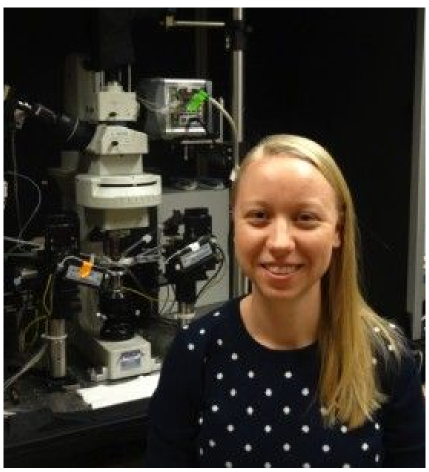
Confronting Misconceptions about Science



Ali Weber is a PhD *student in neuroscience who is interested in how our sensory systems encode information about the world around us. She uses a combination of experiments and mathematical techniques to study the retina, with a focus on understanding how the neurons in our eye adapt to the incredibly varied conditions they face.*

I stood with drink in hand, slowly growing more uneasy as I listened to the woman across from me. "Oh no…" I thought to myself. "I know where this is going." She excitedly described a recent neuroscience experiment that had been splashed across the news. I started wondering to myself if I would correct some of her misconceptions, or simply smile and be happy that someone was excited about neuroscience.

In the study, one of the subjects sat alone in a room, watching the screen of a video game with no access to the game's controls. In a neighboring room, another man sat with the controls at hand, but no access to the screen that displayed the game. The researchers had devised a way to make the hand of the second man push a button whenever the first man merely thought of moving the controls. The two men were able to successfully complete the game, despite neither being able to complete the task on his own and the two having no means to directly communicate with each other.

Researchers had virtually connected the brains of two people, deeming it the first “human brain-to-brain interface.”

On its face, the results are truly astounding, conjuring images of a near-future where mind reading and telepathic control are possible. But as I listened to the woman excitedly describe the potential implications, I grew increasingly uncomfortable. As a neuroscientist, I was familiar with the details of the study and how the results had been dramatically overblown in public-facing news outlets. The study was far from groundbreaking, piecing together two relatively older technologies, with clearly predictable results to anyone with basic neuroscience knowledge. The equipment read out a very particular and strong signal from the brain of the first subject, and implemented a coarse electrical stimulation that caused the muscles of the second subject to twitch, a far cry from “mind reading” and “remote control” of another human.

Standing at the party, I was conflicted because, as a scientist, I revel in sharing my enthusiasm for the topics I study, and moments of excitement, just like the one the woman across from me was experiencing, are what I strive to share with non-scientists. However, I feel compelled to share an accurate picture of the current state of my field. Like many of my fellow scientists, I worry that spreading an exaggerated version of scientific advances can ultimately create disappointment and distrust among the public.

Recently, much has been made of the role of journalism and media in our society. (You need only think about how often you’ve heard the expression “click-bait” to illustrate this.) While the role of journalism has been discussed at length, much less has been said about the role of scientists who are put in difficult positions by media distortion. When someone has been presented an overstated picture of the state of the field, I wonder what the better course of action is: correcting that misperception and potentially replacing their enthusiasm with cynicism, or leaving the misperception intact and hoping they won’t ultimately be disillusioned when the promised technologies don’t materialize. Both have the potential to backfire.

Mostly because I couldn’t help myself, rather than having thought the issue through and made a decision, I launched into my more measured assessment of the study’s implications. We both laughed about the gap that sometimes exists between academics and “the outside world,” and she ultimately seemed happy to have been given a more nuanced perspective on the topic.

It seemed I had accidentally made the right call in this case, but as I thought back on the interaction later, I wondered if this would always be the right thing to do. Scientists already struggle for funding, and a large percentage of the population doesn’t believe the government should financially support scientific research. In such a climate, should scientists really go around dampening the public’s enthusiasm? If people realize how painfully slow scientific progress usually comes, could we reasonably expect people to willingly fund, much less get excited about, scientific research?

This line of reasoning is tempting, but I think we owe non-scientists a more nuanced and accurate picture of how science actually works. We as scientists, whose work is almost entirely publicly funded, owe the public in a very literal sense the most accurate possible picture of what we have, and have not, achieved. I also think we do the public (not to mention our fellow scientists) a disservice by presenting scientific progress as happening in leaps and bounds, rather than by the slow and methodical efforts of often hundreds or thousands of people working together towards a common goal. This is not only the more realistic picture, but I think it also paints a more relatable portrait of a scientist: an individual doing the difficult, and often tedious, day-to-day tasks of working towards a larger goal, rather than an aloof academic in an ivory tower who is struck with a flash of brilliance.

Maybe it's just the scientist in me who can't listen idly to a misrepresentation of science, but I intend to keep chiming in with the more accurate, if more complicated, story.

What Scientists Can Learn from Taylor Swift

Jonika Hash is a PhD *student in the Department of Family and Child Nursing at the University of Washington. She is passionate about working with families to improve outcomes in the face of adversity. Her current work seeks to understand early childhood adversity as it relates to sleep problems and* social emotional *functioning among infants and toddlers.*

Have you ever listened to a Taylor Swift song? I mean, really listened to a Taylor Swift song? Maybe you've found a familiar friend and groovy dance partner in that "Shake it Off" saxophone. Or maybe you've found solace in the midst of a scathing manuscript review crying "why you gotta be so mean?"

But have you ever really taken pause and listened closely to a Taylor Swift song, noting the coming together of words in the verses, chorus, and bridge—and how they form around the melody?

I was cooking the in kitchen the first time I really listened to a Taylor Swift song. I don't remember what I was cooking, but I do remember the experience of feeling suddenly and viscerally captivated by a story of love and loss told in the lyrics of "All Too Well." I felt her story on a human level, as if it were happening not only to her but also to me. I too felt as if "time won't fly, it's like I'm paralyzed by it. I'd like to be my old self again, but I'm still trying to find it." And so she connected with me on a very raw and palpable level, just as she had done time and again with so many others—reaching broad audiences and crossing boundaries from country to pop.

Yet unlike what we see in Swift's career, connecting with broad audiences has proven to be an elusive business for the scientist. Even Nobel Prize winning science has struggled to find a place outside the walls of the Ivory Tower. (Consider as an example this article on the Nobel Prize winning work of Dr. Elizabeth Blackburn: https://www.msn.com/en-us/health/medical/you-may-have-more-control-over-aging-than-you-think-say-'the-telomere-effect'-authors/ar-BBxR44B). For nursing and other health sciences researchers like myself, overcoming this problem in science communication is just one important step toward making our science more accessible to the populations we serve, with the ultimate goal of improving health, wellbeing, and quality of life.

So what can scientists do to better connect with a broader audience? They can learn to tell stories. Just as Swift's storytelling in "All Too Well" conveyed for me a profoundly relatable experience, scientists can make use of storytelling to better convey profoundly relatable ideas.

Stories are powerful tools which facilitate communication by connecting with people in meaningful ways. In his article *The Science of Storytelling,* author Jonathan Gottschall tells us that "stories powerfully hook and hold human attention." When it comes to science, this means stories can help boost the impact of research findings. According to new evidence reported in UW Today's *What Makes Influential Science?,* science "papers written in a more narrative style – those that tell a good story – might be more influential than those with a drier, more expository style." In other words, the holding of our attention with stories makes possible a deeper level of engagement that can shift our science from forgettable facts to lasting impressions.

For University of Washington graduate students enrolled in the Engage Seminar, practicing good storytelling means first learning the basics. This includes the story arc, a basic storytelling framework comprised of four elements: setup, complicating action, development, and climax/resolution.

Through discussion, practice, and improvisation activities, students learn to make use of the story arc to communicate their science in more compelling ways.

So in light of burgeoning interest among researchers to reach diverse audiences, let us take a lesson from Taylor Swift and learn the art of storytelling.

Interested in discovering more about what good storytelling could look like in science? Try checking out how Radiolab communicates science in story form. You can listen to their podcasts here: http://www.radiolab.org

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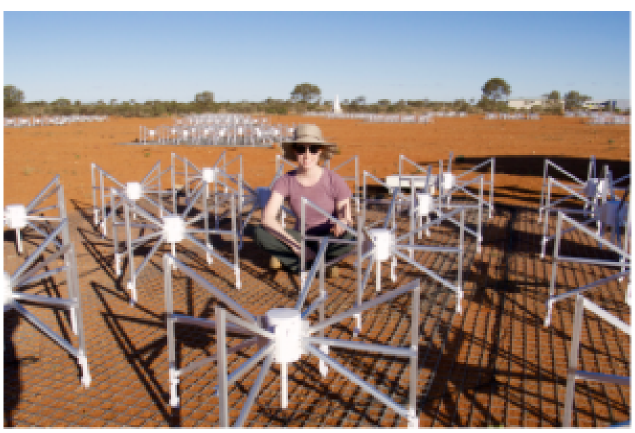
Physics has an image problem



Ruby Bryne uses a radio telescope in the Australian outback to search for signatures from the universe's earliest stars and galaxies. Detecting the first bright objects that lit up after the Big Bang will help us understand the structure of the early universe and the dynamics of star and galaxy formation.

When I tell people what I study, they often let me know that they think physics is inaccessible, difficult, and impossibly complicated. This impression is partly warranted: learning physics isn't something to take on in an afternoon. However, I think bad physics communication is partly to blame for peoples' aversion to the subject.

