Socialization or Rewards? Predicting U.S. Scientist-Media Interactions

By Sharon Dunwoody, Dominique Brossard, and Anthony Dudo

This study investigates scientists as public communicators, with a particular focus on factors that influence scientists' interactions with the mass media. Based on a U.S. survey of scientists, the results show that some of the patterns characterizing these interactions have remained remarkably stable over the course of at least three decades. Scientists continue to interact with journalists more frequently than commonly assumed, and status, socialization, and positive intrinsic rewards are all positively associated with higher frequencies of media contact.

In his 1993 presidential address to the American Association for the Advancement of Science (AAAS) annual meeting, Nobel Prize winner F. Sherwood Rowland noted that "faulty communication" was the most serious problem facing science.[1] Google co-founder Larry Page endorsed those sentiments in a plenary address at another AAAS annual meeting fourteen years later when he reflected that science has a "serious marketing problem."[2]

Although the call is one that has been heard for decades, the prestige behind today's signals suggests that the scientific culture is giving renewed and growing attention to scientists' role in popular science communication. And although the culture has, historically, given primarily lip service (and few rewards) for scientists' engagement in public communication, it may now be putting its money where its mouth has long been. Major scientific and political organizations such as AAAS (http://communicatingscience.aaas.org/Pages/newmain.aspx), Sigma Xi (http://www.sigmaxi.org/programs/public/index.shtml), The Royal Society (http://royalsociety.org/page.asp?id=1151), and the European Union (http://www.sirc.org/messenger/) are now devoting resources to training scientists for public engagement processes.

These calls and initiatives beg a few questions, however. Into what kind of "vacuum" are scientists stepping? We have only modest base-

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line data to provide a modern snapshot of the "U.S. scientist as public communicator." Are these individuals as rare and conflicted about their roles as many senior scientists seem to believe? Or have today's scientists become relatively facile and frequent interacters with both journalists and the public? And whatever the pattern, what factors encourage or discourage U.S. scientists from opting into these behaviors? Identifying these motivations is essential to an improved understanding of scientists' public communication behaviors.[3]

This study seeks to provide some answers to those questions. As part of a five-country survey of scientists' views about and behaviors regarding the public communication of science,[4] a team of U.S. communication researchers surveyed a representative sample of U.S. scientists in two biomedical fields: stem cell research and epidemiology. We offer an analysis here of predictors of those scientists' interactions with the mass media and employ scientists' self-reports of the frequency of their interactions with journalists as our dependent variable.

Scientist-Journalist Interactions

Both science and journalism reflect—with a mixture of regret and bemusement—on a historically thorny relationship. Historian John Burnham devoted an entire book to mapping the evolution of that relationship during the nineteenth and twentieth centuries,[5] and modern accounts support the idea that these two occupations circle each other warily, routinely misperceive each other's motives, embrace different and sometimes conflicting norms, and encounter significant difficulties when interacting with each other.[6]

Scholars over the years have tried to better understand this relationship, primarily from the perspective of the scientist.[7] One of the earliest studies, a survey of French scientists in the 1960s, for example, found that senior scientists were far more likely to interact with journalists than were junior scientists, presumably because those with status in the occupation could more easily weather the critical storms that popularization produced among peers.[8] That same relationship between status and popularization activity emerged in a recent analysis of the popularization activities listed in the annual reports of 10,000 French researchers funded by the Centre National de la Recherche Scientifique (CNRS).[9]

Another seminal study of "visible scientists" in the United States, however, argued that status was no protection from critique and that highly visible scientists were subjected to sustained and sometimes damaging criticism from the scientific culture.[10] One survey of American scientists in the early 1980s found that respondents felt there was "little to be gained within science by engaging in the public dissemination of information,"[11] a sentiment apparently shared, more than a decade later, by Australian scientists surveyed by Gascoigne and Metcalfe.[12] Hilgartner argued that views of popularization as a flawed process that distorts science actually have utility for scientists because they reinforce the social hierarchy of expertise.[13]

Still, in the midst of this decades-long litany of both anecdotal and systematic evidence on behalf of a distant and dysfunctional relationship

between scientists and the media, studies kept unearthing a discordant pattern: Scientists were indeed interacting regularly with journalists and reported enjoying those interactions.

