A JOURNAL BY SISSA MEDIALAB

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Communicating Discovery Science

ESSAY

The challenge of identifying behavioral goals for communication in the context of basic science

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Abstract

This essay highlights the unique challenges that basic scientists may face when trying to identify goals for their engagement efforts. We propose that the difference between basic and applied science, at least when it comes to communication, is primarily about the degree to which scientists can identify audience-specific behavioral goals for their communication efforts. To support our thesis, we provide data from recent survey projects that highlight the degree to which applied and basic scientists have different views about behavioral goals for their communications. We ultimately suggest that basic scientists may need additional help choosing goals and that applied scientists may have more opportunities for focused impact whereas the impact of engagement by basic scientists may be more broad-based.

Keywords

Bridging research, practice and teaching; Professionalism, professional development and teaching in science communication; Public engagement with science and technology

Received: 29th June 2024
Accepted: 22nd September 2024
Published: 21st October 2024

Introduction

Imagine two groups of scientists who are considering putting time and energy into communication in the context of their research. One group studies how to improve solar panels to make them more efficient and less expensive. The other studies black holes deep out in the universe. Now, imagine that a colleague asked you, a science communicator, to help each group be strategic in how they plan, implement, and evaluate their communication efforts.

The material scientists studying solar panels have a range of potential groups — companies, regulators, end-users — with whom they might want to consider communicating. It is likely that they also have an underlying goal of increasing solar panel adoption. Whichever group(s) they prioritize, such communication might have objectives that require building relationships, sharing insights about the risks and benefits of different options, and helping people recognize their ability to make changes. Ideally, they would also have objectives that require listening to others' insights with a goal of ensuring that their solar panel research meets the needs of potential solar panel regulators, manufacturers, and/or users.

The astrophysicists studying black holes, however, may have a harder time identifying the same range of potential audience-specific goals and associated objectives. In this regard, it could be difficult for them to identify specific audiences outside of the scientific community who could materially benefit from their research. There are almost certainly astronomy-interested people across society who might like to hear about the astrophysicists' broad findings, but there would be few direct behaviors that these scientists would want to encourage, and the interested people are probably already fans of science. Further, the work is likely to be so technical that few non-academics will have insights to share that could improve the research. Such scientists may thus default to broad behavioral goals such as encouraging youth to consider science careers, or trying to build or maintain broad societal trust in the scientific community. These are worthwhile goals, but they are not inherently connected to the most scientists' specific research; any scientist could adopt these as goals.

This example highlights the central thesis of our essay: that the difference between basic and applied science, at least when it comes to communication, is primarily about the degree to which scientists can identify audience-specific behavioral goals for their communication efforts. We will (1) briefly outline how we understand the difference between basic and applied science, then (2) explain what we mean by audience-specific behavioral goals and how these are different from other potential communication outcomes. We will also (3) provide some evidence that speaks to the degree to which basic scientists tend to prioritize a subset of broad goals, and (4) discuss paths forward for both research, practice, and training. Our purpose is not to present a specific study but rather reflect on ideas and data that we believe can help researchers, practitioners, and trainers think about helping scientists communicate in evidence-based ways. Much of the thinking underlying this essay derived from the authors' opportunities to study and discuss these issues as part of the Science and Public Engagement Partnership (SciPEP) between the Kavli Foundation and the U.S. Department of Energy.

1 ▪ How do we understand basic science

Basic research is often described as research that advances fundamental knowledge and theoretical understanding. Applied research, on the other hand, is conducted with practical uses and objectives in mind. A classic definition is given in *Pasteur's Quadrant: Basic Science and Technological Innovation* [Stokes, 1997] in which research is classified along two axes: (1) whether it is a quest for fundamental understanding; and (ii) its consideration for use (Figure 1). The quadrants are exemplified by three prominent scientists, Niels Bohr (pure basic research, e.g., quantum mechanics), Thomas Edison (pure applied research, e.g., invention of the light bulb), and Louis Pasteur (use-inspired basic research, e.g., microbiology work leading to the invention of vaccines).

