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Mass communication and public understanding of environmental problems: the case of global warming

Keith R. Stamm, Fiona Clark, and Paula Reynolds Eblacas

Public understanding of global warming, also known as global climate change, is treated here as an example of a mass communication problem that has yet to be adequately solved. A survey of metropolitan area residents found that although people are aware of this problem in a general sense, understanding of particular causes, possible consequences, and solutions is more limited. Both mass media and interpersonal communication appear to make a positive contribution to understanding, as well as to perpetuating some popular misconceptions.

1. Introduction

Public understanding of global warming is treated here as a mass communication problem that has yet to be adequately solved. Surveys of public understanding of this and other environmental problems typically find understanding to be lacking, while studies of media effects conclude that media have little or no effect, or even that they contribute to misunderstanding.

Simon reported some of the initial evidence for limited understanding of environmental problems.[1] She found that although most people had heard about environmental problems such as air or water pollution, they often failed to make any connection between the problem and important causes, such as overpopulation. Similarly, Carter, Stamm, and Heintz-Knowles found that most people do not think of environmental problems in terms of either their causes or their effects (e.g., consequences on people). Instead, when asked about pollution, people tended to think about neither causes nor consequences of pollution, but rather of instances such as smog or garbage.[2] When causes are not well understood, it is clearly difficult to devise effective solutions to a problem. Not surprisingly, the respondents in Simon's study did not think of population control as involved in the solution of these problems. Lacking a clear understanding of consequences, respondents in the Carter, et al. study often assigned a lower priority to environmental problems.

Communication, both mass and interpersonal, holds the key to improvement in public understanding of environmental problems. However, previous research often holds mass media responsible for public inadequacies. Content analysts typically find gaps in media coverage due to episodic coverage of dramatic events, and to focusing superficially on human interest and economic impacts, while overlooking systemic concerns.[3,4] Such findings give rise to the inference that public understanding mirrors the inadequacies of media coverage, an inference

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that has occasionally been supported by studies that have tried to document media effects more directly.[5]

Despite these shortcomings, the extensive media coverage of environmental problems is not entirely a futile effort. Agenda-setting studies show that media coverage is at least partly responsible for focusing people's attention on environmental problems.[6] However, Mazur and Lee note that the level of public concern about environmental issues tends to follow the amount of media attention received, rather than the substantive content of news reports. Since the media are fickle, public concern about an environmental problem is likely to decline when media attention shifts to a different issue.[7]

Research on public understanding of global warming has so far focused mainly on the inadequacies in understanding. Kempton reported that global warming was often confused with the problems of ozone depletion and of air pollution (in general).[8] Bostrom, Morgan, Fischhoff, and Read also found that members of the public frequently confuse global warming with ozone depletion or air pollution. As Bostrom et al. point out, these misunderstandings may result in concerned citizens wasting their energies on ineffective actions, while neglecting strategies that would help to solve the problem.[9] At this point, we do not know whether, or to what extent, media coverage may be contributing to these misconceptions. Nor do we know whether people hold misconceptions side-by-side with ideas that are largely accurate. Given the complexity of climate change, we need not take an all or nothing view of public understanding. And from that perspective it also becomes possible that mass communication can foster both accurate views and misconceptions. This study begins to pursue such possibilities by (1) distinguishing among members of the public in terms of how far they have progressed toward solving an environmental problem, and (2) delineating the different kinds of understanding that might be required.

The case of global warming

We chose global warming, sometimes known as the "greenhouse effect" or as "global climate change," as a case study for a number of reasons. First, it is widely recognized as one of the most important issues on the current international environmental agenda. Although the extent and timing of effects are uncertain, climate change is thought to have implications for arenas including food and water supplies, energy production and use, ecosystem and species survival, human health, and social and political stability.[10] Second, since people generally have little direct contact with global warming, it is probable that many rely on the mass media as a primary source of information about this topic. Third, this topic has generated considerable scientific and political controversy. Although there is now a large degree of scientific consensus that some degree of global warming is indeed occurring, there is less agreement about both the exact consequences of unchecked global warming, and the consequences of strategies to mitigate negative effects.[11] This allows considerable leeway for public confusion over the causes, consequences, and viability of possible solutions to the problem.

2. Conceptualization

In addressing the role played by mass communications in solving environmental problems such as global warming, a better grasp of what constitutes "understanding" of an environmental problem is clearly needed. It should be stressed that the ways in which people think about environmental problems, their individual "understandings," are not necessarily accurate or complete. Nevertheless, these cognitive processes are likely to influence both their willingness and ability to participate in solving the problem.

Ideas about the role of mass communication in solving environmental problems frequently presume that by increasing coverage, the media can create the desired depth and breadth of individual and public understanding, and once that is achieved people will participate. The model is:

COVERAGE————UNDERSTANDING————ACTION

However, this model takes little account of the behavioral processes by which individuals relate to environmental problems. It assumes that coverage is equivalent to exposure and attention to media content, and that this leads directly to understanding. Understanding is then presumed to lead directly to individual action, pressure for action from the appropriate authorities, or consent to actions taken by leadership on behalf of citizens.

In this study, we have looked at "understanding" from three different perspectives, that of the problem, the individual, and the process of problem solving. Beginning with the problem itself, we break it down into three major elements:

Causes: antecedent conditions that are seen as producing the problem.
Consequences: effects the problem is seen to have on people and/or the environment.
Solutions: anything that could be done to remove causes and/or reduce consequences of the problem.

