# Roles of Communication Centers in Communicating Science: A Multi-Disciplinary Forum

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The communicative relationships between scientists and audiences they address beyond their specialized fields have become increasingly strained. These fractures result not simply from an ill-informed lay public, but from deeper trepidation about the ethos of science. "Citizens often know what scientists think, but it seems that a substantial (and by some measures growing) portion of the public simply does not trust science in general" (Pechar, Bernauer, & Mayer, 2018, p. 293). This "science confidence gap" (Achterberg, de Koster, & van der Waal, 2017) has sown a growing institutional distrust of science itself, which can manifest as unwillingness to listen to scientific communication. Important scientific advances may face rising tides of public resistance as "a general mistrust of science and scientists has produced a paralyzing form of skepticism that empowers scientific populism" (Camargo & Grant, 2015, p. 232).

Skepticism about scientific findings along with mistrust of science as a guide for human action has stalled and sometimes reversed major scientifically grounded initiatives. "This mistrust has had disastrous results, as exemplified by the misguided influence of anti-vaccine activism that led to a resurgence in the United States and Europe of infectious diseases that had practically been eradicated" (Camargo & Grant, 2015, p. 232). President Donald Trump dismissed a multi-agency report from his own administration on the massive projected costs of climate change, saying simply, "I don't believe it" (Gardner & Mason, 2018). Despite scientific evidence of environmental degradation, the Trump administration has rescinded at least 85 environmental regulations that address issues such as air and water pollution, toxic substances, and wildlife preservation (Popovich, Albeck-Ripka, & Pierre-Louis, 2019).

If the people who formulate policies and hold the purse strings disbelieve, dismiss, or demean science, what does this bode for the influence of scientific experts? Aside from raising concerns about what the basis of decision making might be, such an intellectual climate could have a chilling effect on future generations of scientists. Confronted with distrust or skepticism, researchers may become more insular, reducing or avoiding public communication that could call their work into question. For example, public backlash against genetically modified organisms (GMOs) has had a chilling effect on disclosure of emerging nanoscience research (David & Thompson, 2008). Fearing that research may be stifled or that funding might evaporate, more pressure builds to shield research from public scrutiny by broadening the scope of proprietary information and classifying more applied research as inscrutable "trade secrets" (Schwartzman, 2014). Restrictions on the sale of genetically modified food products in the European Union suggest that such fears have some justification (Marvier, 2009). Constricting communication about research, however, arouses public suspicion. Pew Research Center (2019) surveys reveal that public trust in science increases when they receive more transparent communication about scientific research, data, and funding. A vicious circle ensues: public distrust of science increases withholding of information, which leads to more distrust.

It is tempting to attribute such conditions to rampant anti-intellectualism, caricaturing science skeptics as naïve or ignorant. Focusing on the knowledge non-specialists lack, the deficit model of science communication suggests that lapses in communicating science can be corrected by promoting greater scientific literacy (McNeil, 2013). Once they understand science better, laypeople will thereby become more amenable to the messages scientists convey. Ample evidence suggests that simply injecting audiences with more knowledge about science does not necessarily reduce suspicions and skepticism regarding scientific findings and policy recommendations. Increasing scientific literacy actually accentuates questions about the validity of scientific findings (Kahan et al., 2012), since new knowledge bolsters pre-existing value commitments that fuel suspicions of science.

Consider the patronizing position the audience occupies in the deficit model. Communication flows one way: the scientist enlightens the benighted public. Scientists control the information disseminated, with lay audiences limited to commenting or asking questions—essentially a reactive role (Weil, 2007). This rather flattering view of scientists may explain the persistence of the deficit model in scientific circles despite the abundant criticisms leveled against it, such as configuring lay audiences as overly passive (Tabernero & Vidal, 2018).

Communication centers occupy a position uniquely suited to mediate and ameliorate these disconnects. Scientific progress is inseparable from how science is communicated, since “the way new technologies or scientific breakthroughs are communicated in social settings is at least as important as the scientific content that is being conveyed when lay audiences interpret new technologies or make decisions about public funding for science” (Scheufele, 2013, p. 14040). This forum offers three distinct, yet intertwined, interdisciplinary perspectives on how communication centers can enhance science communication.

Part I engages with science communication from the administrative perspective of the communication center director. This section highlights how the synergies between communication centers and the sciences can entrench a center’s role as an indispensable resource for preparing scientists to address audiences of non-specialists. Using firsthand accounts of a communication center’s partnerships with science faculty and students training to be scientists, the author discusses the mechanisms for communication centers to connect scientists with constituencies beyond their academic colleagues. Rather than a stylistic add-on of “soft skills” to “hard science” training, communication emerges at the core of skill sets that prepare emerging scientists to face the world. The author offers fruitful suggestions for communication centers encouraging scientific communicators to engage with their publics rather than dictate recommendations and report findings to them.

While the first section discusses how a communication center bridges the gaps between scientists and their public constituencies, the next section details how individual scientists put communication center tutelage into practice. Part II voices the views of a scientist who distills the ways commonly taught communication skills apply to scientific communication. The author explains—and the section embodies—some of the specific communicative practices that best serve scientists as they attempt to relate to diverse audiences. This section treats the scientific communicator holistically, as someone who must relate to the audience not simply as a technical expert, but as a relatable human being who can share the joys and not merely spout the jargon of science. Blending science with communication pedagogy, discussion then moves to the scientific basis of commonly taught advice regarding visual communication. The section concludes by stressing the importance of storytelling that enables scientists to offer compelling accounts of their research and rationales for its support.