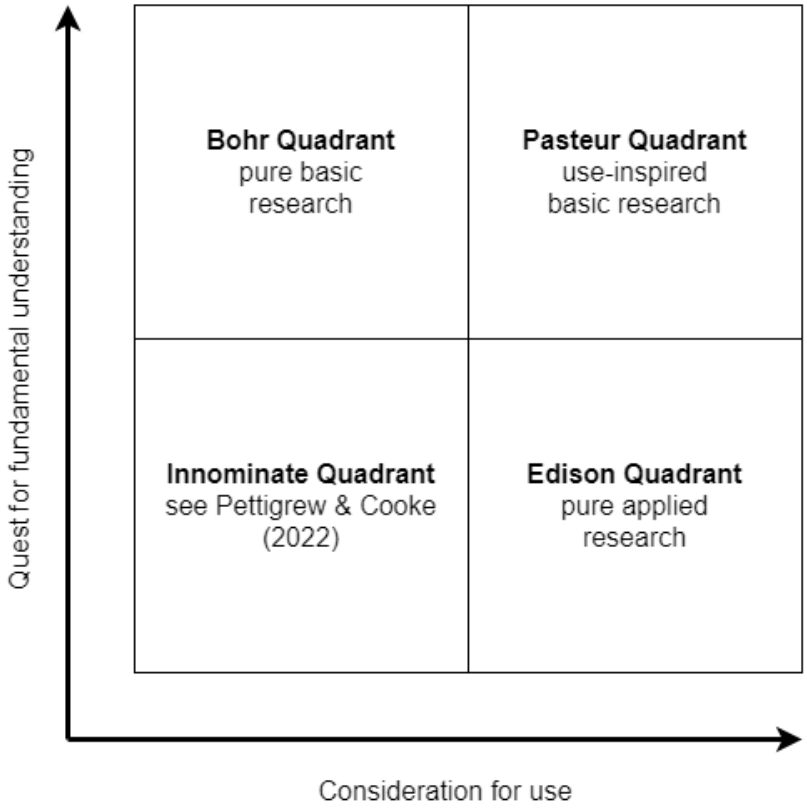

Figure 1. Definitions of types of scientific research. Stokes originally conceptualized the axes to be binary and did not label the lower left quadrant. The continuous axes and Innominate Quadrant were later added by Pettigrew and Cooke [2022].

When it comes to communicating about their science, there is anecdotal evidence that scientists conducting basic research, especially those whose work falls in the Bohr Quadrant, often face unique challenges when asked to describe the relevance of their work to non-scientist audiences [Smith, 2021]. Scientists in general tend to be more "process-minded" in their connection to science and want to share the joy and excitement of scientific discovery [Newman et al., 2019]. Yet, it remains critical that we engage public audiences with basic science discoveries and share the value of such work. Much of the impetus to communicate about its value lies in the need for federal funding of basic science, which lays the groundwork for future applied scientific discoveries (e.g., COVID-19 vaccine).

Recent literature reviews suggest that few studies published in science communication journals [Besley, Peterman, Black-Maier & Robertson Evia, 2021] or discipline-specific journals [Newman et al., 2021] seek to specifically address the interests or concerns of basic researchers. Instead, the literature tends to be organized around understanding how various actors perceive specific technologies (e.g., genetic technologies, nanotechnology, energy technologies) or issues (e.g., accidents, health or environmental threats). It may also be that dichotomous definitions of basic and applied science are detrimental to strategic communication efforts. When the second author asked a sample of mostly scientists from research universities around the U.S. to describe their research on a 7-point Likert scale ranging from "more basic" to "more applied," they found that most scientists self-identified their work along this continuum (M = 3.75, SD = 1.94; Figure 2). Where a scientists' work falls on this spectrum may affect the degree to and ease at which they are able to articulate clear goals, objectives, and tactics for their communication efforts.

