Lillianna Righter*, Hallie Garrison and Elika Bergelson

Language science outreach through schools and social media: critical considerations

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Abstract: As researchers who rely on federal funding and community participation, we have an obligation to return scientific knowledge to the community. Our outreach goals are to share information about language development and sensory impairments, introduce language science to future scientists, distribute scientific results accessibly, and illuminate the breadth of what science and scientists look like. We seek to achieve this in two ways: by sharing about language science beyond the ivory tower through short videos on social media and easy-to-read articles on our blog, and through educational outreach. For the latter, in recent efforts we designed and implemented after-school programming for young public schoolchildren, targeting early negative attitudes about STEM abilities. We presented profiles of underrepresented scientists in a range of fields, including language science, and discussed language modalities using observation games to help children appreciate science as a creative process of questions and failure – something they could do, not just “others” who do not look like them. We used the Draw-a-Scientist Task to assess our impact: children’s drawings were more representative after our program. In this article, we explore our missteps, difficulties, and successes.

Keywords: outreach; diversity in science; language and senses; K–12 education; social media

1 Motivating outreach

We see two manifestations of injustice that language science outreach can counteract: the exclusion of marginalized communities from production of linguistic knowledge, and the propagation of uninformed perspectives that lead to harmful linguistic attitudes.

In terms of the first point, language is an intriguing theoretical topic and window to the mind – but it is also a dimension along which whole communities experience oppression (Baker-Bell 2020; Charity Hudley et al. 2020; Leonard 2021; Lippi-Green 1994; May 2023; Phuong 2017; Soto-Boykin et al. 2021). There are systemic and material circumstances that exclude marginalized people from science, and we do not pretend that outreach can solve those. However, social forces contribute to the valuation of scientific study, and therefore the diversity of participants in a field. Linguistics suffers from a lack of “advertising”: people do not know they can pursue the scientific study of language.

When it comes to the second point, lay audiences often misinterpret or sensationalize findings (Dempster et al. 2022). For linguistics, lay theories and intuitive ideologies are strong, and sometimes not only wrong but offensive. Ask family and friends about Koko the gorilla or Bunny the dog on TikTok – many believe Koko was a fluent signer of American Sign Language and Bunny talks using buttons. This has dehumanizing implications for human signers (“your language is so easy gorillas can learn it!”) and obscures the structure and complexity of language. Correspondingly, another theme across the outreach efforts was to fight still-pervasive myths about sign languages, and misconceptions held by parents of language-learning infants, within misinformation-laden channels, like TikTok.

***Corresponding author: Lillianna Righter**, Department of Psychology and Neuroscience, Duke University, Durham, USA; and Department of Psychology, Harvard University, Cambridge, USA, E-mail: larighter@fas.harvard.edu. https://orcid.org/0009-0008-8732-4441
Hallie Garrison, Department of Psychology and Neuroscience, Duke University, Durham, USA
Elika Bergelson, Department of Psychology and Neuroscience, Duke University, Durham, USA; and Department of Psychology, Harvard University, Cambridge, USA, E-mail: elika_bergelson@fas.harvard.edu. https://orcid.org/0000-0003-2742-4797

With these perspectives, and a new grant inquiring into the language learning of blind and deaf children, we embarked on two outreach efforts. We created an educational curriculum centering the senses, language, and diverse science, and pursued social media dissemination of relevant research. This paper details our activities, points to our successes, and acknowledges our mistakes. While our activities and their measurable effects to date have been relatively small-scale, we unilaterally recommend science outreach.

2 First initiative: education outreach

2.1 Why schools?

Implicitly through literacy instruction, "language" becomes a highly controlled written medium that you can be "good" at (Pauwels and Winter 2006). Furthermore, negative attitudes towards science and the ability to succeed in science begins early for girls and students of color (Bian et al. 2017). Thus, although our local school district (Durham Public Schools) is highly diverse by race and socioeconomic status (DPSNC 2022), messages about what language is "good" is likely to affect students unequally.

