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Scientists are talking, but mostly to each other: a quantitative analysis of research represented in mass media

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Journal publication has long been relied on as the only required communication of results, tasking journalists with bringing news of scientific discoveries to the public. Output of science papers increased 15% between 1990 and 2001, with total output over 650,000. But, fewer than 0.013–0.34% of papers gained attention from mass media, with health/medicine papers taking the lion's share of coverage. Fields outside of health/medicine had an appearance rate of only 0.001–0.005%. In light of findings that show scientific literacy declining despite growing public interest and scientific output, this study attempts to show that reliance on journal publication and subsequent coverage by the media as the sole form of communication en masse is failing to communicate science to the public.

Keywords: citations, mass media, paper publication, research, science communication

1. Introduction/background

The overall reliance scientists place on journalists to communicate research findings to the public seems at odds with the low opinion that scientists have of journalists (Hartz and Chappell, 1997) especially when coupled with the widespread sentiment among scientists that journalists are failing to accurately present research findings (Hartz and Chappell, 1997; Dunwoody and Scott, 1982).

The area of science communication, particularly with regard to the news media, has garnered much attention and study. With the discipline of science journalism coming into existence early in the nineteenth century (Lightman, 2000), analyzing the science journalist's roles and abilities has been the subject of numerous studies. And it is of little wonder, since the media takes on the role of primary source of information about scientific discoveries once individuals complete formal education (Nisbet et al., 2002). Additionally, scientists use the media as a source for science news about new scientific discoveries, thereby allowing researchers to disseminate research findings to other scientists through mass media (Phillips et al., 1991).

With output of scientific research being measured by the growing number of articles published in peer-reviewed journals (NSF, 2006), and input being the growing amount of money that is put into publicly funded research, it would seem that the scientific machine is running smoothly. But as highly productive as science is, it is necessary to examine what quantity of that output is making it to the mainstream public. The scientific community has been operating

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under a contract with society, where it is supported in its efforts to produce "reliable" knowledge, provided that it merely communicates those discoveries to society (Gibbons, 1999). It is therefore important to gauge or quantify the amount of output that reaches the public. Since media is the primary source for news about scientific discoveries, quantifying the amount of scientific discoveries appearing in mass news media becomes important.

The bulk of the research in the area of science communication and mass media generally falls into two categories: how much science appears in mass media, and how effective journalists are at conveying science to the public. While this study attempts to shift the area of focus of communication from the media and the public to the scientific community, it is necessary to set this research against the backdrop of earlier studies that have examined the state of science in the media and the relationship between scientists and journalists. In doing so, the main players in the relationship between science, the media and the public will be examined in order to provide a basis for drawing conclusions from this study.

The news media and the amount of science in the news

Several studies have been conducted in order to examine the amount of science in general that is found in mass news media, and if that amount has changed over time. The content of news stories that appeared in the three US newspapers, the *New York Times*, the *Washington Post*, and the *Chicago Tribune* over three time spans showed that there was a marked increase in total science articles that appeared in later years, though the percentage of articles that cited specific papers remained the same (Pellechia, 1997). This builds on earlier research that showed an increase in science news articles from 1951 to 1971 (Cole, 1975).

In both US and UK newspapers, medicine and health topics have garnered the largest share in science news articles (Weitkamp, 2003; Pellechia, 1997), with journals as well as press conferences, news releases, personal contacts, and other accountable sources (Weitkamp, 2003). It is noteworthy to mention that the majority of journals do not issue press releases (Woloshin and Schwarts, 2002). However, in regards to high-profile medical journals, press releases are regularly released for items that are considered newsworthy, and the issuing of press releases predicted their likelihood of being reported on in newspapers (Stryker, 2002). An extensive study of eight high-profile newspapers in Europe and the United Sates showed that of the 142 news articles on published papers collected, 84% originated from press releases from their respective journals (deSemir et al., 1998).