Randy Olson's book Don't Be Such a Scientist is a plea for scientists to do a better job of communicating their work. He argues that scientists' obsession with being factual and complete (driven by their heads) gets in the way of more accessible communication through emotion, intuition, and sex appeal (driven by hearts, guts, and, well, you know). The scientist in me takes issue with his association of personality traits and body parts, and the feminist in me worries about the implications of mixing sex appeal and physics, but I nonetheless agree with his main point. I've sat through enough painfully boring physics lectures to endorse the idea that science communication needs to be more engaging. While I'm not going to start peppering my talks with sexually charged frat boy jokes, I want to move away from the detail-heavy style that dominates physics communication. I believe that there is a better way to communicate physics, one that relies more heavily on analogy and intuition-building.

The problem with communicating physics is that many advanced physics concepts defy intuition. Einstein's theory of relativity tells us that space and time are essentially the same thing and together make up a thing called space-time. We know that gravity is a distortion in this weird space-time stuff. But what is space-time? What does it mean for it to be distorted? I couldn't say, beyond parroting the usual textbook definitions. I can represent it in math, and I can use this math to solve problems, but I can't understand it in the same way I understand things I can see and feel.

Fortunately, gravity can be described with a simple analogy. Picture a trampoline. A bowling ball in the center distorts the fabric of the trampoline. This is like the bending of space around a big, heavy object, like a planet. Adding another bowling ball a few feet away will cause the balls to roll toward each other. This represents the force of gravity, which pulls heavy objects together.

The trampoline analogy is repeated in physics classrooms around the world. A quick google search returns countless YouTube videos of this demonstration, and also a number of critiques angrily proclaiming that gravity is in no way a trampoline. They're right, of course. Gravity is not a trampoline. Humans walked on the moon because scientists solved equations, not because they played with bowling balls. That said, when I sit down to solve a difficult gravity problem I often think of the trampoline. Despite its limitations, the analogy offers me important intuition in my problem-solving that I can't get from a more complete description of gravity.

Effective science communication, either in the classroom or through community outreach, requires scientists to meet their audience where they are. If imperfect analogies are the best way to convey a point, so be it. Physics is hard enough already.

Analogies and metaphors in science communication: the good and the bad

Siva's research broadly involves the development and application of experimental and computational tools for studying genomes. His current work is focused on centromeres, which are locations on chromosomes that have not been successfully assembled and are 'holes' in our map of the genome.

A common back-of-the-envelope metric for determining whether an explanation of a scientific idea is good is asking if it can be understood by one's grandmother (or other non-expert family member) [1]. In this context, effective communication usually involves the liberal use of analogies or metaphors [1,2]. As I was thinking about ways to make my own research accessible to the public, I remembered a series of letters (Refs. 3 and 4) I skimmed a few years ago in an issue of *Nature*. The letters were part of a correspondence relating to a longer piece published in a previous issue (Ref. 5). I was interested, at the time, not because of the substance of the argument, but rather simply because there was a debate (who doesn't like to watch scientists duke it out through primly written letters to the editor?).

But, before I jump in to the controversy, I think it's useful to quickly define terms and draw distinctions. Analogies are typically considered rational arguments that highlight the similarities between two seemingly different things. Metaphors (and, relatedly, similes) are more nebulous. They are figures of speech in which a direct comparison is made without the apparently rational framework of the analogy. For example, if I said, "He is a great scientist, but he's a bit of a dinosaur," it's relatively clear that I'm just saying he's old (and not actually a dinosaur). To be more specific, as applied to scientific communication, metaphors have three components: "(a) the topic, which is the phenomenon we want to say something about, (b) the vehicle, which is the phenomenon we are using in doing so, and (c) the specific and relevant instances of comparison taken place" [6].

Metaphors and analogies are useful because they distill the important components of a scientific idea and allow non-experts to appreciate and understand the idea [7]. They're indispensible in both written and spoken scientific communication and, popular contemporary science communicators like Bill Nye, Neil de Grasse Tyson, and Neil Shubin use these devices effectively. But the use of "thought mappings" like metaphors and analogies isn't just of utility in communicating with nonscientists [8]. Roald Hoffman argues that they play a role in helping scientists "generate hypotheses, theories and experiments" and he advocates using these devices in communicating with scientists and nonscientists alike: "A naked metaphor clearly shows the analogy's limitations, its capacity for misinterpretation and its productive extensions. It aids its creator as well as its audience" [8].

As a student in the UW MD-PhD program, I have one foot in the lab and the other in the clinic, so I've also seen the importance of metaphors in interactions with patients. Working with patients invariably involves discussions of relatively complicated topics ranging from the cause and course of disease to the ways in which surgical or pharmacologic treatments work. The secret of doctors and nurses who effectively communicate with patients, of course, is using carefully practiced, thought out, and well-placed metaphors. For example, one doctor I worked with explained treatment options for diabetes by likening insulin and its receptor to a key and lock. I won't go through the details, but I'll say that it was a great way to convey the essentials while avoiding jargon. For this reason, analogies and metaphors are used widely in clinical medicine, where better communication means better outcomes [9-11].

But, back to the correspondence in *Nature*: In the piece that kicked everything off, Eleanor Pauwels, a public policy scholar, described her studies of the prevalence of computing and engineering metaphors in the biological sciences [5]. I certainly hear (and have been guilty of propagating) metaphors relating biological concepts to ideas in physical and engineering sciences. Prominent examples include thinking of the genome as "software" [12] or a "code" [6] and referring to the "black hole" or "dark matter" of genomes [13]. But is this necessarily bad? Pauwels summarizes a startling conclusion of her work: "although metaphors are essential in enabling science and in communicating research to the rest of the world, their use can also mislead the public, and even scientists themselves" [5]. Indeed, improper use of metaphors "widens rather than closes the gap between scientific realities and the expectations of policy-makers and the public” [5]. This seemed like bad news given how pervasive this was in my field.

Fortunately, the letters to the editor that followed tempered this view of the use of metaphors and analogies. (They also contain a couple of zingers – it doesn’t really get much more serious in the academic boxing ring than impugning someone’s viewpoint). Andrea Loettgers writes in response that Pauwels’s perspective is too restrictive [3]. Specifically, “Pauwels tends to merge metaphors with analogies and theoretical concepts.” Rather, borrowing engineering terms is “better viewed as the analogical transfer of a scientific concept” [3]. Brett Calcott, the author of the second letter, agrees with Loettgers and writes, “it is an oversimplification to think that all engineering talk in biology is mere imagery” [4]. Calcott also sees the use of metaphors and analogies as a transfer of concepts: “[biologists] take engineering principles — derived from theory and practice — and apply them to biological systems” [4].

What everyone agrees on is the importance of carefully considering the implications of metaphors and analogies to ensure that the scientists and the public are not misled. This notion that the metaphors we use, in addition to shaping public perception and understanding of science, can influence our thinking as scientists is something I hadn’t considered. There are many ways in which this could occur. For example, “[metaphors] can shape the type of questions we ask and influence the techniques we use to investigate them, sometimes resulting in major aspects of a problem being neglected” [14]. Another perspective on the ills of bad metaphors is a bit more abstract: “It encourages the interpretation of a partial view as the whole truth or the attribution of too much importance to the view provided by one metaphor as opposed to the different insights provided by a plurality of them” [15].

It’s clear that metaphors and analogies are useful devices in communicating with nonscientists. I think it is also clear that careless use of metaphors can be problematic. How, then, should we think about using metaphors and analogies to effectively communicate scientific ideas? There’s no one size fits all solution, but here are some helpful ideas I’ve come across:

- Prepare and think carefully. Consider the idea you want to communicate and your audience.
- Involve experts from different fields (scientists, social scientists, and policymakers) to ensure that language is crafted and used in a way that the goals of effective science communication are met [5,15].
- Avoid making value judgments and instead use metaphors to help audiences “understand scientific findings, not convince them without explaining the reasons” [15].
- Craft metaphors in a way that their message is not disproportionate to the evidence at hand. “Strong messaging can undermine the credibility of science – in particularly, when contradictory facts become available and, therefore, scientific uncertainties become visible to a broader public” [15].

It's also valuable to point out here that the consequences of poorly used metaphors aren't just theoretical or academic considerations. For example, recent discussions of CRISPR/Cas9 genome editing technologies have become fraught with bad metaphors [16]. This has arguably confused perceptions of genome editing and polluted important discussions surrounding the ethics of genome editing, potentially influencing public policy [16]. Stated slightly differently: how we communicate our science matters.

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Why Cats and Flash Photography Don’t Mix

Rachel is a PhD Student in the UW Department of Biochemistry who seeks to better understand photoreceptors, the neurons in the eye that detect light. Her current workfocuses on a new mechanism by which photoreceptors can control their signals in response to light and how disruption of this process can affect photoreceptor function and health.

Two weeks ago, I became a cat owner. Like pretty much every other cat owner I know, I promptly spoiled my cat, declared him to be officially more adorable than any other cat ever, and took approximately 100 photos of him. Amid these 100 photos, I managed to leave the flash on when taking a picture of my sweet, adorable Apollo.

Wait. This isn't a sweet and adorable kitty! This looks more like terrifying killing machine…

Pet owners everywhere can probably identify with my problem. Shining light into your pet's eye results in eyes that look more like headlights than windows to the soul. However, when you use flash photography on humans, you never see such bright light; the most some people get is a tiny bit of reflection we've termed "red-eye". Why the difference?

To understand what makes some of our animal friends eyes different from ours, we need to quickly mention some of the many parts of an eye. There are the parts you see from the outside, which include the pupil and the iris; these allow light to enter the eye. What you can't see is an important a part in the back of the eye called the retina, which is home to the neurons that detect the light that enters the eye. However in addition to these parts, many of our furry friends also have a component that we lack: behind the retina is a crystalline layer of tissue called the tapetum lucidum. Easy to remember, right? If it helps, it's Latin for "bright tapestry".

