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Rethinking the Way We Do Research: The Benefits of Community-Engaged, Citizen Science Approaches and Nontraditional Collaborators

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Abstract

There is tremendous opportunity for basic scientists to enhance the impact of our research by engaging more deeply with nontraditional partners and expanding the way we think about interdisciplinary research teams. These efforts can include more deeply engaging our participants, and the broader public, in our research; working with individuals from other fields to take a more active role in the dissemination and translation of our research; and working with collaborators from the arts and communication sciences to make our research more engaging and understandable. In this review, I provide an overview of our efforts along these lines in a project called Spit for Science (spit4science.vcu.edu). This project draws from concepts central to community-engaged participatory research and citizen science. Although conducting research in this way involves a considerable time commitment, it has many potential benefits, including raising awareness about our research areas and findings; creating a public that is more connected to and aware of the importance of research, which can have potential implications for funding for science; creating new job opportunities for students; and increasing participation rates in our studies. By thinking creatively about how we conduct our research, and more broadly engaging diverse groups of individuals in the research process, we have the potential to significantly increase the reach and impact of our science.

Introduction

I will start with a confession: I was a tenured professor with well over a hundred publications before I ever thought much about research participants. Research subjects were an “N” in a methods section, and I was most concerned about whether that “N” was large enough to provide sufficient power to address the scientific question of interest. My guess is that many researchers, particularly other scientists who study basic etiological processes, can relate.

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Why is that? In thinking a fair bit about this question in recent years, I think it partly stems from our training. In graduate school basic scientists are taught a lot about how to do science: how to design a study, how to carry out specific laboratory techniques, how to analyze data, how to write scientific papers, how to present at conferences, how to write scientific grants. But in my experience, far fewer of us receive formal training in how to effectively engage with our research participants, beyond human subjects ethics and IRB training. Even fewer of us are taught how to make our science interesting and engaging *to nonscientists*, or how to write and give talks to community audiences. And the way we think about and carry out our research clearly reflects that.

Certainly, the way we train graduate students has evolved; we have moved toward interdisciplinary, multidisciplinary, and transdisciplinary approaches (Vogel et al., 2014), with increasing recognition of the need for scientific teams with diverse and complementary expertise to tackle the challenges inherent in understanding complex behavioral health outcomes, such as alcohol problems. But frequently, we conceptualize interdisciplinary teams as comprised of *other scientists* with diverse expertise. The move toward integrated, interdisciplinary teams has not been nearly as inclusive of two other groups that I would argue have much to offer basic science: (1) the public, to include our research participants, as well as the broader community of individuals who will presumably benefit from our research; and (2) collaborators with expertise in diverse fields related to the communication of ideas, who can be tremendously helpful at both the front end and back end of our research.

I have become deeply interested in these areas after being nudged in this direction by several visionary senior administrators at my university, and through (quite literally) hundreds of subsequent conversations and interactions that I have had with both expected and unexpected partners from across my university and the surrounding community. These collaborations have grown out of a project called Spit for Science, which is a university-wide research project focused on alcohol and other drug use, and related mental health outcomes (Dick et al., 2014). Spit for Science started as a research project with scientific aims very similar to many of my other on-going studies: to characterize genetic and environmental influences across development, in this case, across the transition through college. But there was one key difference: unlike all of my other projects, where data collection happened at different sites around the world, this one involved data collection right here at our university. The “N” was no longer anonymous. It was our students -- *all* of them. This created a higher degree of visibility and need for coordination with outside partners than had ever been the case on any of my other projects. The senior leadership who opened the doors to help us launch a study of this magnitude also gave us the ultimate challenge: the project could not just be about the research; it had to be about how it would benefit the students and the broader universityⁱ. It couldn't just be “our” research project; Spit for Science had to be a university and community resource. Some of you may be reading this and thinking that

ⁱI am extremely grateful to many people who helped make Spit for Science possible, but I want to express particular gratitude to Dr. Beverly Warren, who was serving as the interim provost at the time we were formulating the idea for the Spit for Science project. It was her vision and encouragement that helped Spit for Science become what it is today.

sounds like your worst nightmare; I found it tremendously exciting (albeit naively, as I couldn't have fully appreciated what I was embarking on at that time).

