Language, Identity, and Becoming a Scientist

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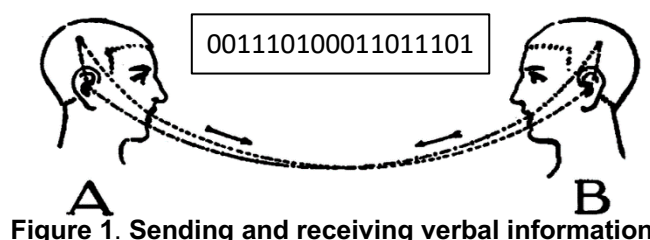Email: ccameron@mdanderson.org

Abstract

Efforts to broaden participation in research careers have grown greatly in number and sophistication during the last 15 years, as research has begun to uncover the dynamics that limit participation of underrepresented groups and to translate that evidence into effective solutions. Evidence-based programs, with support from the NIGMS and the NSF, have contributed a variety of different approaches, including mentoring skills and awareness of the experiences and perspectives of mentees; use of course-based and summer research experiences, peer mentoring, and team-based problem solving; training in stereotype threat, impostor phenomenon, unconscious bias, and micro-aggressions; and more. Our research team's efforts have been dedicated to an approach unfamiliar to many basic and population sciences researchers: scientific communication skills and the ways in which mentors and mentees of all levels can benefit from increased engagement with them. There are a number of misconceptions about this line of inquiry. Some may wonder if it is relevant to "doing" science. Others may question whether it is a strengths-based or deficit-based approach. Still others may wonder how such an approach can be investigated with a rigorous methodology. In this brief paper, we lay out the rationale for, theoretical and methodological approach to, and significance of linguistically-based STEM research and interventions.
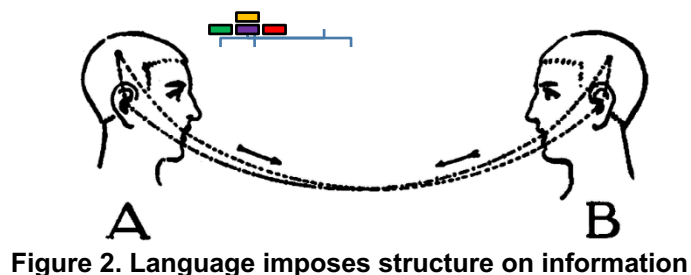
Why Scientific Communication?

We start with a bit of background on language and linguistics. Linguistics, like psychology, is comprised of many sub-fields: cognitive linguistics, sociolinguistics, psycholinguistics, comparative, historical, structural, computational, developmental, and more. All fields of linguistics are concerned with understanding how language is conceptualized, produced, used, organized, or developed. In other words, research linguistics does not include *prescriptive* functions such as teaching composition and grammar, teaching scientific writing, accent reduction, or speaking foreign languages, much as microbiologists are not, for example, concerned professionally with infection control or genetic testing. (Many theoretical linguists

distance themselves from such applications that attempt to control or interfere with language production, i.e., speaking and writing.) What is broadly understood by all linguists is that language use is a fundamental part of human cognition, social interaction, and psychology. These three dimensions—the cognitive, the social, and the individual—are all integral aspects of our study of scientific communication skills and their role in research training.
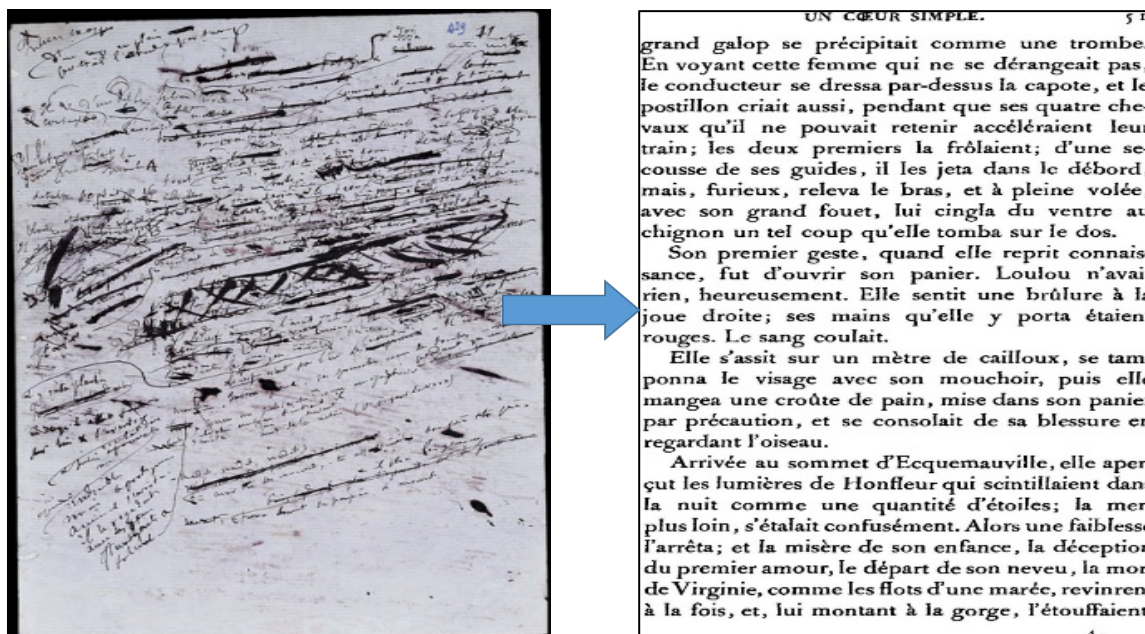
Cognitive. Early structural linguists such as Ferdinand de Saussure and Leonard Bloomfield conceived of language as a transmission of a string of verbal information from speaker to hearer (Figure 1) (de Saussure, 1916).