Part III moves to a more philosophical and theoretical level. Invoking the perspective of science and technology studies, the author reflects on how to bridge epistemological divides that often lead to confrontational relationships between scientists and non-scientists. Rather than settle for simplifying scientific communication directed to non-specialists or encouraging scientific literacy among the public, scientists and their audiences need to understand and adapt to different ways they perceive and interpret communication. Communication centers can equip scientific communicators with the practical wisdom of empathizing with the values and heuristics that shape interpretations of science (Dalal & Interazi, 2016). Working with both scientific communicators and lay audiences in joint endeavors, communication centers can develop mutual respect and restore trust in the institution of science.

## I. A Communication Center Director's Perspective

***Kimberly M. Cuny***

Herr (2016) advocates for reaching beyond traditional STEM (science, technology, engineering, mathematics) education for the nanosciences. He points to the interdependence of every key stakeholder in the educational supply chain coupled with a well-networked infrastructure as necessary parts of an educational system that evolves, adapts, survives, and thus thrives. Herr adds the letter A to STEM for a "seamless integration with the arts. It helps prepare students for careers that value creativity and innovation. It thrives on hands-on problem solving, critical thinking and communication skills" (Herr, 2016, p. 85). Communication centers with mission statements that span the campus are key stakeholders in the educational systems of STEAM efforts. Centers can also provide well-networked infrastructure in support of STEAM programming. There is much to gain for a communication center by participating.

The University of North Carolina at Greensboro (UNCG) Speaking Center's efforts at adding A to STEM have involved competency developments such as teaching nanoscience graduate students to tell their own science stories, communicate interpersonally across cultures, make an elevator pitch, prepare and present an interactive learning module in small groups, design and present an effective poster, start/maintain/end conversations, network a room, create a single image slide to represent their research, and present their research in a 3-minute competition. More recently, biology and chemistry students have been introduced to our 3-minute and single slide programming. We have recently been approached by graduate students in psychology who want us to provide a communicating science workshop. Much of the communication center pedagogy that we have implemented with science students is rooted in the arts of improvisation and storytelling. Frankly, none of it would have happened at all were it not for the commitment and trust of UNCG scientists spanning various specialties, along with the dedicated support from speaking center professionals. Those efforts and findings are outlined in another article published in this journal.

At our communication center, people and relationships are valued over everything else (Cuny 2018), so when we were approached by two nanoscience faculty with an invitation to work with their first- and second-year graduate students we enthusiastically agreed. This meant the faculty and students at the center would forge new relationships and develop additional competencies. King and Atkins Sayre (2012) found that students come to a communication center only after their professors communicate value for doing so. A UNCG research scientist recently pointed out that science faculty members are a notoriously difficult to reach campus constituency. If this is true, and if a center wishes to network their educational infrastructure with science faculty, it is imperative that the center's personnel have a clear understanding of academic literature which is focused on the science of oral and visual communication. The rhetoric of science and cognitive psychology fields would be good places to start. Scientists respect science. The science, not the art of communication, will open the opportunity for forging new relationships with science faculty members, thus making their students available to work with communication centers.

Supporting scientists as communicators will provide many opportunities for the development of communication competencies among communication center students and professionals doing this work. Intentional focus on the professional development of student employees is one of the best ways to ensure that a center thrives. One example of professional development draws on the one-on-one or small group consultation efforts of most centers, where student educators focus on asking questions, guiding, and providing feedback over telling patrons what to do. This is well aligned with what Alan Alda told us at a private event in April 2017 is essential to the work of communicating science. As scientists talk to communication center personnel about their research, be it publicly or interpersonally, center personnel must ask "Why?" again and again. "Why?" is the most important question communication center students can learn to ask (Staweser, Apostel, Carpenter, Cuny, Dvorak, & Head, 2019). Participating in these conversations of "Why?" with scientists allows them to develop their interpersonal communication competency. Plus, it will help the scientists to discover the essence of the research they are doing. Once a scientist knows their work well enough to answer all the "Whys?" the center employees can ask, the scientist is ready to speak about the research more clearly and effectively and to more diverse audiences. This work also "helps center consultants develop as professionals. There are some cases where members of the scientific community question or challenge the credibility of communication center work and practices. Consultants need to be able to maintain their professionalism and not let it affect their confidence" (T. Williams, personal communication, September 30, 2019).

We have experienced additional benefits to our center's ethos. They include improved reputation among STEM faculty on campus, participation in the national dialogue on communicating science, improved reputation among non-STEM faculty across the campus, opportunities to publish, and potential on- and off-campus funding opportunities through grant collaborations. Berube (2018) states that communicating science should be the window, not the window dressing, of external funding collaborations which seek to improve how scientists communicate.