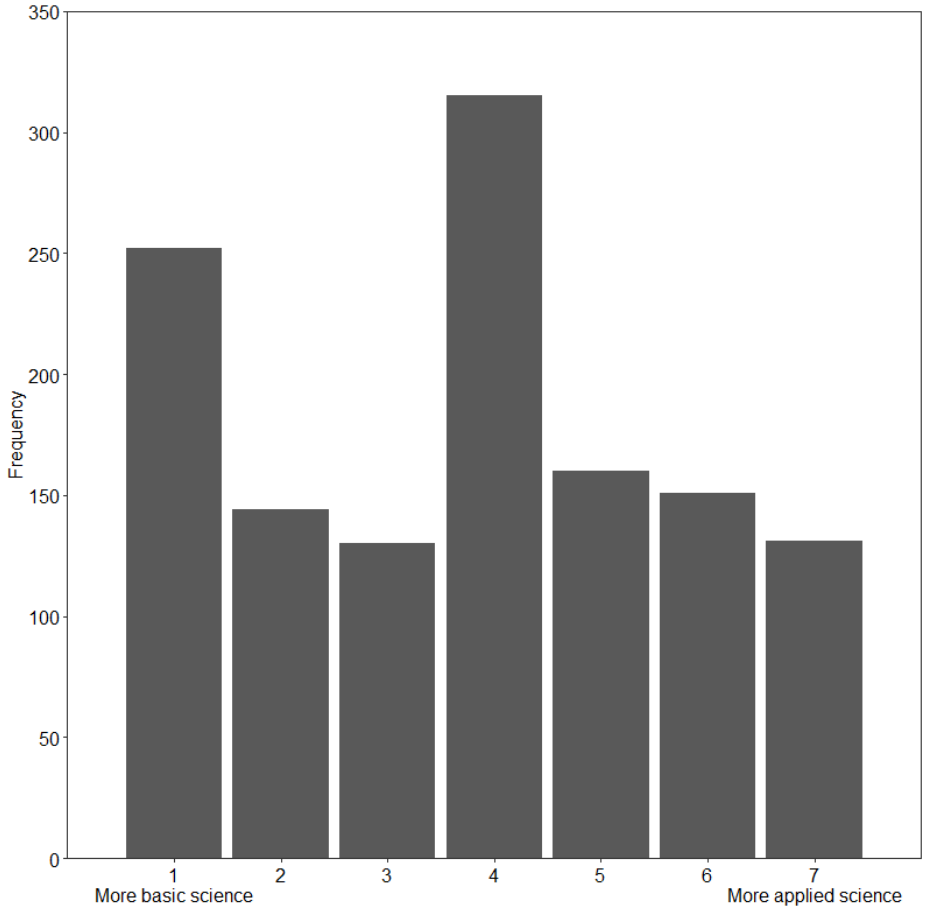

Figure 2. Frequency distribution of scientists from R1 universities in the U.S. identifying their research on a continuum of "mostly basic" to "mostly applied" (N = 1,535). Data were collected by the second author as part of a separate research project (unpublished; research in progress). Names and contact information of faculty in chemistry, physics, mathematics, biology, computer sciences, materials sciences, environmental sciences and biomedical, chemical, electrical, and computer engineering were scraped from public websites of R1 institutions in the U.S. and used as the sampling frame for the project.

2 ▪ What do we mean by audience-specific behavioral goals and why might they help differentiate between basic and applied scientists?

We use the term "audience-specific behavioral goals" to refer to behavior-like outcomes that communicators can intentionally seek to affect through communication efforts. The goals could involve seeking to affect others' behaviors or the communicators' own behaviors [Besley & Dudo, 2022a, 2022b]. Besley and Schweizer [2022], for example, reported that a group of risk researchers' highest-rated goals for their scientific organization were to try and ensure "policymakers *use* scientific evidence" when making decisions and ensuring that "our culture *value*s science as a legitimate source of knowledge" (italics added to emphasize the behavior-like element). In these two cases, the scientists' priority audiences were policymakers and the broader society, but the scientists also gave fairly high ratings to the goal of trying to ensure that "scientists ask research questions that benefit society." In this case, the priority audience for the communication is themselves and this reflects the fact that communicators can (and should) design communication efforts where they are their own primary audience (i.e., genuine consultation). For example, the solar panel researchers noted in the introduction might have a technology adoption goal alongside a goal of rethinking their adoption goal if their communication activities lead them to believe that their initial goal was unrealistic or inappropriate.