Given this, we sought to seed healthy ideas about language and science inclusivity as early as possible, with kindergarten-to-second graders. We focused on creating short programming (previously found to be beneficial; Clark et al. 2016; Laursen et al. 2007). We opted to conduct this as after-school programming to connect to students who are least likely to access extracurricular enrichment (Cutucache et al. 2016), without cutting into critical instruction time. Concurrently, we sought to spark interest in language science, towards diversifying who pursues linguistics training (Clark and Trousdale 2012; Lidz and Kronrod 2014). The standpoint theory of science (see Wylie and Sismondo 2015) argues that scientists from disadvantaged backgrounds conduct more than just science, given their knowledge of their community's needs. Increasing the number of marginalized scholars can push scientific inquiry to more helpful questions and return knowledge to communities (Golle et al. 2022; Wolfram 2012).

2.2 Activities: school outreach

We administered our school outreach in two different formats: in two one-hour sessions over two consecutive days, with a single small group of kindergarten-to-second graders; and in a 30-min rotation schedule, with 3–5 small groups of children once a week, over four weeks. The latter permitted grade-level tailoring. Beyond highlighting the diversity of what science "looks like," we also designed our five activities as an early foundation to prevent myths about language from taking root – seeding a broader understanding of what language is, and how it may differ by sensory modality. The materials are available on OSF (https://osf.io/nxfht/?view_only=05290814ac1649d6883c5372386abc9f).

2.2.1 Introducing the scientists

We introduced ourselves as scientists who study how babies learn to talk. We then introduced five other researchers, providing a portrait and short biography. After each one, we asked if the person was a scientist. Though initially skeptical, eventually students caught on that all five are scientists. We showcased Black, Latinx, Asian, and women scientists to show children implicitly that plenty of scientists look like them (Shanahan et al. 2011). Examples span traditional and nontraditional science fields (e.g., computer engineering, silvology, psychology.) Our goal was for children to see that they could engage in scientific inquiry about *any* topic that interests them, not just chemistry and biology, framing science as creatively asking questions no one knows the answer to.

When asked what they noticed about these scientists, kids earnestly told us they were surprised because they did not think people other than doctors and people who make potions were scientists. They astutely noted our scientists were "mostly girls" and "all Black and brown."

We asked students to choose their favorite scientist, and took a Polaroid of them with the scientist's portrait and gave it to them to take home, along with a biography. We hoped that showing them off to their family would help reinforce their learning.

2.2.2 Rearrange the words

This activity adapted the first part of a lesson on the parts of speech from Western Washington University's Teach Linguistics series (https://teachling.wwu.edu/parts-speech-inductively; Denham and Lobeck n.d.).We wrote each word of sentences like (1) and (2) on a note card, and then passed each card out to a student (reading the word aloud to the student as well).

(1) *The girl ate a bowl of cereal.*

(2) *Alex washed the plates in the sink and Jo put the spoons away.*

We instructed students to act out their word for others to guess. Some were easy, like *bowl*, but function words like *of* stumped them. Most resorted to spelling the word with their bodies. Students then had to rearrange themselves to put the words in order, which was far easier. With extra time, we would have students rearrange the longer sentences like (2) into as many orders as possible, since they readily noticed that nouns or even whole clauses can swap places to create new meanings.

This game demonstrates that language has observable patterns and lets us create abstract, displaced meanings. Language rules are not taught in writing class – they are rules babies learn implicitly, which helps reinforce that students' natural ways of speaking are valid, complex ways of communicating. Asked how they knew what order words should go in, students answered "It just makes sense that way." Eventually, it would click that this was a tough question after all. We closed this activity by telling students to appreciate their brains for how much they have learned without even realizing it.

2.2.3 Line up, abstract versus concrete

For this activity, we had students line up without using language: by height, by rainbow order based on shirt color, and by birthday. The last was the most difficult, since it was not directly observable. We asked the students what would have made the task easier, and they exasperatedly answered "if we could talk!" This activity aimed to drive home that language uniquely allows precise communication, leading up to discussing how sign language is (full-fledged, complex) language too.