For those looking to add this work to their center, identifying STEM faculty allies would be a good place to start. Especially helpful would be approaching faculty members who have previously attended programming at the Alan Alda Center for Scientific Communication, the Communicating Science workshops by the American Association for the Advancement of Science, and/or Becoming the Messenger workshops by the National Science Association. The Association for the Rhetoric of Science, Technology, and Medicine—a National Communication Association affiliate—consists of academics and practitioners dedicated to enriching communication by, about, and with scientists. These faculty members and allies can provide leadership and partnership going forward. Graduate schools often participate in the regional 3-minute thesis competitions. Approaching the graduate school and offering to provide workshop and consultation support would be advisable. If the institution sends undergraduate science researchers to present at conferences, then offering to partner with the undergraduate research office on campus to support science students might be beneficial.

## II. A Scientist's Perspective

***Bruce K. Kirchoff***

Scientists rarely receive any training for how to communicate effectively with other scientists. We are trained to speak to other scientists by watching our peers. We receive little or no formal training in scientific communication. What we do receive comes from our thesis advisors, who may (or may not) provide comments on an early version of our presentations. If you learn to speak well, you learn on your own. Although there have recently been efforts to improve scientific communication, these have mainly been aimed at communicating with the general public, and very few scientists participate in them. We pay attention to what is novel, what is advancing the field, and what is funded by the National Science Foundation (NSF) or the National Institutes of Health (NIH). A presentation will sometimes garner attention if it is from someone at a major university or research center, addresses an old and difficult question, or if it is about something really cool, like dinosaurs. Quality of the presentation has little to do with its impact. These are the underlying reasons why scientific presentations are frequently so poor. We value results and the data that support them. I think we subconsciously feel that our results should speak for themselves. We should not have to sell them through our presentations. But even scientists get tired of hearing poor presentations, so the current trend to improve scientific communication has important implications not just for the public understanding of science, but for how scientists communicate with each other.

If someone were to ask me for one tip that would help them become a better scientific communicator, I would say, "Learn to speak with a twinkle in your eye." To have a twinkle in one's eye means to feel full of joy, happy or mischievous and to show it through your eyes. Having sparkling or twinkling eyes is very attractive. It sometimes happens when people first fall in love, or when someone is excited and enthusiastic about their topic.

What would you have to do if you wanted to speak with a twinkle in your eye? I think that you would have to:

1. Face the audience.
2. Have an open stance, arms at your sides or held slightly open and toward your audience, feet slightly apart: a comfortable stance.
3. Smile, or at least do not frown.
4. Speak loudly and with confidence so that you can be heard at the back of the room.
5. Enjoy what you are saying and show that enjoyment to the audience. This means that you must have done enough preparation so that you can enjoy your presentation.

These guidelines are applicable to any audience. The oft-repeated maxim that presentations must be adapted to the audience is true only for the intellectual content of the presentation. It is not true for the most important part of the presentation, your connection with the audience. Whether you are presenting to a room full of preschoolers or to a scientific panel of experts, the audience will want to see your face, know that you are comfortable in their presence, be able to hear you, and see that you're enjoying your time with them. In this respect, your content does not matter. You could be telling a story about a tree, or you could be talking about the most esoteric and technical aspect of your research. If the audience does not accept you as a person, and believe that you accept and respect them, they will not listen to what you have to say. The fastest way to get an audience to ignore you is to be disengaged. They will take one look at you and wonder why they came. If they are preschoolers, they may start acting out. If they are PhD level scientists, they may be more well behaved, but they certainly will not be more attentive. Despite the title of your talk, they came to see you. If you are not present, they will quickly lose interest. The most important thing you can do in scientific communication is be fully present. As Woody Allen once said, “80 percent of success is showing up.” As long as we understand “showing up” as being present for the audience, we have a good rule of thumb for scientific presentations.

Accepting that the most important thing in a scientific presentation is your connection with the audience has several implications. If you’re going to connect with your audience, you must know your material well enough that you can dispense with written prompts. That means, if you use slides, they should contain little or no text. This will remove any temptation for you to repeat the information that is on the slide or, in a worst-case scenario, read it directly to the audience. One of the sure ways to break your connection with the audience is to read your slide. When you do this your focus is on the slide, not the audience. The audience can also read, so there is no need to repeat what is on the slide. Of course, if they are reading the slide they are not paying attention to you, and this also breaks your connection with the audience (Mayer and Moreno, 1998). Think about how much you retain when you are reading at the same time as listening to someone. If you’re at all like me, it is not much. Someone reading your slide at the same time you are talking will have to tune out one or the other channel, unless you are reading directly from the slide, but we have already covered that.

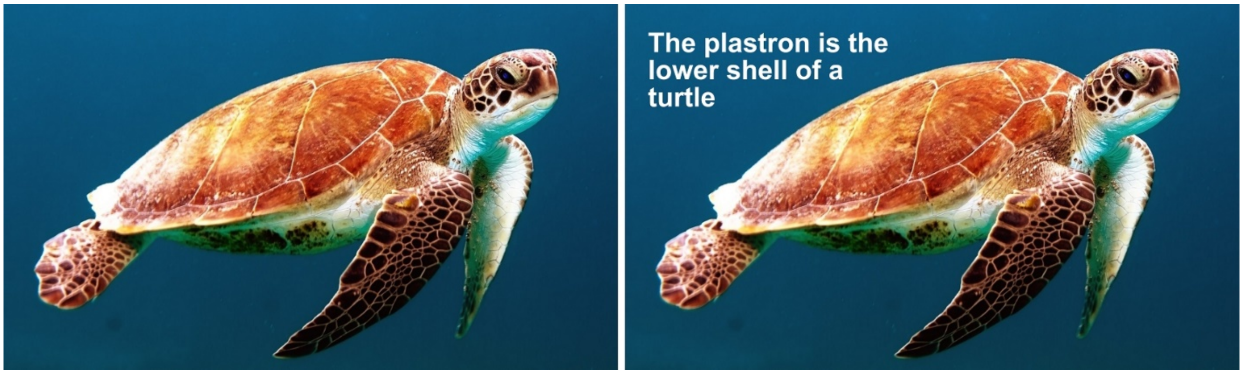


Figure 1. *After Morgan and Whitener (2006). Photo by Wexor Tmg (https://unsplash.com/@wexor) from Unsplash (https://unsplash.com).*

