For undergraduate students, feeling an affinity with a science community is a key factor related to interest and persistence in science. Thus, how students perceive scientists can affect their sense of belonging. In this study, we interviewed biology majors and nonscience majors at two institutions, including students who were hearing and deaf, to understand their perceptions of scientists. We used a mixed-methods analytic approach, including coding to classify responses and box plots, to evaluate how endorsement of both positive and negative stereotypes and desire for science to afford altruistic, communal opportunities may differ between student populations. Groups studied include women and men students; biology majors and nonscience majors; hearing and deaf students; and introductory and advanced biology majors. Findings indicate that opportunities to see altruistic and communal qualities of science may be important for women, nonscience majors, and deaf students. Interestingly, the majority of students did not assign gender to an imagined scientist. Implications for challenging stereotypes about scientists and making altruistic and communal opportunities in science more visible are discussed.

INTRODUCTION

Scientists are often portrayed and perceived stereotypically in popular culture and amongst the general public, for example, as socially awkward single-minded nerds (1, 2). Unfortunately, these stereotypes can convey discouraging social messages about who can or cannot do science. As a result, stereotyped perceptions can prevent students from becoming interested in science careers (3, 4), thus acting as a barrier to recruitment into science majors. Furthermore, these stereotypes disproportionately affect students from groups underserved in science, including women, people of color, first-generation college students, and students of low socio-economic status. In these communities, altruistic, communal career goals are often valued as a way to give back. As a result of the scientist stereotypes, students from these groups do not perceive science as affording altruistic career goals (3, 5, 6).

Altruistic and communal career goals center around working with and helping people, which many people highly value in career choices, especially people who are underserved in science (3, 5, 6). Altruistic, communal career goals include seeking a career that affords opportunities to develop interpersonal connections and to directly or indirectly help other people or society (5, 6). Science can be a vehicle for altruism. Research by Carlone and Johnson (7) illuminated how women of color with altruistic science identities challenged science culture, redefining for themselves what it meant to be in science and whose recognition was important to them. However, the predominant stereotyped perceptions about scientists as nerds working in isolation can negatively influence students’ interest in science. These stereotyped perceptions may contribute to students’ science identity, and seeing oneself as a “science person” may therefore be impossible if one holds misperceptions about scientists (8).

Much research has focused on K–12 students’ perceptions of scientists ((9, 10) and references therein). Students form stereotypical perceptions of scientists—as people who are men, nerdy, socially awkward, and work alone—as early as kindergarten ((9) and references therein). Gendered stereotypes about scientists persist and increase as students grow older, perhaps because of more contact with men in science domains than with women (11). However, research about college students’ perceptions of scientists is more limited (1, 12–15), though there has been substantial recent work on students’ stereotypes about computer scientists (6, 16). Understanding college students’ perceptions of scientists may help minimize barriers to participation in science. This information can also help science educators shape curricular
opportunities to challenge stereotypical perceptions of scientists that impede students’ interest in science learning and careers.

The purpose of this study was to understand students’ perceptions of scientists. We interviewed biology majors and nonscience majors at two institutions, including introductory and advanced biology majors, as well as deaf and hearing students. While this was a qualitative research study that was not hypothesis-driven, prior research findings suggested that students who self-identified as a member of one or more underserved populations as defined by race/ethnicity, gender, or hearing status would be more likely to endorse altruistic, communal careers. Questions that motivated this study included: What characteristics do students ascribe to scientists? Are these characteristics stereotypical or not? What type of activities do students perceive as being involved in scientific work? How do students perceive scientists and science? How do these perceptions fit with students’ career goals?

METHODS

Study context and participants

Study participants were recruited from two universities: Gallaudet University (GU) and the University of Georgia (UGA) (16). GU primarily serves deaf and hard-of-hearing students. Participants were recruited from nonscience majors biology courses as well as majors introductory and advanced courses. Participants (N = 47) were recruited for interviews from fall 2014 through fall 2018 (Table 1). GU serves 1,578 undergraduates, with an average of 30