The public opinion research discussed earlier clearly indicates that awareness of an environmental problem often focuses on instances (e.g., the existence of smog or garbage) and does not entail specific knowledge about the causes, consequences, or solutions to the problem.

Individuals can relate to each of these elements of a problem in different ways. In a study of public understanding of science and technology, these ways of relating were distinguished in terms of the individual's level of "engagement" with a problem or issue.[12] At a basic level, the individual's engagement may begin with "exposure" (i.e., awareness) to an instance of the problem or to one or more elements of a problem. Exposure may take place via the media, through interpersonal channels, or via personal contact with one of the elements of the problem. Engagement may also include additional relating, such as "attention" (i.e., focusing on the problem), "cognition" (i.e., thinking about it), and taking "action." The problem-solving perspective recognizes that problems such as global warming are not solved by virtue of a single act. Solving environmental problems requires a series of coordinated acts carried out over time by various actors. From this perspective, the behavior required to solve an environmental problem has a complex, sequential structure in which we take steps towards a solution, both as individuals and as a society.[13]

In keeping with this behavioral perspective on public understanding, an individual's engagement with a topic is represented in our study as a series of stages along a "path," shown in Figure 1, beginning with awareness of an environmental situation and ending with a sense of how best to solve it. In Stage 0, a person has not been exposed to an environmental situation such as global warming. Engagement is nonexistent. People in Stage 1 have been exposed to, but have not yet focused their attention on the problem. People who have reached Stage 2 on our path have focused their attention and made some assessment of the consequentiality of the topic. Those in Stage 2a have decided that the situation is not a problem (i.e., it presents little or no threat), while those at Stage 2b have decided that the situation is a problem (Stage 2b). To reach Stage 2, an individual needs to engage in thinking about the problem. Some, but not all, of those who conclude that a situation is problematic (i.e., has negative consequences) may go on to think about possible solutions (Stage 3). The final stage is occupied by those people who feel they have a pretty clear idea of what needs to be done to solve the problem. While the type of solutions favored by an individual are likely to depend on a variety of factors such
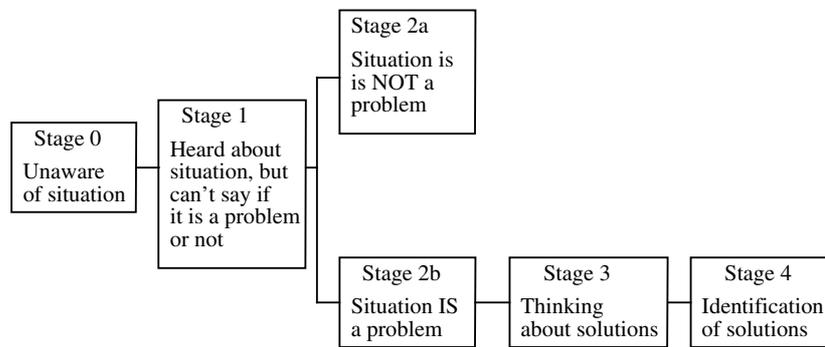
Figure 1. Stages on problem-path.

as lifestyle, political affiliation, or interest in the environment, people at this stage all share the common characteristic of having thought about the problem and arrived at some sense of what should be done.

Making these behavioral distinctions should help us to obtain a more comprehensive description of the status of public understanding for any given environmental problem. While this model is still an oversimplification, it may contribute to the question of media effects, both extant and potential, by showing us the areas in which media have been effective and those areas in which they have not been effective. This clearly has practical applications to the design of public awareness campaigns aimed at increasing public understanding of environmental problems.

Major research problems and research questions

A number of studies have shown that media coverage of global warming has tended to be superficial, episodic, and frequently presented in terms of conflict and scientific controversy.[14] When this type of coverage is combined with the unobtrusive nature of this issue, it is not surprising that previous studies have found that public understanding is generally limited and prone to a number of misconceptions.[15] This leads us to ask a number of questions:

1. For global warming, what is the breadth of understanding in terms of causes, consequences, and potential solutions?
2. How are people distributed among the stages of the problem-solving path? That is, what is their "level of engagement" with the problem?
3. What is the relationship between breadth of understanding and the individual's "level of engagement?" Does breadth of understanding increase as individuals become more engaged?
4. Does path stage make a difference in media use and interpersonal communication?
5. Does media use make a difference in understanding of causes, consequences, and solutions? If so, which media make the most difference?

3. Methods

Sample and interviews

A detailed, self-administered questionnaire was first presented to 100 undergraduate communications students at the University of Washington. On the basis of the responses to this

questionnaire, a shorter questionnaire was drawn up for use in a telephone survey. This second questionnaire was revised slightly following pretests. The final interview was between 10 and 15 minutes in length, and included a variety of questions about whether or not respondents considered global climate change to be a problem; their ideas about causes, consequences, and solutions to global climate change; and their media use, as well as demographics.

The survey was administered during May 1997 to 512 telephone subscribers residing in the Washington metropolitan area. Interviews were carried out by students in an "Effects of Mass Communications" course at the University of Washington. Students received training in interview techniques prior to the survey. Random digit dialing was used to select households, with three call-backs attempted for each number before new numbers were substituted. In order to ensure random selection of respondents at the household level, the interviewers asked to speak to the person in the household who was 18 or older and had most recently celebrated a birthday. Verification checks were performed for 10 percent of the sample, selected randomly.

Of 934 attempted interviews, 512 were completed, for a response rate of 55 percent. Since this response rate is lower than is ideal, caution should be used in extrapolating results from our sample to the metropolitan population as a whole. However, since our primary interest was in variations in media use, understanding, and stage along the path, it was more important that the full range of these variables was represented than that some groups be somewhat under- or over-represented. Demographically, the sample does not differ significantly from census data for the metropolitan area.