2.2.4 Find the object

This activity was our "big experiment." Groups of 4–5 students received boxes containing various small objects. Some were familiar and easily named, like a glove, and some were not, like a plastic file-folder tab. In round 1, we gave one student in each group either noise-canceling headphones or a cloth eye-mask. We gave their teammates a card depicting an object. They had to help their teammate with the sensory device select the right toy out of the box. In round 2, they had to set up multiple objects into a tableau.

We directed students to observe what *other senses* they used when their sight or hearing was disrupted. The goal was to practice observation of which senses were useful when one of them was unavailable. Getting kids to resist using the "ignored" sense (e.g., vision when wearing the eye-mask) was difficult, but once they got into the task, kids quickly realized they could speak aloud when their teammate was wearing the eye-mask, and use visual cues and gestures with the noise-canceling headphones, alongside touch in both cases.

Afterward, we debriefed that the main modalities people use to communicate are hearing and sight. The language of instruction in Durham Public Schools district is English, but we asked if anyone knew about American Sign Language, and several children knew some signs they were eager to share. We talked about how some languages use your mouth and ears, and some use your hands and eyes. We wanted to show the rich information you can learn with each sense. We had to be very explicit that this activity does not compare to the experiences of blind and deaf people – the eye-mask and headphones were just a physical reminder to focus on other senses. This discussion synthesized our activities regarding language and the senses, without repeating harmful myths about sign languages and risking children inadvertently learning misinformation.

2.2.5 Assessment: Draw-a-Scientist Task

Finally, we used the Draw-a-Scientist Task as an established, quantifiable way to assess children's knowledge and associations with what it means to be a scientist (Farland-Smith 2012). We gave students the following prompt:

> Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. Draw the scientist busy with the work this scientist does. Write or tell us some words that tell what this scientist might be saying to you about the work you are watching the scientist do. Do not draw yourself or your teacher.

Each drawing (see sample drawings in Figure 1) was scored for three features – scientist's personal appearance, location, and scientific activity – on a scale of 1 = "sensationalized" image, 2 = "traditional" or "naive" impression, and 3 = "beyond traditional" or more accurate image of what scientists can and do look like, for a maximum score of 9. This was the very first and concluding task of our program.

Higher scores on this task indicate greater understanding of what science can entail. We found that scores increased significantly between our pre- and post-program drawings, as indicated by a paired Wilcoxon signed-rank test (n = 49 total students who completed two drawings, W = 185.5, p < 0.0009; Figure 2). Initially, children overwhelmingly drew someone in a lab coat, with test tubes. After our activities, students often drew a specific scientist we had introduced, or us. Children aged 5–7 are also learning about gender and align themselves with members of their own, so the boys often drew Ralph, our only "boy" scientist. We were nonetheless excited – drawing specific nontraditional scientists still means students drew upon a tangible, positive example when imagining a scientist.

2.2.6 Extending to older children

We also adapted our program for older students: with high schoolers in the Duke University Neuroscience Experience (DUNE; https://dibs.duke.edu/education/dune/), a summer internship for underrepresented students, and an abridged version with middle schoolers as part of the Females and Allies Excelling More in Math Engineering and Science (FEMMES+; https://sites.duke.edu/femmes/) science day. We were excited to present language science and its relationship to neuroscience to students who are already interested in science, boosting

Figure 1: From left to right: a "sensationalized" drawing, a science robot making potions; a "traditional" scientist drawing, with lab coat and test tubes; and an example of a "beyond traditional" drawing, featuring the authors working with infants. The complete set are on OSF (https://osf.io/nxfht/?view_only=05290814ac1649d6883c5372386abc9f).