In this invited review, I provide an overview of the Spit for Science project from the lens of what it can teach us about how we conduct basic research. The project draws from two areas of participatory research that have gained increasing attention in recent years: community-engaged research and citizen science, which I will review briefly here. The project has also led us to rethink how we define interdisciplinary collaborations and our research team, as we have developed rich and meaningful collaborations with nontraditional partners. Finally, Spit for Science challenges us to rethink the boundaries of our roles as scientists and researchers.

Overview of Spit for Science

Spit for Science is a university-wide research study focused on understanding genetic and environmental influences on alcohol and other drug use, as well as related mental health outcomes, among college students (Dick et al., 2014). For four years (so far) we invited all incoming freshmen age 18 or older to complete an on-line survey and give a DNA sampleⁱⁱ. We mail information about the project to all incoming freshman students, and separately to their parents, over the summer, and links to the online surveys are sent to the students' university e-mail accounts approximately one week before they arrive on campus. We collect broad-based information in our surveys on many topics related to behavioral and emotional health, ranging from substance use and mental health challenges, to areas such as sleep, well-being, mindfulness, parental and romantic relationships, e-cigarettes, discrimination, and more. We put out a broad call for faculty across the university to contribute item content, with >30 faculty contributing original item content, and >60 faculty working with the data. In this way, the project is a resource for faculty and trainees across the university, and there have been 19 grants, including 6 training grants submitted using the data. Further, all data are entered into a registry, accessible by any faculty or trainee, for more intensive spin-off studies. Thus far, we have had 9 spin-off studies, ranging from studies on brain imaging, to targeted prevention programming, to trauma exposure. Outside collaborations are also possible: learn more at spit4science.vcu.edu.

A Community Engaged, Citizen Science Approach

For the four years that we have enrolled incoming freshmen, we have achieved nearly 70% participation each year. We are currently following almost 10,000 students longitudinally, with follow-up surveys administered each spring. This compares quite favorably to general rates of college student participation in online surveys, which are usually around 35% (NSSE, 2011). I believe that one of the factors that contributes to our high participation is that a central part of Spit for Science is that we want our participants to feel ownership over the project. We want them to be proud to be in the study, and to be informed about the results.

ⁱⁱMore information about the logistics of launching the project can be found at <http://cobe.vcu.edu/spit-for-science-a-how-to-guide/>.

We go about achieving this in a number of ways. First, the project had to be something students would want to be a part of! We coined the project “Spit for Science” and a graphic designer created banners, signs, and posters (visible at spit4science.vcu.edu), which we plaster across the campus upon student arrival. Colleagues from the Division of Student Affairs alerted us that students love t-shirts, so we give out free Spit for Science t-shirts to all participants. The t-shirt design changes for each wave of data collection, and we hold t-shirt design contests and/or commission our arts students to design the t-shirts each semester. I speak to all the residential advisors about the project, and they all wear Spit for Science t-shirts for the first day of freshmen Welcome Week. We partner with colleagues from our university wellness center, who host popular “Love and Liquor” educational sessions for all the incoming students, and we introduce the science behind Spit for Science at those sessions, so students understand what the project is about and have a chance to get to know the research team. In all my talks, I emphasize that Spit for Science is *their* project. I emphasize both what we’re studying (substance use, mental health, and well-being) and why it’s important: the fact that approximately 1 in 4 individuals over the age of 18 are affected (Kessler et al., 2005); hence, these are challenges that affect all of us, whether it’s personally, or through a family member, friend, neighbor, or colleague. Further, these challenges are the biggest health challenges in their age group (Kessler et al., 2007), and I emphasize that it is only by working together that we can change that. Our emphasis on the broader issues of substance use and mental health challenges in our outreach efforts, rather than focusing more narrowly on problems associated with college student substance use, was intentional and based on conversations with our Wellness Center staff, who raised the excellent point that we want to ensure that our students understand that they are part of a broader scientific societal effort, not being lectured at about risky drinking. I make a point that although the researchers set up the logistics of the project, it is ultimately up to the students as to whether they want to participate and whether they want to make it a success. Our data collection area, located in a central area on campus, is staffed by friendly, approachable individuals (wearing “Ask Me about Spit for Science” buttons). Part of the hiring and training process for staff and students who are involved in data collection is making sure that the participation process is enjoyable, educational, and student-centered. We do on-boarding for even our temporary workers to let them know that they are a critical part of the team too.