Measures

The term "global warming," rather than "global climate change," was used throughout the survey since our pretests had suggested that this might reduce confusion with stratospheric ozone depletion. Stage along the path was measured by asking respondents whether they agreed or disagreed with a short series of statements such as "I do not think that global warming is a problem" and "I am pretty sure what actions need to be taken to solve this problem." In the detailed, self-administered pretest, we had asked a larger bank of questions to determine stage of path, and had also asked respondents to position themselves on a graphical representation of the path. The questions used in the telephone survey were the items that appeared best at distinguishing respondents by stage.

Levels of understanding of the causes, consequences, and solutions to this problem were measured by asking respondents if they had heard of a number of examples of each element in connection with global warming. If respondents had heard of a particular item, they were asked whether the item was not important, somewhat important, or very important as a cause or solution to global warming or about how concerned they felt about a possible consequence. The items used in these lists were obtained from a variety of books and pamphlets about global warming.[16] The lists are far from exhaustive, but the limitations of the telephone interview format imposed restrictions on the number of questions that we could use. Since previous studies and our own pretests had consistently shown that many people mistakenly consider aerosol sprays to be one of the major causes of global warming, we included a ban on such sprays as a possible solution. In this way, we hoped to obtain an indication of public confusion between global warming and stratospheric ozone depletion.

Indices were also constructed as overall measures of breadth of knowledge and depth of concern about the elements of the problem. Breadth of awareness was measured by simply counting how many of the items each respondent had heard of in relation to global warming. A second level of awareness was measured by counting how many of the causes or solutions presented were considered important or helpful by the respondents. Since these lists contained

a number of ambiguous items, making a hard and fast judgment of the relative contribution of each item is difficult; the categories "important" and "very important" were collapsed to a single category, as were "helpful" and "very helpful." Additionally, the red-herring amongst the solutions ("stop using aerosol sprays") was re-coded such that those considering it to be helpful as a solution effectively lost a point when their overall score for understanding of solutions was tallied.

Finally, respondents were read a list of possible sources of information about global warming, and asked to indicate the ones from which they had heard about this topic. The sources listed were newspapers, television, magazines, environmental groups, public radio, the Internet, books, family and friends, and workshops or classes. If the respondent indicated that they had heard about global warming from newspapers, television programs, magazines, or environmental groups, they were asked to provide the names of publications, programs, or groups.

Analysis plan

Each respondent was located at the appropriate point along the path by determining the last stage reached. Descriptive statistics were used to determine the relative importance of various media as sources of information about global warming and to provide an indication of the respondents' ideas about the most important causes, consequences, and solutions. Indices were constructed for understanding of each of the three elements of the problem, and the relationships between these understandings and stage were examined using one-way ANOVA and contrast tests. The relationships between media use and stage were analyzed using cross-tabs and chi-square tests, while one-way ANOVA tests were used to probe for relationships between public understanding and media use. Finally, stepwise multiple regressions were conducted to disentangle the overlapping relationships between public understanding and multiple communication sources.

4. Results and discussion

Distribution of respondents along the problem-solution path

Of the 512 people interviewed, 88 percent had heard the terms "global warming" or "greenhouse effect." This figure corresponds well with the results of other polls reported by Trumbo: these showed that in 1981, only 38 percent had heard of global warming. By 1987, the proportion had risen to 40 percent, but by 1990, it had reached near-saturation at 86 percent.[17]

Figure 2 shows the number of respondents reaching each stage on the path. Twenty-nine cases were excluded due to logical inconsistencies in the data, such as respondents stating that global warming was both "not a problem" and "definitely a problem," leaving a valid sample of 483 cases. As can be seen from Figure 2, the two largest groups of respondents were those who had decided that global warming is a problem but had not yet given serious thought to solutions (30 percent), and those who had heard something about the topic but did not feel they knew enough to state whether or not global warming was a problem (22 percent). Only 18 percent of our respondents were situated in the last stage of our path, feeling fairly certain about what actions should be taken to solve this problem, although an additional 7 percent said that they had thought seriously about solutions.
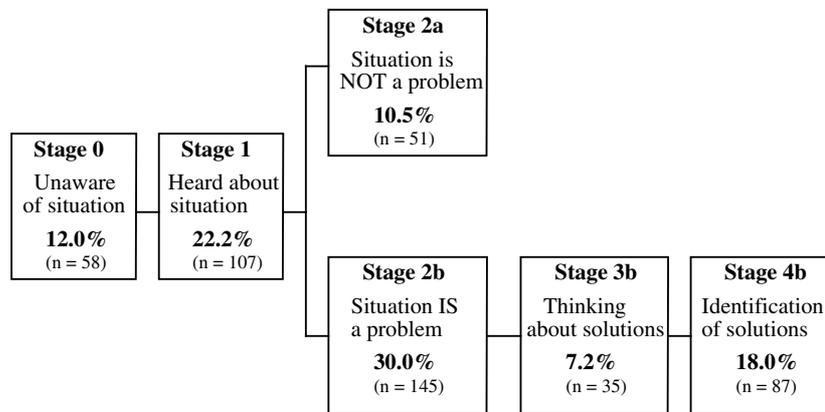
Figure 2. Distribution of respondents on path from awareness to solution for the case of global warming (valid *n* = 483).

