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## Behavioral neuroscience and the media

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## ABSTRACT

To provide assurance that accurate summaries of behavioral neuroscience findings are presented in mainstream news sources, it is important for scientists to cooperate with science journalists and, on occasion, write informative articles for lay audiences or contribute scientific knowledge in other relevant venues. Accordingly, three influential science journalists were invited to a special Presidential Symposium at the 2011 IBNS annual meeting to discuss (1) the importance of public dissemination of scientific knowledge, (2) insightful recommendations for effective science writing for mainstream audiences and (3) the potential impact of science blogs on the communication of science information.

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## Introduction

*You know what they say about old habits...*

Kelly Lambert

The ability to form behavioral habits is advantageous for mammals. As adaptive behavioral patterns are repeated, relevant cortico-basal ganglia loops are established to facilitate responses deemed appropriate for a given environmental context [1]. Interestingly, once these habits and stereotyped behaviors are firmly established, they are difficult to extinguish, even in nonreinforced trials. If extinction is eventually achieved, however, the previously formed habits are easily reinstated when former conditioned cues are subsequently encountered [2].

Such is the way scientists write their manuscripts. We are trained to write in third person narrative using impersonal prose muddled with complex empirically supported and sufficiently referenced sentences. There is little room for personal anecdotes or interesting analogies on the pages of these formal science reports. Although it is difficult to break with tradition it would serve scientists well to incorporate a more accessible writing style on occasion and submit timely and relevant articles to mainstream venues. Even though old habits are indeed hard to break (see [2]!), it is important for behavioral neuroscientists to step outside the confines of their laboratories and become more involved in public outreach.

Thus, the purpose of this unique article is to encourage behavioral neuroscientists to adjust their publication habits; that is, in addition to continuing to submit traditional science manuscripts, to also re-establish those cortico-basal ganglia loops to convey our findings in the most effective and relevant ways to the public. With

approximately two-thirds of scientists expressing frustration with the way science findings are conveyed to the public, it is our responsibility to step up to the plate and cooperate with journalists in order to disseminate our findings to mainstream audiences [3]. Accordingly, as former president of IBNS, I invited three influential science journalists to speak in a special symposium entitled *Science and the Media*.

These three speakers, introduced below, not only agreed to participate in the 2011 IBNS symposium but also took time from their busy schedules to contribute a written version of their informative talks for this special issue of *Physiology and Behavior*. Thus, in appropriate reciprocal fashion, these mainstream journalists have agreed to submit their work to a scientific journal. Their efforts directed toward educating IBNS members on the important topic of scientific outreach are greatly appreciated.

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## Introducing the science journalists:

**Sandra Blakeslee** has spent most of her professional career writing for the *New York Times*; additionally she has co-authored eight science books including *Phantoms in the Brain* (with Ramachandran), a neuroscientific approach to answering some of the mysteries of human nature and, more recently, *Sleights of Mind* (with Macknik & Martinez-Conde), a neuroscience view of how our minds are deceived on a daily basis. Sandra also conducts a science writing workshop each spring.

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**Mariette DiChristina** was recently appointed the 8th Editor-in-Chief of *Scientific American*, the first woman to hold the position. In this role, she oversees both the print and online publications of *Scientific American* and *Scientific American Mind*. She also recently served as president of the *National Association of Science Writers* and became an *AAAS Fellow* in 2011.

**Paul Raeburn** is a journalist, broadcaster and author. He is a frequent panelist on *Talk of the Nation*, *Science Friday* and *National Public Radio*, as well as the author of three books including *Acquainted with the Night*, a memoir addressing the challenges of raising children with depression and bipolar disorder. His current book, *Why Fathers Matter*, will be published in 2013. He writes regularly for the *Knight Science Journalism Tracker* and *Discover* magazine.

### The scientists' role in public outreach

Mariette DiChristina

About five decades ago, C.P. Snow, the British scientist and novelist, saw the problem clearly in his famous essay: a growing division between science and the humanities. It's a problem we're still living with today—and one that scientists are in a position to help fix. But first, a bit of background.

Snow dubbed the issue a matter of “The Two Cultures” in his famous 1956 essay. He noted that the humanities were “overrewarded” in the public eye despite the many successes of science as the major engine behind the Allies' victory in World War II. As a side note, Snow believed Germany and the U.S. better balanced science and humanities education than his native U.K., but the lesson is not lost on us today.