Figure 1. Sending and receiving verbal information

This view of language is still prevalent today; the brain is holding some data, and the tongue or pen is a conduit for that data. Of course, much more than that happens. As we think, we order the "string of data" into groups and hierarchies, such as words, pieces of grammar, phrases, and sentences, to build meaning (Figure 2).

Figure 2. Language imposes structure on information

This structuring process continues as we create larger and larger utterances such as conversations, monologues, or texts. This process of imposing linguistic order on the chaos of our thoughts, over and over as we grow, develops our cognitive abilities. This process is exemplified by the illustrations of Gustave Flaubert's 1877 draft and published manuscript of the work *A Simple Heart*, written late in his eminent career as a novelist. The chaos of thought (A) is iteratively wrestled into order in a work of literature (Kinzler, Corriveau, and Harris, 2011).

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grand galop se précipitait comme une trombe. En voyant cette femme qui ne se dérangeait pas, le conducteur se dressa par-dessus la capote, et le postillon criait aussi, pendant que ses quatre chevaux qu'il ne pouvait retenir accéléraient leur train; les deux premiers la frôlaient; d'une secousse de ses guides, il les jeta dans le débord, mais, furieux, releva le bras, et à pleine volée, avec son grand fouet, lui cingla du ventre au chignon un tel coup qu'elle tomba sur le dos.

Son premier geste, quand elle reprit connaissance, fut d'ouvrir son panier. Loulou n'avait rien, heureusement. Elle sentit une brûlure à la joue droite; ses mains qu'elle y porta étaient rouges. Le sang coulait.

Elle s'assit sur un mètre de cailloux, se tamponna le visage avec son mouchoir, puis elle mangea une croûte de pain, mise dans son panier par précaution, et se consolait de sa blessure en regardant l'oiseau.

Arrivée au sommet d'Ecquemauville, elle aperçut les lumières de Honfleur qui scintillaient dans la nuit comme une quantité d'étoiles; la mer, plus loin, s'étalait confusément. Alors une faiblesse l'arrêta; et la misère de son enfance, la déception du premier amour, le départ de son neveu, la mort de Virginie, comme les flots d'une marée, revinrent à la fois, et, lui montant à la gorge, l'étouffaient.

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Another example is presented in this quote from the contemporary author Ta-Nehisi Coates: "She [mother] would make me write about it…by which I mean not simply organizing a set of sentences into a series of paragraphs, but organizing them as a means of investigation…The writing had to answer a series of questions… She was teaching me to interrogate the subject…These were notes on how to write, and thus, how to think" (Coates, 2015: 29]. Leading experts on teaching writing composition, such as John Bean, affirm the value of drafting and composing for developing thinking skills [Bean, 2001]. Empirical evidence supports the notion that writing-based instruction (and collaborative learning as well, which requires verbal communication) increases reasoning ability (Ebert-May, Brewer, and Allred, 1997). Quitadamo and Kurtz found that biology undergraduate students who engaged in writing composition exercises raised their scores in analysis, inference, and evaluation compared to the control group who received traditional lecture/lab-based instruction (Quitadamo and Kurtz, 2007). This *process* of using language as a means through which to develop cognitive abilities is relevant to the role of scientific communication skills in research training. The more that trainees engage in the practice of communication, especially the hard work of drafting and revising, the more their scientific thinking can develop.