It is also important to differentiate audience-specific behavioral goals from communication's potential cognitive and affective outcomes in the forms of evaluative beliefs, feelings, and frames (i.e., BFFs). Identifying a clear behavioral goal (e.g., what you want someone to *do* because of your communication efforts) allows to identify and prioritize cognitive and affective outcomes (e.g., how your communication efforts affect how someone thinks and feels). Besley and Dudo [2022a] call these types of cognitive and affective outcomes 'objectives' in their Strategic Communication as Planned Behavior (SCPB) approach and point to integrated theories of behavior change and trust to highlight the importance of distinguishing between behavioral outcomes and cognitive/affective outcomes when planning communication. The Integrated Behavioral Model (and its close relative, the Theory of Planned Behavior), in this regard, posits that intentional behaviors can be understood to occur partially as a function of salient (1) beliefs and associated feelings about a potential behavior (i.e., experiential and instrumental attitudes), (2) beliefs about the degree to which a behavior is expected and common, (i.e., injunctive and descriptive norms), and (3) beliefs about whether a behavior is possible given available resources, rules, and capacity (i.e., agency and self-efficacy beliefs)[Fishbein, 2009; Fishbein & Ajzen, 2010; Montano & Kasprzyk, 2015]. Similarly, the Integrative Model of Organizational Trust [Mayer, Davis & Schoorman, 1995] defines trust as the behavior of making oneself vulnerable to a trustee and posits that this behavior is likely to be a function of trustor beliefs about whether a trustee has (1) relevant abilities (i.e., expertise), (2) appropriate levels of benevolence (i.e., caring, goodwill), and (3) integrity (i.e., morality and ethics) [see also: Besley et al., 2021]. A critical component is that scientists using these models to design communication or research need to ensure they are clear about both behavioral outcomes (i.e., goals) and the associated cognitive affective outcomes (i.e., objectives) that they believe could affect the behavioral outcomes.

The SCPB approach, in this regard, points out that these two models provide guidance for both planning and evaluating communication [Besley & Dudo, 2022a]. Specifically, identifying audience-specific behavioral goals allows for formative research to identify what a potential audience currently believes about the goal behavior and key actors' trustworthiness. Such research can help identify cases where beliefs about a behavior may be limiting or enhancing behavioral intentions. For example, our astronomers might do formative research and learn that high school students may believe that science careers are boring, and that the people they need to interact with to pursue such careers do not care about people like them. The astronomers could then use these insights to design communication activities (i.e., tactics) that speak to these potential beliefs (i.e., objectives). Beyond simply designing messages about science career benefits and scientists' characters, this might include reviewing their own behaviors to identify problematic issues that might lead young people to hold negative beliefs about science careers. What is key, however, is that having concrete, audience-specific goals are what enables communicators to discuss and design meaningful, evidence-based communication (i.e., how do we know if something was effective if we are unclear about what we are trying to affect). Further, although goal-free communication will still affect participants, the lack of intention could create added opportunities for unintended negative consequences. To paraphrase Benjamin Franklin: A failure to plan is a plan to fail.

Of course, a challenge of strategic communication designed around behavioral goals is that it creates the possibility that unsophisticated or unethical communicators will pursue goals regardless of context. In contrast, Besley and Dudo [2022b] argue that ethical and practical reasons make it important for science communicators to treat behavioral goals as tentative. This means that communicators should always have the goal of updating one's goals in response to context. In turn, this requires active efforts by scientists to understand the societal contexts in which their research occurs, including other actors' goals and needs. For example, a group of ecologists at a rural research station might initially think it would be interesting to do basic research on the spread of a particular disease but, through discussion with local land managers, realize that it would be useful to include an applied focus on mitigation techniques and perhaps even collaborate with the land managers on the project design.

One thing to recognize, however, is that scientists in this case are not simply listening to local land managers and shifting research to address those managers' needs. Instead, they need to remain open to new ideas and be willing to update their goals if appropriate. There might equally be cases where a group of scientists decide to keep their original goals (or decide not to pursue other potential behavioral goals). In such a case, however, the scientists might still have a goal of maintaining a positive relationship with land managers and thus still devote resources to explaining their rationale for their research and communication choices.