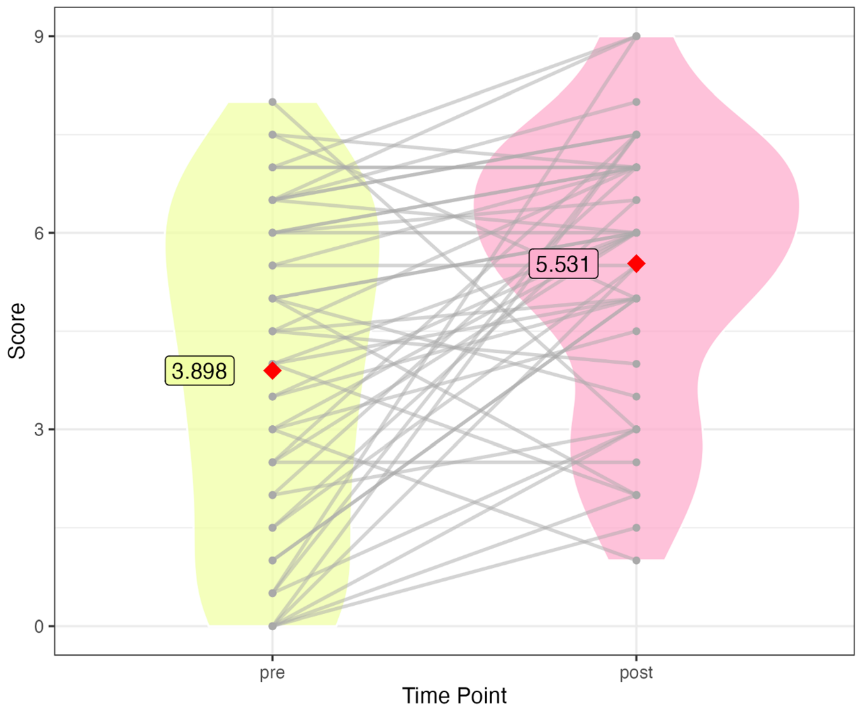

Figure 2: Draw-a-Scientist scores (n = 49), before our program (mean = 3.898) and after (mean = 5.531). Higher scores indicate better understanding of the broad range of who does science and how that work looks.

its status among the more traditional hard sciences. We gave students articles, podcasts, and TED Talks from underrepresented scholars and had each student present one scientist's profile. We could discuss more frankly the barriers and discrimination that the profiled scientists and others who share their identity have experienced. We practiced linguistic analysis: we talked about the history of American Sign Language, used minimal pairs to identify the distinctive features of sign cheremes, and wrote very basic rules describing verb-to-noun inflection and number incorporation. Finally, we discussed brain regions that activate during language across modalities.

2.3 Mistakes and challenges: school outreach

While we felt these outreach activities were a success, we also made errors. Even with good intentions and care, we can be ineffective and even harmful.

Initial iterations of our program had framing issues. The find-the-object experiment bordered too much on disability simulations, which are generally inaccurate and minimize the unique experiences of disabled people (Silverman 2017). We thank The Language Scientists from the University of Maryland Language Science Center for careful discussion of our activities (https://linktr.ee/thelanguagescientists; for more about their excellent outreach, see Oppenheimer et al. 2022). With feedback, we made strides in framing the activity as a way to isolate one sense at a time, and explaining that this experiment is not like being blind or deaf. Another miscalculation was focusing more than needed on the senses, which 5–7-year-olds are already familiar with, and not enough on discussing how the senses are relevant to language, which is the piece children were less likely to know.

Second, before settling on portraits and biographies, we tried to make a video featuring interviews with real scientists. We were asking marginalized scholars to volunteer (or receive an inadequate payment for) their time, which *contributes to* the cultural issues facing diversity in science, rather than combating them. Scientists rarely explain their research to kindergarteners, so the video interviews were too long and too high-level for young attention spans, and generally unengaging.

Third, we felt our positionality, conspicuously. Although lab members come from marginalized genders, races, sexualities, and disability communities, we also ostensibly belong to a white-collar professional class. Not every identity could be represented at every session, meaning the primary scientists in the classrooms were often white women from a “prestigious” university. It sometimes felt like failing to practice what we preach. Axes of marginalization do not experience the same difficulties, so our experiences do not necessarily overlap with those of the children we were working with.