| TABLE 1. Study demographics for each institution. |
|--------------------------------------------------|
| Respondents                                      | Gallaudet University | University of Georgia |
| Total N                                          | 22                  | 25                  |
| % of total                                       | 46.8                | 53.2                |
| Gender                                           |                     |                     |
| Women                                            | 13                  | 10                  |
| % of total                                       | 59.1                | 40.0                |
| Men                                               | 9                   |                     |
| % of total                                       | 40.9                | 60.0                |
| Transgender                                       | 0                   |                     |
| % of total                                       | 0.0                 | 0.0                 |
| Prefer not to respond                            | 0                   |                     |
| % of total                                       | 0.0                 | 0.0                 |
| Race/Ethnicity                                   |                     |                     |
| African American                                 | 4                   | 1                   |
| % of total                                       | 18.2                | 4.0                 |
| Hispanic/Latinx                                  | 3                   | 2                   |
| % of total                                       | 13.6                | 8.0                 |
| Native American, Alaskan Native                  | 0                   | 0                   |
| % of total                                       | 0.0                 | 0.0                 |
| Native Hawaiian, Pacific Islander                | 1                   | 0                   |
| % of total                                       | 4.5                 | 0.0                 |
| Asian American                                   | 0                   | 6                   |
| % of total                                       | 0.0                 | 24.0                |
| White                                            | 12                  | 16                  |
| % of total                                       | 54.5                | 64.0                |
| Multiracial                                      | 0                   | 1                   |
| % of total                                       | 0.0                 | 4.0                 |
| International                                    | 0                   |                     |
| % of total                                       | 0.0                 | 0.0                 |
| Prefer not to respond                            | 1                   |                     |
| % of total                                       | 4.5                 | 0.0                 |
| Self-identification                              |                     |                     |
| Deaf                                             | 12                  | 0                   |
| % of total                                       | 54.5                | 0.0                 |
| Hard-of-hearing                                  | 6                   |                     |
| % of total                                       | 27.3                | 0.0                 |
| Hearing                                          | 3                   |                     |
| % of total                                       | 13.6                | 100.0               |
| Year in School                                   |                     |                     |
| Freshman                                         | 11                  | 7                   |
| % of total                                       | 50.0                | 28.0                |
| Sophomore                                        | 8                   | 8                   |
| % of total                                       | 36.4                | 32.0                |
| Junior                                           | 3                   | 2                   |
| % of total                                       | 13.6                | 8.0                 |
| Senior                                           | 0                   | 6                   |
| % of total                                       | 0.0                 | 24.0                |
| 5th or 6th year                                  | 0                   | 2                   |
| % of total                                       | 0.0                 | 8.0                 |
| Other                                            | 0                   | 0                   |
| % of total                                       | 0.0                 | 0.0                 |

*Demographic data for one of the spring 2018 interviews at GU are missing.*
Biology majors annually, and is classified as a doctoral university with very high research activity (17). In fall 2017, women comprised 60.5% of students, 52.9% of students were white, and 94.8% were U.S. citizens (19). Of GU undergraduates, 88.1% are deaf or hard of hearing (18).

UGA enrolls 38,652 students and is classified as a doctoral university with very high research activity (18). It serves 2,560 Biology majors as well as students in the Division of Biological Sciences, who major in fields such as Genetics, Microbiology, Biochemistry and Molecular Biology, Plant Biology, Cellular Biology, Marine Science, Entomology, and Ecology. In fall 2018, women comprised 57.2% of UGA students, 67.2% of students were white, and 92.8% of students were U.S. citizens (19).

Our total sample of participants included 53.2% students from UGA: 49% women, 59.6% white, 10.6% African American, 10.6% Hispanic/Latinx, 2.1% Native Hawaiian/Pacific Islander, and 2.1% who identified as multiracial (the percentages for each university are shown in Table 1). Our sample included 36.2% Biology majors and 63.8% nonscience majors.

Among the Biology majors, 8.5% were first-year, 10.6% were second-year, and 17% were advanced. Our samples from each university closely resembled the demographics of the larger university populations for both GU and UGA (18, 19).

**Interviews**

The interview protocol was developed based on literature about science identity and stereotypes about scientists (20). The interview protocol was piloted with three deaf students. Students were asked to explain their understanding of the questions, their responses, and identify sources of confusion. Questions were refined after each pilot interview.

Interviews sought to understand students’ conceptions of who scientists are. Participants organically offered characteristics of scientists. All interviews were conducted in American Sign Language (ASL) or spoken English and recorded. All information was deidentified.

Interviews conducted in ASL were translated to English using ELAN (tl.de.mpi.nl/tools/tda-tools/elan/). The translations were calibrated through a series of meetings between the two people (C.G. and a research assistant) translating the videos. Translated scripts were imported into Excel for analysis. Names used in the manuscript are pseudonyms. Research participants were asked whether they wanted to be identified by a particular pseudonym, and if so, that name was used; if participants had no preferences, the researchers selected a pseudonym by using a baby name website which suggested similar yet different names.