Social. Another important facet of language use is that it signals our identity to others. Our manner of speaking and writing plays a vital role in our inclusion in or exclusion from various social groups. We all have multiple styles of communicating, and some are entirely within our conscious control, while others are only partially so. Some aspects of the way we speak stem from our upbringing, as in the case of dialects or sociolects, and some stem from daily choices we make, such as the register we select or a second dialect or sociolect that we might choose to use. Sociolinguists use the term "dialect" to denote regional differences in speech, the term

"sociolect" to refer to differences related to ethnocultural background or social class,[1] and the term "register" to refer to the different styles we use in various situations, such as participating in worship, hanging out with close friends or family, or speaking in the classroom. The deliberate alternation from one sociolect or register to another to signal group affiliation, popularly referred to as "code switching", is an example of consciously manipulating linguistic identities to achieve social objectives.[2]

Typically we acquire and imitate the ways of speaking of groups that we're a part of, such as our family, friends, and colleagues, as illustrated by the author Jhumpa Lahiri's words: "Language, identity, place, home: these are all of a piece—just different elements of belonging and not belonging" (www.livemint.com, Jan. 25, 2014). Conversely, we avoid speaking in ways that would affiliate us with groups we don't want to be a part of, as when teenagers use slang to distance themselves from their parents or other "uncool" people. And we try to acquire and practice the linguistic style of groups that we aspire to be a part of, for example research teams or scholarly communities. Our mastery of the register or style spoken by the group tells others whether we are bona fide members, novice or seasoned, of that community, making it a critically important means of joining a community of practice. We all want to sound like experienced and knowledgeable peers in our research communities. Reaching that point of mastery takes practice and continued exposure to the group's ways of communicating. Being fluent and articulate in scientific communication shows that we belong.

Individual. On the individual level, language use builds identity. The author T.C. Boyle wrote "What is your identity, and how do you know who you are if you don't have language?" (*New York Times*, Sept. 27, 2004). We express our identity, including its professional, cultural, and social facets, in the way we choose to speak or write. The ways in which others respond to our style of language use reflects that identity back to us. If a teenager uses current slang with her friends, they recognize her as one of them (which is what she wants). If she uses current slang with her parents, they might react with exasperation at her rejection of "normal" speaking (which may also be what she wants). If a molecular biology graduate student tries out his still-developing style in the draft of a manuscript, his mentor's reaction has the power to ratify, reject, or encourage that attempt to write like a serious scientist. Again, through gradual and varied practice and exposure, and with encouragement and coaching, the student or trainee not only begins to be included in a community of practice, but develops his or her own science identity as well. Note that "practice and exposure" entails even—perhaps especially—off-the-record

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[1] Some examples of non-standard dialects include Southern, Appalachian, and south Boston. Some examples of non-standard sociolects include Spanish-influenced English, African-American vernacular English, and rural. The standard dialect is traditionally defined as the variety of English spoken on national news programs. Home language variety is not associated with any other personality or intellectual characteristics, although it is frequently used as a way to stereotype others.
[2] 'Code-switching' as a technical sociolinguistic term refers to switching back and forth between varieties within a single sentence or conversation. Example: "Ya voy para Target; you want anything?" (Translation: "I'm heading to Target; you want anything?") Using different languages or sociolects in different settings altogether, such as English at work and Spanish at home, is known as 'diglossia'.