Let us turn to a second problem with placing text on slides before we return to issues that arise when we realize that connection with the audience is the most important aspect of a presentation. If, following the above advice, you decide not to use your slides to convey written content, you will likely use them to convey images or graphs. What happens when you have both images and text on the same slide (Figure 1)? The addition of text to a purely visual image is distracting. It disrupts your visual processing of the image (Hantsch, Jescheniak, & Mädebach, 2012). When we look at the picture of the turtle with text on it our eyes are drawn back and forth between the text and the image. We never fully concentrate on one or the other (Mayer and Moreno, 1998). Placing text on images is visually disrupting. It asks us to do two contradictory things at the same time: to process an image and read text. If we are speaking at the same time, we ask the audience to do three contradictory things: read text, look at an image, and listen to what we are saying. It is amazing that audience members understand anything from presentations like this.

The fact that a good connection with the audience is essential for your presentation is a consequence of the most important thing that you want them to remember. The most important thing for the audience to remember is YOU. You want them to remember you because your career will depend upon the extent to which colleagues recognize you and your work. Of course your work is important, but if they remember your work and not who did it, you have drastically reduced your chances for success in your field. You want them to remember your research, but the primary content of any talk should be you, yourself. The trick is that you have to convey this content by talking about something completely unrelated, your research. By now you have figured out that you're going to accomplish this miracle by establishing a good connection with your audience, but let's enlarge on that a bit by talking about stage presence.

Ideal stage presence occurs when the speaker is so comfortable with their presentation that it flows flawlessly. They live completely in the moment, conveying their content and connecting with the audience. They have, at least metaphorically, a twinkle in their eyes. They have mastered all of the technical skills of the presentation. They know how it flows, and they know how it tells a story. We will return to storytelling below. Let us now look at how a speaker can convey that they have a twinkle in their eyes, even when the audience cannot see their eyes.

All aspects of body stance, gestures, and facial expression contribute to good stage presence (Figure 2). If you are able, you should stand in front of your audience, not behind a podium or lectern, unless some aspect of the room forces you to do this. You should have a comfortable stance, with your legs together or slightly apart (Figure 2, left). Your legs should not be so far apart that you appear to be in a relaxed stance (Figure 2, right). Your gestures, when you make them, should be open and directed toward the audience (Figure 2, left). When not gesturing, your arms can be at your sides, or slightly bent and open toward the audience. Keep your hands open, not in fists, and do not put them in your pockets (Figure 2, right). If you need to gesture at the audience, use your whole hand with your palm open. Do not point. If you want to indicate the whole audience, you can sweep your open hand across the auditorium, with your fingers extended toward the audience. If you are unable to stand, or have other physical limitations, you can adapt these recommendations to your own situation to good effect.

Figure 2. *Good (left) and poor (right) stage presence. Left photo by Product School (https://unsplash.com/@productschool). Right photo by Xander Bissell (https://unsplash.com/@xanderbissell). Both from Unsplash (https://unsplash.com).*

Your gaze should always be toward the audience. If you need to glance down, at your notes, or to the side, it should be brief. You should always let the audience know that you're aware of them. They should never doubt that your attention is on them. They are the center of your concern (Figure 2, left). You should not look down or direct your gaze at something in your hand (Figure 2, right). If you need notes you can use the presenter mode in your presentation software, or print your notes in a large font on a full-size piece of paper. That way you can hold the paper in your hand that is away from the screen and glance at it quickly to remember your place. If you are giving a professional presentation and need extensive notes or must refer to them frequently, you are not well enough prepared for your talk. The audience needs to know that you care enough about them to of spent the time to fully prepare.

Problems can, of course, arise if you pay too much attention to the audience and get distracted. Near the end of my first postdoc I was invited to present a seminar about my research to the department. It was a relatively small department, so the seminar was held in a standard classroom with freestanding desks with small writing areas attached to their right side. Shortly before the seminar my advisor came to me and said, “No matter what happens, do not pay any attention to Dr. Meyer.” This was the best advice I have ever received. Meyer was the department head and, during the seminar, he did everything but stand on his head. He sat sideways in the chair, he leaned forward onto the desk, he pushed his feet out in front of him and reclined, he ran his hand over the top of his head, he propped his chin onto his hand, and he made faces. Oh my God, the faces! He frowned, he raised his eyebrows, he grimaced. I do not recall him shaking his head no, but I wouldn’t be surprised if he had. It was the most theatrical performance I have ever seen from an audience member, and he was sitting almost right in front of me. If I had not been warned, I would have thought his theatrics were about my seminar. It turns out that Meyer performed like this during every seminar. It was part of his normal mode of listening. It had nothing to do with me.