In my experience, when students feel like they are a part of something bigger than themselves, when they are given the opportunity to make a difference, they step up. Millennials have a reputation for not wanting to do things just because they are told to do them. They want to know why. They want to be a part of the process. Although I focus on students, I think that the need to understand “why” before doing something is true of people more generally, and that shifting the way we think about and treat our participants so that they feel invested in and a part of our science is critical.

These concepts are closely connected to the more formal field of community-engaged participatory research. Although there is no one model for community-based participatory research (CBPR), the central tenet of CBPR is that researchers and community partners work together on the research (Weiner and McDonald, 2013). Many of the National Institutes of Health’s 27 institutes and centers encourage investigators to engage the public

in their research, and the NIH Director has a Council of Public Representatives (COPR), which has formulated guidelines and suggestions for CBPR (Ahmed and Palermo, 2010). There is clearly a spectrum of involvement with respect to the level of participation by community members across different community-engaged projects, with community partners varying in their degree of involvement in the planning, implementation, evaluation, and decision-making for the project (Goodman and Sanders Thompson, 2017). It has been argued that, ideally, the voices of community members are given equal weight to those of academic researchers, and that researchers and community partners are equal and active collaborative partners on the project from the design and implementation of the project, to the interpretation of findings and dissemination of results (Goodman and Sanders Thompson, 2017).

Although Spit for Science was not conceptualized or designed intentionally as a formal community-engaged project, clearly it borrows many concepts from community-engaged research. Admittedly, I only became more deeply educated about the field of community-engaged research because community engagement is a strategic focus area for my university, and one of the foundational pillars of our diverse, public, urban research institution located in the heart of a city (<http://community.vcu.edu>). Accordingly, it was my colleagues who were more deeply involved in community engagement that introduced me formally to this area and recognized the clear connections to what we were doing in the Spit for Science project. I believe my ignorance was in part a product of the fact that community-engaged research is largely discussed within the context of reducing health disparities (Wallerstein and Duran, 2010, Cacari-Stone et al., 2014, Israel et al., 2010) and improving health care (Tapp and Dulin, 2010, Williams et al., 2009). There is an extensive literature about the power of the CBPR design to develop more effective interventions for diverse communities, and CBPR practices are far more common among researchers working with underserved or at-risk populations, for example, underrepresented minority groups (Xia et al., 2016) or unique populations that are facing particular health challenges (Orellano-Colon et al., 2017, Noboa-Ortega et al., 2017). CBPR has been discussed extensively with respect to public health approaches and health policy (Ahmed and Palermo, 2010, Morone and Kilbreth, 2003, Wolfson et al., 2017). However, in my experience, these practices have not been broadly discussed in the context of how we conduct or conceptualize basic research. I would argue that the central tenets of CBPR, which involve engaging the community of study to conduct more meaningful and impactful research, has great potential for transforming basic research, as well, and that there are several potential benefits to this approach (delineated further below).