Perhaps the biggest challenge was assessment. For our own sake (and for funding reports), we needed to quantify our impact. We tested several pre- and post-“test” formats: picture matching, read-aloud free questions, and raised hands to true/false questions. However, we found that 5–7-year-olds’ reading, writing, and impulse control were too variable to make it through all the questions, much less for us to trust that they reflected children’s true knowledge. Our time in the classroom was admittedly chaotic, and often focused on behavior management and how best to implement the tasks, leaving it challenging to infer children’s understanding even impressionistically. We landed on the Draw-a-Scientist Task as our numeric (though simplistic) indicator of change. We did not successfully obtain a quantitative assessment of children’s change in attitudes about language and the senses.

The final challenge was structural. Public school infrastructure was overburdened even before the pandemic, and trying to partner with schools placed another demand on teachers and administrators. The adult-to-child ratio in our programs was often difficult to navigate, since we were sometimes supervising a group of children with whom we lacked an established, trusted relationship. We are deeply grateful to the schools who welcomed us, and to the many teachers and mentors who attended the sessions with students.

2.4 Positives

Quantifiably, students’ scores in the Draw-a-Scientist Task improved significantly, indicating we successfully expanded their representations of what scientists can look like. Another key outcome was the relationship we built with students and teachers at our partner schools. One school asked us to return and lead an activity during their all-day intersession program; our participation took a tiny bit off their plates. Our experience was consistent with the established literature: continued support and community building is the driving factor in science outreach success (Millar et al. 2019).

More selfishly, the outreach program improved our lab’s science communication skills. If you can explain your question to a kindergartener, you can probably adapt it for anyone. Teachers and support specialists also hold a wealth of knowledge for interacting with kids, which helped us refine our classroom strategies in ways we could take back to further science dissemination. This dovetailed with our second initiative, described below.

3 Second initiative: social media

The second prong of our outreach initiative was social media content relevant to language development. While this was planned before COVID-19, it became all the more relevant as life became increasingly digital.

3.1 Who are we trying to reach with online outreach?

Alongside lay audiences, we target parents of young children. This was especially relevant during lockdowns, when they were lacking their usual “village.” We had also seen (and continue to see) rampant misinformation online, and hoped to play a role in correcting it. For example, a recent trend on TikTok shows expecting parents how to “hack” a gestational diabetes test. Healthcare professionals are rightly aghast, explaining why the test is necessary, and should be taken as directed (see, e.g., many 2023 Tiktoks from @dr.emzieees and @drjessicaknurick). Within language science, one of the biggest pieces of our expertise we seek to relay to anxious parents is that babies’ brains are fantastic at learning language, and that as long as children are getting language input, there’s no magic formula for the type or number of languages that would be “optimal.”

3.2 Accounts

We opened four social media accounts: a blog (https://www.babiesandlanguage.com/), a Twitter account (@Babies_Language), a TikTok account (@babiesandlanguage), and an Instagram account (@babiesandlanguage). For our ongoing blog writing, we aim to write posts at an eighth-grade reading level, easy to understand and engaging. We title each post with a realistic question: what a child's first words will be, or if it is difficult for a child to learn more than one language.

Using TikTok, we seek to push our content to people who were not actively seeking it (Radin and Light 2022). Across platforms, short-form video is the most popular content type for most internet users, in our experience. We create a mix of video styles, some using popular audios (https://www.tiktok.com/@babiesandlanguage/video/6936185911797386502) or trends (like the Twilight Renaissance; https://www.tiktok.com/@babiesandlanguage/video/7172662301059861802). We also post plainly informative videos (https://www.tiktok.com/@babiesandlanguage/video/6948429362031119621) and stitch viral videos (https://www.tiktok.com/@babiesandlanguage/video/7109849177596742958) and explain what is intriguing about them from a language development lens (https://www.tiktok.com/@babiesandlanguage/video/7199710227841682730), using informative captions and humor to engage. "Stitches" and "duets" of viral videos are an easy entrée to TikTok that we would recommend; reacting to current tides of discussion is prominent in the app's culture. Undergraduates find this aspect of outreach the most rewarding (and are skilled at creating socially relevant TikToks!). They also find it educational to communicate why our research matters to the public.