This layer of tissue works exactly like the reflectors you (hopefully) wear if you're out late at night on a walk or a bike ride. The tissue doesn't emit any sort of light, it just reflects light that shines onto it. Interestingly, when you look at the tapetum lucidum it looks like the pattern of a reflector! Here is an image of a cat tapetum lucidum collected by Bernstein and Pease in 1958[1]:

Alright, so cats, dogs, and many more animals have this extra layer. But what is its actual purpose? Why would you want your eye to *reflect* light? It turns out it has to do with the layer in front of it called the retina. When light hits neurons in the retina, a signal is broadcast to other neurons and eventually to the brain. If you have a reflective layer behind the retina, then light will bounce of the back and then stimulate the neurons in the retina again – basically giving the neurons another chance to signal that they have “seen” light. This is really helpful in a situation where there is not a lot of light in the first place; with a tapetum lucidum, you essentially get “double” the stimulation from the same amount of light entering the eye! This is what allows our furry friends to confidently stalk around the house at night while we are left stumbling in the darkness. In the case of Apollo, his tapetum lucidum increases his visual sensitivity by 44%, allowing him to see light that is totally imperceptible to my human eyes[2].

Earlier, I mentioned that sometimes in humans you will see something reminiscent of the bright eye-shine we’ve discussed called “red-eye”. Our eyes lack the tapetum lucidum, so they don’t reflect nearly the same amount of light as a cat; however, a little bit of light can be reflected off the blood vessels in the back of the eye, giving the light a red color. Are we humans alone in lacking this reflective layer? No. We haven’t found a tapetum lucidum in most primates, squirrels, kangaroos, and pigs. These animals share an important trait: they are mostly active during the day. Thus, they don’t really need to amplify light stimulation in their eyes – they’re already getting plenty of it when they’re most active.

Finally, there’s another interesting attribute of the tapetum lucidum: not all animals reflect the same color of light, and in some animals the color of light reflected changes as they get older! Apollo has a yellow-green eye-shine, but if he were younger it would look more blue[3]. The color seems to depend on type of reflective material in the tapetum lucidum, which varies among animals. So as the animal ages and the structure and composition of this layer change, the color it reflects can change too. Is there an advantage to reflecting a specific color? Unfortunately, we don’t have a definitive answer to that question. Some have postulated that the color may correlate with the wavelengths of light best detected by the neurons in the retina in each species[2].

So next time your photo of your adorable animal is foiled by the flash on your camera, remember that the reflective tissue that makes that happen serves an important role in letting your friend see in the dark!

Thanks for your help, Apollo!

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ENGAGE-ing Science Communicators at Science Talk NW

Last week, I and four other members of the ENGAGE Board of Directors had the opportunity to go down to Portland and attend the inaugural *Science Talk Northwest* science communication conference, held at the *Oregon Museum of Science and Industry*. It was the first of what hopefully will become an annual conference, a single-session conference where researchers, students, and science communicators met to discuss strategies that would be useful for science communication. It was remarkably well-attended, to the point where the conference itself sold out.

Over two days, a lot of interesting topics were discussed, including the use of improv techniques as a tool for improving our communication skills, how to talk to the media, how to get a blog started, how teenagers use social media (a presentation given by a genuine high school senior), and how to reach out to kids and adults using programs like *SPICE*—a science-intensive summer program for young girls—and *Science On Tap*, which combines adult beverages and science lectures in the best way. Todd Reubold from the University of Minnesota gave an engaging presentation on how to ‘fight the Powerpoint’ and create presentations that are visually interesting and tell a great story (big takeaways from his talk: never use Powerpoint templates, never use Comic Sans, never use images with watermarks, cut down on text and don't be afraid of white space). The *Alda Center* and organizers Allison Coffin and Janine Castro talked about how to deal with nervousness, and Todd even brought up the idea of having a separate 'presentation' persona, one that you can hide behind as an introvert uncomfortable with public speaking.

What was surprising to me, however, wasn't how different the messages were between speakers. I expected that. What surprised me, and maybe it shouldn't have, was how many things were the same. Although every speaker was talking about science communication in different ways—from how science should be communicated to policymakers, to the media, to kids, to adults, to just about everyone you could think of—there were several underlying themes that were repeated over and over again during the seminar's two day run.

One of these was the importance of storytelling. The idea that storytelling was an important tool for science communication, an idea that I presented on in my portion of the ENGAGE talk, was echoed several times, most memorably by Dr. Paige Jarreau of Louisiana State University who talked about the importance of story arcs in each of her blog posts (a link to her blog can be found here: *http://www.fromthelabbench.com/*). It was touched on in talks about how to use images to tell a story, in conversations about oral presentation skills, and it was even commented on by keynote speakers Jorge Cham and Kiki Sanford as they talked about their projects *PhD Comics*and *This Week in Science* respectively.

Another topic that came up often was the use of analogies and metaphors to get difficult points across. Roxanne Carini covered the analogy portion of our ENGAGE talk, where she showed how Legos could be used as an analogy for amino acids and protein building—just as the final outcome of a Lego building project can be very different depending on the blocks used, the use of different amino acids can change the shape and function of proteins. The message of using analogies in science communication went hand in hand with storytelling, with this idea that we needed to make our messages more accessible and relatable.

Spontaneity was another common theme. Improv techniques and how they can be used for science communication were discussed in a couple of different ways. Will Chen represented ENGAGE on that front, showing off an example of an improv game and talking about how using improvisational techniques allows us to think on the fly and deal with unexpected situations. Prior to our ENGAGE presentation, the subject of improv was also introduced by the Alda Center, a group based in the University of Oregon that helps to train scientists to better engage with the public and with journalists. The exercise that we showcased ("Spelling Bee") was very similar to the exercise used by the Alda Center, the differences being that the participants in the Alda Center exercise were allowed to stop and think to produce the right answer, whereas our exercise invited participants to just go with the flow and be spontaneous.

Finally, it seemed that the takeaway message for most talks was the ability to convey 'why' to the audience. Why are we doing what we do? Why do we spend so much time working on science, or thinking about science? Why is it important? This isn't just why it's important to the world or to our field, but why it's important to us as people. A general theme that came up a lot was that we need to engage with the public as humans, to show them what excites us about our field and our science and not to just give them facts or scare them into doing what we think is best.

By the time we got around to giving our ENGAGE talk on Saturday afternoon, all the topics that we wanted to cover had already been covered. And that's a good thing. As wonderful as it would have been to be able to give a talk on something entirely new and fresh and unheard of, repetition has its uses too. We were able to show that we are considering many of the same things that professionals in this field consider, and we showcased our ability to apply them. Not only that, we helped cement the idea in many listeners' minds that these were things that needed to be paid attention to—that storytelling wasn't just confined to fiction, that improv wasn't just about theater and comedy, that analogies were more than just literary devices.

And we weren't completely redundant either. We were still the only group of graduate students that could say we started this program on our own—by graduate students for graduate students. We were the only talk that had four people get up on stage, each of us wearing ribbons on our nametags that said both 'Speaker' and 'Student', and that was pretty cool.

Written by Elisa Bonnin.

Simplify your life—with yeast!

Anne wants to understand how genomes encode traits. To do so, I work on associating differences in traits with differences in genomic sequence, using baker's yeast as a model organism.

What do you do when you want to understand how something works, but that thing seems impossibly complicated? For example, let's say you want to figure out how a car works from scratch. You probably don't start by trying to work out all of the details of a Prius, with its hybrid gasoline and electric system, power steering, and electronic keys. Instead, you might look at a stripped-down go-kart with fewer parts that are also easier to examine.

Biologists want to understand how living organisms work, but, as is the case with cars, some organisms are much easier to study than others. Humans are made up of somewhere around 40 trillion cells (and that number is way larger if you include bacteria). Each of these cells contains a copy of the individual's genome, which is like an instruction manual for building that person. Human genomes are about 3 billion letters long (a thousand times as long as *War and Peace*), and contain about 20,000 genes. Each of these genes provides instructions for making a single protein, and these proteins are, in turn, responsible for carrying out all of the complex tasks inside of cells. My main point with all of these definitions and huge numbers is that humans are really complicated. And while we'd ultimately like to be able to understand ourselves, starting with an organism that's easier to study can be immensely useful.

Baker's yeast, a single-celled fungus, has been one of the most effective model organisms for the past few decades. Its genome is about one two-hundredth the size of the human genome (only five copies of *War and Peace*!), and contains less than a third as many genes. We're related to yeast by an ancestor that lived a billion years ago, and we've been evolving separately since then—yeast remaining single-celled, and us becoming 40-trillion-celled giants. It might be hard to imagine that we have much in common with yeast, being such distant relatives, but I've actually already pointed out a couple of similarities: we're both made of cells and built from genomes. It turns out there's a surprising amount of similarity in the specific genes we have as well.

A couple of years ago, researchers at UT Austin published a study on "humanized" yeast, in which they systematically replaced yeast genes with their human counterparts. About one-third of yeast genes have a clear counterpart in humans, and the researchers specifically focused on the subset of these that are essential to yeast—the ones that can't be deleted from the genome without killing the yeast. Going back to the car example, you can probably think of some parts of a go-kart that are essential to its function—the transmission, perhaps. We can replace the go-kart transmission with a Prius transmission and then see if the go-kart runs. If it does, the two transmissions are probably pretty similar, and learning about the go-kart version is probably going to help us understand the Prius version as well.