Spit for Science also borrows from the concept of Citizen Science, which is the idea that every-day citizens can be a part of research, working in collaboration with scientists. Zooniverse.org is the largest online site for citizen science research projects. It brands itself as “people powered research” that “enables everyone to take part in real cutting edge research in many fields across the sciences, humanities, and more...it creates opportunities for you to unlock answers and contribute to real discoveries.” Talk about making research fun! Like community-engaged research, there is emphasis on partnerships between scientists and the public and the importance of working together to advance research. However, in citizen science, it is clear that the researchers design the studies, and the citizen scientists

contribute to them; thus, unlike community-engaged participatory research, the idea is not an equal partnership in which both parties work together on all aspects of the research project. That said, on Zooniverse there is encouragement for volunteers to join the conversation with researchers through discussion boards, stating, “Many of the most interesting discoveries from the Zooniverse projects have come from discussion between volunteers and researchers” (<https://www.zooniverse.org/about>). Zooniverse groups projects by discipline across Arts, Biology, Climate, History, Language, Literature, Medicine, Nature, Physics, Social Science, and Space. As of March 2017, there were only 2 projects listed under Medicine!ⁱⁱⁱ

Not all citizen science projects are registered with Zooniverse. The American Gut project (americangut.org) is a great example of a crowd-sourced, citizen science project run out of a lab at the University of California, San Diego, that is studying the human microbiome. According to their website, the project has raised nearly \$1.4 million in 4 years, with >9000 contributors as of April 2017. Individuals pay to get their samples processed and receive information about their microbiome, while providing the researchers with samples for the on-going science.

Another great example of citizen science that is closer to the alcohol field is the Genes for Good project (<https://genesforgood.sph.umich.edu>). Led by researchers out of the University of Michigan, Genes for Good aims to identify “biological insight into the causes of common diseases” and covers a spectrum of common, complex genetically influenced disorders, including heart attack, cancer, diabetes, blindness, migraines, obesity, addiction, and mental health. Participants complete brief health history and tracking surveys, and once they have completed a designated number of surveys, they receive a free DNA kit (for saliva sample collection). Participants can compare selected results from their survey data to other participants (e.g., where they fall on personality dimensions relative to the population), and for individuals who complete the DNA component, the researchers return ancestry results and the participant is provided with their own raw genotypic data. According to their website, as of November 2016, Genes for Good has enrolled over 21,000 participants, with over 800,000 completed surveys.

Beyond the Science: Redefining Translation

Another aspect that defines Spit for Science is that the project is about more than the science. By design, it is bigger than the research aims. An integral part of Spit for Science is to use the project as a vehicle to raise awareness and to give the science back to the participants and the broader community in ways that benefit them. The high visibility of the project makes it a great opportunity to raise awareness. We use the project as a way to broadly introduce students to the importance of research. At our welcome week information sessions described above, we emphasize the critical role that universities play in *generating* knowledge, in addition to disseminating knowledge. Further, we emphasize the many ways that research impacts our lives, and we emphasize how they can play a critical role in that research, and by corollary, the discoveries and policies that come out of the research. We

ⁱⁱⁱNature and Space have the most projects, totaling about 50

also use Spit for Science as a means to raise awareness about substance use and emotional health issues on college campuses and to get students talking about these issues. Additionally, it provides a venue to talk about the importance of genetics in health related outcomes, and to increase public understanding about complex genetic outcomes – outcomes that are genetically influenced, but don't follow the simple single gene inheritance patterns that we were all taught in basic biology. If genetic information will ultimately be useful for prevention, intervention, and practice, there needs to be greater understanding by the public about how complex genetics works. We view the project as a venue to raise public understanding of the issues that drive the research.

We have formalized these translational efforts into the College Behavioral and Emotional Health Institute (COBE; cobe.vcu.edu). COBE's mission is to bring together the diverse faculty from across the campus who are working on Spit for Science, with the twin goals of (1) growing the collaborative research on substance use, mental health, and well-being in young people, and (2) translating the research into improved prevention, intervention, programming, and policy. This translational mission has led to new collaborations across the university with both obvious partners, such as faculty and staff from our Wellness Resource Center and Counseling Center, as well as non-traditional collaborators, such as faculty in the School of the Arts and the School of Mass Communications.