**Data analysis**

We used mixed-methods analysis. The research questions were used to frame the iterative coding process. We began by using descriptive coding, as well as in vivo coding to capture participants’ voices (4, 21, 22) (Fig. 1). The coding process was iterative, with a first read to identify coding categories and subsequent iterations to hone the classifications. We added categories as they emerged from the data. The authors coded the interview data individually and then aligned their codes through discussion. They identified classifications that converged and diverged and defined meanings.
of codes. The authors discussed until agreement was reached. Patterns in the data emerged through this process. Statements were classified as stereotypical conceptions of scientists based on categories described in the Draw-a-Scientist test (9, 23) (Table 2).

The categories were coded into positive and negative stereotypes (Table 3). Each student was given a score of 1 for each specific stereotype endorsed. Then, each student’s responses were summed for all positive or neutral stereotypes (maximum score = 12) and all negative stereotypes (maximum score = 5), yielding two scores. Additionally, interviews were coded for whether students endorsed a preference for altruistic, communal career opportunities but did not perceive these opportunities to be afforded in science (24) or did not endorse a preference for altruistic, communal career opportunities (0) (maximum score = 3). Scoring was based on counting the number of codes (3) in the interview data related to altruism. Then, we calculated percentages of stereotype endorsements and altruistic scores for each population.

We used box plots to evaluate whether the number of positive and negative stereotypical characteristics assigned to scientists, as well as altruistic score, differed between majors and nonscience majors; majors in introductory classes and advanced classes; deaf and hearing students; and men and women students (25).

Efforts to ensure study validity

Numerous efforts were made to ensure study validity. From fall 2014 to spring 2016, interviews with Gallaudet students were conducted by one author (C.G.) with a research assistant who is deaf and a fluent signer. Conducting interviews allowed us to capitalize on follow-up research (majors: 47.1%; nonscience majors: 41.4%) and stereotypical conceptions of scientists as people who conduct experiments (61.7%). Both majors (76.5%) and nonscience majors (53.3%) ascribed this characteristic to scientists. More men students (68.2%) endorsed this characteristic than women students (56%). Hearing students (92.3%) more frequently endorsed this characteristic than deaf students (25%).

Overall, both majors and nonscience majors held stereotypical views of scientists (majors: 47.1%; nonscience majors: 24.1%) (Table 2). Nonscience majors were more likely to characterize scientists as really smart people (majors: 11.8%; nonscience majors: 24.1%) who wear lab coats (majors: 23.5%; nonscience majors: 50%). Majors were more likely to characterize scientists as doing work that included writing (majors: 41.2%; nonscience majors: 17.2%) and carrying out experiments (majors: 76.5%; nonscience majors: 55.2%) in order to learn new things (majors: 35.3%; nonscience majors: 17.2%).

Only 8.5% (n = 4) students identified themselves as having perspective shifts in thinking about who scientists are and what scientists’ everyday work looks like. All four students were nonscience majors. Students often offered both nuanced descriptions of research (majors: 58.2%; nonscience majors: 41.4%) and stereotypical conceptions of research (majors: 47.1%; nonscience majors: 24.1%).

We used box plots to evaluate differences in endorsements of positive and negative stereotypes, as well as preference for altruistic, communal career opportunities which were not perceived to be afforded in science (altruistic score), among student populations, including women and men students, Biology majors and nonscience majors, students in introductory Biology classes and students in advanced Biology classes, and deaf and hearing students. Because of the lack of diversity in race and ethnicity in our sample, we are unable to draw conclusions about group differences by race or ethnicity. As a hypothesis-generating study, future studies with larger sample sizes are needed to make conclusions about differences among student populations.

IRB approval

IRB approval for Project #2520 was obtained from GU after expedited review, including approval for work at UGA. All participants signed informed consent forms.

RESULTS

Students’ perspectives about scientists

We identified 17 characteristics of scientists and activities involved in doing science from interviews (Table 2). These descriptors included activities, personal characteristics, and characterizations of scientific work. Five of the 17 characteristics were classified as negative stereotypes, while 12 were classified as positive or neutral.

An overwhelming majority of students either did not assign a gender to their descriptions of a scientist or described scientists as both men and women (majors: 94.1%, nonscience majors: 96.6%; 95.4% of men students, 92% of women students; 100% of deaf students; 92.3% of hearing students). The absence of a gender specifier was the most frequently endorsed characteristic throughout the total sample (93.6%) (Table 2).

Students also frequently identified scientists as people who conduct experiments (61.7%). Both majors (76.5%) and nonscience majors (53.3%) ascribed this characteristic to scientists. More men students (68.2%) endorsed this characteristic than women students (56%). Hearing students (92.3%) more frequently endorsed this characteristic than deaf students (25%).