When the researchers replaced essential yeast genes with their human counterparts, 43% of the time the yeast survived, indicating that the human gene was a suitable replacement. So even after a billion years of separate evolution, we still share many genes that are similar enough to be interchangeable. And, in fact, annotating genes with their functions has been one of the primary successes of using yeast as a model organism. It's much simpler to figure out what a gene does in a yeast cell than in a mouse, dog, or human, and frequently the general function is the same across all those species.

Of course, we can't learn everything about human biology from studying yeast, as these single-celled organisms lack some important human characteristics like brains, hearts, lungs…and organs in general. But for basic cellular functions, yeast research remains a powerful tool for making some really complicated questions about how life works a little easier to answer.

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Cancer biology reproducibility initiative challenges confidence in published results

Kathryn Baker looks into the role of DNA mutations in the development of colorectal cancer in patients with ulcerative colitis. By studying both mitochondrial DNA mutations and clonal expansions, she hopes to better understand cancer development in an inflammatory setting and to help develop biomarkers for early cancer detection in UC patients.

Most scientists take comfort in the idea that science is essentially self-correcting. Faith in research hinges on the collection and publication of observable data and facts, the peer-review process, and the possibility of recreating our experiments to verify the findings. The question is then, what happens when study results are held up for scrutiny? Cancer researchers are discovering that their discoveries may not be as iron-clad as previously thought.

At a time when research funding continues to be tight, convincing either researchers or granting agencies to move forward with reproducibility studies is difficult. Because resources are scarce, the pressure to fund and produce exciting, novel, “sexy” science can seem insurmountable. Scientists want to believe in their results, but they know that many times, the effort will not be put forth to prove that they’re reliable. In 2012 the trend was broken by Amgen, a powerhouse biotechnology firm located in Thousand Oaks, California. (1) Citing the fact that oncology clinical trials have the highest failure rate versus other therapeutic areas, Amgen set out to validate 53 “landmark” studies. They shocked the scientific community when they reported that they could only reproduce six publications, or 11%, of the 53 they attempted. While some difficulty in reproducing results is expected, this failure rate was unprecedented. (1) These results were not made public, however, so the rest of the scientific community was in the dark about which studies were actually recreated.

Reproducibility studies for a wider audience arrived when The Reproducibility Project: Cancer Biology began in 2013. The large-scale collaborative effort set out to recreate findings from 50 major cancer studies published in high-impact journals like *Science* and *Nature.* In contrast to the Amgen studies, the project’s work will be openly available online. (2) In January of 2017, results for the first five studies were released. Two studies were “substantially reproduced” but faced some minor problems, like problems with statistical calculations. Two had strange, unexpected results and were deemed “uninterpretable” because they could not be reasonably compared to the original study results. The last was unable to be reproduced. (3) With such mixed findings, no one is quite sure what this means for the field yet.

It might be easy to be unsettled by these results, but it's important to keep in mind that just because these results were not replicated immediately, does not mean that the findings are not true. There are a number of factors that might make the process less than straightforward. Some studies' methods and protocols are vague or not specific enough to accurately recreate, and could thus create unforeseen areas of variability. Reproducibility Project scientists are working with the original study authors to understand where those differences could arise. While some authors worry that a single failure to replicate will reflect poorly on them and their work, the goal is not to cast doubt on good work, but to encourage better reporting practices in the future.

Despite concerns, The Reproducibility Project will likely help the scientific community in several key ways. First, it could help researchers and oncologists understand why some preclinical studies fail to become viable cancer treatments. It might help implement new research checks and practices or prevent time wasted on clinical studies that can't be well reproduced and won't help patients in the long run. Second, it will encourage scientists to communicate their findings better by using more specific and clear language in their publications and eliminate confusion surrounding possibly important medical findings. And finally, but perhaps most importantly, scientists may become more skeptical of even their own work, and will then work harder to be sure that they are putting out solid, reproducible science.

For more information on The Reproducibility Project: https://osf.io/e81xl/wiki/home/

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Whose job is it anyway?

Molly Grear studies the environmental impacts of installing marine renewable energy. Her PhD work focuses on how marine mammals might be impacted by colliding with the moving parts of these energy producing devices.

Here's an all too common question I get about ENGAGE when talking my fellow scientists:

"Why are you taking a class on science communication? Isn't that taking away time you could be researching? Is that even part of your job?"

My reaction is often surprise. I think science communication is a valuable tool and a worthwhile investment of my time. First, I'm really excited about my work. I study creating renewable energy from the ocean. The oceans are a largely untapped energy resource and the more people know about the potential, the more people might start thinking 'ocean energy is the perfect solution for my coastal town'. I believe we have a duty to make sure our science is communicated so that others can use it.

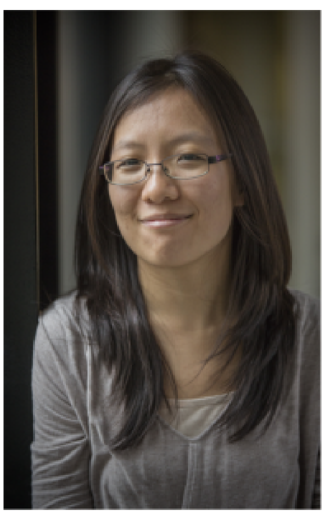
Second, breaking down and illustrating my ideas to a general audience makes me a better scientist. It forces me to create a compelling story for anyone, not just those interested in the minutiae of my work or the ones I share an office with. And when I successfully connect with this broader audience, in return I get new perspectives and a better understanding of my work.

Still, my science needs a little push to get out into the world. And who better to shepherd that process than me? I know exactly what the larger implications of the work are. I know exactly when I've made a big discovery. However, navigating that process can be intimidating.

This week in ENGAGE we found an important resource on campus to help: UW Today. UW Today is continually producing stories on scientific papers and studies coming out of every department at the University of Washington. I've seen this resource before and I assumed that the stories picked up here were written based on some sort of meritocratic system that rewarded the very best science being done. I'll let you in on an insider secret: these stories are written largely because the scientist asked them to be written. The journalists interview scientists, create a compelling feature, and help translate science to the public. These short articles from UW Today can act as a press release for your science, allowing the work to get picked up by other media outlets.

Sure, UW Today can make our jobs as scientists easier, helping researchers to craft stories in a way that is engaging and far-reaching. But it's my job to make sure they start writing the story in first place.

Matters of Fact



I want to understand how viruses evolve. Recently, I've been studying how flu virus changes over the course of a single patient infection and comparing those changes to flu's evolution on a global scale.

Science has been in the news a lot lately—not just scientific discoveries, but the scientific enterprise itself. In response to President Trump's moves to cut scientific funding and place "gag orders" on certain federal agencies, a March for Scienceplanned for April 22 will bring together scientists and science enthusiasts. Thousands have already signaled their support of facts and evidence.

Facts and evidence—they're usually what we talk about when we talk about science, whether in textbooks, museums, news articles, or documentaries. Countless studies lament the public's lack of scientific literacy, as measured by their knowledge of facts. According to one report, nearly half of Americans think that antibiotics kill viruses, and a third don't know that it takes the earth a year to go around the sun. With phrases like "alternative facts" and "post-fact era" entering public discourse, these matters of fact take on new urgency.

At Engage, we're taking a slightly different approach to science communication. The course emphasizes stories, narratives that draw in audience members and engage them in the material. The idea is that effective communication relies on emotional connection as much as clarity of presentation. And it draws from research that suggests that facts alone rarely change people's minds.

On the first day of class, we watched a video about public perceptions of scientists. On scales of technical and emotional capability, scientists rated as competent but cold, in a category with lawyers and businessmen. It's easy for scientists to be perceived with suspicion or jealousy, and non-scientists aren't always convinced that scientists are acting in the public interest.

I thought back to that lecture as I read a widely discussed (and controversial) op-ed in the *New York Times* about the March for Science. "Rather than marching on Washington and in other locations around the country, I suggest that my fellow scientists march into local civic groups, churches, schools, county fairs and, privately, into the offices of elected officials," wrote the author, a climate scientist. "We need storytellers, not marchers."

It's easy to say, but I think we need both. The March for Science is organizing a series of teach-ins alongside the rally so that people can meet scientists and learn about their research. We've also talked in class about the importance of considering your audience: there's space for protests and shows of strengths, as well as quieter moments aimed at changing hearts and minds.

I would argue that we need a third space as well. Beyond facts and stories, the day-to-day process of science is rife with ambiguity and uncertainty. Logic and reasoning have their places, yes, but intuition and interpretation do as well. The messiness of science is obvious to everyone who does science, but it tends to be swept under the rug when we talk to the public, replaced instead with cleaner narratives, straightforward facts.

Threats to science have put scientists on the defensive. Admitting to the messiness of the process feels like airing dirty laundry: it seems to provide ammunition for critique. In polarizing times like these, it's tempting to skip over the halting, uncertain processes by which scientific facts are made. Not "made" as in fabricated, snatched out of thin air, but instead constructed through a painstaking process of experimentation, evidence-gathering, interpretation, analysis, re-analysis.

Science has nothing to hide. We should talk more about scientific methods: they are not the clean-cut, eight-step process that textbooks make them out to be, but they are reasonable and justifiable, and more so for being better understood. Facts and stories should be openings for delving into the complexities and uncertainties of science. “Most things in the world are unsettling and bewildering, and it is a mistake to try to explain them away,” physician and writer Lewis Thomas wrote in his essay collection *Late Night Thoughts on Listening to Mahler’s Ninth Symphony*. “They are there for marveling at and wondering at, and we should be doing more of this.”

Counting Snow Leopards

Snow leopards are possibly the most poorly understood big cat species in the world, due to their secretive, cryptic lifestyle and the rugged weather and terrain of their high elevation habitat. In the mountains of Central Asia, my colleagues and I are combining cutting-edge technology like GPS satellite collars and powerful genetic tools with age-old skills like tracking and observation to explore the ecology of snow leopards and other big predators in unprecedented detail.

