. Even though these three media represent dominant information

sources today, people could certainly learn about global warming from other media or nonmedia sources. More importantly, general media use is not a sensitive measure of audience selectivity. It does not tell us what specific information audience members attend to when they consume the media. An individual may report heavy media use but spend very little time on content related to global warming. On the other hand, a different individual may report very limited media use but spend most of her media time on gathering information about global warming. The media use measures in the GSS were not able to differentiate between these two types of individuals. As a result, this study provided only limited insights into the level of audience selectivity in respondents' prior media use. Indeed, this limitation is probably part of the reason why television viewing did not emerge as a significant predictor of global warming perceptions in this study—compared to newspapers and the Web, television is probably more often used for entertainment purposes than for information acquisition (Kaye, 1998; Papacharissi & Rubin, 2000; Vincent & Basil, 1997).

Despite this limitation, this study produced relatively clear evidence for the role of media use as a mediating variable between exogenous variables and global warming perceptions. Indeed, the fact that the media use measures used in this study were not sufficiently sensitive to audience selectivity suggests that the current results very likely have underestimated the relationships between media use and the other variables. This possibility is partially confirmed by the other key finding from this study that showed perceived knowledge and concern about global warming to be strongly associated with future information seeking—a highly selective form of media use.

This study extended previous research in two important ways. First, it tested the reinforcing spirals model in a new topic area where the interaction between the media and the public seems to be particularly active and consequential (Boykoff, 2008; Dunwoody, 1999). This kind of topic provides an ideal environment to test the model's central predictions. It also offers a rich opportunity to explore other intricacies of mediated communication's spiraling progress (such as the specific mechanisms through which media use could influence risk perceptions). Second, this study tested the two pivotal propositions of the reinforcing spirals model simultaneously, whereas previous cross-sectional research has examined only the first proposition (Slater et al., 2007; Slater & Rasinski, 2005). This was made possible by including future issue-specific information seeking in the analysis as a final endogenous variable representing a newer phase of audience selectivity. In so doing, this study offered a fuller snapshot of the reinforcing spirals model and generated relatively more complete evidence for the model's central tenets.

This study examined perceived knowledge and perceived scientific agreement as two potential mediators of media effects in the context of global warming. It was found that media use (newspaper reading and Web use to be exact) influenced global warming perceptions mainly through its effect on perceived knowledge. Consistent with some previous research (Krosnick, Holbrook, Lowe, & Visser, 2006; Stamm et al., 2000), this study found that the influence of the media on perceived knowledge on global warming was positive in nature. This suggests that the media has

served a distinctive educational function in the case of global warming. How to harness and exploit this function, naturally, is a meaningful and consequential question to ask not only for researchers but also for policy advocates.

Previous research suggests that media use might lead to lowered perceived scientific agreement over global warming. This prediction did not receive support in this study. There was no direct effect of media use on perceived scientific agreement. The indirect effects of media use through perceived knowledge were positive although not significant. These findings raise some interesting questions about the much maligned balanced reporting on global warming by the American media (Boykoff, 2008; Boykoff & Boykoff, 2004). Is this pattern of news coverage truly responsible for the lingering doubts about global warming in the public's minds? What methods, if any, do average audiences use to derive judgments on scientific certainty from mediated information? The current data are not able to offer definitive answers to these questions, but they certainly afford these questions much greater urgency.

In this study, we expected concern over the effects of global warming to predict future information seeking about the polar regions. We also expected concern to mediate at least part of the effects of perceived knowledge and perceived scientific agreement. Both these expectations were confirmed. These findings are consistent with previous information-seeking research, which showed issue appraisal or risk perceptions to be an important motivator of information seeking (e.g., Griffin et al., 2004; Rimal, 2002). While focusing on concern as a key predictor, this research also considered the possibility that perceived knowledge and perceived scientific agreement might influence information seeking through other unspecified mechanisms. In this study, a direct effect emerged for perceived knowledge but not for perceived scientific agreement. The direct effect of perceived knowledge suggests that concern is not always necessary for well-informed people to engage in further information seeking. Other effects of perceived knowledge, such as increased curiosity, may also spur the desire for more information. Perceived scientific agreement, on the other hand, could only lead to information seeking when it results in elevated concern. Alternative routes of influence, at least in the current data, do not seem likely.

Another interesting finding of this study has to do with the effect of political ideology. Recent polls revealed significant differences between Democrats and Republicans on a variety of topics concerning global warming (Maibach et al., 2008; Pew Research Center, 2007). This study showed that party affiliation had no effect on media use or perceived knowledge, but it had significant impact on perceived scientific agreement. In fact, party affiliation was the only exogenous variable to influence perceived scientific agreement in this study. Other things (including education) being equal, people leaning toward the Republican Party perceived much less scientific consensus than those leaning toward the Democratic Party. This perceptual difference also existed in reported concern over the effects of global warming on the polar regions, although to a slightly lesser degree. These findings, together, suggest that political ideology has an important and independent role to play in shaping public understanding of the science of global warming.