Overall, both majors and nonscience majors held stereotypical views of scientists (majors: 47.1%; nonscience majors: 24.1%) (Table 2). Nonscience majors were more likely to characterize scientists as really smart people (majors: 11.8%; nonscience majors: 24.1%) who wear lab coats (majors: 23.5%; nonscience majors: 50%). Majors were more likely to characterize scientists as doing work that included writing (majors: 41.2%; nonscience majors: 17.2%) and carrying out experiments (majors: 76.5%; nonscience majors: 55.2%) in order to learn new things (majors: 35.3%; nonscience majors: 17.2%).

Only 8.5% (n = 4) students identified themselves as having perspective shifts in thinking about who scientists are and what scientists’ everyday work looks like. All four students were nonscience majors. Students often offered both nuanced descriptions of research (majors: 58.2%; nonscience majors: 41.4%) and stereotypical conceptions of research (majors: 47.1%; nonscience majors: 24.1%).

We used box plots to evaluate differences in endorsements of positive and negative stereotypes, as well as preference for altruistic, communal career opportunities which were not perceived to be afforded in science (altruistic score), among student populations, including women and men students, Biology majors and nonscience majors, students in introductory Biology classes and students in advanced Biology classes, and deaf and hearing students. Because of the lack of diversity in race and ethnicity in our sample, we are unable to draw conclusions about group differences by race or ethnicity. As a hypothesis-generating study, future studies with larger sample sizes are needed to make conclusions about differences among student populations.
TABLE 2.
Student-volunteered characteristics of a scientist.

| Student-Identified Characteristic | All Students Endorsing Characteristic % (n) | Nonscience Majors Endorsing Characteristic % (n) | Majors Endorsing Characteristic % (n) | Example student quote |
|-----------------------------------|--------------------------------------------|-----------------------------------------------|----------------------------------|-----------------------|
| No gender specified               | 93.6% (44)                                 | 96.6% (28)                                    | 94.1% (16)                       | “There are different types of scientists; they could be girls or guys.” |
| Scientists do experiments         | 61.7% (29)                                 | 53.3% (16)                                    | 76.5% (13)                       | “A person in a lab coat, with glasses, a microscope, always researching about what happens, if a hypothesis is supported or not. They develop hypotheses and then experiments. For days, months, years, whatever. It’s not long work. . .but more like challenging work. They need to be patient, you can’t expect fast results.” |
| Comment describing nuanced view of research | 46.8% (22)                                 | 40.0% (12)                                    | 58.8% (10)                       | “I think it’s a lot of questioning. Questioning your experiment, questioning yourself. A lot of questions. I feel like it’s just full of questions. The real question for them is going to be what question is the one they want to answer most.” |
| Scientists wear white lab coats   | 44.7% (21)                                 | 71.4% (15)                                    | 19.0% (4)                        | “The standard white lab coat, a know-it-all, knows how to use equipment, experimental tools.” |
| Comment about stereotypical research | 31.9% (15)                                 | 23.3% (7)                                     | 47.1% (21)                       | “I think of a chemist and a chem lab, mixing chemicals.” |
| Doing science involves writing    | 26.1% (12)                                 | 16.7% (5)                                     | 41.2% (7)                        | “They write papers; they might work outside the lab; normally they’d do experiments, but mostly write papers.” |
| Scientists learn new things       | 23.4% (11)                                 | 16.7% (5)                                     | 35.3% (6)                        | “I basically think about someone who really likes to learn things and in order to get to an answer they ask a lot of questions.” |
| Scientists know everything/are really smart (inborn trait) | 19.1% (21)                                 | 23.3% (7)                                     | 11.8% (2)                        | “I think like a person that’s smart. Seriously smart. Knows a lot. Knows how. . .knows a lot about the world or humans or animals or flowers. He just knows a lot, does a lot. I think you have to be smart to become a scientist.” |
| Participant acknowledges stereotypes | 17.0% (21)                                 | 23.3% (7)                                     | 5.9% (21)                        | “I first thought a man with a white (lab coat). Everyone must have a white coat, goggles, gloves, but now I realize it’s just normal clothes. That’s what I’ve seen in TV shows. At first I thought it was really strict, you must have this, this, this. But then I realized they’re just normal people. . .so it could be any person.” |
| Scientists use tools (microscopes, etc.) | 17.0% (21)                                 | 20.0% (6)                                     | 11.8% (2)                        | “The standard white lab coat, a know-it-all, knows how to use equipment, experimental tools. I struggled with using the microscope, I couldn’t use it. Ugh, it was such a struggle, my eyes hurt, trying to adjust it, finally I gave up. I just couldn’t scoop the worms up under the microscope. I couldn’t. I kept missing it. That happened last week. A scientist would adjust a microscope effortlessly. I’m new at it and awkward.” |