Instagram hosts a large community of parent bloggers and is a similar outreach tool to TikTok (Caspari 2022), though with a slightly older audience, including more parents of youngsters. By cross-posting our TikToks to Instagram Reels we have found more consistent levels of engagement on Instagram.

We have unexpectedly found that people are more likely to engage in criticism of a video than in good-faith interest. Our "viral" video is one where a research assistant holds a pig plush and inadvertently refers to it as a cow (https://www.tiktok.com/@babiesandlanguage/video/6974019169691946246); we have received hundreds of comments pointing out the error but few about its broader content. The oppositional nature of the audience, and disparity in background knowledge, requires patience and a lot of disclaimers and contextualization to be built into your content to create any sort of nuanced understanding.

While numerical engagement metrics are a straightforward way to assess our "impact," quantity does not necessarily reflect our goals. We intentionally omit these metrics – first, they are very small and constantly changing (ranging from tens to hundreds of engagements, depending on the post and platform), and second, they do not feel like a meaningful way to understand our effectiveness. Twenty "omg so cute" comments do not give us the same teaching opportunity as one comment we received asking if hearing babies can learn American Sign Language from Deaf parents (we enthusiastically replied "yes!"). We want to reach people, but also feel all change is small change – we aim to continue our social media efforts without sacrificing informativity for virality.

3.3 Online missteps

Our largest challenge was keeping up with social media. Algorithms prioritize people who post regularly. While everyone in the lab (undergraduates to principal investigator) contributes to social media, without a full-time social media manager, continuous engagement is a challenge. This intersects with our commitment to accuracy and accessibility, leaving it hard to join a trend whose lifespan is days or hours.

We opened our Twitter account (now X) as a partner to our blog, but failed to meet our goals and generally would not recommend it for outreach. This is partially because of mismatches between Twitter audiences (leaning towards academic/technical crowds) and our target (caretakers, early education providers). It requires abundant time to follow appropriate accounts, interact and gain followers, and scroll for relevant content.

Finally, we were not well trained to make our multimodal content accessible, the irony of which does not escape us given our research topics. Simple changes, like adding alt-text to images, separating hashtags with mixed caps, and ensuring captions or voice-to-text rendered correctly have improved our posts and led us to consider accessibility more deeply.

4 What would improve our outreach and make it more tenable for others?

Plainly, scientists need more time to devote to outreach. Underlyingly, hypercompetitive funding prioritizes research products over outreach, paired with a lack of training in *effective* science communication. Earmarked time for thoughtful dissemination to the public would improve public scientific literacy (Helsel et al. 2022), the scope and quality of our findings, and public trust in science. We note that the US National Science Foundation pushes scientists in the right direction, requiring applicants to articulate broader impacts; we would love to see more funds allocated to this.

Our lab is lucky to have funding specifically for outreach, and the resources to support multiple research staff members who lead such initiatives, whose schedules permit them to go to schools at irregular hours and revise curriculum with short notice. Research staff still have administrative and research duties – which we starkly deprioritized during school programs. We would not be able to sustain a school program that lasted more than a few weeks at a time and continue making strides in research, since it requires full-on engagement. Social media is a flexible way to engage regularly and can be a regular undergraduate research assistant task. Science outreach is a continuing and important goal of our lab, but we also will be able to engage at varying levels depending on our size and funding.

Currently, outreach is an added “service” task that typically holds less weight in career advancement, and often falls to early career researchers and trainees – disproportionately, women and people of color (Andrews et al. 2005). Structural change is needed to extend outreach.

5 Conclusions

Despite its challenges, doing direct language science outreach is worthwhile. The social applications of our science are vital given people’s daily experiences of language as a broker for nearly every activity. We successfully broadened kids’ impressions of scientists, indicated by their Draw-a-Scientist scores. On the other hand, that is our only “hard numbers” assessment. Thoroughly assessing outreach efficacy is a challenge, but we still find it indisputably valuable. Outreach creates memorable connections for our community, from kindergartners yelling “the scientists are here!” when we walked into their school library; or a twelve-year-old shyly saying, on a rainy Saturday morning spent analyzing morphemes, “I think this is the kind of science I want to do.”

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