The example of Meyer’s behavior shows that it is possible to pay too much attention to the audience. There will almost always be someone in the audience who is frowning, sleeping, or making faces. These behaviors almost never have anything to do with your presentation. They have everything to do with that audience member. Perhaps they slept poorly last night, and just can’t keep their eyes open. Maybe they just had a fight with their partner and are mulling over those events while only seeming to listen to your presentation. It could be anything. You cannot know what their behavior means, and you should not try to decipher it during your presentation. Of course it will bother you, but the solution is to look away and find someone in the audience who is nodding in agreement, or smiling, or appears attentive. Occasionally glance at those people, imagine them saying good things about you, and concentrate on your presentation. If it seems to you that you are only connecting with one or two people in the audience, then you are doing your job correctly. You are really connecting with everyone, it’s just that the feedback is coming from a few people. Thank them for it by smiling back, and everyone in the audience will thank you for having a good connection.

Although having a good connection with the audience is the most important part of your talk, we cannot neglect the content. Content presented without a good connection will annoy your audience and, though they may remember you, it will be for the wrong reasons. However, connection without content has no value. It certainly is not science. It may be Dadaist theater, but it has little meaning. How can we present scientific content without losing our connection to the audience?

The answer is to tell a story.

Stories are the universal language. They are the way we create meaning. They help us remember complex data. Read any good abstract of a scientific paper and you will find a story. In the abstract authors reduce the complexity of their presentation and put it in a format that is easy to understand. The best ones tell a story. But what is a story? Let us begin by looking at a standard format of Hollywood storytelling, the logline (Barton, 2013).

A logline is a brief summary of the central conflict of a theatrical presentation written to summarize the plot and generate interest. A logline is not the same as the teaser used to promote the movie. It is a full, but brief, plot summary. Here is the logline from a famous movie as told by Barton (2013).

> In a time of the Galactic Civil War, on a quiet farm, and impatient young man gets his life upended when he finds a message from a kidnapped princess and meets an old man who tells him about The Force. After his family is murdered, the young man hires a cocky space pilot to help him rescue the princess and aid the rebel alliance. But when the princess's home planet is destroyed and the young man is drawn into the enemy's battle station, he must learn how to use The Force in order to destroy the enemy, and save the Princess and the rebel alliance (*Star Wars*).

Let us look at the parts of this typical logline and see how they relate to a scientific presentation.

1. In a time of Galactic Civil War (in the world as it exists today): this is the introduction. In a scientific talk it presents the relevant state of current knowledge.
2. Luke gets a message from Leia Organa (something happens to upset the status quo): you now introduce the problem—our present knowledge is incomplete, or there is contradictory evidence. This calls into question the facts of the world as we know them.
3. Luke meets Old Ben and learns of The Force (taking stock of the situation): what are the possible solutions to the problem, how might the contradictory evidence be reconciled? What are possible hypotheses that could be pursued?
4. Luke hires Han Solo (the hero commits to action): you outline your study and your hypotheses, and explain how they address the problem you identified. You present your research.
5. The planet Alderaan is destroyed by the Death Star (the stakes get raised): not all of your experiments go as expected, or there are contradictory or unexpected findings.
6. Luke learns to use The Force (the hero learns the lesson): experiments are done, or data is collected that reconciles the contradictory evidence.
7. Luke destroys the Death Star (the antagonist is defeated and the hero achieves their goal): you support or reject your hypothesis, or solve the original problem. A new status quo is created, and new hypotheses are proposed.

If we remove the references to *Star Wars* we will see the scientific story more clearly.

1. Introduction: Present what is currently known in the field that is relevant to your work.
2. Present the limits, or problems with what is currently known.
3. State your hypotheses, or the problem(s) you will address.
4. Present your main experiments and the main findings of your research.
5. Present your unexpected results, or the difficulties you had. What did not go as expected?
6. Describe how you reconciled your main findings and the unexpected results. How did you pull everything together to have your work make sense?
7. Present your solution to the original problem. Propose a new status quo. Generate new hypotheses.

The value of thinking about your work in a storytelling format is that it helps you decide what to present, what to exclude, and how to structure the information. It suggests a way to deal with your unexpected results. It tells you where they fit within the presentation, and how to make sense of them for the audience. It also gives you a clear view of how to present your next steps. It clearly demonstrates how the last part of your talk creates a new status quo around your research question. It shows you how you are setting up a new story. The audience will be intrigued and want to know the outcome of that story. They will remember you and your research because you have told them a story, and then left it open to further developments at the end. It is a classic cliffhanger. The audience will be hooked.

Let us return to our discussion of slides now that we have an overview of how your scientific story can be told. We have already seen that you want to minimize the amount of text on your slides. What about data and graphs, how should you present your data?

As we have seen, text and images on the same slide can be difficult to interpret. Simple graphic images with no text are easier to interpret. However, few technical scientific presentations can rely solely on graphic images of this nature. Some text is necessary, as are graphs and other types of figures. If we keep these facts in mind, and remember that we want to tell a story, we can see that too much information on a slide will disrupt our communication with the audience. The narrative flow of our presentation should be like the flow of a river. It may meander, but it moves steadily in one direction. Each slide should move us slightly farther downstream. When there are multiple pieces of information on a slide they easily create eddies in the movement. It is as if we get stuck in a small whirlpool and momentarily lose sight of where we are going. Of course it is possible to get stuck in an eddy even if there is only a single piece of information on a slide, but the digression is easier to spot and correct under these circumstances. If you force yourself to change slides for each major point, it will be easier to notice when the flow of your narrative is disrupted. You can then make a conscious decision about whether that disruption is necessary, or whether you should eliminate it in preference to continuing the main flow. Carter (2013) has many other excellent recommendations for slide design and images.