Returning to the example at the beginning of this essay, our argument is that basic scientists who want to communicate will often find it challenging to identify specific audiences and goals that flow directly from their work. In turn, a lack of audience-specific behavioral goals makes it impossible to prioritize cognitive and affective outcomes around which to design communication. Faced with this challenge, it seems likely that many basic scientists who want to communicate will end up focusing on educating people about some aspect of science (i.e., seeking to increase scientific knowledge, but not affect behavior), or prioritizing behavioral goals that do not directly flow from their research. This might include encouraging young people to consider science careers or trying to foster broad trust in science and

scientists (i.e., acceptance, legitimacy). Some basic scientists may choose specific goals such as limiting light pollution to enable astronomy and bird migrations (i.e. dark skies initiatives), or ensuring that policymakers provide funding for basic science, but these seem less common.

It is worth noting that there is nothing inherently wrong with broad behavioral goals. However, scientists who pursue such goals may find it difficult to get credit within the current academic rewards structures [Rose, Markowitz & Brossard, 2020]. In contrast, applied scientists focused on research-relevant specific goals can use communication to enhance the impact of their current research and improve their future scholarly efforts. These near-term benefits may thus make it easier to justify putting time and other resources into communication. To use a metaphor from the world of diplomacy, an applied researcher could be understood as a 'trade representative' who can demonstrate clear impact by fostering near-term imports and exports of products and services. In contrast, basic researchers may be more like 'cultural attachés' whose task is to promote cultural understanding with the hopes of longer-term, future benefits. Both roles are important and distinct; they may therefore require different timelines and outcomes on which to measure success.

3 ▪ To what degree do applied and basic scientists have different views about potential behavioral goals and associated constructs?

In this section, we use survey data collected in recent years to both demonstrate and delimit the conceptual argument above. Specifically, we use two surveys of scientists to explore the degree to which a focus on basic science is associated with different communication priorities. In doing so, we recognize that the scientists surveyed were often reporting what they said they saw as potentially important and not what they had previously prioritized or were planning to prioritize in the future. Nevertheless, the data support the idea that scientists with a greater focus on basic science may tend to have slightly different communication priorities than scientists with relatively more focus on applied science.

The first survey was sent via email to a randomized sample of academic scientists from the 62 research universities that are members of the Association of American Universities (AAU). Surveys were sent during the fall of 2021 to 13,663 email addresses (excluding bounces/bad addresses). After five emails (initial request and four reminders), 783 scientists responded to the survey for a response rate of 7%. Of these, 486 completed 50% or more of the survey. The second survey was sent during the fall of 2022 to 25,608 email addresses (excluding bounces/bad addresses) obtained from authors of research and review articles published between January 2017 to June 2022 from up to 20 journals in six fields with at least some focus on basic science (astrophysics, atmospheric sciences, chemistry, particle physics, nanoscience, and neuroscience) based on Web of Science categorization. Although response levels varied by question, about 1,919 scientists provided useful data for the current analyses for a response rate of about 7% (this varied by field) after four contacts (n = 2,234 completed 50% or more of the survey).[1] Demographics for both surveys are provided in Table 3.

1. Response rates are consistent with other online surveys of expert communities [e.g., Dudo & Besley, 2016; Besley, Newman, Dudo & Tiffany, 2020; Scott et al., 2011]. Further, we are most interested in the pattern of results rather than the means/averages of specific variables such that we are less concerned about non-response error as we

The 2021 survey of scientists (n = 486) at high-ranking American research universities found that scientists who were more focused on basic research were also somewhat more likely to prioritize communication goals focused on promoting science careers for youth, research funding, and trust (in the form of wanting people to 'value' science). Goals such as wanting to use communication to ensure scientists are asking research questions that benefit society were negatively associated with a focus on basic science. In contrast, scientists whose relative focus was on applied science tended to favor communication goals such as ensuring that policymakers use science, strengthening personal reputation, and ensuring that research benefits society. In most cases, however, the correlations are fairly low (Table 1).