Just a year later, the famous Sputnik launch again galvanized the U.S., renewing the country's focus on science and technology, this time to win the Cold War. President Kennedy called for the goal of landing a man on the moon in a decade. This push led to the moon landings and many other related achievements, but it wasn't without cultural consequences. It was hip at the time to excel in science and math, it's true. But that elevation meant that some others, who were not part of the great wave of science, felt excluded or left behind, as Rush Holt, a physicist and Congressman from Princeton, N.J., argued during his lecture to incoming Fellows at the American Association for the Advancement of Science (AAAS) conference in February 2011. (I attended as a new AAAS Fellow and was struck by the notion.)

Today, according to President Obama and others, the U.S. faces a new “Sputnik moment.” With science and math scores sliding against those of competing countries in the global marketplace, the administration has stated its intention to “restore” science to its rightful place in decision-making and in educational emphasis. Toward that end, the White House has launched the Educate to Innovate initiative as well as the public–private partnership called Change the Equation. (Disclosure: *Scientific American*, as part of Nature Publishing Group, is a member of Change the Equation.) During the 2011 State of the Union address, President Obama called on Americans to celebrate “not only winners of the Superbowl” but also “winners of the science fair.” Adding emphasis to that call, the White House has included science activities at the past two Easter Egg Rolls on the White House lawn; I was a volunteer in 2011. Later in the year, the President hosted the three winners of the first annual Google Science Fair—all girls from the U.S.—for a White House visit.

As the saying goes, these efforts are necessary, but they are not sufficient to inspire broad engagement with science. The media, beset by the commodification of “24/7” news availability for free online, isn't in a strong position to help, because it has shed thousands of jobs. Quality journalism has a cost. As the World Federation of Science Journalists study about attitudes of journalists in 2009 noted: “A 400-year-old business model was destroyed in 15 years by the delusion that quality contents come for free.”

The public, finding plenty of information (even if unreliable) for free online, refuses to pay for digital versions of publications that

they used to purchase in print. With the economy in a several-year tailspin, advertisers also are not supporting publishing as they had in the past. As a result, quality science journalism is under threat during this sea change in the publishing business on multiple fronts. Newspaper staffs have crashed in number. Magazines are shrinking, as newsstand sales, ad sales and overall circulation in print are down while digital page views are rising exponentially. Broadcast TV offers little science coverage, because it is expensive compared with other types of news, requiring greater investment to do properly. CNN, for instance, closed its entire science unit in 2008 and in November just shed 50 more jobs, saying that the user-generated iReport, which invites viewers to post videos and other content to CNN's Web site, made their jobs redundant. Blogs have exploded in number, contributing to the growth of online information that is such a commodity that few will pay for it. In many ways, people are consuming more science-related information than ever, but they are not paying for it and what is available is less reliable as a result.

In response, some institutions have gone straight to the public, such as Futurity, a Web site collaboration of many academic institutions that posts the equivalent of press releases and single-source features posing as journalism.

### What scientists can do

That is not to say things will be easy for scientists who want to help bridge the gap to the public. There's a dichotomy in the U.S., where the public both love and disdain science. On the one hand, public attitudes about science are generally positive. The public may be unequipped to understand the science, however—and they blame the media. At the same time, the top headlines in today's news—think of global climate change, energy, medical advances—are science related. The public understands that science is an engine of modern prosperity. Yet the science teaching is not there. And culturally (shades of C.P. Snow), it's OK to say science is “not for me” and “I don't get it.”

If you think the public doesn't care about science, you're in for a pleasant surprise. Pew conducted a survey about science attitudes, which was released in July 2009. The public's attitudes were surveyed in two telephone surveys of 1005 adults. Pew also gave a science knowledge quiz to 1005 adults. Last, they also surveyed 2533 members of AAAS about the public's science knowledge.

For instance, the study found that the public has high regard for scientists, with 84% saying that science's effect on society is “mostly positive,” and only 6% saying “mostly negative.” (10% said “other” or “don't know”.) When asked to rank jobs that contribute “a lot” to society's well being, scientists came in near the top, in third place after members of the military and teachers. Lagging scientists were medical doctors, engineers, clergy, journalists, artists, lawyers and, last, business executives.