As an ecologist and conservationist studying wild snow leopards in the highest mountains on the planet, I’ve never had much difficulty hooking people’s curiosity about my research. No matter the audience, snow leopards are always popular, as are two particular questions that I’ve grown accustomed to hearing: “Have you ever seen one?” and, “How many snow leopards are left?”

The first question is easy to answer. Snow leopards are secretive, solitary large cats that live on the so-called “Roof of the World” – the mountains of Central Asia. They’re threatened with extinction as humans and livestock encroach on their habitats and as climate change brings changes to their mountain homes. They’re so well camouflaged and good at staying hidden, that in nearly five years of studying them, I’ve *never* seen one that wasn’t in a trap or wearing one of my tracking collars, and even then, I often miss them. They’re that rare and elusive.

While it seems like a simple thing, the next question is *much* harder.

How many snow leopards are left? Depending on who you ask, snow leopard experts will likely tell you that there are somewhere between 3,000 and 10,000 wild snow leopards in the world. Hardly a satisfying answer.

If you've just lost your job and you're worried about how much money you've got left, you're not going to feel confident if the bank tells you, "Well, you might have $10,000, but then again, maybe its only $3,000." (Actually, as a grad student, I'd be thrilled to find $3,000 in my bank account). That range, while perhaps *accurate*, is nowhere near *precise* enough to plan a budget. The same principle applies to snow leopards. While we may have covered our bases with such a broad range of population size, we don't have enough information to plan conservation actions effectively, or even to say whether the population is growing or shrinking (in the bank account analogy, whether we're earning interest fast enough to compensate for money we're spending). These population changes over time (or differences between areas) are particularly important to understand if we want to protect the species.

Clearly, we can (and must) do better. But remember, in 5 years, I've never chanced upon seeing a wild snow leopard. How do you count a thing that's so difficult to find? Someone once described counting fish as being exactly like counting trees – except they're invisible and they move around! It's also a fair way to describe snow leopards. But with snow leopards, it turns out that the very thing that makes them so difficult to see – their camouflage – also provides us with the information we need to answer this question.

Like most other big cats, snow leopards have spots (more technically, the have rosettes, but lets call them spots). These spots are just like fingerprints – unique to each individual animal. By placing motion-triggered camera traps at locations where we suspect snow leopards come to mark territories and communicate with each other, conservationists can build a database of "known" animals. Even more, we can track those known animals as they move around the mountains.

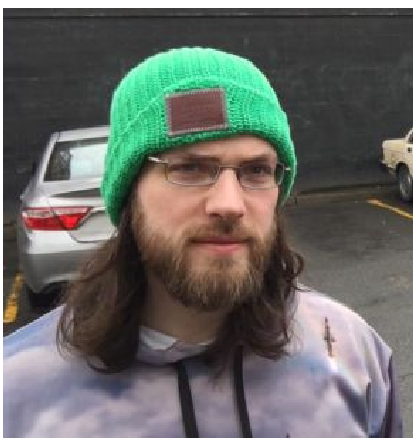
The trick is taking information about animals we do see, and using it to say something about animals that we don't see. Using sophisticated computer programs built on principles of statistics and probability, we can detect and analyze patterns and gaps in our observations of *known* snow leopard movement. By filling the gaps in our observations, we can not only say how many animals we *know* in an area – we can make an informed prediction about how many animals we *don't know*! Its almost like placing odds on a big game or election. In other words, we've come up with a hack to "count" animals that we never see.

Two different snow leopards scent-mark the same rock in the Pamir Mountains of Tajikistan. Photo credit: S. Kachel, Panthera, University of Delaware, Tajik Academy of Sciences.

This means for example, in one study, that instead of saying that there were between 20 and 60 snow leopards in an area roughly the size of Rhode Island, that instead there were 18 to 25. Because this range is more precise, it will now be easier to determine if the population changes over time, or if this area is home to fewer or more snow leopards than other areas.

If we can apply this strategy to enough of the places that harbor snow leopards, we will soon be able to present far stronger and precise predictions about the *global* population size, and to detect changes in that population much sooner. This is promising news not only for snow leopards, but for other rare and elusive species as well.

How not to talk about climate change



Robert studies materials for rechargeable batteries in the materials science department. He focuses on magnesium (Mg) batteries, an experimental alternative to the Li-ion battery in your phone and laptop. Mg has advantages of low cost, high energy density, and improved safety, but unfortunately Mg is not nearly as cooperative as Li. He studies the chemical conditions where Mg is well-behaved.

Hello dear reader,

Well here we are. If you are reading this around early 2017, then I don't need to tell you that science and empiricism have been having a rough week. We recently added "alternative facts" to "fake news" and "post-truth" as integral parts of the American lexicon circa the late 2010's. Oil pipelines are getting OK'd and climate change appears to be getting scrubbed from government websites. The specter of budget cuts looms ominously over some of the best basic science labs in the world, anti-vaccination proponents now have considerable political capital, and oh by the way Flint, MI still has lead in the water.

All this is in spite of the large body of observational evidence that says a) we are really taking Mother Earth to pound town, b) vaccines are one of the most cost-effective public health measures, and c) lead is really, really bad for you.

So what are we to do? Well, since I'm a scientist, being an "intellectual" (often used derisively) is the only thing I'm particularly competent at. I like to collect data, analyze it for meaning, and produce objective results with as little emotional content as possible. And so does the rest of the science community. But for exactly this reason, science communication has been doing much worse than science, and for much longer. We've been doubling down on very helpful tools like rationality, facts, and data – and we should stop using them ASAP.

Now I can already imagine the chagrin this might cause. Abandon all reason? What a ridiculous suggestion. But we should stop using science alone to communicate science, and even science backs that up.

Our first clue is that facts clearly aren't working. This is how your standard exchange goes: You can say "Look here at these very, very tremendous facts." But instead of agreeing, opponents to your issue will say "No no no, that's Nazi propaganda. *These* are the real facts, which are the best facts obtained by the best scientists. Believe me." And from there the conversation just devolves into "nuh uh – yeah huh" because we don't agree on whose facts are more factual. You will notice here that we are guilty of a particularly egregious bit of bad science-ing: we are repeating the same experiment and getting the same result without making any changes in between. (Sad!)

This is because facts are very boring. They are only persuasive to the people who have your same values and already believe your argument. And even then, they do not influence decision making. For example, I know I should go to the gym and eat healthy and all that, but do you know what's better? Lying in bed eating raw cookie dough until my arteries are lined with butter. Clearly the knowledge that something is bad does not activate me to do something about it, even if I am not actively hostile to the message itself. This is a major problem for climate change because it is something that will affect Future Me and his Future Grandchildren much more than Present Me.

Second, a common refrain is that we can educate ourselves out of this hole. This idea is called the Public Irrationality Thesis or Science Comprehension Thesis, and maintains that the general public just doesn't have the tool kit required to assess the risk of climate change like us scientists do. Even if it were true, I'd say it is a bit too condescending to be useful in polite conversation. But the science of science communication says it isn't. You can read more about it in this paper (doi:10.1038/nclimate1547), but I just told you that facts don't matter so you don't even need to bother. Believe me.

The last point I want to make here is that we are fundamentally irrational creatures and facts are almost completely irrelevant for decision making. If the 2016 presidential election has not convinced you of this, then there isn't anything I can do to dissuade you. But if logic and reason and being smart were things that mattered, you'd expect people to be able to have a powwow and reel off a set of bullet points defending their positions, and when all the facts are in we'd weighed the issue objectively and we'd all figure out the one true answer. Your lived experience would suggest otherwise. (In fact, logic and reason likely evolved to win arguments, not find truth, but that is a topic for a different blog post.)

So where can we go from here? What hope do we have if facts (as we see them) are of no avail? To that, I give you my pal John:


John [redacted] Many would call me a stereotypical, knuckle-dragging, right-winger. Why? Because I am a conservative, I like guns and I fly the US flag at my home. Oh yeah, I am a Christain who attend church every week and I am a heterosexual. Yet, I have solar panels on my house, I recycle and I practice no trace camping. I believe in being a good steward of the earth and all the God has given me. I wholeheartedly reject all this man-made climate change garbage and completely trust the market to find solutions that will make far greater differences than anything government can think up.

Like · Reply · 77 · January 16 at 10:35am

11 Replies · 29 mins

John here is remarkable. I found him in the comments section of some video maligning the absolute hoax of climate change. But notice what he's doing. He has done two important things here. First he is engaging in all the environmental behaviors I'd like him to anyway (while still managing to complain about it), and secondly he is giving us a window into how to frame the conversation better.

We have been doing things the very unhelpful way by appealing to our own values and expecting everyone else to capitulate under the weight of our facts. This completely ignores the fact that one's stance on climate change is largely a statement of identity rather something any of us have sat down and given serious consideration to. To be completely fair here, climate change is an issue I feel strongly about – but even so I haven't read any of the primary literature, I haven't set up any satellites for measurements and I haven't built any models to investigate climate change. I have no idea what is going to happen in the future (but there appear to be enough arrows pointing in the direction of Very Bad Things that I will work to mitigate them). For the most part, I'm taking it on faith that other scientists (on my Team) have done their jobs well. Similarly, I would bet anyone who disagrees is a disagreeing because of their membership to the Other Team, and probably not because of any deep thinking (although they will surely say that they have facts that say otherwise). Moreover, the lesson of 2016 is that those folks on the Other Team have – in my view – thrown the baby out with the bathwater and do not trust any of us egghead intellectuals right now. So I suggest we rebuild trust first and worry about the facts later.