For example, a survey of scientists at two midwestern universities conducted in the late 1970s found that some two-thirds of respondents had spoken with journalists and, further, had done so five times, on average, during their careers.[14] A study of first authors of scientific articles published in the country's two top medical journals—the *New England Journal of Medicine* and the *Journal of the American Medical Association*—found that six in ten had been contacted by journalists directly and that 88% of the resulting stories were perceived by the scientists as accurate.[15] A highly touted national study of scientists and journalists by the Freedom Forum with the proposed take-home message vividly conveyed in the title, *Worlds Apart: How the Distance between Science and Journalism Threatens America's Future*,[16] made much of the dysfunctional relationships uncovered, but also found that 74% of the scientists surveyed had been interviewed by journalists at a frequency of from "every few years" to "more than once a month," that more than 80% of the sample would welcome communication training, and that nearly 90% would like to engage journalists in conversations about science journalism.

Similarly, a nationwide survey of British scientists conducted for The Wellcome Trust found that more than half of the scientists had participated in at least one public communication activity in the previous year and that 66% of the sample considered speaking on television or radio to be an effective method of communicating research to the public.[17] The study of CNRS scientists in France did find that more than half of the individuals had, in fact, *not* been involved in popularization activities but also determined that the number of activities reported by these scientists had increased over time.[18]

Frequency of interaction is a relatively common dependent variable in past studies, as it is capable of capturing both behavioral and affective states. The behavioral component is contingent on memory, of course, which is why most of the operationalizations of this measure are ordinal in nature. And while the association between affect and behavior is likely mediated by a host of other variables, frequency of media contact tends to be positively associated with positive evaluations of the quality of media coverage.[19]

Factors Influencing Frequency of Interaction

So do scientists today run from media encounters or embrace them? And what might explain those approach/avoidance patterns? Past studies have explored a number of independent variables that can influence scientists' popularizing behaviors. In this particular analysis, we will concentrate on four whose recurrent nature in past work reflects their importance and permits comparison: (1) a scientist's status, (2) familiarity with the media landscape, (3) socialization to public communication processes (captured in this study as the degree of formal training in communication skills and perceived self-efficacy at managing

interactions with journalists), and (4) perceptions of possible rewards deriving from public visibility.

First, though, we offer a research question to catalyze the baseline data portion of this analysis:

> **RQ1**: How frequently do scientists in this study interact with journalists?

Status. Although typically (and unavoidably) confounded with time in the occupation, status has loomed as one of the most reliable correlates of both scientists' frequency of media contacts and their attitudes toward media coverage of science.[20] Scientists who have been acknowledged as successful members of the occupation have been more likely to welcome and appreciate interactions with journalists than scientists whose credentials are still being forged in the fire of probationary status. Although the popularity of science communication training among science graduate students at many universities suggests that young scientists are indeed interested in public communication and may be more likely today to engage in communication behaviors than in the past, the consistent empirical record leads us to hypothesize:

> **H1**: Other factors held constant, a scientist's status in the occupation will be related to her frequency of media contacts. Specifically, we expect to find that the higher the status level, the greater the volume of interactions.

Familiarity with Media. As Zajonc demonstrated many years ago, simple exposure to a phenomenon can positively influence one's affective response to that phenomenon.[21] One might expect, then, that extended exposure to mass media as an information consumer would encourage a scientist to feel more positive about mediated channels and, thus, render him more likely to interact with media representatives. However, the media-saturated nature of American culture may blunt such familiarity effects. At least one study found no relationship between public engagement activities and scientists' use of "non-specialist information sources."[22] However, because there is some evidence that scientists attend to mediated channels to monitor developments in science,[23] one might wonder to what extent, if any, exposure and attention to media stories about science might influence scientists' willingness to interact with journalists. We therefore propose the following research question:

> **RQ2**: Other factors held constant, is there a relationship between a scientist's level of exposure to mass media and his frequency of contact with journalists?

Socialization. Individuals who invest in effortful learning about something are quicker to embrace and utilize it. Thus, we consider public communication learning opportunities to be catalysts for scientists' willingness to engage both journalists and the public, regardless of

whether the scientists opted into those learning situations voluntarily or not. We characterize this process as socialization and seek to capture two dimensions:

•*Formal Training.* The steady, world-wide increase in formal communication training opportunities for scientists suggests that the scientific culture believes that development of knowledge and skills will have a positive effect on a variety of aspects of scientists' public communication attitudes and behaviors.[24] While evidence for such effects is difficult to find because the bulk of programs have not been subjected to evaluation, some survey results suggest scientists who feel equipped to communicate their research and who have received training are more likely to participate in public communication.[25] The common-sense nature of a training-behavior link seems hard to dispute. So we hypothesize:

> **H2**: Other factors held constant, the extent of a scientist's formal training in public communication skills will be positively related to her frequency of contact with journalists.