Public perceptions of global warming

Causes. Greenhouse gases, primarily carbon dioxide, methane, nitrous oxide, and members of the halocarbon family, such as CFCs, "trap" heat in the lower levels of the atmosphere.[18] With the exception of the halocarbons, these gases occur naturally, and play an important role in regulating the earth's climate. However, a number of human activities are increasing the atmospheric concentration of these gases, and there is now a growing scientific consensus that there is "a discernible human influence on global climate."[19]

To date, the most important greenhouse gas is carbon dioxide.[20] This is released primarily through the burning of fossil fuels such as oil, coal, and gas and, to a lesser extent, through deforestation and the destruction of other vegetation. As shown in Table 1a, more than 80 percent of the respondents who had heard of global warming reported that they had also heard about these topics in connection with global warming.

However, along with this high level of awareness, a number of misconceptions were also discovered. First, although fossil fuel use is responsible for over 50 percent of anthropogenic contributions to global warming, just over half of our respondents considered this cause to be "very important" (Table 1b). In contrast, deforestation is responsible for only about 15 percent of worldwide carbon dioxide emissions, but this activity was considered to be "very important" by more of our respondents than any other cause on our list (Table 1b).[21]

A substantial number of people in our sample (43.8 percent) considered the use of CFCs to be a "very important" cause of global warming. While CFCs are indeed important greenhouse gases, they are generally better known for their role in the depletion of the ozone layer, and previous studies have documented widespread public confusion between global warming and stratospheric ozone depletion.[22] Although the time limitations imposed by the telephone interview format prevented us from probing further into this issue, it appears probable that our respondents were also confusing the two.

The industrialization of developing countries is also considered to be another important contributor to rising levels of greenhouse gases. It is beyond the scope of this paper to address the debate on whether the developing countries should restrict growth in order to solve a problem created primarily by the developed world. However, as Stern points out, the People's Republic of China is currently the world's third-largest producer of carbon dioxide, and is increasing its rate of carbon dioxide emissions faster than any other country.[23] Other developing

Table 1a. Awareness of causes of global warming.

Possible causes of global warming	% heard about this topic ($n = 425$†)
Fossil fuel use	84.0%
Deforestation	83.3
Industrialization of developing countries	78.6
Use of CFCs	75.1
Overpopulation	67.3
Agriculture	44.9

† Only those respondents who had heard of global warming and whose position on the path could be determined are included.

Table 1b. Importance accorded to causes of global warming.

Possible causes of global warming	% considering "very important" ($n = 425$†)
Deforestation	54.1%
Fossil fuel use	51.3
Use of CFCs	43.8
Industrialization of developing countries	40.2
Overpopulation	39.3
Agriculture	13.9

† Excludes those who have not heard about global warming or whose stage cannot be determined.

countries, such as Brazil, India, and South Korea are also increasing emissions by substantial amounts.[24] While almost 79 percent of our respondents had heard of industrialization of developing countries as a cause of global warming, only 40 percent considered this cause to be "very important."

Population increase is also considered to be another social force driving emissions of greenhouse gases, since it changes land-use patterns and frequently leads to increased usage of fossil fuels, although the exact level of contribution is difficult to determine.[25] Sixty-seven percent of our respondents had heard of overpopulation as a possible cause of global warming, with 39 percent considering this issue to be a "very important" cause.

The contribution made by agricultural practices was less well understood by our respondents. Deforestation to clear land for farming releases carbon dioxide into the atmosphere. In addition, rice paddies and gas produced by ruminant livestock such as cattle make an appreciable contribution to increased concentrations of atmospheric methane, while the fertilizers used in intensive agriculture are a source of nitrous oxide.[26] However, only 45 percent of our respondents had heard about agriculture as a cause of global warming, with 14 percent considering this cause to be "very important."

Taken together, these results suggest that many respondents are aware of a range of causes of global warming, although understanding of the relative importance of key human activities, such as fossil fuel use, is much more limited.

Consequences of global warming. Even in scientific circles, the likely consequences of global warming are less well understood than the causes. This is because effects will depend on factors such as the amount of warming, the rate at which it occurs, and the extent to which humans and other species are able to adapt to these changes. To further complicate matters, effects are likely to vary widely from region to region. While recognizing that it is difficult to make

specific predictions, we presented a short list of possible effects drawn from the literature on global warming to our respondents.

While people had heard of a wide variety of these effects (Table 2a), it was surprising that the greatest concern was for plant and animal extinction rather than impacts on humans such as health problems and water shortages (Table 2b). It may be that Seattle-area residents have a high degree of concern about ecological issues in general and that, as Read et al. suggest, any future ecological problem is viewed "as a plausible consequence of climate change."[27] Given the widely noted confusion between global warming and stratospheric ozone depletion, there may also be confusion between the health risks associated with ozone depletion (skin cancers) and those associated with global warming. Further research is clearly needed on these topics.

Table 2a. Awareness of possible effects of global warming.

Possible effects of global warming	% heard (n = 425†)
Extinctions of plants and animals	81.9%
Health problems	74.1
Heat waves	68.5
Sea level rise	65.2
Water shortages	62.6
Increased world hunger	54.1
Social unrest	34.6

† Excludes those who have not heard about global warming or whose stage cannot be determined.

Table 2b. Level of concern about possible effects of global warming.

Possible effects of global warming	% "very concerned" (n = 425†)
Extinctions of plants and animals	53.6%
Health problems	48.9
Water shortages	40.7
Increased world hunger	33.2
Sea level rise	22.1
Heat waves	21.6
Social unrest	16.0

† Excludes those who have not heard about global warming or whose stage cannot be determined.