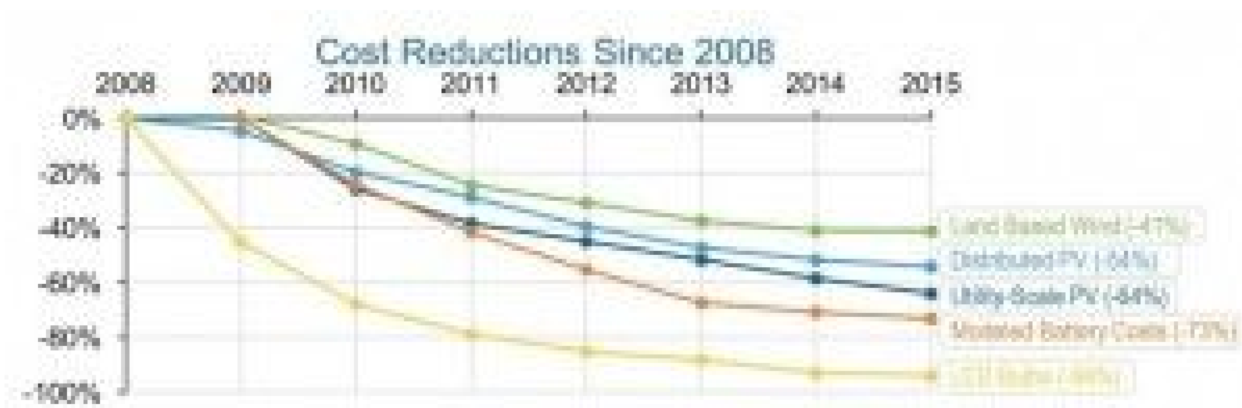
Therefore, I implore you to never ever ever ever again say something like "97% of scientists agree that…" It does not help because everyone who agrees with this statement already agrees that climate change is an issue. But how do skeptics/non-believers respond? They do not respond by saying “hmm what a good point, let me reconsider my position.” No, they say, “Wow, look at those brainwashed liberals giving in to appeals from authority. They don’t even know their own position well enough to defend it properly.”

Instead of our dumb, fact-based approach, we need to focus on the smart, irrational way of going about this. We need to communicate the truth of the situation in a way that preserves the identity our climate skeptic. That means talking to conservatives in terms of conservative values. John offers two examples:

- Protecting the Good Lord’s creation and
- Doing it in a way that doesn’t hurt the economy.

Part 1) is such an obvious pro-life issue that I am somewhat amazed that we have to litigate this, but here we are. I don’t care if you aren’t religious. Use this point to find common ground with conservatives who don’t believe in climate change. Everyone should be able to agree that it is better not to clutter up God’s Green Earth with smog and oil spills and trash.

Part 2) is on me and my fellow battery engineers to get those EVs on the road and other solutions integrated into the grid. But we can make the case that we are on the cusp of an inflection point where everything changes and fossil fuels become obsolete. Costs for wind, solar, batteries, and LEDs have fallen off a cliff in the past few years.



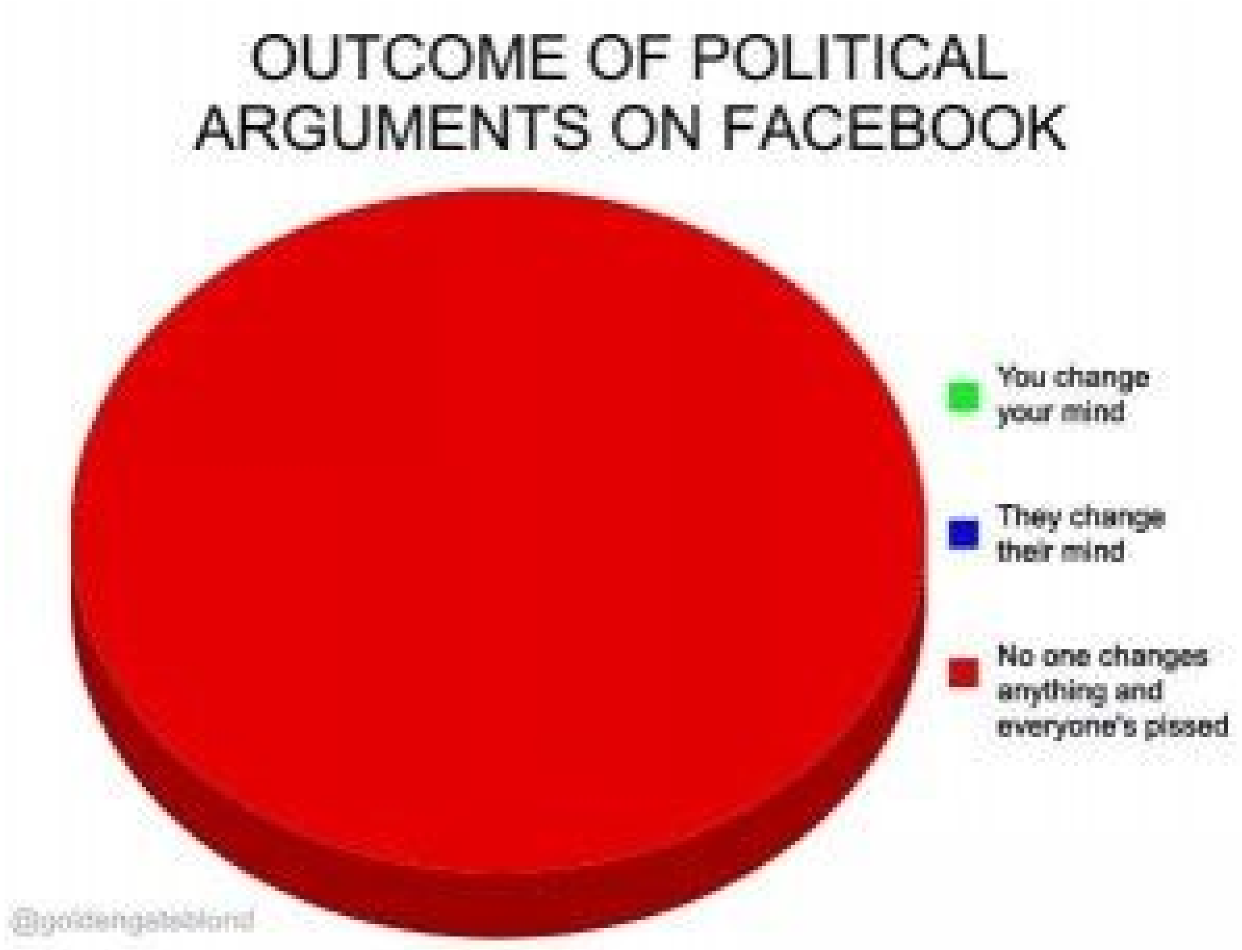
http://rabett.blogspot.com/2016/10/chart-of-year.html

The case we should be making is that solar and wind are becoming superior to coal, competitive with natural gas, and creates all kinds of jobs. With big enough batteries, we transform our 100-year-old dumb grid into a smart grid and wipe away the intermittency problem (sun goes down, wind stops blowing). This transition protects the environment and strengthens the economy simultaneously. As an added bonus, we even get to cripple the economies of our geopolitical rivals!

You may have noticed we just had an election where we decided between a Russian puppet and a Saudi Arabian puppet – countries that are entirely driven by oil exports.

Therefore, you can use facts if you must, but make sure it is connected to a story that resonates with the target audience. If you are arguing to persuade, then you need to build trust, truly understand their values – even and especially if you do not agree with them – and construct a narrative that works with instead of against this core identity.

Or just keep arguing to win. Let me know how that turns out for you.



The Scientist's Role in the Anti-Vaccination Movement

My research focuses on developing biomaterials-based strategies to deliver vaccines and other therapeutics that modulate our body's immune response in order to improve our ability to fight off infections and prevent diseases.

All parents want what is best for their children, right? We want our families to be happy and healthy. We want to know what is going into our bodies and why. We want to be responsible and make the most informed decisions we can regarding the health of someone we love. But an increasing number of parents are making the decision to not vaccinate their children… why?

There is an incredible amount of evidence supporting vaccine safety and efficacy. Since the development and wide-scale use of vaccines, about 6 million deaths are averted world-wide every year, the risk of developing cervical cancer has been reduced through the HPV vaccine, and the eradication of smallpox has been accomplished. In the developed world, we worry less and less about getting infected with diseases that used to run rampant, such as polio, diphtheria, measles, and whooping cough. For this, we have vaccines to thank.

While over 80% U.S. adults say vaccines are safe for healthy children (1), the anti-vaccination movement has been a small but prevalent group for the past few decades. More parents are opting their children out of scheduled vaccinations through the use of religious, medical, or personal exemptions and because of this we are starting to see a rise in number of cases of vaccine-preventable diseases. (2) Often, areas with low rates of vaccination arise in areas with higher median incomes. Here in the Pacific Northwest, Vashon Island has one of the lowest vaccination rates in the country with a 20% vaccination-exempt rate. So why is there momentum in the anti-vaccination movement and what is the role of scientists in this public health discussion? How can we as scientists more effectively convey the truth surrounding vaccinations to ensure that all children are protected?