•*Perceived Self-efficacy.* Regardless of training, one's perception of one's ability to successfully negotiate a complex interaction will be influential. Self-efficacy has a long and distinguished history of serving as an important precursor to a variety of behaviors (e.g., participatory behavior),[26] and we would expect to see that effect here as well:

> **H3**: Other factors held constant, a scientist's perception that he can successfully manage interactions with journalists will be positively related to frequency of contact with journalists.

Rewards. Scholars have frequently posited that, as in other occupations, scientists will be sensitive to both positive and negative rewards that stem from interactions with journalists and the resulting public visibility.[27] Anecdotal examples are common. For example, a sociologist who encountered a flood of journalistic queries as the result of presenting a paper at a national meeting wrote a piece reflecting on both negative and positive outcomes of that experience: Her sociology peers chastised her for getting embroiled in behaviors (interviews with reporters) that took her away from her research, but the study that made headlines became one of her most-cited pieces of research in the sociology literature.[28] On the more forcefully negative side, almost all science writers can reflect on tales of scientists who feel they were "burned" in earlier interviews and, as a result, now refuse to talk with journalists.[29]

It seems logical, if not obvious, to argue that rewards matter. But do certain types of rewards matter more than others? The job satisfaction literature has long reflected on two reward domains: intrinsic and extrinsic. Intrinsic rewards come from characteristics of work that give

individuals personal feelings of being valued, of having made a difference. Extrinsic factors illuminate relationships between action and overt rewards, such as higher status or higher income levels. In general, intrinsic rewards have been more highly correlated with job satisfaction than have extrinsic rewards.[30] That is, the intrinsic satisfaction of performing an interesting or stimulating task well often trumps such external rewards as pay or promotion.

Extrinsic and intrinsic dimensions are also inherent in the reward systems relevant to public communication. On the one hand, scientists complain that they are given scant credit for public communication in terms of merit and peer reviews (extrinsic) while, on the other, many identify such things as improving public understanding as important reasons for engagement (intrinsic). Some scholars have already begun to explore these reward dimensions in science communication. Martín-Sempere, Garzon-Garcia, and Rey-Rocha, for example, uncovered both intrinsic and extrinsic factors in a study of motivators of Spanish scientists engaged in a science fair,[31] as did Gascoigne and Metcalfe in their survey of Australian scientists' communication behaviors.[32] Thus, we hypothesize:

H4a: Other factors held constant, perceptions of extrinsic rewards will be positively related to frequency of interactions with journalists.

H4b: Other factors held constant, perceptions of intrinsic rewards will be positively related to frequency of interactions with journalists.

Methods

The data used in this study were collected via a mail survey of stem cell scientists and epidemiologists who are based within the continental United States. These data are part of a larger, five-country survey of scientists that was conducted in late 2005/early 2006 in the United States, Great Britain, Germany, France and Japan.[33] The sampling strategy described below was applied uniformly to scientist populations in all the countries. To our knowledge, this is the first study of scientists' public communication activities to apply a systematic sampling strategy to capture a representative sample of *productive* researchers.

The Sample. Our goal was to sample active researchers in two fields, stem cell research and epidemiology. Using the PubMed database, we first used search strings to select journal articles in the two fields published between 2002 and 2004, (indexed before August 17, 2004 for stem cell texts and before September 19, 2004 for epidemiology texts). After pulling the names of all authors and coauthors and eliminating researchers who had coauthored only one article during the time period (we worried that such an individual's connection to the research area could be tangential), we then sought specific addresses for the remaining scientists. After eliminating scientists who were no longer residents of the countries under study and those for whom addresses were not retrievable, 7,669 researchers remained in the population, nearly 58% of them in

the United States. We then drew simple random samples of U.S. researchers from the two research arenas, giving us a final sample of 1,254 U.S. scientists.

The Survey. An adapted version of Dillman's Total Design Method[34] was used as the procedure for conducting the mail survey. A postcard announced the survey and was followed by an initial mailing of the survey. Next, a postcard reminder was sent to individuals who had not yet responded, followed by the second mailing of the survey. In the final stage, an electronic version of the questionnaire was employed as a stage three mailing effort, and non-respondents were directed to the electronic questionnaire via e-mail contact.