Good scientific presentations are memorable. They tell stories. Their ideas flow well because each slide presents a single idea and does not contain too much text. They are based on a good connection between the presenter and the audience. It is clear that the presenter wants to be there giving this talk. Their presence is palpable. The audience can see the sparkle in their eyes. Applying these principles will improve any scientific presentation, no matter if it is to a general or a scientific audience.

## III. A Science and Technology Studies Perspective

***Roy Schwartzman***

Simplification and public education cannot suffice as guidance for improving science communication. A fundamental and relatively unaddressed problem underlies the persistent disconnections between scientists and the public realm: the epistemological divides between scientific methods and heuristic knowledge production. The deliberative processes practiced in scientific research do not align with the intuitive drivers of much “common sense” perception. Extensive research stemming from the Elaboration Likelihood Model (Petty & Cacioppo, 1986) and cognitive heuristics (Kahneman, 2011) affirms that people initially process unfamiliar information beyond their ordinary realm of expertise or interest through various cognitive and emotional filters. In short, people often think *through* their initial, emotion- and value-laden perceptions to shape how they think *about* things beyond their customary cognitive territory. Thus activating these heuristic drivers (Cialdini, 1993) enables communicators to connect with and influence audiences without relying on deep technical understanding or advanced scientific training. Communication centers can reconcile the epistemological divides in communicating science by addressing two areas that often divide scientific and public perceptions: conflicting frames and moral foundations. This section concludes with reflections on how communication centers can become key connectors between scientists and non-scientists, helping to bridge epistemological gaps that impede social communication of science.

**Framing**

Communication centers can call attention to the effects of framing scientific messages in different ways. Climate science illustrates this point. Disadvantageous framing rather than sheer scientific illiteracy has contaminated the messages of climate scientists. Consistently associating economic hardships (job losses, more expensive energy, inconvenience) with climate change remediation renders the warnings of climate scientists unpalatable (Stoknes & Randers, 2015). This prevalent loss frame stigmatizes climate scientists' policy recommendations as undesirable even if their projections are accepted as probable. The nomenclature of "climate change" also suggests a natural volatility beyond human capacity to predict or control. (*Plus ça change, plus c'est la même chose*.) Natural risks seem unavoidable and uncontrollable, so human intervention seems futile (Sandman, 1993). Altering frames has made a difference in perceptions about climate change. "Nonetheless, recent research on climate communication has identified several techniques that can assist in communicating contested scientific findings . For example, a mere change in wording—from "tax" to "offset"—increased Republicans' willingness to pay for carbon producing activities" (Lewandowsky & Oberauer, 2016).

Communication centers can place communicators in low-stakes practice situations to gauge audience reactions to alternative discursive frames. Beyond that, communication centers can assemble audiences of non-scientists to assess the preferability of various frames. These audiences could be generated in several ways. Many science-related departments at universities already partner with local schools to discuss and demonstrate scientific research. Communication centers also can record presentations and push the video content out to students in various courses across several disciplines, asking the students to rate and critique the presentations. Practice presentations delivered in communication centers can serve as excellent writing prompts in composition courses. Students could view the presentations, then write summaries of the content (to provide an indicator of comprehension), or they could write formal feedback to the presenter—including suggestions for improvement. Ample feedback could be generated by posting a practice video on an online discussion board, which would allow observers to interact with each other about the presentation. In each case, the audiences emerge organically from courses or activities already taking place.

Experimenting with different discursive frames for discussing science can reveal how rhetorical choices render science communication more than neutral reports of findings. For example, how could measures to address climate change create opportunities and not simply incur costs? How do different options for naming phenomena affect audience perceptions and reactions?

The communication center discussed in this forum has addressed such questions by administering "three-minute thesis" competitions. In these events, graduate students have three minutes to explain their thesis or dissertation to an audience and judging panel of non-scientists. These audiences can consist of VIP guests to the event, preferably people mirroring the profile of the non-scientist audiences the speakers would address in their professions. To prepare for the "three-minute thesis," communication center consultants advise the speakers in selecting frames that generate the desired emotional and perceptual reactions while accurately conveying the scientific information. Similar activities could furnish testing grounds for framing scientific findings. Communication centers could structure friendly competitions around devising brief video advertisements (using visual communication techniques discussed in Part II above) or oral "pitches" for grant funding delivered to simulated grant review panels playing the role of philanthropists who have non-scientific backgrounds.

**Moral Foundations**

Public attitudes toward science are filtered through fundamental moral convictions. Communicators ignore these commitments at their own peril. The more religious an audience is, the more suspicions they harbor about technological innovations overall (Brossard, Scheufele, Kim, & Lewenstein, 2009). This connection between degree of religiosity and beliefs about science does not specify any particular religion, only the strength of religious commitment (Scheufele, Corley, Shih, Dalrymple, & Ho, 2009). Especially in the U.S., stronger religious faith is associated with greater skepticism about science (Kahan, 2015; Pasek, 2017).