communication, such as discussions of a presentation, talking about research over pizza after work, being introduced to the mentor's colleagues in social settings, etc. Because being included in these interactions is at the mentor's discretion (i.e., not formal requirements), they are perhaps more genuine signals of inclusion in the community.
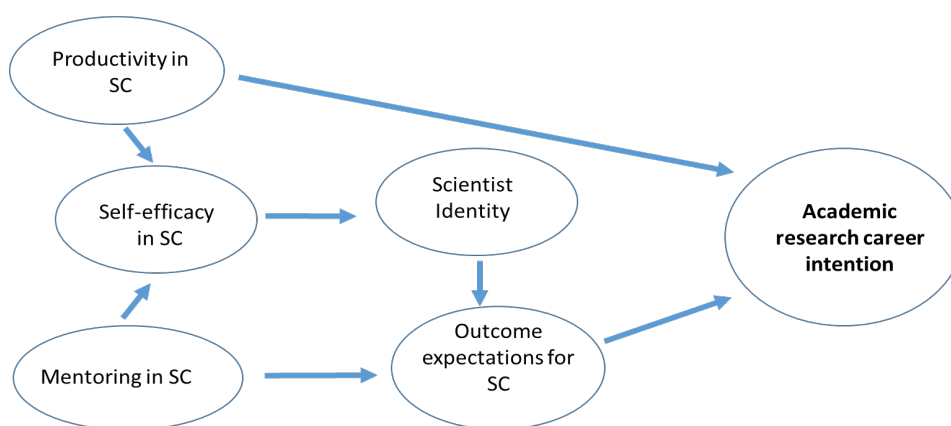
Design of the Research Program

The concept for this research was developed over 10 years ago in response to an NIGMS request for grant applications that would investigate factors and interventions that help broaden participation in STEM research careers through recruitment and retention of underrepresented minorities. Based on the social-psychological principles underlying communication skills and language use outlined above, we designed a social-cognitive career theoretical study to survey both research trainees (PhD and postdoctoral levels) and mentors about how scientific communication skills were developed within the context of the mentoring relationship. We investigated whether scientific communication skills were predictive of career outcomes and what factors might mediate or moderate the process. To carry out this project, expertise was needed from the disciplines of social psychology and sociolinguistics and methodologies including psychometrics, survey design, and structural equation modeling. The study was *not* designed to measure, test, or develop recommendations regarding the "correctness" or skill with which trainees communicated, or to measure, test, or develop recommendations for mentors on prescriptive mentoring for language correctness or skill. Rather, its purpose was to interrogate the *role* of scientific communication skill development and mentoring in trainee career outcomes.

Engagement in and perceptions about three modes of scientific communication were included in the research design: scientific writing, formal presenting, and spontaneous conversations in the research environment. For each of these three modes, items queried self-efficacy, frequency of engagement, and mentoring practices.

For both the initial cross-sectional study of trainees and unmatched mentors (Phase I) and the subsequent longitudinal study of paired mentor-mentee dyads (Phase II), an extensive online survey queried trainees' prior experience, self-efficacy, frequency of engagement, outcome expectations, and perceived mentor practices for learning and using scientific communication skills, as well as demographics (including native language, bilingual status, and home language variety), science identity (Phase II only), and career intention (expressed as intention to remain in a research career and to pursue the status of academic independent investigator). The Phase II study also included items for perceived mentoring style (demandingness and responsiveness). For Phase I, mentors were queried on their perceptions of scientific communication (SC) skills as an important issue in research training; their own self-efficacy for SC as well as their SC mentoring self-efficacy; and perceptions of barriers to mentoring presented by trainees, by their environment, and by their own capacities and resources [6]. For Phase II, mentor self-perceptions of mentoring style were also queried.

A structural equation model (Figure 3) was constructed from Phase II results (Cameron et al., in review). This model illustrates that research career intention is predicted by factors related to SC skills and their mentoring. Productivity (our study's term for frequency of engagement in SC) contributed both directly and indirectly, through self-efficacy in SC, to career intention. This measure of productivity did not count number of completed or submitted papers or presentations, but rather how often the trainee engaged in writing, presenting, and importantly, spontaneous speaking activity. Self-efficacy in SC, influenced by productivity and mentoring practices in SC, was a source of science identity, suggesting that frequent participation in and mentoring of SC helps build science identity. Science identity, in turn, reinforces positive outcome expectations for SC, together with mentoring practices. Put another way, this means that trainees come to expect that SC will pay off for them, and this expectation is fostered through SC mentoring and active engagement. Finally, positive outcome expectations and productivity directly predict career intention. Thus, our research shows that trainees who receive active mentoring and communicate freely are likely to have stronger intentions to remain in research careers.

All paths statistically significant at p<.05 or more.