The beginning of this movement was centered around a retracted study that linked vaccination with autism. Of course this is a terrifying thing to hear as a parent, so it's really important to know exactly why this study has no merit: the study falsified data in which the true accounts of what happened in the patients were not the results published. (3) Neither the author of the study nor other research groups were ever able to reproduce the published results. Additionally, this study only evaluated 12 participants, which is a very small sample size to draw conclusions or claim causality. Since then, there have been hundreds of studies investigating the effects of vaccination on the risk of autism. (4) (5) These studies have looked at hundreds of thousands of children and each concluded that there is no link between vaccines and autism. So with this data out there, how does this gap still exist in which parents don't see the benefit of vaccinating their children? From what I have learned through Engage, a lot of it has to do with scientists' inability to convey complicated topics and data to people outside of their field. Ultimately, this inability leads to a lack of public trust in science, resulting in parents accessing inaccurate information and making the decision that vaccinating is not worth the perceived risk.

Understanding the science behind vaccines is challenging. In my opinion, the immune system is a completely under-taught and often overlooked topic in science. Our immune system is in incredibly complicated network of cells and signals that work in perfect coordination to protect our bodies from foreign invaders like germs while preventing attack of our own healthy tissues. Every day, our immune system is making millions of decisions when it comes in contact with foreign substances: are these things here to hurt us or are they benign? I didn't learn about the key features and mechanisms of our immune system until I took an immunology course my first year in graduate school. During every lecture, I kept thinking, "how have I never been exposed to or learned this before?!" It wasn't until I had this information that I was really able to understand how vaccines worked, why we have what we have in vaccines, and their immense benefit to public health.

Of course every parent wants as much information as possible before making decisions about their own health and the health of their families. As scientists, we must step up to the challenge of getting out of our comfort zones and start communicating about our science in a way that everyone can understand and use in their own lives. We need to write more op-eds, give talks in the community, have conversations with people outside of our science bubble. There are thousands of open eyes and ears wanting accurate, accessible, straight-forward information and it's our job to provide that.

If you would like more information on how the immune system works, I highly recommend this video by Kurzgesagt. This company has a ton of fascinating videos on lots of other science topics that I would encourage you to get lost in on a rainy afternoon.

Sources:

(1) http://www.pewresearch.org/fact-tank/2015/07/17/5-facts-about-vaccines-in-the-u-s/

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Poles Apart

Maddie Smith is a PhD student in the Applied Physics Lab at the University of Washington interested in understanding how waves are impacting changing polar oceans. For her research, she travels to the ends of the world to measure ocean waves in ice-covered regions. Better understanding the relationship between wind, the ocean, and sea ice will allow safer navigation of the area and better prediction of future conditions.

SCENE: INT. HIP SEATTLE BAR – FRIDAY HAPPY HOUR

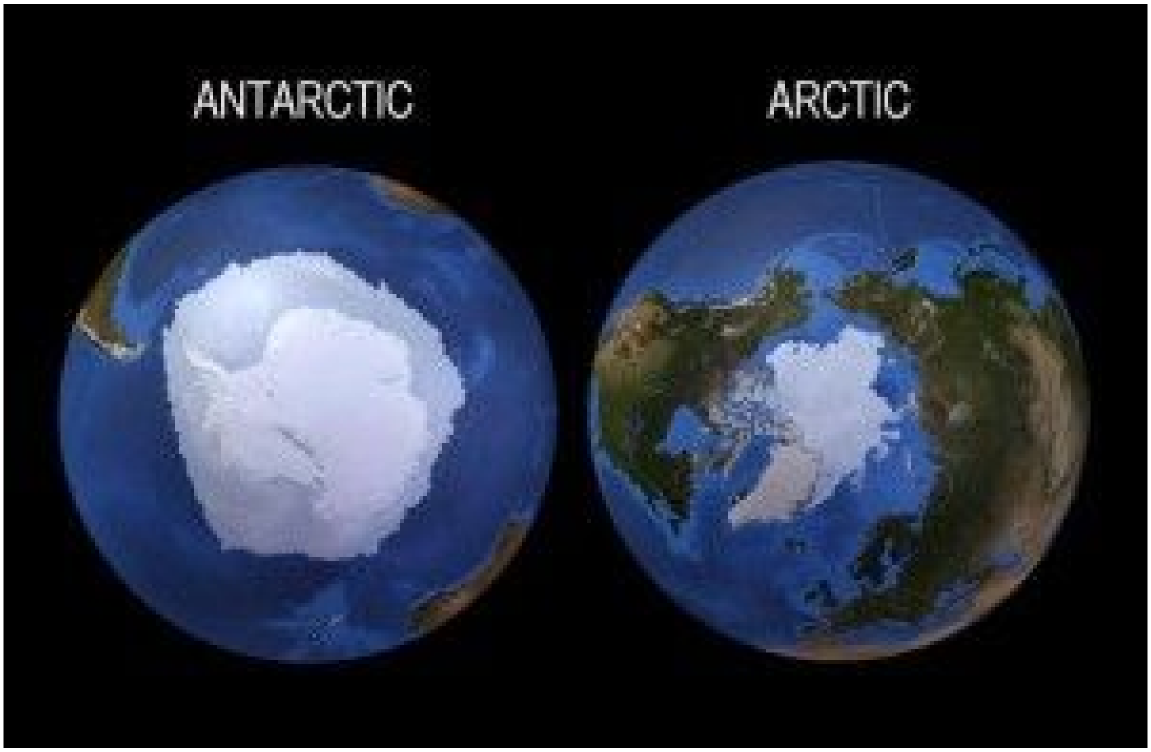
FRIEND 1

Why do you need to go to the Antarctic, since you already spent six weeks in the Arctic? Wouldn't it be easier to just go back to there?

As a scientist who studies the oceans in Polar Regions, this is a familiar moment. The North Pole and South Pole, though geographically as far apart as possible, occupy the same space in many of our minds; they are cold, icy places that no sane person would volunteer to spend months of their lives living in. And yet, I spent six weeks in the fall of 2015 living on a ship in the Arctic Ocean, as far north as one can get that time of year, and this spring I will another spend eight weeks on a ship in the Southern Ocean, just off the coast of Antarctica. During both trips, my research focused on understanding ocean waves and how waves impact the ice that is present in both regions. Why, indeed, do I plan to travel all the way to the Antarctic, when there are waves to study in the Arctic Ocean, much closer to home?

One notable difference between the Arctic and Antarctic is that the former is home to the charismatic polar bear, while the latter is home to penguins. Unfortunately, the confusion for many between the Arctic and Antarctic begins here, thanks in large part to a charming yet geographically confused Coca-Cola ad campaign.

So, my trip to the Antarctic is admittedly partly motivated by my desire to see the real-life version of March of the Penguins, an experience that will never be obtainable in the Arctic. But as an oceanographer, the elephant in the room for me (or polar bear, as the case may be) is not what is in the ocean, but where the ocean is! Antarctica is a continent surrounded by ocean (known as the Southern Ocean) while the Arctic is primarily an ocean surrounded by land.



Source: NASA

One of the most important things to understand about waves is that they need space in order to grow. Think back to a small pond or lake you likely swam in growing up: did you ever worry about big waves on the lake like you might when swimming in the ocean? Unless you grew up on one of the Great Lakes, probably not – most lakes are too small for waves to get very big. The same idea can be scaled up to the Southern and Arctic Oceans. In the images from NASA, you can that the open Southern Ocean surrounding the Arctic Ocean is massive, especially when compared to the small areas of open water in the Arctic between the ice cap and the surrounding land.

During the time I spent in the Arctic for research we experienced one huge wave event, with waves of nearly 15 feet tossing the ship back and forth. Though waves this large are becoming more common there, we considered ourselves “lucky” to have captured such an exceptional event. We are still working to analyze data from this event to understand the effect of waves on the ice and ocean. In contrast, in the Southern Ocean, we will be lucky to get waves only as big as 15 feet; 50 foot waves are common in this ocean! Studying large waves in the Arctic is like studying the endangered polar bear: large waves are rare, elusive, and exciting to find in the wind. In contrast, studying large waves in the Antarctic is like studying a pet dog: predictable, dependable, and, sometimes, a nuisance!

Perhaps, now, I'm ready to help my friend understand the differences between the Arctic and Antarctic…

MADDIE: Great question! In the Antarctic, we do expect some of the same things that we saw in the Arctic… lots of ice, snow, and cold temperatures. But there are perhaps more differences than similarities. Instead of polar bears, we'll be keeping for watch for penguins. Instead of hoping for waves to measure, we'll likely be praying for them to stop! And last but not least, the ice in the ocean is decreasing much more rapidly in the Arctic than in the Antarctic: nearly 5% of sea ice in the Arctic is being lost every 10 years, on average, while less than 2 is being lost every 10 years in the Antarctic. Is some of the reduction in ice in the Arctic a result of waves? We will be leveraging another similarity between the Antarctic and Arctic to help us answer this question – the interaction of waves with ice. Being in the Antarctic, where waves so persistent, will help us learn their effect on the ice and ocean, so that we can apply this knowledge to improve future predictions for both the Antarctic and the Arctic.

Practicing Imperfection

Emma is a fisheries ecologist interested in understanding how human actions impact marine species, and the fisheries that human communities rely on. More specifically, she studies the impacts of ocean acidification in the California Current, what species are at risk, how the ecosystem might change and which ports on the west coast will be most impacted economically.

Imagine you are about to give a presentation.

It might be to a crowd of 15, or maybe 150. Regardless, you have been preparing for weeks. You have timed everything that you want to say with when each slide is supposed to pop up on the screen. You have been watching TED Talks to see how engaging speakers make it work. Your nerves are running high, perhaps you are jittery, or maybe you have what feels like a fist in your stomach, but at the same time – you know you are ready.

You hear the person doing your introduction and you wait for your cue to walk out on stage.

You start off a nervous, you might think your voice is shaky, but to the audience you are holding it together. Folks are smiling and nodding, they laughed when you were hoping they would.