Continued on next page
A greater range of women students than men students expressed preferences for altruistic, communal career opportunities while not perceiving these to be afforded in science (Fig. 2). Likewise, a greater range of both deaf students (Fig. 2) and nonscience majors (Fig. 2) than hearing students and majors, respectively, expressed interest in altruistic, communal career opportunities while not perceiving these to be afforded in science. Interestingly, neither introductory nor advanced biology majors expressed interest in altruistic communal qualities of science (Fig. 2). We hypothesize that either both groups are already exposed to and familiar with altruistic communal qualities of science, or that these goals are less salient for majors than nonscience majors. Future studies may test these hypotheses to determine the importance of perceiving science as altruistic to students who are nonmajors.

Men and women students shared relatively similar endorsements of positive and negative stereotypes about scientists (Fig. 3). Nonscience majors and majors were similar in terms of endorsements of positive stereotypes (Fig. 3). However, the range of endorsement of negative stereotypes was slightly larger for majors than for nonscience majors (Fig. 4). It is possible that nonscience majors had a more uniform view of scientists than majors. Our study included fewer majors (36.2%) than nonscience majors (63.8%), which might also contribute to the wider spread. Advanced Biology majors tended to endorse positive stereotypes slightly more often (Fig. 3) and also endorsed a slightly larger range of negative stereotypes than introductory Biology students (Fig. 4). Finally, students who were hearing tended to endorse more positive stereotypes about scientists than students who were deaf (Fig. 3). Furthermore, students who were hearing endorsed a larger range of negative stereotypes and tended to endorse slightly more negative stereotypes about scientists than students who were deaf (Fig. 4). Future studies may test hypotheses regarding the importance of stereotypes about scientists among student populations.

### Study limitations

Our study has a few limitations. First, our survey was developed in 2014. Since then, language for demographic categories has changed, specifically, the term Latinx is now preferred to Latino/a, as it is gender neutral. Further, our survey confounds geographic and language heritages as we combine Hispanic/Latino as one category. Likewise, while our study afforded participants the opportunity to self-identify their gender (following a more contemporary and expansive definition...
study participants self-identified as only men or women. Thus, our study methods and results describe only results from self-identified men and women students.

Our study is also limited by its small sample size. Larger samples sizes may be useful in future studies. Recruitment and sampling are a challenge at GU given the small deaf community. To incentivize participation, participants were compensated $20 during fall 2015 and spring 2016.

The challenge of conducting a bilingual study is another study limitation. In some interviews at GU, participants switched between ASL and spoken English. To minimize mistranslation from ASL to English, translations were conducted by two individuals, including one who was deaf and fluent in ASL.

Future studies should attempt to track individual students longitudinally. Our study is limited in that we studied different years of cohorts in time. Study logistics and resources prevented us from studying the same individuals through time.

There are other measures of stereotypes of scientists, including the Draw-A-Scientist test (27), the Image of Science and Scientists scale (ISSS) (28), and the Stereotypes of Scientists (SOS) scale (12). Our study relies on interview data. Future studies might consider using multiple instruments in addition to interviews to build study validity. For

| Positive or Neutral Stereotypes | Negative Stereotypes |
|--------------------------------|----------------------|
| Acknowledges Stereotypes       | White Lab Coat       |
| Nuanced Research               | Goggles              |
| No Gender Specification        | Isolated in the Lab  |
| Perspective Shift about Scientists | Stereotypical Research |
| Does Experiments               | Knows Everything/Inborn Intelligence |
| Learns New Things              |                      |
| Writing                        |                      |
| Helping Society                |                      |
| Scientists are Normal People   |                      |
| Research is Challenging        |                      |
| Research Requires Patience     |                      |
| Uses Tools (Microscopes, etc.) |                      |

FIGURE 2. Students’ desire to see altruistic, communal opportunities afforded by science. Results are shown by student population: women, men, hearing, deaf/hard of hearing (HH), nonmajor, major, introductory major, advanced major.
individuals studying the deaf community, it would be important to translate these instruments from English to ASL, to ensure access.

**DISCUSSION**

Our study offers new insights about college students’ perceptions of scientists. Our work shows that stereotypical perceptions of scientists continue among college students, with differences between nonmajors and majors.