Solutions. Respondents were generally aware of a wide range of solutions to global warming (Table 3a). The option "stop use of aerosol sprays" was included in this list to obtain an indication of the degree of confusion between global warming and ozone depletion. As expected, many people reported that they had heard this suggested as a possible solution to global warming.

The respondents' ideas of what constitutes a "very helpful" action to solve global warming are shown in Table 3b. Five solutions were seen as very helpful by a little over 50 percent of the respondents: reducing industrial emissions of greenhouse gases, planting more trees, introducing energy-efficient technologies, driving less, and halting deforestation. All of these options could make useful contributions to solving the problem of global warming, although tree-planting would need to be carried out on a massive scale in order to make any substantial contribution. Only 37 percent thought that reducing energy use in the home would be a very helpful strategy, although a number of experts consider that this would be a very useful action.

Table 3a. Awareness of possible solutions to global warming.

Possible solutions to global warming	% heard about ($n = 425$†)
Drive less	88.2%
Stop using aerosol sprays	87.5
Plant more trees	85.2
Reduce industrial emissions of greenhouse gases	81.9
Introduce energy efficient technologies	77.4
Halt deforestation	78.4
Reduce energy use in the home	68.9
Promote family planning	40.9

† Excludes those who have not heard about global warming or whose stage cannot be determined.

Table 3b. Perceived helpfulness of solutions to global warming.

Possible solutions to global warming	% considering "very helpful" ($n = 425$†)
Reduce industrial emissions of greenhouse gases	60.5%
Plant more trees	57.6
Introduce energy efficient technologies	56.5
Drive less	52.0
Halt deforestation	51.3
Stop using aerosol sprays	44.5
Reduce energy use in the home	36.7
Promote family planning	22.4

† Excludes those who have not heard about global warming or whose stage cannot be determined.

As expected, based on the work of other researchers, such as Read et al., and on our own pretests, a relatively high number of respondents (44.6 percent) believed that stopping the use of aerosol sprays would be "very helpful" in solving the problem of global warming.[28] In reality, the use of CFCs in aerosol sprays has been prohibited in the United States since 1978.[29] In many cases, however, CFCs have been replaced by other halocarbons: hydrochlorfluorocarbons (HCFCs) and hydroflurocarbons (HFCs). These are also greenhouse gases but, because of their relatively short lifetimes, they make a much smaller contribution to global warming than CFCs.[30] Thus, while refraining from the use of aerosol sprays might make a small contribution to solving the problem of global warming, it is by no means as important a solution as a significant minority of our respondents seem to believe.

Public understanding, by stage on problem-solution path

While it is clear that a number of misconceptions exist and are widespread, Table 4 clearly shows that the problem-solution path has some validity as a tool for examining public ideas about global warming. People in the later stages of the path are more likely to be aware of causes, effects, and consequences of global warming, more concerned about possible ill-effects, and more likely to take action to help address this problem. In contrast, while respondents located at Stage 2b ("not a problem") may be aware of a range of causes, consequences, or solutions, they are less likely to consider them important. While it appears that the aggregate scores for Stage 3 are frequently higher than those for Stage 4, the differences between average scores for these two groups do not achieve statistical significance at the $p < 0.05$ level. Also, some respondents may have "jumped" to Stage 4 ("feeling sure of solutions") prematurely,

Table 4. Average understanding of causes, consequences, solutions, and actions taken by stage on path.

Average score†	Stage 1 heard about situation	Stage 2a not a problem	Stage 2b definitely a problem	Stage 3 thought about solutions	Stage 4 clear about solutions	*F*	*p* <
Causes/heard	3.65	4.10	4.26	5.00	5.16	14.57	0.001
Causes/importance	2.91	2.75	4.03	4.94	4.91	27.56	0.001
Effects/heard	3.55	4.04	4.36	5.43	5.36	15.55	0.001
Effects/concern	1.34	0.80	2.38	4.06	3.83	37.00	0.001
Solutions/heard	5.15	5.75	6.20	7.03	6.86	13.62	0.001
Solutions/helpful	4.06	4.00	5.27	6.09	5.93	19.58	0.001
Actions taken	1.44	1.12	1.78	3.20	3.18	26.70	0.001
n‡	107	51	145	35	87		

† Average scores were calculated by summing the number of causes, effects, solutions, and actions the respondent had heard of, was concerned about, etc. For example, the value 3.65 in cell 1 means the 107 respondents in Stage 1 had heard of an average of 3.65 causes out of a possible 6. Maximum score for causes, effects, and actions = 6; maximum score for solutions = 8.
‡ Excludes those who have not heard about global warming or whose stage cannot be determined.

without passing through Stage 3 ("thinking seriously about solutions").

A question arises whether these stage differences could be due to demographic differences between the stages. Gender and age did not differ significantly by stage, but blue-collar workers, retired people, and unemployed people were predominant in the unaware stage, while those with professional, managerial, and technical occupations were predominant in the later stages. It is therefore possible that what appears to be a stage difference could simply be a reflection of differences in occupation and/or education. It is also the case that levels of understanding about global warming are related to occupation, with lower understandings in the blue-collar/retired/unemployed group, and higher understandings in professional/ managerial/technical groups. However, controlling for occupation (using two-way ANOVAs) consistently shows that stage differences in understanding occur within each occupational group, and that the main effect of stage is consistently much greater than that of occupation. We conclude, therefore, that the stage difference is robust and not an artifact of occupation.

Table 5. Sources of information about global warming.