This study is one of the initial tests of the reinforcing spirals model. Future research should continue to test this model while being mindful of the limitations of the current accumulated evidence. First, the existing evidence in support of the model is garnered from only a few isolated contexts. Greater confidence in the validity of the model will demand relatively consistent evidence across different issues and different populations. Second, although the model suggests mutual reinforcement between audience selectivity and media use, it also acknowledges the possibility that such reinforcement can be mitigated or overridden by other social and psychological influences. Identifying these influences in different issue contexts will be a meaningful topic for future research. Third, the reinforcing spirals model contends that the interaction between audience selectivity and media use has important implications for the shaping and maintenance of social identity. This proposition has not yet been examined by the existing studies. Future research should make a conscientious effort to fill this void.

This study has produced some interesting results regarding global warming perceptions. The independent effect of political ideology on perceived scientific agreement is a particularly provocative finding. Future research may consider exploring this effect in greater depth by identifying specific political values that are especially potent in influencing perceptions of the science about global warming. Finding messages that can overcome such partisan divide also constitutes meaningful topics for future strategic communication research. The lack of relationship between media use and perceived scientific agreement is another interesting finding of this study. This finding contradicts the suspicion that balanced coverage of global warming in the media has resulted in unwarranted uncertainty in public perceptions (Boykoff, 2008; Boykoff & Boykoff, 2004). To resolve this conflict, future research may consider using experiments to assess the impact of balanced reporting on audience perceptions. Dovetailing news content analysis and longitudinal audience surveys is another method that might prove useful to reach a more definitive conclusion.

Much of the future research proposed above requires overcoming the methodological limitations of the GSS data. An important weakness of this study, as mentioned earlier, was its crude measurement of media use. Such measurement could be improved by including a wider variety of media sources and by focusing more closely on information-rich media content such as news and educational programming. Some of the other measures used in this study were also less than ideal. It would be desirable, for example, if perceived knowledge and perceived scientific agreement were measured not with single items but with multiple-item scales. It would also be advantageous if a measure of actual knowledge about global warming was available to replace the perceived knowledge measure.

Finally, it should be acknowledged again that the GSS data were cross-sectional in nature. As a result, causal relationships could be suggested but not established in this study. Note, however, that the working model for this study had a fairly natural time order. Demographics and political affiliation were clearly exogenous influences. Future information seeking was a prospective behavior, thus fit naturally at the end of the causal chain. Because the media use variables used in this study were

about general media use, treating them as antecedents of specific issue perceptions also appeared to be more logical than treating them as the consequents of the perception variables. Indeed, this model was found to be more consistent with the data than models with different causal orders. Besides, findings from this study were consistent with previous longitudinal evidence. All of these should afford us reasonable confidence in making tentative causal interpretations of the current results.

## Notes

1. The author would like to thank Edward Maibach, Connie Roser-Renouf, and two anonymous reviewers for their helpful comments on earlier drafts of this article.

2. The American Association for Publication Opinion Research (AAPOR) provides several standard definitions of response rate for surveys. The minimum response rate is RR1, which is the number of complete interviews divided by the number of eligible cases plus the number of cases with unknown eligibility. RR5 is obtained by dividing the number of complete interviews by the number of eligible cases only. RR5 appears to be more appropriate for the 2006 General Social Survey (GSS) because the majority of the cases with unknown eligibility were vacant/uninhabited dwelling units. National Opinion Research Center reported only RR5 in the GSS codebook.

3. The Sobel test is a conservative test of mediation. It has relatively low statistical power because indirect effects often are not normally distributed as is assumed by the test (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). In view of this, researchers have recommended bootstrapping—a technique without distribution assumptions—as a more desirable alternative to the Sobel test (Preacher & Hayes, 2004, 2008). However, in this study the test model contains complex mediation processes involving multiple mediators and sometimes also latent variables. In such case, the Sobel test can be easily conducted for each specific mediation effect using the appropriate path coefficients and standard errors. Bootstrapping, on the other hand, can pose feasibility challenges. The bootstrapping capability of Amos (and many other modeling packages) only produces significance tests for total indirect effects, thus is unable to offer insights into coexisting, alternative mediating mechanisms. Preacher and Hayes (2008) recently published SAS and SPSS macros for bootstrapping that can be used to test multiple mediators simultaneously. But it is difficult to capture all the complexity of the test model using these macros. Besides, these macros do not have the ability to handle latent variables. Based on these considerations, it was decided that the Sobel test was a better overall choice for the current analysis.

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