Most importantly, this work revealed that a greater number of students who identified as either women, deaf, or non-science majors (as opposed to men, hearing, or science majors) tended to express interest in altruistic, communal career opportunities while not perceiving these to be afforded in science. Prior research illustrates that altruistic, communal opportunities are important to many students (3, 5–8), and in fact, persistence in science is supported by embodying an altruistic science identity that redefines what it means to be in science (7). Consequently, altruistic, communal career goals are salient for many students, and this...
work suggests that we are failing to make these opportunities visible to students. As a result, these stereotyped perceptions of science may serve as barriers to recruiting students to science. Our findings suggest that future studies should investigate the importance of altruistic career goals and stereotyped perceptions for gender, major, and hearing status amongst college students.

Our results offer some encouragement that students’ stereotypes about biology may be changing—in terms of students’ stereotypes about gender representation of biologists. Interestingly and importantly, when asked to describe a scientist, the overwhelming majority of students (93.6%) did not assign a gender to their imagined scientist. This is a positive change from Rosenthal’s work (15), which compared drawings of scientists from liberal arts majors and Biology majors. More than 20 years ago, liberal arts majors’ drawings of scientists included 41% more images of men as well as other stereotypical characteristics than did those of Biology majors. At that time, Biology majors’ drawings were more likely to include scientists of indeterminate gender (15). Among college students, these stereotypes were beginning to shift a decade ago (12). Women’s participation in biology has steadily increased, which may influence students’ perceptions of scientists, as they interact with increasing numbers of women scientists (29). Likewise, children’s drawings of scientists have diversified over time, though children still associate science with men as they grow older (11).

However, students in our study did hold other stereotypical perceptions about scientists. Interestingly, the most commonly held stereotype was the idea that scientists conduct experiments. This is not a negative stereotype, but it is limiting, as scientists do more than conduct experiments—and in fact, not all scientists conduct experiments. This particular stereotype might result in students failing to ascribe a scientist identity to themselves, as this stereotype limits the potential definition of who a scientist is and can be (30). Science educators may challenge this stereotype by creating opportunities for students to learn about the many ways that scientists work, involving students in a range of types of research that scientists conduct, including observational studies and cross-sectional research.

Both majors and non-science majors volunteered stereotypical perceptions of scientists. We learned that non-science majors and majors focused on different aspects of what it means to be a scientist: non-science majors focused on scientists’ personal attributes, looks, and personality, often echoing common stereotyped perceptions that are perpetuated through popular media (9, 16), while majors focused on scientists’ everyday work. We wondered whether holding stereotypes about scientists’ personal attributes, without concurrent opportunities to challenge these stereotypes through participation in doing science themselves, might influence students’ own science identities. For example, might students believe that they had to be inherently brainy and smart, as opposed to determined and hard-working, in order to be a successful scientist? Likewise, other recent studies report that students continue to endorse stereotypical perceptions, even if these stereotypes could be classified as “positive.” For example, that scientists are “curious,” “intelligent,” “interested in work” (1, 12, 13). Similarly, Dikmenli (14) reported that non-science majors tend to focus on scientists’ personal characteristics, such as social abilities and personalities. However, other recent work reported students’ stereotypes were focused more on professional competencies and the work of doing science (1). Taken with other recent work, our study suggests that stereotypical perceptions about scientists persist amongst college students. Future research may explore whether these differences between non-science majors’ and majors’ stereotyped perceptions are related to students’ engagement and familiarity with science. Future research might also explore whether opportunities for students to do science themselves challenge students’ perceptions of scientists, by examining students’ perceptions of scientists before and after participating in science.

Our findings also indicate an urgent need for better messaging about the altruistic and communal opportunities afforded in science careers. We are failing to make these opportunities visible to students. Like others’ work, our data suggest that women tend to value altruistic, communal opportunities. Our recent work also supports that students in the deaf community tend to more highly value careers which are altruistic and communal and afford opportunities to give back to the deaf community (4). These current findings suggest that this is also the case for non-science majors. In fact, this may be an important factor to further explore to understand how to better engage non-science majors in science learning. As educators, we can do more to make these opportunities manifest, in order to remove this barrier to recruitment of science majors. For example, we need to make curricular learning relevant to students’ everyday life, to show how science addresses common issues we face as a society. Science educators can share ways in which scientists’ work benefits communities, to directly connect classroom learning with outcomes in real life. We may look to examples in computer science, engineering, and other STEM fields (31–33).