The fact that the public values the worth of science and respects the scientists themselves, however, doesn't mean that people are equipped to understand scientific advances. Among the “major problems” for science itself, according to AAAS scientists: some 85% of the scientist respondents believed the public does not know very much about science, 76% felt the news does not distinguish between well-founded findings and those that are not, 48% believed the news media oversimplify scientist findings, and 49% said the public expects solutions to problems too quickly.

The science quiz also revealed some disheartening gaps in the public's basic scientific knowledge. For instance, just 46% knew that electrons are smaller than atoms, only 54% knew that antibiotics do not kill viruses as well as bacteria and only 76% knew that the continents have shifted over time.

I hope I've shown that the public is open to the science perspective and may even welcome it—and that they could really benefit from more direct engagement with science. There are many associated

outreach challenges for scientists. But also, there are many potential ways to educate the public. You can find something that suits you. I'll suggest some tactics to consider.

#### *Taking science to the people*

OK, maybe you're willing to try public outreach. Now what? You could start by simply being willing to make time for interviews or being a resource for fact checking—an investment that will pay off later in better coverage. Scientists can also cultivate sources, rather than waiting for a reporter's call. Magazines, newspapers, and Web sites also offer places to contribute, whether in essays or in editorials. Last, social media such as Facebook, Google+ (which seems to have more professional, early adopter types) and Twitter, offer yet more options.

But let's say you want to take matters into your own hands, at least once in a while. Increasingly, many scientists have their own blogs, letting them contribute at will whenever it is convenient for them. Blogs are a growing point of contact for readers. The platforms are off the shelf and blogging is flexible: you can write what you want when you want. You can talk directly to the public, and get further outreach experience from their responses and interests. They can be on your own lab site or in a blog network. Among the notable examples or biologist PZ Meyers, "Bad Astronomer" Phil Plait and the physicist Sean Carroll.

Of course, I wouldn't be doing my job if I didn't introduce you to *Scientific American* and its bimonthly sister title about psychology and neuroscience, *Scientific American Mind*. Launched in 1845 as "The advocate of industry and enterprise, and journal of mechanical and other improvements," *Scientific American* is the country's longest continuously published magazine.

Today, its audience finds mind and brain topics very appealing. The magazine (in print and online) offers journalistic coverage and news. Scientists can contribute feature articles about a topic that they feel deserves attention.

*Scientific American* has 14 translated editions worldwide, with a combined audience of more than 3.3 million. In the U.S. alone, it has a print circulation of 450,000; online, the Web site draws more than 3.5 million unique visitors each month. *Scientific American Mind* has a U.S. circulation of about 170,000 and seven international editions.

#### *Making a connection*

A few tips for your writing. I often tell people to think of the reader to help them target their language. Many editors find it helpful to think of a particular person in their demographic. In my case, I often think of my Aunt Joan. She's widely read, keeps up with the news, and is very interested in a variety of topics. But she has no specialized degree. Likewise, a scientist should tailor the message for the lay reader.

And a word to the wise about lay readers: They are not your peers or professors. They can stop reading anytime. You should be very afraid that they will. Your blogs or stories should make clear the topic's relevance, authority/credibility, clarity, brevity, timeliness (explain why now), and be accessible. A good story trumps all. Tell stories about your experiences. Explain what drove you and the steps you took. If you ran into a roadblock, tell people how you got around it. Capture them with your drive and passion. Articles should include fun anecdotes, and should make a connection to the lives or interests of readers. They should explain why the story is important to know now, and should be clearly written. Pretty pictures or good explanatory art really helps.

All of this is not to discount the challenges for scientists who want to engage in public outreach. They aren't generally trained to translate their work into accessible language for laypeople. They write in journals, for an audience of highly trained peers, not for consumer publications. They are comfortable with the precision of the jargon of their fields—which might as well be another language for the average untrained person.

Scientists also have big day jobs. They may be running labs around the clock at critical times for their experiments. Telling stories about science, instead of conducting science itself, is not primary. Further, the requirements of writing grant proposals, dealing with varied funding and other factors can hamper outreach efforts.

Nevertheless, the public funds and affects the successful conducting of science. They vote for the budgets and elect the policy leaders that can help or hinder science progress. They also pay the taxes that fund the government grants. At a December AAAS Leadership Seminar on Science and Technology Policy, members of Research! America, a medical research advocacy group, argued that scientists need to be more visible to the public to avoid deep funding cuts and to help influence policy leaders. Making a connection to the public—inspiring them and engaging them with the value of science—is a worthy endeavor.