The three waves took place between November 2005 and February 2006. Of a total of 1,254 potential respondents, 363 returned completed surveys, resulting in a response rate of 34.5%. Comparisons of responses of early to late responders to the questionnaire did not show any significant demographic or response differences, leading us to a guarded level of optimism about the representativeness of this sample.

Operationalizations. Next, we describe the construction of our dependent and six independent variables. In addition to the five predictors discussed above, we added gender as a control variable.

Dependent Variable: Scientists' Contact with the Media. Scientists responded to the question "In the past 3 years, have you had professional contact with journalists from the general mass media face to face, by phone, or by mail/fax/e-mail?" We aggregated the four response possibilities into three: No contact (32% of our sample), modest contact (1-5 times) (29%), and frequent contact (6 times or more) (29%).

Independent Variable: Status. We aggregated two variables—career level (junior, mid-career, senior) and number of career publications (a five-value variable that ranged from "fewer than 10" to "more than 100")—by first standardizing and then summing them (r =.67, p< .001).

Independent Variable: Rewards. To be sensitive to extrinsic/intrinsic differences, we factor analyzed a bank of specific reward items to explore their ability to aggregate into the two reward dimensions. We got three dimensions instead:

•*Intrinsic Rewards*. This variable is the sum of responses to a request that the participant indicate "how much you personally would enjoy engaging in this activity" on a scale of 1 (dislike intensively) to 4 (enjoy very much) with respect to four items: explaining your research and its results to the public, describing the possible practical uses of your research, discussing the social and ethical aspects of your research, and contributing to public debate about policy related to science (alpha=.85, M=14.8, sd=3.5).

•*Negative Extrinsic Rewards*. Respondents were asked to respond to the following stem: "Regardless of whether you yourself have interacted with the media, how important to you personally are the following concerns that increase scientists' reluctance to agree to contact with the media?" on a scale ranging from 1 (very important) to 4 (not impor-

tant). An index variable was constructed based on their recoded responses to four items: Possibility of negative publicity, possible critical reactions from peers, possible critical reactions from the head of one's department or organization, and possible critical reactions from the public (alpha=.73, *M*=9.97, sd=2.67).

•*Positive Extrinsic Rewards*. The stem for this set of items was "How important to you personally are the following possible outcomes that make scientists feel more positive about contacts with the media?" This was measured with a 4-point scale (1=very important; 4=not important). An index was constructed based on the recoded responses to three items: Increased visibility for sponsors and funding bodies, enhanced personal reputation among peers, and enhanced personal public reputation (alpha=.71, *M*=7.83, sd=2.10).

Independent Variable: Familiarity with Media. We had gathered data about both channel exposure and attention to science stories across a number of channels. Exploratory factor analyses resulted in three aggregate variables. Each variable sums responses to two items for three channel types: "How often in the typical week do you read newspapers or news/public affairs magazines, listen to radio, watch TV, or use the Internet" and then "How often in the typical week do you specifically read, listen to, or watch science-related media coverage?" All responses were limited to the following options: almost every day, several times a week, once a week, or less than once a week. Correlations between pairs of exposure measures were: print exposure ($r = .64$, $p < .001$), radio exposure ($r = .29$, $p < .001$), and television exposure ($r = .34$, $p < .001$)

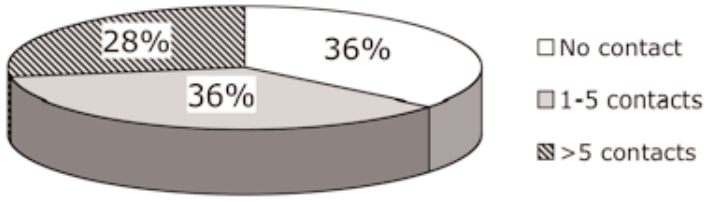
Independent Variable: Formal Training. This variable sums the responses to two variables. Those respondents who said no to "Have you ever had formal training in communication skills, whether brief (e.g., a workshop) or lengthy (e.g., a course or internship)?" were given a value of 0 on the aggregate formal training variable. Individuals who said yes to that first question were then asked to check any of the responses to the next question: "If you have received formal training in communication skills, at what audience were those skills aimed? (students, scientists, general public, mass media). We summed those "checks" for a final formal training variable that ranged in value from 0 to 4 (*M*=.65, sd=.95).