Our work has implications for science teaching and learning. Interventions to challenge students’ perceptions about scientists are needed. Scientist Spotlight is one current intervention available. This out-of-class assignment effectively challenges students’ stereotypical perceptions of scientists and increases their ability to personally relate to scientists. In this assignment, students review a resource related to a counter-stereotypical scientist’s research, as well as a resource about the scientist’s personal history (34).

Additionally, recent work using scientists’ selfies to challenge public stereotypes of scientists may be applicable to the classroom (35). In this study, participants perceived Instagram posts of scientists’ selfies as significantly warmer...
and more trustworthy and no less competent than scientists posting photos only of their work, which could mitigate negative attitudes toward scientists (34). This type of activity could be incorporated as a course activity. Moreover, such an activity may enhance the visibility of science as affording altruistic, communal opportunities. Our research suggests that students need to “meet” real-life current working scientists to challenge their perceptions about who scientists are—especially for nonscience majors, who tended to view scientists with stereotyped perceptions about personality and looks—to be exposed to a diverse range of scientists, emphasizing scientists as humans with full, multidimensional lives.

We hope our work motivates other work on students’ stereotypes of scientists and perceptions of science as altruistic at the college level. Future work may include a greater sample size and focus on testing hypotheses generated through this qualitative study. Additionally, future work might include longitudinal exploration of students’ evolving perceptions of scientists and the work they do, particularly in relation to their own interest in learning science and science identity. Future research might also investigate when students’ perceptions of scientists change, as well as which course and research experiences spur these changes. As mentioned above, future research may also explore whether differences in nonscience majors’ and majors’ stereotyped perceptions are related to their engagement and familiarity with science. Additionally, future research could investigate whether opportunities for students to do science themselves challenge students’ perceptions of scientists, by examining students’ perceptions of scientists before and after.

ACKNOWLEDGMENTS

The authors thank Megan Majocha and Amber Marchut for their assistance in conducting interviews and doing translations. The authors thank Kristen Miller for support with research logistics at the University of Georgia. We also thank Gallaudet University Research Support and International Affairs for funding support of this research study. Finally, we thank our research participants for their willingness to contribute to this project.