#### **Journalists are from Venus, scientists are from Mars**

Sandra Blakeslee

In talking to scientists, I often start by asking for a show of hands. How many of you read *The Economist*? (A few hands might go up).

How many of you watch *60 Minutes*? (Depending on the age of the audience, maybe one or two hands go up. Usually none).

How many of you read *The New York Times*? (This is getting better. Three out of four people might raise a hand).

How many of you watch *John Stewart*? (Virtually all hands fly up. *The Daily Show*, it seems, is a major source of news for highly educated scientists. I, too, am an avid fan.)

But what is this informal survey telling us? First, we like to be entertained. *The Daily Show* mixes wicked humor with bona fide news — especially video clips that most of us would not otherwise see. (How many 2011 Republican debates did you actually sit through?)

Second, three of the media outlets mentioned above cover a good deal of science. But *The Daily Show* does not. It's rarely on their radar. If it were, science stories would have a huge, enthusiastic audience.

Third, many Americans no longer turn to traditional mainstream media (national newspapers, magazines, television network news) for news (science or otherwise.) They don't read *The Economist* or watch TV shows like *60 Minutes* because they get their news from online sources — blogs, websites, list serves, RSS feeds, Facebook, Twitter and the like. Old media are being eviscerated by digital technologies. Our content is given away for free. The blogosphere and social media are ascendant. In my own field of newspapers, thousands of reporters have lost their jobs. Hundreds of daily papers and weeklies have shut down. Traditional science reporting is especially hard hit. A recent survey of the National Association of Science Writers found that out of 1784 members, only 3% were employed as newspaper staff writers. Take it from the former editor of *Science* magazine, Donald Kennedy: "The disastrous decline of the print news business has probably been harder on science than on any other beat reporting."

So what, you say? As a scientist, I am getting all the science news I need. I read the major journals, attend meetings, talk to my peers. Why should I care?

You should care because the public needs to be informed about science and technology if we are to make good decisions in the political arena. Scientific literacy has never been more important. Yet the number of traditionally trained science journalists continues to decline. Meanwhile, the number of people who blog about science is rising. This is an important distinction. Many science blogs are excellent. They cover the same topics you might see in the *New York Times*, only they do it in a more relaxed, entertaining style. The blogger is having a conversation with you, the reader, in which he or she can make editorial comments with impunity. The journalist, on the other hand, works under the constraints of needing to find multiple sources for every claim in every story, to check all the facts, to find accurate quotes and to avoid editorializing. (When I write a story, I

believe that my readers don't give a hoot for what I think. When a blogger writes a story, what he or she believes is often central to the narrative.)

This trend in science reporting – indeed it is a phase transition – matters because, with fewer journalists around and more bloggers on the scene, you, as scientist, need to step up and take more responsibility for publicizing your work. No one can translate your research better than you. Why let bloggers, even the best of them, do it for you? If your work is to be discussed accurately by nonscientists (also known as taxpayers who support your research), you need to frame it so that your grandmother or twelve-year-old child can understand it.

I can suggest several ways. Since you are the real expert, you could start your own blog (more on this later). You can make an effort to reach out to reporters (we really like that), or at least get to know the public information officer at your academic institution who can help you do that. You can volunteer in schools or give talks to local organizations. And when a journalist does call, you can be prepared to give a dynamite interview.

Talking to reporters may sound daunting. When you were in graduate school, it's likely you were warned to never talk to the press. A senior professor might have said, "they'll misquote you, confuse the facts, pick up the wrong message." Moreover, you have no idea how to explain your hard won discoveries to an audience beyond your peers.

But you can learn how to communicate clearly by following some simple guidelines.

First, know your audience. How familiar are they with science? Readers of the New York Times science section and most science blogs are pretty knowledgeable but don't assume too much knowledge. Someone with an advanced degree in geophysics needs considerable help in reading about protein folding disorders. When thinking about your audience, consider the distinction between innocence and ignorance. Like the geophysicist, most people are innocent when it comes to understanding the nitty gritty of your research. They are not ignorant. You may need to define some basic concepts, such as shape determines function in biology. Once they understand the concepts that you and your peers take for granted, they can follow your arguments to a sophisticated level.