The science journalist and the role as science communicator

When considering how effective journalists are at conveying science to the public, the prevailing sentiment among scientists has been dissatisfaction with perceived misrepresentation of work, as scientists seem primarily concerned about how their work is presented, in both accuracy and background (Hartz and Chappell, 1997). The percentage of science articles that were judged by scientists to be error-free ranged from 8.8% to 29.4% (Tankard and Ryan, 1974; Pulford, 1976). However, additional study found that the most common error cited by scientists (60%) was failure by the journalist to include qualifying statements regarding the research (Singer, 1990). This points to a desire or expectation on the part of scientists for journalists to communicate details regarding the nature of scientific studies, despite the idea that most scientists (91%) believe that journalists fail to understand the nature of science (Hartz and Chappell, 1997).

Several studies lay out suggestions for improving science reporting, but the suggestions offered, namely journalist training, focusing on audience needs, and working more closely

with sources (Weigold, 2001; Kua et al., 2004) are mostly directed at science journalists. However, since there are so few science journalists, even at near-perfect accuracy, the extent of possible research covered is limited. Much responsibility, and subsequently much attention, has been placed at the feet of a small number of journalists where little has been directed towards the scientific community with regard to quality and quantity of public communication.

The science consumer

With the biennial publication of the National Science Foundation's (NSF) *Science and Engineering Indicators*, the state of the science consumer has been effectively tracked. When considering which sources the public turns to for science news, in 1992 the top sources were television news (95%), newspapers (56%) and news magazines (28%) (Miller and Pifer, 1993). In 2001, the top source remained television news (44%), followed by news magazines (16%) and newspapers (16%) (NSF, 2002). The Internet as a source for science news ranked 4th with 9% in 2001, but as will be discussed later, the portals for news on the Internet remain mainstream news media outlets.

Interest in learning about science discoveries has remained high. In 1992, 85% of respondents indicated a moderate or high interest in learning about new scientific discoveries; in 2001 that percentage grew to 92% (NSF, 2002). Despite this, there has been little change, especially for the better, in the public's scientific literacy. In 1992, 55% of respondents believed humans coexisted with dinosaurs, and that percentage decreased to just 52% in 2001. Evolution, phrased as "human beings, as we know them today, developed from earlier species of animals" netted 45% correct answers in 1992, up to 53% in 2001, but declined to just 50% in 2004 (Miller and Pifer, 1993; NSF, 2002, 2006). Out of the 16 questions that were asked in 1992 and 2001, only four questions showed a greater than 3% increase in correct answers; correct answers declined for three questions and showed no change for three questions (Miller and Pifer, 1993; NSF, 2002). Not surprisingly, the percentage of people feeling very well informed about new scientific discoveries was just 14% in 1990 and remained unchanged at 14% in 2001 (NSF, 2002).

The scientific community

An important factor when considering how much science is being reported to the mainstream public is how much scientific research is being produced, and how that has changed over time. A key measure of science output is defined by NSF as the number of articles published in peer-reviewed journals (NSF, 2006). The scientific community has increased output in recent years, with total output of articles climbing from 508,795 in 1990 to 649,795 in 2001 (NSF, 2006).

Another change within the scientific community that must be considered is the branching out into sub-disciplines. The fields of science have branched into numbers of specializations, each with their own corresponding vocabulary and interest group (Weigold, 2001). Along with this branching out, specialized journals have emerged, and that is certainly a factor in the increase in output. The number of articles that result from journals that emerged after 1985 increased from 23,160 in 1990 to 125,950 in 2001, indicating a fourfold increase by 2001 of articles resulting from journals not indexed by ISI (Institute for Scientific Information) in 1985 (NSF, 2006).

Since a central point of this study relies on the assumption that the scientific community relies on journalists to communicate research findings to the public, it is necessary to explain our rationale for this. Paper publication in peer-reviewed journals is the only accepted form of communication of results that the scientific community engages in en masse. Most scientists want the public to know about their research (Hartz and Chappell, 1997) and scientists also use the mass media to popularize scientific findings and ideas (Lieverouw, 1990). Additionally,

despite the desire to communicate with the public, DiBella et al. (1991) found that of those scientists who have participated in interviews with news media, none had participated in solely scientist-initiated interviews. It is also known that the public uses mass news media as the primary source for news about scientific discoveries after completion of formal education (Nelkin, 1996). While the benefits and desires for communicating science to the public are widely accepted (Hartz and Chappell, 1997; Nelkin, 1996) the primary responsibility for communicating science to the public rests on the shoulders of news media (Treise and Weigold, 2002).