The scientists surveyed in 2021 also answered questions about cognitive and affective objectives; it appears that scientists with more focus on basic science were somewhat more likely to emphasize 'getting people interested or excited about science' than applied scientists. This is consistent with the prioritization of youth careers in science. Similarly, scientists who reported a relatively higher degree of focus on applied science were somewhat less inclined to prioritize this objective and more inclined to prioritize a listening-focused objective (i.e., hearing what others think about scientific issues). Again, the correlations are fairly small, but are consistent with the idea that there is at least a small difference in the goals and objectives that basic and applied scientists see as important.

The 2022 survey of scientists in six fields — astrophysics, atmospheric sciences, chemistry, particle physics, nanoscience, and neuroscience — with a high degree of focus on basic science provides similar findings, although the correlations are even smaller. These 2022 data suggest that those with relatively more focus on basic science tend to see ensuring funding as relatively more important and updating research decisions as less important. Interestingly, these data suggest that applied scientists were somewhat more likely to see building trust as important. The data for objectives is consistent with the goals data inasmuch as degree of focus on basic science correlated with a desire to foster positive emotions towards science — as is common in youth-oriented programs — whereas trying to understand others (i.e., an objective associated with listening) was negatively associated with a focus on basic science. Basic scientists were also somewhat less likely to indicate they see communicating trustworthiness (e.g., ability, benevolence, and integrity) as important. This is inconsistent with the idea that basic scientists might seek to build broad societal trust but compatible with the idea that applied scientists may want to ensure that people trust them for advice. Again, however, the correlations are fairly small. It is also noteworthy that degree of focus on basic or applied sciences was not meaningfully associated with goals related to diversity, equity, and inclusion.

4 ▪ Where do we go from here?

We started by making a conceptual argument about the potential value of recognizing that basic scientists may have a more challenging time identifying audience-specific behavioral goals than applied scientists. We then showed that there appear to be small differences in the degree to which a focus on basic or applied sciences is associated with differences in scientists' rating of the importance of goals and associated objectives. These differences,

have no reason to think that the pattern of results might be different in non-respondents (whereas it may be reasonable to think that non-respondents might have more negative views about communication and thus give all potential outcomes less priority).

Table 1. Correlations (Pearson's *r*) between American scientists' behavioral goals, cognitive and affective objectives, and degree of focus on applied and basic research for 2021 survey of AAU scientists.

	Degree of Focus on Basic science[2]	Degree of Focus on Applied Science[2]	Combined Applied-Basic[3] (r = .44)
Behavioral Goals[1]			
Getting more young people to choose scientific careers, including youth from diverse backgrounds	.17*	.00	.10*
Ensuring adequate funding for scientific research	.14*	.00	.06
Ensuring our culture values science	.09*	-.04	.06
Ensuring policy makers use scientific evidence	.01	.12*	-.03
Helping people use science to make better personal decisions	-.02	.12*	-.03
Fulfilling a duty to society	-.03	.09	-.06
Strengthening my own professional reputation	-.12*	.14*	-.18*
Ensuring that scientists are asking research questions that benefit society	-.24*	.33*	-.27*
Cognitive and Affective Objectives[1]			
Getting people interested or excited about science	.23*	-.11*	.17*
Showing the scientific community's expertise or ability to solve problems	.08	.00	-.05
Showing that the scientific community cares about society well-being	.08	.13*	.06
Discrediting people who spread myths or incorrect scientific information	.03	.05	.00
Helping to inform people about scientific issues	.02	.09*	.00
Demonstrating the scientific community's openness and transparency	.00	.06	.02
Hearing what others think about scientific issues	-.05	.15*	-.11*

Notes: *p < .05. [1]Respondents reported the degree to which they saw each goal or objective as the most "unimportant" (1) to "important" (100) to scientists like themselves when taking part in public engagement. [2]Scientists indicate the degree to which they focus on basic and applied science using a scale which ranged from "never" (1) to "a great deal" (5). [3]Applied science was reverse-coded and then combined and averaged with basic science. Basic science is coded high. Faculty from these 62 AAU universities were randomly sampled. Eight randomly selected departments were chosen out of 25 total departments. These departments were drawn from the National Science Foundation's list of approved STEM fields (NSF Approved Fields of Study).

while relatively small, are consistent with the idea that basic scientists tend toward broad, youth-oriented goals and prioritize objectives that foster positive emotions, whereas applied scientists tend to orient toward goals that seek to directly benefit other's well-being and prioritize hearing from non-scientists.