Medium	% having obtained information from that source (*n* = 425†)
Newspapers	84.9%
Television	75.5
Magazines	60.2
Family and friends	57.9
Environmental groups	42.6
Public radio	46.1
Books	28.9
Workshops and classes	22.8
Internet	9.4

† Excludes those who have not heard about global warming or whose stage cannot be determined.

Media use by stage

While newspapers and television are the most frequently used sources of information about global warming (Table 5), no statistically significant differences were found between use of these two media and stage on the problem-solution path (Table 6).

Table 6. Percent use of media to learn about global warming by stage of path†.

% use of:	Stage 1 heard	Stage 2a not a problem	Stage 2b definitely a problem	Stage 3 thought seriously about solutions	Stage 4 clear about solutions	Chi-sq.	*p* <
Newspapers	83.8%	91.8%	90.1%	88.2%	90.5%	3.35	ns
Television	77.0	73.9	81.0	75.8	85.4	3.48	ns
Magazines	56.0	65.3	58.9	84.4	71.6	12.11	0.05
Environmental groups	36.4	48.9	36.5	74.2	62.8	27.62	0.001
Public radio	54.5	51.0	42.8	58.8	50.7	4.79	ns
Internet	6.1	12.5	8.4	12.5	15.0	4.90	ns
Books	21.6	32.6	25.7	54.3	40.5	18.06	0.001
Family and friends	49.5	58.0	56.9	67.6	75.6	14.41	0.01
Workshops and classes	14.3	26.5	21.1	38.2	33.8	25.08	0.01
n	107	51	145	35	87		
						F	*p* <
Average number of media used	3.82	4.35	4.13	5.41	4.93	8.5	0.001

† Does not include those who have not heard about global warming or whose stage cannot be determined.

As shown in Table 6, the average number of media used as sources of information about global warming was higher for the respondents located in the two last stages of the path. These respondents clearly made greater use of both mass media (television, newspapers, magazines, and books) and interpersonal communication (environmental groups, family and friends, and workshops or classes).

Breadth of understanding of global warming and media use

If both understanding and media/interpersonal communication are increasing as people move along the problem-solution path, we should also find a relationship between communication and understanding. This relationship, if found, would provide evidence that as people move along the path, the increased communication makes a difference in their breadth of understanding. We will analyze this relationship in terms of a variety of media and interpersonal sources and in terms of specific causes, effects, and solutions.

It appears that use of media and interpersonal sources is closely related to awareness of global warming causes, effects, and solutions. As shown in Table 7, in almost half of the cases (10 of 21) awareness was related to use of several media (three or more). This was particularly true for the causes "use of fossil fuels" and "agriculture," the effects "heat waves" and "sea level rise," and the solutions "introduce energy efficient technology," "halt deforestation," "reduce home energy use," and "use of family planning." In each of these cases, the only source that was not related to understanding was television. Awareness of some items was related only to mass media use—the causes "fossil fuels," "deforestation," and "CFCs," and the solutions "plant trees," "reduce industrial emissions," and "halt deforestation." In contrast, awareness of some others was related only to interpersonal communication with family and friends—the effects "health problems" and the solution "stop the use of aerosol sprays." This suggests there

Table 7. Percent awareness of causes, effects, and solutions by use of mass media and interpersonal sources.

	Newspapers		Television		Magazines		Public radio		Books		Family/friends	
	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Causes												
Fossil fuels	**76**	**92**	86	91	**84**	**94**	85	95	88	95	91	90
Deforestation	**69**	**90**	86	88	**81**	**91**	87	88	86	92	85	89
Industrialization of developing countries	76	86	84	86	**78**	**88**	82	87	82	89	**80**	**88**
Use of CFCs	78	86	79	86	**77**	**89**	82	88	**82**	**91**	82	87
Overpopulation	63	73	64	74	68	74	71	74	**68**	**78**	61	79
Agriculture	**27**	**56**	55	52	**40**	**59**	43	63	48	64	40	60
Effects												
Extinctions	90	88	86	87	83	89	**82**	**92**	85	92	**82**	**90**
Health problems	73	82	76	83	81	81	80	82	81	82	**73**	**86**
Heat waves	**58**	**75**	67	75	**60**	**80**	68	77	71	77	65	78
Sea level rise	**50**	**75**	66	73	**63**	**76**	64	79	67	81	60	79
Water shortage	63	70	63	71	**62**	**74**	64	73	**65**	**77**	59	75
Hunger	56	61	55	61	54	62	57	62	**55**	**68**	48	65
Social unrest	41	40	42	39	35	42	35	43	**35**	**46**	30	45
Solutions												
Drive less	87	90	86	91	**84**	**93**	84	95	88	94	85	93
Stop sprays	95	91	94	91	90	93	91	92	91	92	**89**	**94**
Plant trees	84	91	89	91	86	92	88	92	**87**	**95**	87	93
Reduce industrial emissions	**74**	**90**	89	88	86	89	85	91	**84**	**98**	88	90
Efficient tech.	**68**	**89**	87	87	**76**	**91**	79	93	81	95	80	91
Halt deforestation	**57**	**87**	80	84	**76**	**86**	80	87	79	92	81	85
Reduce home energy use	**53**	**78**	71	76	**65**	**79**	66	83	68	89	64	81
Family planning	**30**	**48**	41	46	**39**	**49**	38	54	38	58	33	52
N†	**46**	**361**	**82**	**321**	**147**	**256**	**199**	**196**	**274**	**123**	**165**	**246**

For values appearing in boldface, $p < 0.05$ by chi square test.

† *N* may vary due to missing data.

is some difference between what is traveling through mass media and interpersonal channels, although both are implicated in the confounding of climate change with the depletion of the ozone layer.