REFERENCES

1. Schinske J, Cardenas M, Kaliangara J. 2015. Uncovering scientist stereotypes and their relationships with student race and student success in a diverse community college setting. CBE Life Sci Educ 14:1–16.
2. Losh SC. 2009. Stereotypes about scientists over time among U.S. adults: 1983 and 2001. Public Underst Sci. https://doi.org/10.1177/0963662508098576.
3. Brown ER, Thoman DB, Smith JL, Diekman AB. 2015. Closing the communal gap: the importance of communal affordances in science career motivation. J Appl Soc Psychol 45(12):662–673. https://doi.org/10.1111/jasp.12327.
4. Gormally C, Marchut A. 2017. Science isn’t my thing: Exploring non-science majors’ science identities. J Sci Educ Stud Disabil 20(1): ar1. https://doi.org/10.14448/jsesd.08.0001.
5. Allen JM, Smith JL, Muragishi GA, Thoman DB, Brown ER. 2015. To grab and to hold: cultivating communal goals to overcome cultural and structural barriers in first-generation college students’ science interest. Translat Iss Psychol Sci 1(4):331–341. https://doi.org/10.1037/tpsi0000046.
6. Diekman AB, Brown ER, Johnston AM, Clark EK. 2010. Seeking congruity between goals and roles: a new look at why women opt out of science, technology, engineering, and mathematics career. Psychol Sci 21(8):1051–1057. https://doi.org/10.1177/0956797610377342.
7. Carlone H, Johnson A. 2007. Understanding the science experiences of successful women of color: science identity as an analytic lens. J Res Sci Teach 44:1187–1218. https://doi.org/10.1002/tea.20237.
8. Hazari Z, Sadler PM, Sonnert G. 2013. The science identity of college students: exploring the intersection of gender, race, and ethnicity. J Coll Sci Teach 42(5):82–91.
9. Finson KD. 2010. Drawing a scientist: what do we do and do not know after fifty years of drawings. Sch Sci Math 102(7):335–345. https://doi.org/10.1111/j.1949-8594.2002.tb18217.x.
10. Ozel M. 2012. Children’s images of scientists: does grade level make a difference? Educ Sci Theory Prac Autumn:3187–3198.
11. Miller DL, Nola KM, Egley AH. 2018. The development of children’s gender-science stereotypes: a meta-analysis of 5 decades of U.S. draw-a-scientist studies. Child Dev 89(6):1943–1955. https://doi.org/10.1111/cdev.13039.
12. Weyer M, Scheider J, Nassar-McMillan S, Oliver-Hoyo M. 2010. Capturing stereotypes: developing a scale to explore U.S. college students’ images of science and scientists. Int J Gender Sci Technol 2(3). http://genderandset.open.ac.uk/index.php/genderandset/article/viewArticle/78.
13. Andersen HMKL, Lykkegaard E. 2014. Identity matching to scientists: differences that make a difference. Res Sci Educ 44:439–460. https://doi.org/10.1007/s11165-013-9391-9.
14. Dikmenli M. 2010. Undergraduate biology students’ representations of science and the scientist. Coll Stud J 44(2):579–588.
15. Rosenthal DB. 1993. Images of scientists: a comparison of biology and liberal arts studies major. Sch Sci Math 93(4):212–216. https://doi.org/10.1111/j.1949-8594.1993.tb12227.x.
16. Cheryan S, Piatu VC, Handron C, Hudson L. 2013. The stereotypical computer scientist: gendered media representations as a barrier to inclusion for women. Sex Roles 69:58–71. https://doi.org/10.1007/s11199-013-0296-x.
17. Carnegie Foundation. The Carnegie classification of institutions of higher education. 2010. Available from http://classifications.carnegiefoundation.org.
18. Gallaudet University. 2018. Annual Report of Achievements.
19. University of Georgia. 2018. Fact Book 2018.
20. Varelas M. 2012. Identity research as a tool for developing a feeling for the learner, p 1–6. In M Varelas (ed), Identity construction and science education research. Sense Publishers, Amsterdam.
21. Corbin J, Strauss A. 2008. Basics of qualitative research: techniques and procedures for developing grounded theory. Sage Publications, Inc., Thousand Oaks, CA.
22. Saldaña J. 2013. The coding manual for qualitative researchers. Sage Publications, Inc., Thousand Oaks, CA.
23. Farland-Smith D. 2012. Development and field test of the modified draw-a-scientist test and the draw-a-scientist rubric. Sch Sci Math 112(2):109–116. https://doi.org/10.1111/j.1949-8594.2011.00124.x.
24. Feldman KA. 1988. Effective college teaching from the students' and faculty's view: matched or mismatched priorities? Res High Educ 28(4):291–344. https://doi.org/10.1007/BF01006402.
25. Nuzzo RL. 2016. The box plots alternative for visualizing quantitative data. Phys Med Rehab 8(3):268–272. https://doi.org/10.1016/j.pmrj.2016.02.001.
26. Patton MQ. 2002. Qualitative research and evaluation methods. Sage Publications, Inc., Thousand Oaks, CA.
27. Chambers DW. 1983. Stereotypic images of the scientist: the Draw-A-Scientist Test. Sci Educ 67:255–265. https://doi.org/10.1002/sce.3730670213.
28. Krajkovich JG, Smith JK. 1982. The development of the image of science and scientists scale. J Res Sci Teach 19(1):39–44. https://doi.org/10.1002/tea.3660190106.
29. NSF National Center for Science and Engineering Statistics. 2019. Women, minorities, and persons with disabilities in science and engineering. National Science Foundation, Arlington, VA.
30. Siy JO, Cheryan S. 2016. Prejudice masquerading as praise: the negative echo of positive stereotypes. Person Soc Psychol Bull 42(7):941–954. https://doi.org/10.1177/0146167216649605.
31. Belanger AL, Diekman AB, Steinberg M. 2017. Leveraging communal experiences in the curriculum: increasing interest in pursuing engineering by changing stereotypic expectations. J Appl Soc Psychol 47(6):305–319. https://doi.org/10.1111/jasp.12438.
32. Steinberg M, Diekman AB. 2018. Considering “why” to engage in STEM activities elevates communal content of STEM affordances. J Exp Soc Psychol 75:107–114. https://doi.org/10.1016/j.jesp.2017.10.010.
33. Cheryan S, Master A, Meltzoff AN. 2015. Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. Front Psychol 6:1–8.
34. Schinske J. 2016. Scientist spotlight homework assignments shift students' stereotypes of scientists and enhance science identity in a diverse introductory science class. CBE Life Sci Educ 15(3):ar47. https://doi.org/10.1187/cbe.16-01-0002.
35. Jarreau P, Cancellare I, Carmichael B, Porter L, Daniel T, Yasmine S. 2019. Using selfies to challenge public stereotypes of scientists. PLOS One 14(5):e0216625. https://doi.org/10.1371/journal.pone.0216625.