Our translational activities take many forms. COBE faculty have created an interdisciplinary course that covers the causes of substance use and mental health outcomes, along with research on the promotion of well-being. However, a twist on the course is that it was designed to be interactive such that students complete personal surveys and get information about their own risk profiles and associated prevention strategies. In other words, we make the research personal to them in a way that is intended to be preventative. We host a monthly "COBE Connect" speaker series, which draws faculty, staff, students and community members, for talks that are intended to be approachable presentations of research that are designed to invite discussion with the audience. Our wellness center produces a monthly "Stall Seat Journal" (<http://www.thewell.vcu.edu/campus-norms/stall-seat-journal>), which is an educational flyer with information related to behavioral health and wellness and is placed on the back of every bathroom stall (and, I'm told, in front of all urinals) in all bathrooms across the campus! Each month, a corner of the Stall Seat Journal ("COBE Corner") features information about the Spit for Science project and/or related translational activities, ranging from data collection logistics, to research results, to upcoming COBE events. We have started an annual COBE Town Hall Meeting, marketed largely to our local community, in which we spotlight research results from faculty working with Spit for Science, as well as outside faculty with expertise related to different aspects of substance use in young people, with the goal of bringing together research and administrative faculty from multiple units across the campus, along with students and community members, to discuss issues related to substance use in young people. The meetings have been well-attended, with 300–400 registrants each year, underscoring the public's interest in research and desire to both learn from it and be an active part of the conversation. We are currently working with local schools to bring the research findings into their programming for students and for parents.

One of the most fun pieces of our translational efforts has involved partnering with non-traditional collaborators, namely, faculty and students from the fields of arts and communication. Although these partnerships are more commonplace in public health, in my experience, they are less common among basic researchers. Faculty in the areas of journalism, advertising, and public relations all have much to offer to researchers, from helping us market and advertise our studies in ways that potential participants find engaging, to disseminating our results to the public in ways that are relatable and outlets that are accessible. Science is, by its very nature, a creative process, making it a natural partner for the arts and communication sciences. For example, our arts and mass communications students help to develop t-shirt designs for Spit for Science and COBE, as well as marketing materials and creative ways to disseminate the research, for example through infographics, illustrations, and podcasts.

I am on the faculty advisory committee for a new contemporary art museum that is being launched as a partnership between my university and the community. I have been incredibly impressed as I have learned from the curator about what goes into creating an exhibition, including deep consideration of the many factors that affect how an audience experiences and understands art. I was struck by how little I, as a scientist, know about how the public understands and experiences my science. Do they understand the findings? Do they find them interesting? Are they relevant to their lives? Our colleagues from the arts and communication sciences can assist us in finding the answers to those questions, and thereby, enhancing the impact of our research.

Hurdles and Challenges

Growing Spit for Science, COBE, and the associated translational activities is admittedly a labor of love. Running a community-engaged project that involves a large non-traditional and diverse collaborative team requires a tremendous amount of work on the part of many people. The project necessitates coordination and support from multiple divisions across the university (e.g., to obtain e-mail addresses for incoming students; to secure a large central space for data collection; to distribute t-shirts to all residence hall advisors and door tags for all freshman residence hall rooms; etc.). Accordingly, strong commitment from senior leadership, and a key champion at the highest level of the university (in our case, the Provost) was critical in initially obtaining support from so many university divisions. We were met with some resistance from key leaders of various divisions at the university, as there was concern that the project would benefit the researchers at the expense of using the students as “guinea pigs”; there was concern that we would collect our data and disappear back into our labs. Accordingly, demonstrating our commitment to the students, to working with university partners, and to giving the research findings back to the community in ways that benefit our students and our university has been key to winning over the more skeptical stakeholders. Practically speaking, engaging with our community has meant countless hours of meetings on my part, listening to concerns and getting to know large numbers of individuals around the university who all play important roles in the many pieces of this large-scale project. Although this is incredibly time-consuming, it has also been extremely rewarding. Developing connections with new colleagues, and listening to the concerns of

colleagues, have ultimately informed and improved the research. But be forewarned: sweat equity is required.

Another major challenge has been the sustainability of such a large effort. Changes in senior leadership and university priorities can have a significant impact on the scope of the project and associated translational activities. Enrolling new cohorts annually would allow us to track whether the implementation of various translational initiatives has an impact on substance use and mental health; however, practically, this has been difficult, as inconsistent funding has led to gaps in cohort enrollment, and an inability to systematically study outcomes associated with our translational initiatives.