As already noted, there is nothing inherently wrong with broad behavioral goals, but it is important to recognize that broad goals often do not reflect researchers' actual work. It therefore may be harder for scientists pursuing broad goals to justify putting time and resources into communication efforts as they cannot argue that such communication enhances the impact of their specific research. Our experience is that non-strategic communicators often appear to see common tactics such as sharing press releases, graphics, and compelling stories as the purpose of communication. Indeed, a substantial amount of communication training seems to focus on teaching scientists to speak clearly and tell stories as though simply telling a clear, compelling story is the solution to every communication problem [Dudo, Besley & Yuan, 2021]. In contrast, a strategic approach that starts with audience-specific

Table 2. Overall correlations between North American scientists from six different basic science-oriented fields' behavioral goals, cognitive and affective objectives, and degree of focus on applied and basic research, conducted in 2022.

	Degree of Focus on Basic science[2] r		Degree of Focus on Applied Science[2] r		Combined Applied-Basic[3] (r = .41)	
	r	N	r	N	r	N
Behavioral Goals[1]						
Trying to ensure that relevant decision-makers provide robust funding for scientific research	.11*	1,905	-.01	1,896	.05*	1,915
Trying to increase the likelihood that youth from groups that are under-represented pursue scientific careers	.05	1,905	-.01	1,895	.03	1,915
Ensuring the overall scientific community makes choices that move itself towards being more just, equitable, diverse, and inclusive.	.01	1,901	.03	1,891	-.02	1,911
Trying to increase the likelihood that people consider scientific evidence when making decisions	-.01	1,887	.08*	1,877	-.06*	1,897
Advocating to increase the likelihood that people will make specific decisions that are consistent with the available science.	-.03	940	.15*	934	-.12*	945
Building trust in the form of strong relationships with priority audiences	-.03	1,896	.09*	1,885	-.08*	1,905
Trying to increase the likelihood that people will make decisions	-.04	966	.06	962	-.07*	971
Ensuring that scientists like you make the best possible research decisions	-.06*	1,887	.21*	1,878	-.18*	1,897
Cognitive and affective objectives[1]						
Fostering positive emotions about scientific issues (e.g., excitement, awe, wonder, interest)	.16*	948	-.11*	945	.15*	952
Ensuring that people understand the scientific process	.08*	945	-.06	943	.08*	950
Feeling a sense of satisfaction or enjoyment from doing their part to advance science	.05	945	.03	943	.00	950
Ensuring that scientists understand others' values/integrity/motivations	.00	940	.10*	938	-.07*	945
Ensuring that people see scientists as sharing at least some of their values and/or identity	.00	946	.06	943	-.05	950
Ensuring that people are informed about scientific issues	-.03	950	.08*	948	-.08*	955
Fostering negative emotions about scientific issues (e.g., worry, fear, anger, disgust, frustration)	-.03	866	.08*	864	-.07*	871
Ensuring that people see scientists as people who care deeply about societal well-being	-.05	945	.17*	943	-.15*	950
Ensuring that people see scientists as eager to hear others' perspectives/views	-.05	948	.14*	946	-.12*	953
Ensuring that people see scientists as having high levels of expertise/knowledge	-.05	945	.11*	944	-.10*	950
Ensuring that scientists understand others' perspectives/views	-.06	943	.15*	941	-.13*	948
Ensuring that people see scientists as having high levels of integrity/honesty	-.06	947	.10*	945	-.10*	952

Notes: *p < .05. [1]Respondents reported the degree to which they saw each goal or objective as having "very low importance" (1) to "very high importance" (7) to scientists like themselves. [2]Scientists indicated the degree to which they focus on basic and applied science using a scale which ranged from "never" (1) to "a great deal" (5). [3]Applied science was reverse-coded and then combined and averaged with basic science. Basic science is coded high. The sample size for the objectives questions is lower because about half of the respondents were randomly assigned to answer these questions. For additional details, see: Besley and Dudo [2023].

behavioral goals — something that we suspect is easier for applied scientists — can help potential communicators choose goals and prioritize cognitive and affective objectives and the tactics needed to achieve those objectives. A press release, in this regard, is unlikely to help a group of ecologists build trusting relationships with local land managers. Similarly, sharing interesting stories related to science might increase the likelihood that young people develop positive beliefs about science careers, but a strategic approach would (a) provide guidance on the types of stories to emphasize (including who should share stories), and (b) enable a broader discussion about different ways to achieve the prioritized goals. It may be that telling stories is not the most effective way of achieving the goal.