Focus of this study

It is clear that the area of science communication with regard to the scientific community, the news media, and the public, warrants additional research. While much study has examined the role of media and the amount of science they carry and how they present scientific research, notably lacking in the field of science communication has been a quantitative analysis of scientific output compared to coverage in mainstream news outlets. The goal of this study is to examine the volume of scientific output and the amount of output that makes it to a mainstream audience in order to test the validity of using paper publication as the accepted method of communicating science discoveries to the public. Specifically, this study attempted to answer the following questions:

1. How many scientific papers that were published in peer-reviewed journals made it to a mainstream audience?
2. What percentage of papers was represented in the mainstream news media?
3. Since the number of papers published has increased, has the number of papers reported on increased?

2. Methods

News sources/sampling

The years 1990 and 2001 were selected as years to include in the study. For media coverage and scientific paper analysis, all of 1990 and the first 3 months of 2001 were used as the data set. For citation comparisons, all of 1990 and 2001 were used as the data set. Sufficient time had elapsed between the two study years in order to see trends, and both sets were time periods when no single news story dominated news coverage.

Television, newspapers, and news magazines were all evaluated in order to determine what media sources should be included in this study for a comprehensive picture of mainstream news media coverage of published science articles. Newspapers, particularly the *New York Times* and *Washington Post* have been found to be most extensive in both the comprehensiveness and total number of science articles (Pellechia, 1997). However, the decision not to include newspapers in this study resulted from the fact that newspaper readership positively correlates with education level (Nisbet et al., 2002). Since those individuals with a college degree or higher represent the largest percentage of individuals that use newspapers as their primary news source (NSF, 1993), newspapers do not seem indicative of what news the mainstream public is receiving. Television as a news source has a negative correlation with education level, and while news magazines show a positive correlation, it is to a lesser degree than newspapers (NSF, 1993, 2002).

The news magazine *Time* and the news program *NBC News* were selected as the mainstream news media outlets for this study because of their consistently high circulation/ratings

numbers during the study period of this research (Project for Excellence in Journalism, 2006; Audit Bureau of Circulations, 2003).

Previous studies have defined science news articles to be those articles that deal specifically with research findings (Evans et al., 1990; Pellechia, 1997), but that methodology was not used in this study because it did not encompass all instances of references to published papers. Instead, all articles printed and aired during the time periods of the study were examined for the following reasons:

1. A cursory sampling revealed that the number of papers that were reported on was very small, and varied greatly week to week depending on what items were topical in the news.
2. Since journalists report to being interested in presenting a human angle on stories (Nelkin, 1996; Hartz and Chappell, 1997), articles that were on the subject of a timely event may have referenced a paper even though the paper was neither the impetus nor the topic of the article.
3. Research papers were only referenced by journal and author 25–50% when reported on in mainstream news media. In order to distinguish which studies originated from papers from those that originated from industry or other sources, it was necessary to attempt to match referenced research to actual published papers. A sampling or screening method may have overlooked these articles.

The following methodology was employed in researching the questions presented as part of this study. All articles that referenced research, a journal finding, paper, researcher or study were compiled. To determine which of those articles originated from a published paper, information obtained from the media article was correlated to published papers using ISI's Web of Science.

The number of papers reported on in 1990 was obtained from NSF's *Science and Engineering Indicators 2006* and compared to the number of papers reported on in 2001. Included in the counts were articles indexed by ISI's Web of Science as Science or Social Science categorized as articles. Omitted from the counts were records categorized as reviews, notes, letters, corrections, book reviews, news items, editorial and other opinion pieces that were not submitted as products of research.

