MINORITIZED SCIENTISTS IN THE UNITED STATES:
AN IDENTITY PERSPECTIVE TO SCIENCE COMMUNICATION

ABSTRACT

This study investigates how tenure-track faculty from historically marginalized groups in the environmental sciences approach science communication based on their self-identities. A thematic analysis of 28 in-depth interviews with US-based participants using the Communication Theory of Identity and Border-Crossing Theory was conducted to explore the interrelation of layers of identity, identity gaps participants experience, and their communication practices. The results show that communication merges fragments of identity not to form a fixed identity, but to create an evolving consciousness about who you are and how you communicate. Implications for science communication training are discussed.

Keywords: Communication Theory of Identity; Identity Gaps, Science Communication, Minoritized Groups, Diversity, Equity, Inclusion

Members of historically minoritized and marginalized groups can experience multiple forms of oppression (Crenshaw, 1989). In the United States, Black, Indigenous, and People of Color (BIPOC) have and are particularly targeted. Racist policies have led to inequities in education, income, health, etc. These inequities can also manifest into limited racial and ethnic diversity in science, technology, engineering, and mathematics (STEM) (Berhe et al., 2021; National Science Indicators, 2022).

The lack of diversity in STEM results in a limited scope of scientific research that often ignores issues of importance to minoritized groups (Chen et. al, 2022). It also results in public communication of science and related scientific discourse that excludes minoritized voices, hence affecting people's perceptions of scientists (Long et al., 2001; Martin et al., 2021). This in turn creates a vicious cycle, one in which historically minoritized groups do not see themselves represented in science and as a result are less likely to follow a career in STEM (Martin et al., 2021). In the UK, marginalized people have been systematically excluded from science communication based on ethnicity, class, and cultural imperialism (Dawson, 2018), which parallels similar dynamics in the United States.

Science communication scholarship has yet to vigorously explore empirically the experiences of marginalized identities in science, despite wide agreement of its need (Callwood et al., 2022). Dawson et al. (2022) criticize the dominant paradigm of science communication research that largely ignores the experiences of marginalized people, as well as alternative forms of science communication. The present study responds to their call. Theoretically, the study of science communication involving minoritized scientists requires the inclusion of concepts and theories that account for the role of identity and culture. As personal and collective experiences become part of one's identities, they can affect individuals' interpersonal communication (Hartley, 1999). This applies to scientists and the ways they approach science communication practices (e.g., goals, strategies, tactics, etc.) (Medin & Bang, 2014). This study presents a step forward by examining how minoritized scientists' identities relate to their science communication practices.

The role of identity in communication has been explored from several theoretical perspectives, both at the individual and group levels (e.g., Gallois, Ogay, & Giles, 2005; Giles, 2016; Ting-Toomey, 2015, 2017). This study is based on two theoretical frameworks: the Communication Theory of Identity (Hecht et.al., 2001) and Border-Crossing Theory (Anzaldúa, 1987). It also investigates the experience of inhabiting a territory between two worlds (in cultural and scientific contexts) — the interrelation of personal, enacted, communal, and relational layers of the identity of scientists from minoritized groups in the United States, and how this relates to their communication practices.

A thematic analysis of 28 in-depth interviews with US-based tenure-track professors was conducted to explore what identity gaps participants experience when communicating about science and within academic settings. Identifying gaps provides an additional layer of theoretical understanding to understand scientists' motivations to communicate and engage with diverse audiences (Besley et al., 2018). The present study describes a thematic analysis of the content of the interviews that identified relationships between the way scientists from historically minoritized groups see themselves, the way they think others see them, and how these gaps can affect their communication practices. Implications for science communication practice and training, and for future research related to identity and minoritized populations are discussed.

LITERATURE REVIEW

Recent research in science communication has examined individual and contextual factors related to scientists' willingness to engage in science communication (Besley et al., 2018a), their selection of goals, objectives, and tactics (Besley et al., 2018b; Joubert et al., 2019), and existing training efforts (Yuan et al., 2017). Scholarship has also examined the question of who should communicate, with an emphasis on credibility and trustworthiness (Lewis & Wai, 2021). Some scholars have highlighted the problems with the dominant paradigm of science communication, including the limited focus on diversity, equity, and inclusion — an area of research that has slowly emerged in the last few years (Judd & McKinnon, 2021). Among those issues, science communication is dominated by the use of English, the lingua franca of science (Márquez & Porras, 2020).

The lack of equity in science communication is a direct result of STEM cultural norms that are shaped by the dominant US cultural norms: Eurocentric, White, masculine, heteronormative, able-bodied, affluent, and neurotypical (Bennett et al., 2022; Callwood et al., 2022). Current STEM cultural norms directly impact science communication training spaces, as the main and dominant voices in this field are predominantly White educated men (Puritty et al., 2017, Valdez-Ward et al., 2023). The dominance of this demographic group of science communicators can affect communication efforts of marginalized individuals. Further, it influences what counts as science communication, who feels included, and who can participate (Canfield & Menezes, 2020).