Focusing on sources, we see that all sources—with the exception of television—were positively related to public understanding of climate change, most notably books and family/friends. Use of newspapers and magazines was most clearly related to awareness of causes and solutions, while public radio was related to awareness of effects and solutions. Use of books was positively related to awareness in all three domains, but the relationship was strongest for awareness of solutions. Interpersonal communication (family/friends) was also positively related to understanding of causes, effects, and solutions, but, in this case, the strongest relationship lay in the domain of effects. A number of the differences between users and non-users of the selected media were fairly large—15 percent or more (Table 7). Newspapers, magazines, books, and family/friends were responsible for most of these large differences, which were also restricted to a few items. Among these were the effects "heat

waves" and "sea level rise," and the solutions "energy efficient technology" and "reduced home energy use."

We recognize that the relationships between media use and understandings are correlational, and need to interpreted with caution. It is possible that being aware of and engaged with the problem of climate change encourages different patterns of media use. However, numerous studies have documented the ability of mass media and interpersonal communication to produce effects on knowledge, opinions, and behavioral intentions.[31] It therefore seems likely that both mass media and interpersonal communication are contributing to awareness of the connection between climate change and energy consumption. We note also that there were no large differences due to media use for "CFCs" as a cause or for "stop aerosol sprays" as a solution, perhaps because these misunderstandings have become so widespread that it is difficult to trace them back to any particular source.

As we look beyond awareness to level of concern and perceived importance (of causes) and helpfulness (of solutions), the relationship between understanding and media use diminishes, while the relationship with interpersonal communication grows stronger (Table 8). If we regard the relationships in Table 8 as roughly comparable to agenda-setting effects,[32] then it appears that family/friends are more important than the media in setting the agenda of causes such as fossil fuels, deforestation, and industrialization of developing countries. While television made a difference in the perceived importance of fossil fuels, overpopulation, and agriculture as causes of global warming, mass media more often set an agenda of consequences—extinctions, sea level rise, water shortage, and social unrest. Only television and interpersonal communication contributed to the agenda of preferred solutions. Curiously, television use was closely associated with solutions involving trees and deforestation. It was also the only channel related to the perceived helpfulness of family planning. Interpersonal sources were associated with an increased conviction that "stopping aerosol sprays" would help solve the global warming problem. However, they were also associated with stronger beliefs in the efficacy of reducing personal energy use, by driving less and reducing home energy consumption, and in the importance of reducing industrial emissions and introducing energy-efficient technologies.

The results in Tables 7 and 8 indicate frequent overlap between understandings and the use of various sources. This suggests that, in many cases, the same difference in understanding can be attributed to more than one source, and that some relationships are spurious due to the considerable overlap in source use. For example, of those who reported using television to obtain information about global warming, over 80 percent also consulted newspapers. In order to more clearly sort out which media and/or combinations of media make a difference in understanding, we conducted a series of stepwise multiple regressions. The standardized partial correlations (betas) in Table 9 measure the strength of association between understanding and use of each medium with the effect of all other media removed (or "controlled").

Perhaps the most startling finding in Table 9 is the larger number of significant correlations found for family/friends compared to media sources. This certainly strengthens our inference from the previous tables that interpersonal sources have played an important role in furthering public understanding of global warming. In that regard, we also note several cases in which interpersonal sources were the only significant predictor: importance of the causes "deforestation" and "industrialization of developing countries"; concern about "health problems"; and helpfulness of the solutions "drive less," "stop use of aerosol sprays," "reduce industrial emissions," "introduce energy efficient technologies," and "reduce home energy use." Interpersonal communication was also a predictor in several other cases, including the importance of fossil fuel use and concern about extinctions.

The relationship of television to understanding suggested in Table 8 was further "unmasked" by the regression analysis. Constructive contributions became evident from

Table 8. Mean importance of causes, concern about effects, and helpfulness of solutions by use of mass media and interpersonal sources.