Next, please unlearn standard academic writing style. It is stiff, formulaic, and unfriendly to readers. You know the format. You begin your articles with, "This is what I am going to say, now I am saying it, this is what I just said." Yuck.

Use analogies. As Douglas Hofstadter says, "analogy making is at the core of human cognition." It is also at the core of human understanding. Here's one from an NPR environment podcast (Aug 12, 2010): "If there were a giant with her head in Baltimore and her toe off the coast of South Africa and she was bit by a great white shark on the toe on Monday, she wouldn't feel it until Wednesday and she wouldn't jerk her toe until Saturday."

Avoid jargon. Instead of saying "semiochemicals" say "chemicals that carry a message." Instead of saying "ligand" say "binding site." Instead of "autophagy enhancement" say "increased cell death." Instead of "vibrissae" say "whiskers." Instead of "allele" say "different forms of a gene."

Avoid all those caveats. You know what I am talking about.

Never ask people to do math in their heads. Round off numbers and translate them into conversational terms. Instead of saying a 90% increase in population, say the population almost doubled.

Use frequencies instead of probabilities. Instead of saying "the lifetime probability of developing liver cancer is 0.46%", say "out of every 1000 people, fewer than 5 will develop liver cancer".

Compare and contrast. Put numbers into context. For example, on average, only one person dies from shark attacks in the U.S. each year. In comparison, lightning strikes almost 50 people.

Distinguish significance from magnitude. Most people do not understand the meaning of significance in a statistical sense. Small but

significant differences can sound unimpressive and unimportant. Present your data so that the magnitude is striking. Instead of saying, "we've seen a 4% annual decline since 1992", say "we've lost more than 260,000 square miles in the past twenty years, which is an area the size of Texas."

Why are journalists from Venus and scientists from Mars? We operate in very different time frames. While we are all curious, skeptical, and competitive, we have nothing in common when it comes to reporting results (see Fig. 1).

In reporting your results, you begin with the background, give all the supporting evidence you can muster (including those caveats), and you end with your conclusions. We reporters do it exactly the opposite way. We begin with your findings, we explain the "so what" and why it matters, then we end with supporting evidence.

The "so what" is critically important. You need to figure out why your findings matter in advance of any media interview. Why should the reader (or listener or viewer) care? Why now? Why is this research being reported today and not last week or last year or next year? When answers to these questions are clear in your head, you can give that dynamite interview.

Other reasons we are from different planets: Scientists are slow, driven by caution, strive for in-depth understanding, tolerate uncertainty, look for specifics and believe credentials matter. Journalist are fast, driven by deadline, like a quick overview, want certainty, look for generalizations and believe that emotions matter.

To summarize with a colloquialism: Put the hay where the mules can reach it. Know what you want to say. Be yourself. Don't be afraid to tell stories about your scientific adventures. For practice, you may find it useful to start your own blog. The writing style is informal, entertaining, opinionated (your opinions count the most) and accessible. You may have only 50 readers but it's great preparation for when The Economist, 60 Minutes or the New York Times calls. And if you get a call from The Daily Show, you've hit the jackpot.

*Resources:* Here are three books that will help you communicate your science.

"Escape from the Ivory Tower. A guide to making your science matter." By Nancy Baron. (special thanks to Nancy Baron because some of examples I used were borrowed from her book.)

"Explaining Research. How to reach key audiences to advance your work." by Dennis Meredith.

"Am I Making Myself Clear? A scientist's guide to talking to the public," by Cornelia Dean.

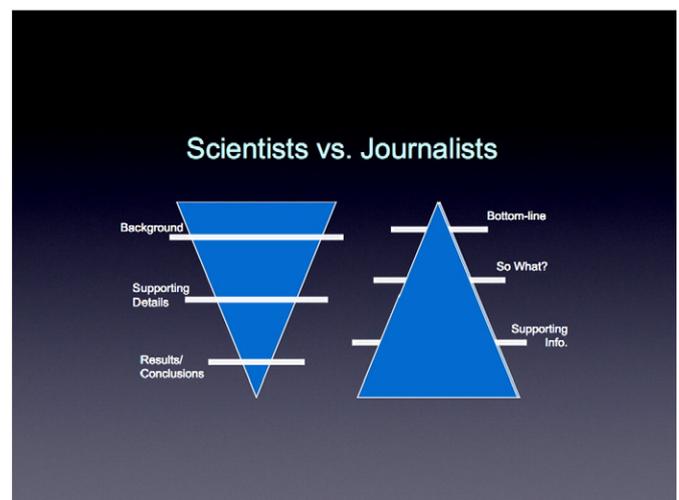


Fig. 1. Scientists and journalists present their data in opposite ways (Baron, *Escape from the Ivory Tower*, 2010).