3. Results

While there were 508,795 total science articles published in 1990, only 66 unique papers were reported on in *Time* and *NBC News*, which represents only 0.013% of the total papers published. In 2001 the total number of papers published grew to 649,795. The adjusted total for the 3 months sampled was 162,448, with 55 unique papers appearing in *Time* and *NBC News*, representing 0.034% of the total papers published. In 1990, 12 papers were reported on by both *Time* and *NBC News*. In the sample from 2001, there were no instances of duplicates.

Articles that appeared in mainstream news media were found to readily categorize into four broad groups: Health/Medicine, Environment/Ecology, Space Science, and Research Science. These categories were selected based on how news media treated the topics, regardless of whether or not scientific research was referenced. Health/Medicine articles generally dealt with treating ailments and new research that showed advancement. Environment/Ecology articles covered environmental hazards or topics affecting specific regions or animals. Space Science articles referenced advancements in the space program or proposed advancements in space exploration. Research Science articles dealt with reports of advancements in fields such

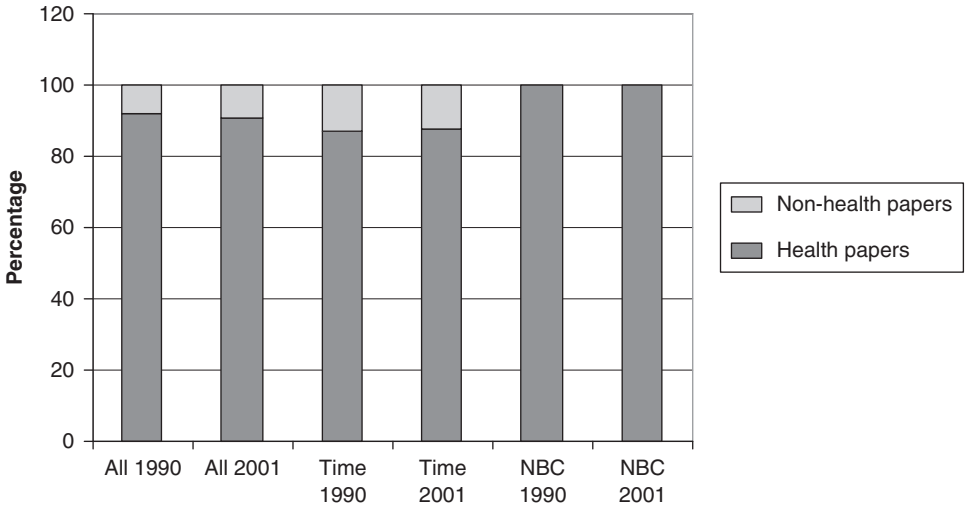

Figure 1. Distribution of papers reported on according to health versus non-health stories.

as chemistry, geology, mathematics, and physics that included no direct connection to the public. In contrast to the articles in the three other categories that typically couched research into a broader story, Research Science articles presented research as the main focus of the article with little or no tie-in to the public well-being.

Figure 1 displays a breakdown of published papers for each media outlet on papers reported on that were referenced in either health/medicine or non-health stories. While total papers reported on by both outlets in 1990 was 0.013%, the number fell to just 0.001% for non-health papers that were reported on. In 2001, 0.034% of all papers were reported on, but again the percentage of non-health papers reported on was lower at 0.005%.

As Table 1 shows, in 1990 *Time* reported on 38 published scientific papers. Of those 87% referenced papers in stories on the topic of Health/Medicine, 5% Environment/Ecology, 0% Space Science, and 8% Research Science. In 2001, of the 43 *Time* articles that included references to scientific papers, 88% were on the topic of Health/Medicine, 0% Environment/Ecology, 5% Space Science and 7% Research Science. In 1990 *NBC News* reported on 41 published scientific papers. Of those 100% referenced papers in stories on the topic of Health/Medicine. In 2001, of the 11 *NBC News* articles that included references to scientific papers, 100% were on the topic of Health/Medicine.