The way we define the “community” has also evolved over the years. Initially the goal was to create a university-wide initiative focused on substance use and mental health. The project has been quite successful to that end; however, we belatedly realized that we should reach beyond our university community and engage more broadly with our local community. We realized that the same translational goals we set for our university community (raising awareness about substance use and mental health; how health is a product of our genes and environment; the critical role of research; giving our research findings back to the public; translating our research into improved prevention and intervention) were equally important in our extended community. Accordingly, the most recent COBE-related activities have focused on building partnerships that extend beyond the university, starting initially with local schools, with parents and family members of individuals experiencing challenges, and with service providers who work in the area of substance use and mental health. However, these efforts are admittedly in a much earlier stage and there is great potential to build them further.

The Benefits of a More Engaged Approach

So why go to all the trouble? It is certainly far easier to stay in one’s lab, run research participants anonymously, compensate them, and have everyone go on their merry way. We present the findings at a conference, publish them in a scientific journal, and move on to the next study. But I would argue that this approach undermines the “why” behind our research. I would guess that most of us went into research to generate new knowledge and to have those discoveries positively impact our world. I have yet to read an undergraduate application for the Spit for Science research team that says they want to do research so they can have a lengthy CV or high h-index. We are attracted to research because of the excitement of discovery. So it seems a bit unfair to keep all that discovery to ourselves! Much of our research is funded by the National Institutes of Health. That means it is funded largely by tax payer dollars. Many of us work for public institutions and hence our salaries are funded in part by state and federal monies too. And in my opinion, part of the responsibility of being a researcher funded by taxpayer dollars is ensuring that research feeds back to benefit the public.

Further, the current political climate in the United States underscores the importance of creating a public that feels connected to and better understands science. Funding for science is always a concern. My guess is that millions of people across the United States have

participated in a research project at some point or another (remember those Psychology 101 research participant pool requirements?). Imagine how much more invested in science the public would be if they felt more connected to that research and invested in the findings - if they could take pride in their central role in scientific discoveries, and more explicitly recognize how they benefit from research findings.

Another benefit: our graduate students and postdocs are going to need jobs. The number of available tenure-track positions in academia are shrinking (US Department of Education, 2010), and many universities are attempting to address this with panels about job opportunities outside of academia, often organized by our offices of research or graduate studies. However, many, if not most, of us who are currently in senior positions in academia have spent much (or all) of our careers in academia; accordingly, we are not in the best positions to advise our students on careers outside of the academy. But when our students get out of the university and engage with the community, they open up new networks, new connections, and new job possibilities. Research is useful in countless segments of society; engaging with the public can open new doors for our science and for our students.

Finally, if I haven't sufficiently appealed to your altruistic side, here's another benefit: engaging your research participants is likely to lead to higher participation rates in your research. You get higher participation. They learn from the study. You bring in more funding for your research. It's a win all around.

Concluding Thoughts

There is tremendous opportunity for basic researchers to improve the relevance and impact of our science by better engaging non-traditional partners in our research, including our research participants, the broader public, and colleagues with expertise in areas that can assist with marketing our projects and disseminating our results. The principles behind community-engaged research and citizen science have great potential to be more widely applied in behavioral science, particularly by those of us who work in basic research. The idea that we can do better, more impactful research by understanding community priorities and working with the public to generate research questions, design studies, and interpret and disseminate results, is something that could benefit all areas of research, not just research focused on health care, equity, and policy, as has been the focus of most CBPR. Scientists who conduct more basic research in the alcohol field have great opportunity to better take advantage of these methodologies.

It is striking that despite radical shifts in media and technology in recent years, the way we conduct research has remained largely unchanged. Scientists recruit research participants and run studies. We write up findings for other scientists. We speak at conferences to other scientists. We publish our findings in journals read by (and until recently, not easily accessed by) the general public. How many journal articles have you written compared to the number of Wikipedia entries you've written/edited? Now think about how many people search and read Wikipedia versus PubMed. Clearly there is a disconnect between where we publish the research we generate and where the public goes to find knowledge.