## Open science: How the rise of science blogs is changing research

Paul Raeburn

The year 2011 was neutral for the stock market, which ended up almost exactly where it started. But not so for newspaper stocks; they plunged 27%. Newspaper advertising revenues peaked in 2005 and they've been falling ever since. Newspaper profits have fallen from 28.5% in 1999 to 14.9% in the first nine months of 2011. Publishers are slashing the staff, delivering less news, and otherwise scrambling to deal with the downturn.<sup>1</sup>

So journalism is dying, right? And science journalism, which is rarely able to compete for front-page space with politics and crime, could expire at any time. Indeed, it might already be time to pull the plug.

That's the conventional wisdom. But I don't buy it. Here's my take on the future of journalism, and science journalism in particular: I'm wildly optimistic. Before you decide to stop reading (on the assumption that I've lost my mind after spending too many late nights puzzling over commas or struggling to find the right way to define "genomic imprinting" to readers unsure of the difference between a gene and a chromosome) please give me a moment to explain.

Here are more of the grim statistics regarding the state of journalism, the statistics that might lead you to think that my wild optimism is wildly misguided:

- ❖ Based on staffing reductions in American journalism between 2005 and 2010, a rough calculation suggests that 1 million stories that might have been written were not written.
- ❖ 14,000 daily newsroom jobs disappeared in the past decade
- ❖ 3500 people work for the big four television outlets—ABC, NBC, CBS, and Fox—down about 25% in recent years.<sup>2</sup>

But there are brighter statistics, as well. Here are a few of those:

- ❖ There are still about 40,000 journalists working in daily newsrooms.
- ❖ Another 10,000 work for weekly papers.
- ❖ The AP, Reuters, and Bloomberg employ about 7500 editorial staffers.
- ❖ Add all of these up, along with Time, Newsweek, the alternative press and business press, and the guess is that we have about 65,000 journalists working today.
- ❖ Conclusion: Traditional news outlets have been suffering, but they are not close to disappearing.<sup>3</sup>

If you've been paying close attention to these statistics, you might have noticed what's missing: Online media—the blogs, and the online news sites. Online news sites, especially science and journalism blogs, hold the key to the future of journalism. And their rise to prominence is the main reason why I'm wildly optimistic about the future of journalism.

Here is an example—perhaps the best example so far—of how blogs are changing science. It involves the claimed discovery of arsenic-based life at Mono Lake, in California, by geomicrobiologist Felisa Wolfe-Simon, who collected organisms from lake-bottom sediments.

Mono Lake is an unusual and particularly interesting body of water, primarily because of its unusual chemistry—with high salinity, high alkalinity, and high levels of arsenic. This chemistry is in part a result of Mono Lake's isolation from its sources of fresh water for 50 years.

The story began on Dec. 2, 2010, when NASA issued a press release saying researchers "have discovered the first known microorganism on Earth able to thrive and reproduce using the toxic chemical

arsenic." This was a momentous discovery, in NASA's view, largely because it broadened the possibilities for life on other planets. The press release continued: "The definition of life has just expanded," said Ed Weiler, NASA's associate administrator for the Science Mission Directorate at the agency's Headquarters in Washington. "As we pursue our efforts to seek signs of life in the solar system, we have to think more broadly, more diversely and consider life as we do not know it."

NASA didn't stop there. It made the kind of grandiose claim normally reserved for only the most important and unusual discoveries. "This finding of an alternative biochemistry makeup will alter biology textbooks and expand the scope of the search for life beyond Earth," it said in the press release.<sup>4</sup> The research was published online by Science Express.<sup>5</sup>

In the usual course of events, such an announcement generates letters to journal editors, which appear months later. It sparks efforts by others to confirm or challenge the finding. And scientific meetings organize special sessions to discuss the implications. Months after that, the researchers who made the discovery respond to the letters and to any questions or criticisms that have been raised. It's all done in a most courtly and careful way.