Table 2 shows the distribution among originating journals for papers that were reported on by *Time* and *NBC News*. In 1990 *NEJM* contributed 39.4% of the papers reported on, *JAMA* 21.2%, *Science* 9.1%, *Nature* 6.1% and all others 24.2%. In 2001 *NEJM* contributed 24.1% of the papers reported on, *JAMA* 14.8%, *Science* 3.7%, *Nature* 9.3%, *Circulation* 5.6%, *Neurology* 5.6%, and all others 37.0%.

4. Discussion

If the output of science articles were the volume of a swimming pool, the total papers that made it to a mainstream audience through news media would fill only a quart, and the non-health/medicine papers would be just two tablespoons.

Coverage of published papers did increase between 1990 and 2001, though most notably in *Time* rather than *NBC News*. In contrast to its publication in 1990, in 2001 *Time* regularly

Table 1. Distribution of science papers reported on according to story category in which they appeared in *Time Magazine* and *NBC News* in 1990

	Papers in *Time Magazine*		Papers on *NBC News*		Total papers reported on in *Time* and on *NBC*[a]	
Story category	*N*	%	*N*	%	*N*	%
Health/Medicine	33	86.8	41	100	61	92.4
Environment/Ecology	2	5.3	0	0	2	3.1
Space Science	0	0	0	0	0	0
Research Science	3	7.9	0	0	3	4.5
	38	100	41	100	66	100

[a] Totals were adjusted to account for duplicate papers—papers that were reported on in both *Time* and on *NBC News*.

Table 2. Distribution among originating journals for papers that were reported on through mainstream news media *Time Magazine* and *NBC News* in 1990

	Papers in *Time Magazine*		Papers on *NBC News*		Total papers reported on in *Time* and on *NBC*[a]	
Originating journal	*N*	%	*N*	%	*N*	%
NEJM	15	39.5	19	46.3	26	39.4
JAMA	5	13.2	10	24.4	14	21.2
Science	3	7.9	3	7.3	6	9.1
Nature	4	10.5	3	7.3	4	6.1
Other[b]	11	28.9	6	14.6	16	24.2
	38	100	41	100	66	100

[a] Totals were adjusted to account for duplicate papers—papers that were reported on in both *Time* and on *NBC News*.
[b] Papers that were reported on through mainstream news media that originated in journals other than *JAMA* (*Journal of the American Medical Association*), *NEJM* (*New England Journal of Medicine*), *Science* or *Nature* were found to be in unique journals. No other journal was found to be the originating journal for more than one paper that was reported on.

published a "Your Health" weekly feature that included short briefs that typically reported on research findings in single paragraphs. While this clearly allowed for a greater number of papers to be reported on, it will unlikely quell the argument that many scientists hold on to concerning the depth and breadth of specific research findings reported on.

NEJM and *JAMA* contributed 60.6% of the papers that were reported on in 1990, with *Science* and *Nature* following at 9.1% and 6.1%. These results positively correlate with findings that both *NEJM* and *JAMA* depict human interest in 100% of their press releases, where *Science* and *Nature* depict human interest in only 33% and 35% respectively (Kiernan, 2003). Since journalists rank human interest as an important consideration for reporting on a study (Hartz and Chappell, 1997) this may have increased the likelihood of papers from *NEJM* and *JAMA* being reported on.

Since health articles appear in greater frequency in news media, it is not surprising that the majority of papers reported on originated in *NEJM*, *JAMA*, *Science*, and *Nature*. However, the extremely small number of papers reported on outside of the field of Medicine/Health may be cause for alarm. Nearly half of all papers published in 1990 and 2001 were non-health papers (NSF, 2002), but only 8–9% of papers reported on by *Time* or *NBC News* were non-health. As was noted by the classification of published stories in mass media, non-health stories outside of Environment/Ecology and Space Science tend to be

missing the connection to people, which correlates with Kiernan's (2003) study on the inclusion of human interest depicted in press releases that ranked both *JAMA* and *NEJM* at 100%. As journalists seek the human-interest angle on research stories, this may account for the very low percentage of papers from Research Science.