But five minutes into your 20-minute presentation, someone calls out “no way! That’s a lie!”…

Or,

maybe a baby starts crying and the parents can’t get it to stop…

maybe you hear people talking to each other and the murmur gets louder and louder…

maybe you hear laughter, and you cannot tell if folks are talking to each other or laughing at you…

maybe one person stands up and walks out, then another and another…

maybe your slides stop working, and all of a sudden they start speeding up, slide after slide of your carefully crafted presentation is flying across the screen and your clicker won’t stop it.

What would you do?

If you were a graduate student, like those of us in this class, you would probably get distracted, thrown of your game and all of a sudden realizing you need to find a way to pull the attention back to you, to keep your audience engaged. But if you had never had an experience like this, would you be able to pull it back together? Perhaps, or perhaps not.

That’s why this week in class we practiced *what to do when something goes wrong*. Yes, you really can practice just about anything, and the more you do it, the more you are able to go with the flow. We created muscle memory for how to deal with an unexpected hiccup in our presentations.

Did it work? Only time will tell – as we give presentations and things unexpectedly go wrong. It sure felt scary to practice, even in a low-stress environment like class, but gaining the tools to deal with these situations is invaluable… and I for one feel less nervous about what to do if people start talking and laughing during my talk… *No Emma, they are not laughing at you. Take a breath, change it up to re-engage your audience, and keep going. But stay on your toes.*

Hopefully, if we are all lucky, nothing will ever go wrong. We will end our talks in 20 minutes, to an audience of smiling facings and folks nodding along, and just as we finish four hands fly in the air as interested listeners want to ask for more… fingers crossed this is always what happens.

What I got from Engage

Born and grown up in China, Jake is now fourth year PhD student at the Forestry department. Unlike most of his colleagues who grow trees, Chang's research is about using trees to make biofuels. He consider himself as an biochemical engineer with a loving heart of nature. He is an outdoor guy and likes to walk in the forest and listen to the whisper of trees.

Before I come to ENGAGE, the first image depicting in my head about science communication is the busy conferences – peers presenting results and sharing ideas with each other, all speaking at the same "language". Well, that may be true if you just want to talk your exciting research to a professional community of a couple thousands of people (or even less). However, most of us do want to approach to the general public and somewhat change their understanding of the science world.

Push science into the world, and let others enjoy the excitement of our discoveries. I have to say, that sounds easier than doing it. On day one of the class, without preparation, everyone was asked to make a 3mins talk about the research project. Apparently, we all tried the best. But, I found it was challenging to catch all the information and eventually failed to follow some talks. So, even the graduate students who had a long-term scientific training may experience such difficulties in understanding each other. What can we expect the lay audience to understand us?

As it is getting closer to the end of the lectures, here I wrap up 10 key points of what I learned most from ENGAGE:

- Different audience may have different ideas from what your say. We need communication not argument. So, know your audience before building the content. Try to think about how they will feel. If necessary, try to avoid too strong/sensitive words. (Climate change, GMO, abortion, etc.)
- What will attract the audience is the story rather than your pale research results. Every research project is driven by a strong scientific motivation. Connect that to everyone's daily life, it could be the best beginning of your story. Like drama, it is always good to undulate the story with tension and ups and downs to keep engaging your audience.
- Well, it is true most science are difficult and may be hard to explain. Jargon is most likely the barrier. To translate your science into daily language and sell that to your grandma, analogy shall be your best choice. Examples we have in ENGAGE 2017 class are: antenna of eye – photoreceptor cells (rods, cones), ripped-off pages in a book – missing DNA fragments, windmill – tidal power turbine, etc.
- Participation is a good way to draw audience's attention and relax the atmosphere. When people answer your questions, they are joining in your show and becoming part of your story.
- Projection is another powerful tool to seize your audience. Especially in a big room without microphone, make your voice loud enough until you can hear the echo.
- Confident body affects the brain and in turn makes you feel confident. To show your authority in the stage, "open up" the whole body and breath deep.
- Besides love, humor is the language everyone share. Accept the risks, so you have confidence to show yourself. Humor is not something we born to have, but needs practice too.
- Practice, practice, practice. It is always good to get feedback from others (different group of people). Get feedback from your colleagues, from your family, from your friends. Videotape the talk and watch it, you will be the pickiest audience to help you to improve.
- Know the most about the environment of your coming talk. If you can, be there and practice. Otherwise, try to mimic the situation (similar room size, stage, audience). Before the talk, go through all the media to make sure they all work well (and just in case, save slides into pdf).
- Be prepared with the emergencies, like hostile audience, noisy environment, indifferent public, and even a crying baby.
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Blood of Komodo dragons could provide antibiotic alternative

Meredith uses computers to simulate how molecules move and wiggle. Her calculations might help us get a clearer picture of what these molecules look like and how they act.

In January of this year, the Center for Disease Control and Prevention (CDC) published a much more frightening Morbidity and Mortality Weekly Report than usual: a woman in Nevada had perished from a bacterial infection that no antibiotic in America could fight. Doctors administered 26 different antibiotics to no avail.

“If we’re waiting for some sort of major signal that we need to attack this internationally, we need an aggressive program, both domestically and internationally to attack this problem, here’s one more signal that we need to do that,” Lance Price, the head of the Antibiotic Resistance Action Center at George Washington University, told STAT News.

Recently, researchers at George Mason University made a discovery that could add to science's arsenal against antibiotic resistance: the presence of powerful bacteria-killing chemicals in the blood of Komodo dragons.

All classes of life have some natural immune resistance to bacteria that are harmful to them. The first line of defense against bacteria and viruses are chemicals called antimicrobial peptides (AMPs), which are typically found in the tissues and organs in the animal that are most exposed to airborne diseases. Natural and man-made AMPs have been the subject of intense study due to their ability to kill or stop the growth of antibiotic-resistant bacteria.

However, AMPs do have weaknesses when considering them as a way to fight bacterial infections in a context such as the doctor's office: they are sensitive to their environment, and easily break down when confronted with certain natural chemicals or a high pH; they are costly to make or isolate; it is difficult to engineer them to fight specific strains of bacteria; and several kinds of bacteria are AMP-resistant. Luckily, many kinds of AMPs exist, even within the same organism–300 different AMPs live on the surface of a frog's skin. There is therefore ongoing research to find and categorize different AMPs found in nature, to find the ideal version to fight different kinds of bacteria.

The researchers at George Mason University were particularly drawn to the Komodo dragon because of its incredibly robust immune system. Not only does it recover from physical battles with other members of its species–which often result in open wounds–but it also commonly eats bacteria-ridden dead meat, and bacteria from its bite can contribute to the death of live prey it attacks. In all, the saliva of the Komodo dragon was found to contain 57 separate strains of bacteria, over 90% of which could be classified as disease-causing strains. That this lizard could live with so many disease-causing bacteria in its mouth and also frequently endure bites from other members of its species justified a deeper look at its collection of AMPs.

The researchers found 48 previously undiscovered AMPs in Komodo dragon blood, and tested 8 of them against 2 antibiotic-resistant strains of bacteria: MRSA and *pseudomonas aruginosa*. There is only one antibiotic–vancomycin–known to be effective against MRSA, which is responsible for over 10,000 deaths in the U.S every year. Not only that, the bacteria has already developed strains that are resistant to this antibiotic, which has doctors extremely nervous. In the lab, all 8 AMPs were able to kill *P. aruginosa*, and 7 were able to effectively kill MRSA!

There are not currently any AMPs being used as therapeutic agents for human patients, but labs across the country are constantly finding more and testing their bacteria-killing potency. The Komodo dragon AMPs join a growing collection being studied by scientists who are racing to find new antimicrobial treatments as bacteria are racing to find ways around them.

Many people ask Dr. James Johnson, a professor who studies infectious diseases at the University of Minnesota, how scared the public should be about antibiotic resistance. He gave his response to STAT News: "We're already falling off the cliff," he said. Hopefully AMP research will eventually help us pull ourselves back up.

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A First Place Finish Brought to You by the Engage Program

Post written by Paige Northway, a former Engage student.

Today I won an elevator pitch contest. It wasn't prestigious, there were only 16 of us, and we were pretty much all from engineering backgrounds (read: not stiff competition), but for me it really highlighted some of the principles I learned while taking the Engage science communication class.

The biggest and most common mistake people made was to jump into the specifics of their project. There were so many cool projects, but a few hours later I couldn't tell you anything beyond a vague premise of any one of them. I practiced some serious restraint and only spent 20 of 120 seconds saying anything about my specific work, with as little jargon as possible. This was point 1 for me: stay big picture.

Related to point 1, point 2 was telling a story. I didn't jump into what my work was, but started with "a tale of two very different problems that have solutions stemming from a single base idea." I could immediately see by the reaction from the audience that this suspense was unexpected and captured their interest in a way that "I work on plasma propulsion for small satellites and upper atmospheric UAVs" would have made eyes glaze over.

From there out, it was all [Amy Cuddy](). I read the schedule wrong. I thought I had the lunch hour to time myself and practice, only to find out at 9:20 that I had to be ready by 9:45. Cue the nerves. I surreptitiously started power posing while the invited speaker finished, and when I got to the podium, the very first thing I did was grace the audience with a sweeping smile. It is amazing what a difference that can make. Point 3: I looked, even if I didn't feel, like I was totally comfortable, and that helped me feel more confident.

I would love to say that I had memorized it so well that I had forgotten it, another concept I learned in Engage, but in honesty I didn't have it fully planned out until that morning. I should also admit that point 4 for me was having actually touched on all the points we had been given, but I don't believe that is why I won. In fact, I'm sure I would not have won if I hadn't gone through the Engage program and learned what I did.

So Thanks! This first place finish was brought to you by the Engage program.