That is emphatically not what happened with the arsenic life discovery. On Dec. 4, 2010—a mere two days after the discovery was announced—Rosie Redfield, a microbiologist at the University of British Columbia, wrote what Dennis Overbye at The New York Times called a "scathing commentary" on Wolfe-Simon's paper.<sup>6</sup>

Redfield wrote that Wolfe-Simon's paper "doesn't present ANY convincing evidence that arsenic has been incorporated into DNA (or any other biological molecule)." And she summed up her findings this way:

**Bottom line:** Lots of flim-flam, but very little reliable information. The mass spec measurements may be very well done (I lack expertise here), but their value is severely compromised by the poor quality of the inputs. If this data was presented by a PhD student at their committee meeting, I'd send them back to the bench to do more cleanup and controls...I don't know whether the authors are just bad scientists or whether they're unscrupulously pushing NASA's "There's life in outer space!" agenda.<sup>7</sup>

Scathing, indeed. But it gets more interesting. Rather than responding, Wolfe-Simon and her colleagues refused to comment on the criticism, saying the debate should appear in peer-reviewed publications. "We cannot indiscriminately wade into a media forum for debate at this time," declared the paper's senior author, Ronald Oremland of the U.S. Geological Survey, in an email to the science blogger Carl Zimmer. "Any discourse will have to be peer-reviewed in the same manner as our paper was, and go through a vetting process so that all discussion is properly moderated," Wolfe-Simon told Zimmer in an email. "The items you are presenting do not represent the proper way to engage in a scientific discourse and we will not respond in this manner."<sup>8</sup> Zimmer published these responses in a post on Slate on Dec. 7—still only five days after the finding was published.

Meanwhile, the storm of web criticism continued to grow. In a post for On Science Blogs at the National Association of Science Writers, Tabatha Powledge, writing from a journalists' perspective, noted that there was "an issue that transcends this paper: what kind of analysis – and what sort of venue – is right for criticizing scientific research?"

<sup>4</sup> [http://www.nasa.gov/topics/universe/features/astrobiology\\_toxic\\_chemical.html](http://www.nasa.gov/topics/universe/features/astrobiology_toxic_chemical.html).

<sup>5</sup> <http://www.sciencemag.org/content/early/2010/12/01/science.1197258.abstract?sid=109ecc44-315d-4262-bbe6-f1a021602f91>.

<sup>6</sup> <http://www.nytimes.com/2010/12/14/science/14arsenic.html>.

<sup>7</sup> <http://rrresearch.fieldofscience.com/2010/12/arsenic-associated-bacteria-nasas.html>.

<sup>8</sup> [http://www.slate.com/articles/health\\_and\\_science/science/2010/12/this\\_paper\\_should\\_not\\_have\\_been\\_published.single.html](http://www.slate.com/articles/health_and_science/science/2010/12/this_paper_should_not_have_been_published.single.html).

<sup>1</sup> <http://newsosaur.blogspot.com/2012/01/newspaper-shares-plunged-27-in-2011.html>.

<sup>2</sup> <http://newsonomics.com/13308/>.

<sup>3</sup> <http://newsonomics.com/13308/>.

On Dec. 11, Ed Yong, who writes the Not Exactly Rocket Science blog at Discover magazine, ticked off the developments in the story up to that point—nine days after the announcement. “Looking back, it is astonishing how quickly these events unfolded and the sheer number of bloggers and media outlets that became involved in the criticism. This is indeed a brave new world, and one in which we are *all* the infamous Third Reviewer.”<sup>9</sup>

Science, which initially published the paper online, did not get around to publishing it in the journal until June, 2011. It also simultaneously published eight critiques of the article.<sup>10</sup> By that time, however, the debate was old news. Carl Zimmer, in another blog post, summed up the situation:

In earlier times, such critics didn't have many options. They could write to *Science* and hope that their letter would be published long after the public's attention had turned to other things. They could write to their local newspaper and try to sum up their objections in 50 words. They could grouse over a beer with likeminded colleagues. Now, however, they can form an online community. Blogging scientists read the #arseniclife paper and aired their complaints. On Twitter, they kept each other up to date on new developments in the story. Within a couple weeks the *New York Times* and the *Washington Post* were reporting not on the *Science* paper, but on the online debate. The center of gravity had shifted.<sup>11</sup>