Independent Variable: Self-efficacy. This measure of a respondent's perceived communication skills sums five reactions (on a 5-point scale from 1 [extremely difficult] to 5 [extremely easy], alpha=.83, *M*=17.36, sd=3.72) to this stem: "Certain skills necessary for public communication may differ from the skills required to do research and communicate to your peers. Please give us your first impression of whether you personally would find it difficult or easy to": explain scientific facts in a way that lay people can understand, adjust to different kinds of lay audiences (e.g., children, politicians), anticipate lay people's potential points of interest in your work, deal with critical objections of the audience, and anticipate lay people's level of knowledge.

Independent Variable: Gender. Given the male-dominated nature of science, we decided to add gender to the mix of independent variables in order to detect the possible gendered nature of public communication

FIGURE 1

Scientists' Amount of Media Contact in the Last Three Years (N=*363)*



activities. In a recent study, Jensen et al.[35] found that female scientists were more active in popularization activities than were males. Male (66% of sample) is coded 1 and female is coded 0.

Results

Because our frequency-of-contact dependent variable was ordinal in nature, we used ordinal logistic regression to test our hypotheses and explore our second research question.[36] Our model fit the data well (Deviance chi-sq = 650, df = 682, $p > .05$; -2LL = 639, $p < 0.001$). As indicated by the result of the test of parallel lines, the proportional odds assumption was not violated (chi-sq = 8.88, df = 4, $p > .05$). The model accounted for 32.4% of the total amount of variance in frequency of contacts with the media.[37]

RQ1 asked about the frequency with which scientists in the sample interacted with journalists. Within the previous three years, some two-thirds of the scientists indicated they had been in contact with a journalist, 36% (133) of the respondents indicating up to five interviews and the remaining 28% (100) recording six or more interactions (see Figure 1).

As predicted in **H1**, status was positively associated with frequency of contact with media. For a one unit increase in status, the expected ordered log odds increased by .42 as we moved to the next higher category of frequency of media contacts (see Table 1).

In response to our **RQ2**, we did not observe any statistically significant effect of media exposure/use on frequency of media contact, when others variables were held constant.

In contrast, feelings of self-efficacy towards public communication activities and extent of formal training in communication were both significantly associated with frequency of media contacts, supporting **H2** and **H3**.

The picture was more complex for the rewards indices, however. Perceptions of extrinsic rewards—whether positive or negative—were not associated in a statistically significant way with frequency of contacts with journalists, so **H4a** is not supported. However, perceiving

TABLE 1

Ordinal Logistic Regression of Association between Frequency of Media Contacts[a] and the Independent Variables of Interest (Controlling for Gender)

	Log Odds	95% Confidence Interval Lower Bound	Upper Bound
Demographics			
Gender (Male)	.26	-.21	.72
Status	.42**	.29	.56
Familiarity with Media			
Print Media	.06	-.05	.18
Radio	.02	-.12	.15
Television	-.12	-.26	.02
Socialization			
Self Efficacy	.07 *	.01	.13
Formal Training	.34**	.11	.56
Perceptions of Rewards			
Positive Extrinsic Rewards	-.01	-.11	.10
Negative Extrinsic Rewards	-.06	-.14	.02
Intrinsic Rewards	.13**	.06	.19
Nagelkerke Pseudo R^2 (%)	32.40		
-2 log likelihood	631		

**$p < .01$, *$p < .05$

[a] Scored as no contact; low contact (1-5 times); and high contact (6 or more times) over the last three years)

intrinsic rewards in these contacts was associated with more frequent interaction, supporting **H4b**. For a one unit increase in "intrinsic rewards" the expected ordered log odds increased by 0.13 as one moved to the next category of frequency of contacts.

Discussion

Our analysis of productive American researchers in the fields of stem cell research and epidemiology paints a picture of scientists who are indeed interacting with journalists occasionally and, in some cases, routinely. Although nearly a third of our sample indicated they had had no contact with journalists in the past three years, fully two-thirds had experienced such contacts. Interestingly, this proportion is identical to that found in studies from the 1980s,[38] as well as to patterns unearthed in the 1990s.[39] The level of journalistic engagement of scientists over time looks greater and far more stable than the persistent, anecdotal cautionary tales would suggest.