	Newspapers		Television		Magazines		Public radio		Books		Family/friends	
	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Importance of causes												
Fossil fuels	2.44	2.63	**2.47**	**2.65**	2.56	2.63	2.59	2.63	2.58	2.69	**2.51**	**2.68**
Deforestation	2.63	2.63	2.60	2.64	2.61	2.63	2.61	2.64	2.58	2.71	**2.54**	**2.69**
Industrialization of developing countries	2.38	2.50	2.48	2.49	2.42	2.51	2.46	2.49	2.46	2.52	**2.39**	**2.54**
Use of CFCs	2.52	2.52	2.47	2.54	2.52	2.51	2.46	2.49	2.51	2.51	2.42	2.57
Overpopulation	2.35	2.51	**2.28**	**2.52**	2.39	2.55	2.46	2.55	2.43	2.55	2.52	2.47
Agriculture	2.07	2.15	**1.93**	**2.21**	2.15	2.15	2.09	2.16	2.18	2.11	2.02	2.20
Concern about effects												
Extinctions	**2.38**	**2.60**	2.57	2.59	2.48	2.61	2.52	2.61	2.53	2.65	**2.48**	**2.63**
Health problems	2.48	2.57	2.52	2.57	2.58	2.56	2.54	2.59	2.58	2.54	2.58	2.56
Heat waves	1.88	2.17	1.98	2.19	1.95	2.22	2.01	2.27	2.05	2.38	1.97	2.25
Sea level rise	1.84	2.04	**1.82**	**2.07**	1.99	2.03	**1.93**	**2.12**	1.99	2.12	**1.87**	**2.11**
Water shortage	**2.19**	**2.53**	2.38	2.50	2.42	2.51	2.41	2.56	2.44	2.60	2.42	2.53
Hunger	2.42	2.52	2.51	2.51	2.48	2.52	2.50	2.54	2.50	2.55	2.45	2.55
Social unrest	**1.70**	**2.17**	2.00	2.14	2.00	2.15	2.01	2.18	2.09	2.14	2.11	2.13
Helpfulness of solutions												
Drive less	2.42	2.58	2.56	2.57	2.56	2.55	2.51	2.58	2.55	2.56	**2.45**	**2.63**
Stop aerosols	2.47	2.46	2.48	2.45	2.51	2.41	2.41	2.49	2.46	2.48	**2.33**	**2.53**
Plant trees	2.54	2.68	**2.55**	**2.70**	2.66	2.67	2.64	2.68	2.66	2.70	2.59	2.71
Reduce industrial emissions	2.72	2.73	2.66	2.75	2.73	2.72	2.71	2.73	2.74	2.69	**2.65**	**2.77**
Efficient tech.	2.56	2.72	2.64	2.72	2.74	2.67	2.70	2.70	2.69	2.71	**2.62**	**2.76**
Halt deforestation	2.50	2.64	**2.47**	**2.67**	2.58	2.64	2.61	2.63	2.60	2.68	2.57	2.66
Reduce home energy use	2.31	2.47	2.52	2.43	2.48	2.45	2.39	2.50	2.45	2.45	**2.30**	**2.54**
Family planning	2.18	2.35	**2.02**	**2.45**	2.27	2.37	2.33	2.36	2.35	2.32	2.23	2.40
N†	**46**	**361**	**82**	**321**	**147**	**256**	**199**	**196**	**274**	**123**	**165**	**246**

Values appear in boldface when probability of difference due to source is less than 0.05 by F test.
† *N* may vary due to missing data.

the correlations with importance of fossil fuel use, overpopulation, and agriculture. But interestingly, television was even more clearly associated with the misconceptions that planting trees and halting deforestation are effective solutions to the problem.

Table 9 also reveals that in several cases more than one medium appears to be making independent contributions to public understanding. This is most apparent in the correlations with indices of awareness, but also for importance of fossil fuel use and concern about extinctions.

5. Implications and conclusion

Compared with previous studies, our findings provide a more encouraging picture of public understanding of global warming, along with evidence of some positive contributions from mass media and interpersonal channels of communication.[33] With nations throughout the world currently considering policy responses to global warming, it appears many members of

Table 9. Standardized partial correlations† between media use and public understanding of global warming causes, effects, and solutions.

	Television	Newspapers	Magazines	Public radio	Books Books	Family/ friends	Environ. Groups
Awareness of causes		0.18			0.21	0.15	0.15
Awareness of effects			0.13		0.12	0.23	0.17
Awareness of solutions		0.20	0.11		0.18	0.16	0.12
Importance of causes							
Fossil fuel use	0.13					0.14	
Deforestation						0.13	
Industrialization of developing countries						0.12	
Use of CFCs							
Overpopulation	0.14						
Agriculture	0.18						
Concern about effects							
Plant/animal extinct.		0.11					
Health problems						0.11	
Heat waves				0.12			
Sea level rise	0.13					0.14	
Water shortage		0.16				0.11	
World hunger							
Social unrest		0.19					
Helpfulness of solutions							
Drive less						0.14	
Stop aerosol sprays						0.16	
Plant trees	0.11						
Reduce industrial emissions						0.12	
Energy efficient tech.						0.13	
Halt deforestation	0.14						
Reduce home energy use						0.18	
Family planning	0.24						

† Values are beta coefficients derived from stepwise multiple regression in which all dummy coded source variables were entered in one block. Only betas significant at $p < 0.05$ were entered in the table. "Use of CFCs," "health problems," and "world hunger" had no significant predictors.

the public, despite some significant misconceptions, are poised to provide support for policy initiatives to deal with global warming. Most of our respondents recognized global warming as a problem, many were significantly engaged with the topic, and many were communicating through mass media and interpersonal channels with significant effect on the breadth of their understanding.

Despite their current shortcomings, our results suggest that the media are already making some contribution to public understanding of global warming. The crucial understanding of the connection between fossil fuel consumption and climate change was significantly related to use of major media (television, newspapers, magazines, and books) and to communication through interpersonal channels (family/friends). Communication behavior was also linked to support for key solutions, such as driving less, reducing home energy use, and using more energy-efficient technology.

Along with this positive beginning, the evidence also identified important areas for improved communication. Our findings suggest that the overemphasis on deforestation as a cause of the problem can be traced back to interpersonal sources, although a belief in the efficacy of halting this process and/or planting more trees is more strongly associated with television use. The persistence of the belief that reducing spray-can use is an effective solution can also be traced back to interpersonal communication. Perhaps more progress toward solving the problem would be made if the distinction between ozone depletion and global climate change could be introduced through interpersonal channels. In any event, it seems clear from this study that we need to be just as concerned about the content of public dialogue as we have been about the accuracy of media coverage. We also need to be concerned about the relationship between the two.

The importance of interpersonal communication also suggests that it may also be useful for the designers of public education campaigns to consider ways of creating community involvement in solving the problem of climate change. At present, attempts to solve this problem tend to concentrate on individual actions or on national or international policy options. However, there is evidence suggesting that providing targets for a community to reach can be effective in reducing waste or energy consumption.[34] This is another area in which communications research might make a useful contribution to engaging the public in solving environmental problems such as global climate change.

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