Jaron Lanier (2011) comments that technologies take on superhuman characteristics as if they guide human actions. Thus, enthusiastic endorsement of a technological innovation may strike a more religious audience as a usurpation of God's authority. Communication centers could guide emerging scientists toward (a) greater awareness of and (b) concrete adaptations to the values that audiences may harbor—values that are not directly tied to science but that guide interpretations of science communication.

Research on moral foundations theory identifies relative prioritization of five core value clusters—compassion, fairness, purity, authority, and ingroup loyalty—as a reliable indicator of political attitudes (Graham et al., 2011; Haidt, Graham, & Joseph, 2009). Alignment toward these same values also affects attitudes toward science policies, such as actions to address climate change (Dickinson, McLeod, Bloomfield, & Allred, 2016). Communication center coaching could equip emerging scientists with the ability to appeal to each of these value clusters, depending on their centrality to the audience and the issue. A communicator could invoke purity, one of the three values shaping climate change attitudes, by discussing climate change as "climate corruption," a degradation of pristine natural systems of checks and balances that humans have disrupted. Compassion, one of the main drivers of climate change attitudes, could be aroused with narratives tracing the miseries of specific communities of indigenous people whose lives are threatened by climate change. Some such efforts have featured animals (e.g., a "family" of polar bears) affected by climate change, but profiling the climate-induced pain of fellow humans would render the effects more urgent and immediate.

**Forum Synthesis**

This forum began by calling attention to the widening rifts between scientists and non-scientists that have led to mutual mistrust that could threaten important scientific and technological contributions to social problems. Communication centers offer an attractive mediator between scientists and laypeople because, as Cuny notes in her contribution to the forum, centers generally have a strong commitment to respect and serve all clientele. By providing an environment for respectful communication, communication centers can devise encounters between scientists and non-scientists that transcend political, religious, or ideological polarizations that impede deep discursive engagement. Elaboration on this engagement will follow in the concluding section.

Cuny's experience in nurturing a multi-year partnership between her communication center and communities of scientists can energize such efforts at other communication centers. Both scientists and communication centers must perceive clear benefits they will incur from sustaining an ongoing collaboration. Allies become critically important in supporting the legitimacy of a center's involvement with academic areas distant from the native fields of most communication center administrators. If initial allegiances at one's home institution prove difficult, external allies from neighboring institutions or professional organizations (in the sciences or in communication) can create the momentum to devote more attention to science communication.

Moving to the next section, research in science and technology studies strongly endorses Kirchoff's call for crafting compelling narratives, especially in social communication beyond scientific communities. When interpreting communication about emerging scientific research, enthusiasts and skeptics do not differ in the data they use as much as they differ in their "narrative schemata" (Gordon, 2007, p. 105). Enthusiasts employ more optimistic, future-directed plot lines with science as a positive force to overcome problems. Skeptics construct stories that often express nostalgia for a more natural past that preserves untainted purity and reject scientific innovations that upset the balance of nature. For example, at the root of many fears surrounding nanotechnology lies the theme of the Sorcerer's Apprentice (Laurent & Petit, 2006, p. 270). This familiar motif describes how an amoral scientist usurps the power of nature for evil ends, contravening the rule that science should serve the public good. Suspicion of science and scientists has a deep narrative heritage.

Stories and personal anecdotes can transcend an audience's politically polarized scientific views (Lewandowsky & Oberauer, 2016). Kirchoff's own narrative holds particular appeal to scientists who may harbor suspicions about tutelage from non-scientists who populate communication centers. His experiences of witnessing, practicing, and sometimes violating the communicative practices that build conditions for public dialogues about science invite other scientists to incorporate communication mentoring into their professional preparation.

In the third section, science and technology studies brings framing and heuristics to bear on improving science communication. Communication centers allow scientists to experiment with different ways to frame their messages to generate desired reactions from their audiences.

Greater awareness of the cognitive shortcuts and value clusters that affect attitudes toward science can improve understanding of how to restore scientific credibility when addressing non-scientists.

Discussion continues with an overview of the discursive environment communication centers can foster for science communication. Finally, the practical benefits to scientists and to communication centers furnish a basis for any communication center to pursue partnerships with scientific communities.

**Discursive Environment for Productive Science Communication**

Communication centers offer means to reconcile disjunctures between scientists and the public. Toumey (2006) notes that "public understanding in a scientific controversy is largely shaped by the rhetorical strategies of the competing parties" (p. 405). Communication centers can foster mutual appreciation between scientists and non-scientists by cultivating respect, beginning with unpacking why people (dis)believe the processes, findings, and implications of scientific investigations.

As intermediaries between scientists and broader social audiences, communication centers can initiate, maintain, and deepen dialogues across these communities. Ideally, the exchange between scientists and lay citizens enacts a mutually educational dialogue. Laypeople become more aware of scientific research, while researchers gain greater insight about public priorities, hopes, and concerns. Communication centers can facilitate discussions that involve the public early in the research cycle, thereby reducing the power disparity that stems from presenting already completed results to an audience that lacks background and can only comment on what has been done (Weil, 2007).