Our academic system is set up to perpetuate this disconnect. We are rewarded for writing scientific papers and obtaining research grants. The promotion and tenure process in academia is highly dependent on these traditional measures of productivity and success. Infrequently is the reach and impact of our science evaluated beyond the traditional metrics of scientific citation. To encourage researchers to move in a new direction, we will need to change the way we reward scientists to more fully value contributions to research dissemination in nontraditional – *but potentially more impactful* - ways. I share a comment by a colleague in response to a fellow education scholar's tweet that "Sometime before morning, my blog hits 21 million page views", to which he replied: "And researchers everywhere worry about their journal's 'impact factor'". His comment should give us reason to pause and rethink the way we disseminate research and how we ensure that our research is actually making a difference.

Perhaps you are reading this thinking, "But that's not my job. I generate research; it's up to someone else to translate that research and communicate it to the public." Fair. That was my position for the last 20 years. Somewhere in all of my papers and all of my NIH grants was a sentence along the lines of "Understanding how genetic influences impact alcohol use outcomes across development and in conjunction with the environment, will be critical to develop more effective prevention and intervention programming." And I truly believe that. But I assumed it was someone else's responsibility to actually be doing that translation from basic science to prevention/intervention. But here's the problem: *no one is*. Faculty and staff who work in prevention/intervention have their own conferences and their own journals. They aren't reading the journal of Behavior Genetics. Even at the Research Society on Alcoholism meeting, where researchers from multiple backgrounds come together, we often attend our own parallel symposium sessions. No one understands our research findings, or is better equipped to explain what our results mean (and don't mean), than those of us who generate them.

I certainly don't mean to imply that there are not research groups that are doing elements of what I describe. But as a whole, I think it's fair to say that the practices I describe in this review are not commonplace among basic researchers, and that as a field, we could benefit from greater integration of non-traditional methods and colleagues, and to thinking about nontraditional ways of conducting and disseminating our research. Because ultimately, if we really want our research to have maximal impact, we need to think creatively about how we conduct and disseminate our science, and this will require us to step outside of our comfort zones.

I want to note that there are scholars with deep expertise in community-engaged participatory research and citizen science efforts who may take issue with my conceptualization of the Spit for Science project in these terms, since the project was not designed specifically with these principles in mind. I would agree with them that there is much room for continual improvement in how we engage our participants and our broader community in our research. I hope this will not detract from my broader point that all of us can borrow from the important lessons of these fields and think about how our own research could be informed, and hopefully improved, by applying some of their tenets. Why shouldn't we make our research more engaging, relatable, and (gasp) fun?

Not everyone is going to be equally good at this. That's OK. Not all scientists are equally good at laboratory techniques, or advanced data analyses. Not everyone is equally good at (or interested in) formulating research questions or writing grants. There is a niche for all of us in science, and in my experience, the best scientists learn to play to their strengths. But in the same way that a PI can't have a strong project without someone on the team who can analyze the data, I would argue that our science is not having the impact that it could when we don't include community members, and faculty or staff with relevant expertise in communication, as part of our projects. Expanding the engagement of a broader audience in research has the potential to benefit all of us.

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A Community-Engagement Citizen Science Approach	
Key Elements	Benefits
<ul style="list-style-type: none">• Community helps develop question(s)• Participants feel engaged in the research• Results disseminated to participants and broader community• Nontraditional expertise used in presentation and dissemination of findings• Effort is made to use findings to benefit the community	<ul style="list-style-type: none">• Creates a public that values science• Raises awareness about findings• Increased support for science funding• More invested participants• Higher participation rates• Expanded job opportunities for trainees

“Traditional” Scientific Approach	
<ul style="list-style-type: none">• Recruit Participants• Run Study• Conduct Analyses• Present at Scientific Conferences• Publish Results in Scientific Journals• Repeat	

Figure 1.
Comparison of different methods of conducting research