The results of this study concur with previous findings that describe current communication channels as a narrow filter, with only stories that appeal first to "scientific community gatekeepers" and media able to get through (Mazur, 1981). Whatever the cause of the failure for a paper to make it to mainstream news media, be it faulty translation (Kua et al., 2004), the sheer volume of research findings, or lack of perceived human interest (Nelkin, 1996), this study shows that research is overwhelmingly going unnoticed by the mainstream public.

Scientists, industry professionals, politicians, and science educators use news media to learn about discoveries, much as the lay public does (Burns et al., 2003). The number of journals being published has grown exponentially since 1750, and the overwhelming amount of information published is impossible for scientists to review (Arndt, 1992). It must be noted that even if the bulk of published research is of no value to the general public, unless it is in their direct field, even other researchers will be unlikely to ever see it without seeking it out (Levy-Leblond, 1992).

5. Additional notes

But, what of the Internet?

It is true that the Internet has in recent times surged to become the second highest source for science news selected by individuals seeking science news (NSF, 2006). However, when the top ranking sources of news on the Internet are examined, they are found to be professional news organizations (Nielsen, 2005). The top three are *Yahoo News*, *MSNBC*, and *CNN* (Nielsen, 2005). Therefore, the science journalist remains the gatekeeper. However, the volume of science news stories carried through these portals is not limited by time or printed page allotments, as is the case with television news and print media (Kua et al., 2004), and these avenues could present a unique opportunity for the scientific community to increase its representation in media. Though the effectiveness of this medium is beyond the scope of this study, the growth of the Internet offers unique opportunities for science to establish additional channels of communication with the public. Science topics and information will be there, but the question is, will the scientific community have a prominent role in disseminating it? The numerous studies concerning the language of science versus the language of science journalism, should temper the enthusiasm with caution, however. As Kua et al. (2004: 319) advise, scientists must learn to translate research both in "language and in idiom." The Internet presents a forum, but the message must still be catered to be understood by its potential audience. It is a venue, rather than a method.

6. Conclusion

Overwhelmingly, scientific research is not making it beyond the borders of the scientific community, and an increasing amount is failing to gain attention from researchers outside the specialized fields. Though scientific output continues to rise, its appearance in news media is less than 0.013% of total articles published, a mere 66 unique papers appearing in *Time* and on *NBC News* out of the 508,795 papers published in 1990. The high volume of output and scientists'

strained relationship with media coupled with the small number of science journalists, all contribute to limit the flow of output to the public.

Though there is merit in studying how journalists may improve their coverage of science, and how scientists may improve their communication with journalists, with so few individuals employed as science journalists, expecting that profession to pick up the slack left by the scientific community is a little akin to squeezing blood from a turnip. With the exorbitant amount of science output there is simply only so much published research science journalists can effectively cover.

Responsibility for communication to the public is strikingly absent from the modern scientific community, despite the contract Gibbons (1999) asserts that it operates under. Criticism remains high of journalists, and while they clearly have a self-appointed job of bringing science to the public, they entered into no agreement to absolve scientists of their own obligations to communicate to the public. It is true that the public turns to mainstream news media for science news, but one must consider if that is at least in part due to lack of alternatives.

In his address in 1993, F. Sherwood Rowland, of the American Association for the Advancement of Science called for more effort to be placed on communication "by all of us":

> We are also finding, usually with dismay, that the society which surrounds us and which has supported us quite generously in the past seems less than fully appreciative of what we see as our tremendous success. (Rowland, 1993: 1575)

Scientific literacy has declined in many areas (NSF, 2006) while research output has increased, and the scientific community must shoulder some responsibility for this disparity. With fingers pointed at the scientific community for its role in such diverse topics as Hurricane Katrina, global warming, and evolution, the stakes of scientific literacy of the public are high. If scientists do operate under an obligation to communicate research to the public, by showing how little actual research makes it to a mainstream audience through existing news media channels, this study shows the need for scientists to communicate beyond the borders of science.

Communication is a responsibility we must shoulder en masse. As Albert Einstein astutely pointed out, "It is just as important to make knowledge live and to keep it alive as to solve specific problems" (Einstein, [1932] 1954: 70).

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