This, further, suggests that the recent "boomlet" in training programs within universities and scientific organizations is emerging not so much in advance of a trend as in response to it. Cultural change with

respect to scientists' involvement in public communication has been under way for some time;[40] these new skill-building components may well serve to hasten it.

A number of variables that proved potent in earlier studies also emerged here as predictors of scientists' level of contact. The most powerful was status. Senior, productive researchers in these two fields are encountering more journalists than are more junior individuals with, at present, lower levels of productivity. The world of public science communication still appears to be one dominated by seasoned, experienced scientists as sources. The continuing dominance of status as a behavioral predictor suggests, among other things, that media contacts of researchers remain largely institutionalized, that is, bound to leadership roles and, thus, regulated by scientific and organizational norms.[41]

That may change, as universities charged with training the next generation of scientists are increasingly offering graduate students the opportunity to develop communication and outreach skills through courses, workshops, and certificate programs. Illustrative of this trend is the University of Wisconsin-Madison's Delta program (www.delta.wisc.edu), which offers STEM (science, technology, engineering, math) students coursework and internships in informal science education leading to a certificate.[42] The popularity of these offerings suggests that scientists-in-training may seek to make popular communication a part of their intellectual portfolio at the very beginning of their careers; if so, status could decline in importance as a predictor over time.

Public science communication also appears to be a world where scientists are driven by the prospect of positive intrinsic rewards, by a sense that their participation can influence public understanding of science and the role of science in society, a pattern also found by Martín-Sempere and colleagues.[43] That extrinsic rewards did not survive the multivariate analysis process is a bit puzzling, as the culture of science seems to believe strongly that those types of rewards—positive or negative—are an influential part of the picture. But this analysis suggests that appealing to scientists' moral and ethical values may be a better way to catalyze their public communication behavior.

Both formal training and a scientist's perception that she already has the requisite skills predicted a greater number of interactions with journalists. These results echo the findings of The Wellcome Trust report *The Role of Scientists in Public Debate* about British scientists[44] and will be heartening to scientific organizations and universities that are investing in such training.

Finally, our media familiarity variables fell away. This result is similar to that found by Willems & Woudstra[45] and complements their argument that the media are such a ubiquitous part of the American culture that exposure to them will have little bearing on interaction decisions. Even capturing scientists' level of attention to science in these channels—items that were part of our aggregate exposure measures—did not make them predictive. Still, given the variance in

the nature of science coverage across channels, it seems plausible that patterns of media use should both vary by scientist and somehow be linked to scientists' evaluations of the public communication process. Is it possible, for example, that the influence of media use may be indirect, that is working through scientists' beliefs about differential aspects of the communication process? Future research could explore this possibility.

Some aspects of this study may have led to an overestimate of scientists' public communication activities. Jensen et al. found a positive relationship between scientists' research productivity and their popularization activities,[46] so this study's focus on active researchers, while allowing us to explore the scientists most likely to be generating the knowledge of interest to the mass media, also may overestimate the public communication activities of the "typical" scientist.

Additionally, it is possible that popular interest in medicine and health has given biological scientists—the focus of this study—more opportunities to interact with journalists and, thus, has encouraged behaviors and attitudes different from those of scientists in other domains, such as the physical sciences.

A third possible source of overestimation is the modest 34.5% response rate. We did compare early and late survey responders and found no significant differences in their answers. But one can imagine that scientists who are indifferent to popularization may be less likely to respond to our invitation to participate in the survey. If indifference is linked to low levels of interaction, then the sample might reflect higher-than-average interactions levels.

Our title asked whether socialization or rewards predict scientist-media interactions. These data suggest that the answer is "both," but that a combination of status and socialization is playing a more powerful role than rewards. It should be noted, however, that a larger number of interactions between journalists and scientists does not necessarily mean that these are successful interactions. In any exchange process, one or both of the participants could experience frustration if their individual goals are not met. Future research should focus on analyzing the nature and content of scientists' communication efforts and whether outcomes match the strategic goals scientists and their institutions set for these efforts.

This analysis provides a useful update to a literature exploring scientists' media interactions that dates back nearly forty years. Over the course of this nearly half century, some of the patterns found have been remarkably stable. It will be interesting to open this question again in another decade or so, after today's efforts to stimulate more communication behavior on the part of scientists have had a chance to bear fruit. That next study will also need to begin to explore direct—not just mediated—relationships between scientists and the public, as one outcome of increased interest in communication will be scientists' skillful use of the Internet to "speak" directly to various publics.

NOTES

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