Figure 3. **How SC skills predict research career intention**

Relevance to Broadening Participation in Research Careers. Another facet of this work concerns the dynamics of SC skill acquisition and mentoring with respect to underrepresented and well-represented groups. No significant difference by gender or race/ethnicity was found for the processes described above. However, some differences were found between trainees who were raised in families using standard English and those who were raised speaking non-standard varieties of English, i.e., the dialects and sociolects referred to above. Study participants responded to an item asking whether they were raised speaking a different type of English than

what was usually spoken in the research or academic environment.[3] If they answered yes, a list of language varieties (including "other" and "I don't know'" was presented.

As we show in the research report [Trachtenberg et al., 2018)], the data indicate a trend towards feelings of discrimination or discomfort among trainees who were raised speaking non-standard varieties. Moreover, consistent with other studies on dialect discrimination (Kinzler, Corriveau, and Harris, 2011; Lev-Ari and Keysar, 2010), the mentors of trainees who were raised speaking non-standard varieties perceived them differently on some measures. These measures included perceiving the trainee as presenting higher barriers to mentoring SC due to language and "attitude or personality" differences. The mentors were not informed of the trainee's language variety and may not have noticed it in interaction, since most trainees use standard academic English in the research environment. These trends were not associated with either race or ethnicity in either trainee or mentor responses (see also Kinzler et al., 2009) indicating that not all members of a given racial or ethnic group were raised speaking the same way. Further research is needed to fully understand these preliminary data, but if similar trends emerge in future studies, a novel indicator of potential bias in the research environment that is more specific than race/ethnicity or socioeconomic status may be identified.

Implications for STEM Research Training and Mentoring

Both the trainees' activities and the faculty mentors' practices investigated in the study discussed here were typical, everyday practices, such as asking questions in a meeting, writing sections of a manuscript, or giving poster presentations for trainees, and, for mentors, giving feedback on writing projects, helping trainees rehearse for formal presentations, etc. We measured not quality of output, but level of engagement. The more trainees communicated and mentors mentored communication, the greater the influence on trainee self-efficacy and outcome expectations for SC and, ultimately, intention to persist in a research career. What this tells us is that mentoring and practicing SC skills does not need to be intricate or expert-level to be effective; simply being aware of the importance of SC and engaging in it is beneficial.

While these findings are suggestive, they have not been tested in practice. To assess their effectiveness and usability, an intervention to equip mentors with skills for helping trainees develop SC has been launched with funding from an NIGMS IPERT (Innovative Programs to Enhance Research Training) R25 award. The intervention consists of a half-day workshop for mentors, delivered over five years at four sites nationally, including Georgia State University in Atlanta, the Gulf Coast Consortia in Houston, the University of Colorado Boulder, and the Big Ten in Chicago.

In the workshop, participants learn why and how to foster scientific communication skills of PhD and postdoctoral trainees. A longitudinal, dyadic research project associated with the workshops

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[3] To avoid confounding, this item was presented only to US citizens and permanent residents who claimed English as their primary language or claimed bilingualism, defined as native level capacity in both languages.

will measure participants' uptake and use of SC skills as well as the attitudes, productivity, self-efficacy, science identity, outcome expectations for SC, and career intentions of their matched mentees before the faculty mentor attends the workshop and six months after. (Mentees do not attend the workshop.) This project will also continue to investigate the possible influence of trainees' home language variety on level of comfort in the research environment and other factors, as well as mentors' attitudes associated with language variety.

How Mentors Can Help

To conclude, we offer some thoughts on the important role of language use in various facets of personal and professional development and the ways in which mentors can harness it to benefit their trainees.

Cognitive Development. As discussed above, academic writing has been shown to develop—not just reflect—critical thinking skills in university students, and writing has long been considered by humanities instructors to be the most powerful tool for teaching students how to think. As we engage in the work of organizing and re-organizing our nebulous thoughts into intricate structures built of deliberately selected symbols (i.e., words), arranged in well-formed, ordered strings of relationships (sentences) and logically ordered strings of sentences (paragraphs), we train the mental muscles of complex thought. The developmental value of drafting and revising in the creation of a mature text is undisputed by scholarly and literary writers, editors, reviewers, and educators, and is reflected in the time-honored use of theses, dissertations, and publications as the final test of readiness for scholarly professions—the ultimate conferral of professional identity. This takes time, and it's not easy. Writers often experience frustration as they struggle with drafting.