One additional reality that basic scientists may face when starting with audience-specific goals is that it may not always make sense for scientists to take the lead on all aspects of science communication. For example, a group of astronomers who want to play a role in increasing the number of kids who choose science careers may be better off collaborating to support a dedicated informal educator and/or making themselves available to existing activities by organizations like a museum rather than organizing activities for themselves. It might similarly make more sense to send graduate students who are closer in age or who share other aspects of identity with the target students. Providing support to others, in this regard, may be more strategic than trying to develop or lead new programs in which they take a primary role. In contrast, the types of goals that applied scientists want to achieve might be more likely to require active participation by the scientists themselves. Applied scientists might still benefit from the help of communication professionals, but it also seems likely that they will need to be more directly involved in nurturing trusting relationships, listening to others' ideas, and sharing any insights that emerge from their research.

Understanding the challenges that basic scientists face when it comes to selecting goals, focusing on objectives that serve those goals, and employing relevant tactics for a given audience is key to advancing effective communication of discovery science. This requires more efforts between researchers and practitioners to understand and share best practices for communicating basic science with different audiences, as well as elevating and promoting successful examples of engaging public audiences on basic science. Regardless of the context of one's research, our hope is that readers of this essay recognize that communication and engagement is a collaborative effort. Although we highlight the different challenges faced by basic and applied scientists in this essay, the concept of strategic science communication applies more broadly. To clearly and effectively have a dialogue about the role of science in society, it is imperative that our communication efforts are thoughtful and well-planned. Applying lessons learned from fields such as public relations and marketing, and relying on empirically tested tactics of communication to achieve clear objectives that serve long-term goals will help scientists engage with stakeholders and communities who might benefit, both in the short- and long-term, from their research.

Acknowledgments

This material is based upon work supported by the National Science Foundation (Grants: DRL-1906864, AISL-1421214-1421723, and SBE-22828259), the USDA-AFRI program (MICL02468). the Chan Zuckerberg Initiative, the Burroughs Wellcome Fund, The Kavli Foundation, and The Rita Allen Foundation. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funders.

A ▪ Demographic information of respondents in the scientist surveys

Table 3. Demographics for surveys.

2021 Association of American Universities Survey[1]		**2022 Survey of Scientists in Science Fields**	
Field		**Field (as sample)**	
Biology or medical sciences	39%	Astrophysics	22%
Social/behavioral sciences or policy	27%	Particle physics	17%
Physics or astronomy	15%	Atmospheric sciences	24%
Geosciences	12%	Chemistry	16%
Computer science or math	11%	Neuroscience	17%
Engineering	9%	Nanoscience	5%
Chemistry	8%		
Gender		**Gender**	
Female	35%	Does not identify as a man	31%
Male	65%	Identifies as a man	69%
Career level		**Career level**	
		Student	6%
Junior (e.g., post-doc, assistant professor)	10%	Junior (e.g. post-doc, assistant professor, entry-level researcher/analyst)	23%
Mid-career (e.g., associate professor)	15%	Mid-career (e.g., associate professor, mid-level administrator, or research/analyst)	21%
Senior (e.g., professor)	75%	Senior (e.g., full professor, senior administrator or researcher/analyst)	43%
		Retired/Emeritus	6%
		Other	1%

Notes: [1]n = 486. Respondents were allowed to select more than one scientific field. [2]n = 1,919. In both cases, some percentages may not add up to exactly 100% due to rounding.

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How to cite

Besley, J. C., Yeo, S. K., Newman, T. P. and Dudo, A. (2024). 'The challenge of identifying behavioral goals for communication in the context of basic science'. *JCOM* 23(07), Y02. https://doi.org/10.22323/2.23070402.

ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it