Peters (2007) suggests relational intelligence as common ground for discussing the ramifications of scientific or technological innovations. Discussing the implications of how science induces people conceive of their relationships with each other or with God does not presume or lend advantage to a particular constituency. Everyone, regardless of technical training, has an equally legitimate voice regarding the most desirable forms of human relationships. Perhaps the consideration of other people as the primary discursive domain rather than the substance of scientific knowledge provides a level playing field for including a wide range of stakeholders. When asking questions such as "How likely will this form of technology cause human health risks?" those with access to various cognitive resources (e.g., research findings, understanding statistical probabilities, etc.) already hold an advantage in framing how potential answers will be constructed. The rules of the language-game have been defined according to terms conducive to specific groups of stakeholders. If we could engage in collective discussions of models and methods of conducting human relationships, substantive questions could arise that invite fuller participation. Questions such as "What view of other human beings are we enacting?" recognize that all participants in the discussion have the capability to engineer their social world (Pearce, 2007). Recognizing the cooperative and complementary roles everyone could play in co-creating reality would provide productive ways to engage diverse constituencies.

A communication center-engineered dialogue approaches public engagement as anticipatory governance, involving direct interactions with the non-scientific public to gauge their attitudes and to anticipate potential problems that may arise in integrating new technologies into society

(AZoNanotechnology, 2008). Anticipatory governance, unlike risk communication, is not crisis driven. Instead, it remains proactive, seeking ways to avoid confrontations and misunderstandings.

**Practical Implications**

Hemali Rathnayake (2019), a nanoscientist who has collaborated with a communication center for several years to prepare graduate students for public communication of science, recently discussed how refining her own and her students' communication skills has enriched them personally and professionally. Erin Harrison (personal communication, September 30, 2019), associate director of UNCG's University Speaking Center, generalized these reflections to highlight the advantages of a synergistic relationship between a communication center and science students.

1. It exposes student consultants at the communication center to research and presentations in science, furthering understanding of the scientific method.
2. It creates connections between humanities and sciences, building cross-disciplinary knowledge and networks.
3. It dispels the myth that all science presentations are boring and uninteresting.
4. It requires student consultants at the communication center to "up their game" in the realm of feedback because they are often coaching students working on graduate degrees.
5. It requires student consultants to step out of the jargon box of communication studies or training and development language to make their feedback accessible to other audiences.

Notably, these observations point to intellectual silos (marked by jargon) as a challenge affecting non-scientists as well as scientists. The educational benefits of the communication center's work flow in multiple directions: to the emerging scientists who receive the coaching, to the communication center consultants doing the mentoring, and to the (current or eventual) audiences the researchers will have when they present their research in broader social contexts.

Communication centers can foster convergence between scientific communicators and their audiences. During that process, the student peer mentors acquire knowledge and skills not readily obtainable in the conventional consultation work. Such partnerships between communication centers and scientists can improve science communication and enable closer cooperation between researchers and the stakeholders affected by their research. Ultimately, the capacity of science and technology to continue improving the world hangs in the balance. The stakes could not be higher.

**Conclusion**

Given the significance and urgency of improving the interfaces between science and society at large, what specific roles can communication centers play in this process? First, communication centers can enrich the interactions between scientists and non-scientists, facilitating dialogues that build mutual trust. Trust provides a way to build a rhetorical bridge that spans the epistemological gaps between scientists & the lay public. Communication centers can provide forums that depart from the traditional (and problematic) power dynamic of the esoteric specialist enlightening uninformed laypeople. Instead, communication centers could design different communicative formats that disrupt such power hierarchies: citizen panels that pose questions to researchers, teaming scientists with non-specialists to tackle wicked problems that elude purely technical solutions, as well as the activities described earlier in this forum. Most discussions of deliberative democracy in science communication remain rather insulated from the actual practice of collective deliberation (Farrelly, 2007). Communication centers can foster the practice of collaborative, dialogically driven decision making.

Second, communication centers can take specific measures to rehabilitate science and scientists as trustworthy dialogical partners. Communicator credibility—a staple of rhetorical education since Aristotle—constitutes a communication center's stock-in-trade. Trust in science is a multidimensional construct, consisting of epistemic trust (trusting science as an institution), interpersonal trust (communicator credibility), and perceived antagonism (e.g., opposition to the audience's values and interests) (Sjöberg & Herber, 2008). If communication centers work with scientists to enhance their personal credibility, particularly through demonstrable respect and goodwill toward the audience, scientists likely would encounter publics less likely to dismiss scientific communication outright. Since perceived antagonism fuels public distrust of science (Sjöberg, 2008), nourishing rapport between researchers and non-scientists could improve receptivity toward science communication.

Third, communication centers can work with scientists in acknowledging and adapting to persuasive techniques beyond scientific argumentation that drive attitudes and behaviors of their audiences. Scientists need to become more reflective about the societal and ethical implications of their own work instead of assuming that simply conveying their research findings will suffice (Stilgoe & Wilson, 2007). This forum identifies several communication competencies that scientists can hone by working with communication centers, such as: storytelling, strategic use of discursive framing, and respectful acknowledgment of the audience's core values. Communication center workers, acting as mock audiences, can furnish useful proving grounds for testing public reception to these approaches.

Cumulatively this forum issues a clarion call for communication centers to become more active participants in exoteric science communication. Communication centers can and should play a pivotal role in whether public communication of science becomes conversational or confrontational. As honest brokers between scientists and the public, communication centers can promote discourse as a remedy for distrust.

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