As recommended in the SCOARE mentor-training workshops, mentors can help trainees in several ways. First, normalize the process. Mentors can make sure their mentees understand that *everyone* experiences this process and that this intermediate work is valuable. Next, give feedback that guides the writer rather than simply pointing out problems. Discuss points of confusion and make sure they understand how to proceed. Start the drafting and editing process early enough so that the trainee produces the final draft, without the mentor overwriting the trainee's words. Voice develops over time and with practice. Finally, any points of "stuckness" or blocks in drafting may be addressed by the use of "freewriting." Freewriting is simply writing out whatever comes to mind, unedited, for five minutes or more, without stopping. For the first few minutes, the writer typically produces random and trivial thoughts, but as the process continues, the writing develops in meaning and complexity. This technique is used by many academics to overcome writer's block. Part of the benefit of this exercise is that the writer is not forced to think about a particular subject or cogitate on a particular problem or idea; it is entirely non-prescriptive (Bolker, 1998; Elbow, 1998; Cameron, 2016).

Joining the Community of Practice. Inclusion in social groups happens through language. To join a social group, whether personal or professional, we must acquire the language of that group

and demonstrate that we are familiar with it (or at least are on the way towards that goal). The group's members are sensitive to these linguistic cues even in very brief exchanges and may choose their response based on evaluation of the "authenticity" of our speech. In these moments, a rebuff can have a withering effect, and a validation can be invigorating. These dynamics hold whether the scenario is a graduate student discussing her poster with a senior investigator or an investigator attending grant review study section for the first time. Junior scientists who have frequent opportunities to practice using professional language in nurturing, mentored environments have an advantage in developing these skills. Learning the accepted style builds identity as a practitioner of the discipline and invites the novice into a community of practice.

Mentors who are aware of the powerful role of language in self-esteem and face can avoid unintended consequences. They can help by encouraging mentees to speak early and often, intentionally including them in conversations about research and providing opportunities to talk with other senior scientists. Modeling professional ways of asking and answering questions helps trainees build poise and confidence. On a related note, both fully bilingual individuals as well as *bi-dialectal* individuals have been shown to have certain cognitive and social advantages (Kinzler, 2016). This suggests that the greater the number of not only words, but also entire linguistic systems that we have mastered, the greater the benefits to our social resources and our thinking skills. Thus, rather than attempting to suppress or replace their mentees' home style of speaking, mentors can recognize that trainees are best served by acquiring the *additional* register of SC, trusting that bilingual and bi-dialectal individuals understand and are able to select the appropriate register for a given context. Indeed, such individuals have the advantage of being able to translate scientific register to the quotidian or "everyday" register used by their communities, an important contribution to the public understanding of scientific research. By positioning the use of register or style as a conscious choice, the mentor can allow the mentee to make that choice, thus affirming the multiple facets of their identity.

Identity as a Whole Scientist. Mediating thought and emotion through language has been shown in various contexts to have psychological benefits. Behavioral scientists have found that even very brief guided writing interventions can have long-term, meaningful impacts on student achievement while also addressing socio-cultural disparities. Examples of such interventions include values affirmations and utility-value affirmations. In such interventions, students write a brief paragraph describing their own personal values or the relevance of a given course to their education (Harackiewicz et al., 2016; Brown et al., 2015). Prospective writing, in which people who have suffered adversity are asked simply to write about new opportunities for a better future, has shown promise in facilitating post-traumatic growth (Roepke et al., 2018), and the use of diary-writing exercises in which writers transition their pronoun usage (moving from "I" to "you" and finally to "he/she/they"), has shown a decrease in negative emotion and increase in positive (Chang, Huang, and Lin, 2013). The mechanisms underlying such interventions may also underlie activities in which researchers talk about their work to lay or non-specialist audiences. In occasional periods of discouragement, communicating their commitment to science and

research can help trainees reconnect with their goals, values, and motivations. Many have told us that activities such as creating elevator speeches about science, writing science blogs, and leading lab tours for prospective students have been helpful at difficult points of their careers. Mentors would do well to consider encouraging these strategies rather than dismissing them as an unproductive use of time.

Conclusion

Language use is a powerful tool. Far beyond serving as a means to an end "product"—the research report—it is the medium through which we can build thinking skills, community, inclusion, and identity; manage affect and promote well-being; and generate new ideas, strategies, and perspectives. Each of these aspects benefits early-career researchers, helping them to become whole scientists and bring all of their potential to bear on contributing to research. By encouraging and stimulating frequent practice of scientific communication, whether conversation, presentation, or writing, and whether formal and scholarly or informal and conversational, we foster growth and development in emerging researchers.

Acknowledgments

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