This is just one example of how blogs and online news sites are changing the nature of science. Behavioral neuroscientists are not immune from such criticisms and public challenges. And here's where I begin to preach: You should prepare yourselves for public debate, whatever you might think about the sanctity of peer review or the proper venue for scientific debate. This new world is being thrust upon you, and you ignore it at your peril. Behavioral neuroscientists should, I think, be particularly attuned to public criticism, because so much of the work you do can be controversial, whether it challenges popular notions of free will, or steps on some people's religious beliefs. You are telling us how we learn, how we think, how our brains operate—in short, you are telling us, in scientific terms, who we are. And outsiders don't always take kindly to that sort of thing.

Perhaps your best defense against being victimized by criticism in the new media is to take the offensive—to start a blog yourselves. The only thing stopping a bold neuroscientist from getting more readers than the Sunday New York Times is his or her initiative, cleverness, and originality. It's not easy—I've been writing for the public for a long time, and each new piece poses a new challenge. But you, as people who sit at the bench or examine patients are in a position to do it differently. I hope that some of you will give this some thought—and, ultimately, get in the game.

#### **Lambert's concluding thoughts (this time with no references)**

As I sat in the audience listening to these three informative talks at the 2011 IBNS meeting, the growing interest in the audience members was palpable. Many questions, comments and personal opinions

followed the formal session. After absorbing these messages for several months, I couldn't help but notice that the advice my Program Officer recently shared concerning the new NSF guidelines for submitting *preliminary proposals* sounded eerily similar to the advice generously dispensed at this session. I was instructed to answer the “so what?” question right out of the gate and to avoid getting lost in the methodological weeds. Details mattered less than the big picture in this short proposal format where I had limited space to hit it out of the park and score an invitation to submit a full proposal. Only time will confirm my success or failure with this new grant writing endeavor, but I have to admit that it was a bit of a refreshing change.

I realize I'm in no position to do so, but if I could humbly offer yet one more piece of advice to my scientific peers it would be a renewed appreciation of balance in our scientific professions. We became scientists because someone—a parent, teacher/professor, journalist—told a compelling story and, from that moment on, we had to learn more about the fascinating world of behavioral neuroscience. Our stories are still required to attract the next generation of students and, equally important, to shape relevant social policy in informed ways.

With reality shows gaining popularity in our entertainment culture, it appears that our professional culture may also need a good dose of reality. If our research has become so esoteric that we have nothing to say to interested journalists or other forms of mainstream audiences, it may be time to re-assess the “big picture” of our life's work. Of course our meticulous laboratory research, detail-rich lectures and mundane science reports remain critical elements of a balanced science career; however, it is extremely rewarding to share this information with individuals outside of our laboratories and specialized conferences.

Although I have many wonderful memories associated with my career during the past quarter of a century, one memory that is especially relevant in the context of this topic stands out.

Several years ago I volunteered to give a talk in our campus-wide faculty luncheon series. During these lectures, faculty members present their research to an audience comprised of faculty from the entire campus, as well as any interested staff members. This is an opportunity to learn about the research passions of faculty members outside of familiar home departments. After presenting my talk I received a message that made me swell with pride. This message wasn't from the President or Provost, it wasn't even from a fellow faculty member, it was from a dedicated member of the college staff who made sure our department was clean and orderly each day. We often talked about our kids or the weather during our frequent encounters in the department but I had never brought up my research. “Kelly,” she said in the voice of a wise mother, “I am so proud of you. I understood every word of your talk yesterday.”

I'm not sure that my lecture deserved such praise but it was viewed as high-praise indeed, and reminded me how rewarding it is to share our findings with a broad audience, most of whom will never have a Ph.D. following their names.

<sup>9</sup> <http://blogs.discovermagazine.com/notrocketscience/2010/12/10/arsenic-bacteria-a-post-mortem-a-review-and-some-naval-gazing/>.

<sup>10</sup> <http://www.sciencemag.org/content/early/2011/05/26/science.1208877>.

<sup>11</sup> [http://www.slate.com/articles/health\\_and\\_science/science/2011/05/the\\_discovery\\_of\\_arsenicbased\\_twitter.single.html](http://www.slate.com/articles/health_and_science/science/2011/05/the_discovery_of_arsenicbased_twitter.single.html).