In addition, Callwood et al., (2022) argue that science communication trainers have a fundamental role in changing the STEM culture that systematically privileges Whiteness — a white supremacy culture. These authors proposed a culturally responsive practice in science communication training. To achieve this objective, it is necessary to reflect about how the White racial identity shapes perspectives, experiences, and responses of marginalized people, including access to science communication trainings (Bennett et al., 2022). By recognizing that identity affects communication practices not only for people from minoritized groups, but also for people from all backgrounds, it is possible to develop science communication approaches and training that does not center on White identity.

To foster inclusive science communication, this “must be conceptualized as a process of cultural exchange, rather than as a process of translation” (Bevan et al., 2020, p.1). Science communication also should incorporate a focus on communities, in contrast to the dominant paradigm that emphasizes individuals and broader society (Orthia et al., 2021). To achieve an inclusive science communication, Orthia and colleagues proposed a series of principles that include the creation of long-term partnerships and acknowledging differences among community members, among others, but most importantly to the present study, “having science communicators who come from within communities, or share an identity with prospective community partners” (2021, p.11).

Science communication can create a sense of belonging and can influence who benefits from STEM research (Archer et al., 2015; Menezes et al., 2022). However, current approaches of STEM spaces perpetuate inequalities (Callwood et al., 2022; Judd & McKinnon 2022). Scientists from racial and ethnic minority groups are often overlooked and undervalued in science communication efforts (Feinstein & Meshoulam, 2014), and there is a lack of inclusive training spaces (Canfield et al., 2020; Valdez-Ward et al., 2023). This study explores how identity gaps might influence communication goals, styles, and strategies used by minoritized scientists in their science communication and public engagement activities. Our findings could inform the development of science communication training that acknowledges, considers, and incorporates the unique perspectives of scientists of historically minoritized groups (Canfield et al., 2020, Valdez-Ward et al., 2023).

The role of identity

Social science frequently conceptualizes identity as "social roles, helping to explain how social positionality influences one's sense of self (Schlenker, 1985; Stryker & Burke, 2000)" (Jung & Hetch, 2004; p.265). Hecht and Choi (2012) describe identity as a discursive process and list the common axiomatic propositions of the Communication Theory of Identity. These axiomatic propositions are the starting point for further arguments the theory brings about how identities are constituted. They affirm that identities are not fixed, being both enduring and changing.

Hetch and Choi (2012) proposed ten axioms that define identity as both enduring and changing; as affective, cognitive, behavioral, and spiritual; as involving subjective and ascribed meaning, among others. Identities also have "individual, social and communal properties" (Hecht & Choi, 2012, p. 139). The present study is guided by these axiomatic propositions but pays particular attention to two of them because they provide an operational framework for analyzing and extracting meanings from the codes, core symbols, and labels the participants mentioned: a) identities are "codes that are expressed in conversations and define membership in communities," and b) "identities have semantic properties that are expressed in core symbols, meanings, and labels" (Hector & Choi, 2012, p. 139). These propositions are about how words and phrases generate meanings in the form of norms and values. Identity labels are "particular words that are used to identify a person as an example of a kind of person" (Carbaugh, 1996, p. 33).

Identity has been explored in science communication research from the perspective of gender (Robertson & Orthia, 2021). Scholars have also examined science communication as culture (Davies & Horst, 2016) and as a function of collective identities, and as meaning making (Davies et al., 2019). Davies et al., (2019, p.3) argue that "understanding science communication as meaning-making, therefore, draws our attention to its functions at the level of shared identities and imaginations, alongside its undoubted role in disseminating particular scientific notions."

Stewart (2022) and Stewart and colleagues (2023) applied the Communication Theory of Identity as a framework for understanding STEM identities among undergraduate students. Because of the lack of representation in STEM fields, people from historically minoritized groups can "face barriers to developing STEM identities based on race, ethnicity, and gender (Stewart, 2022, p. 149)." It means that people from historically minoritized groups may choose a different field of work, especially because they don't see themselves as the stereotype of who can or should be a scientist. The present study builds on this line of work with a focus on junior tenure-stream faculty.

Although social identity has been examined as a strong factor in understanding people's engagement with science, perceptions of scientists, or trust in science, such conceptualizations of identity have been largely limited to organizational culture, political ideology, or broadly constrained to racial and ethnic categories such as White, Black, Asian, or Hispanic.

Communication outcomes

Science communication scholarship has examined the communication outcomes by scientists. Outcomes have been conceptualized as behavioral intentions (e.g., willingness to engage with the public), behaviors (e.g., social media use, media appearances), gains in technical communication skills (e.g., to write jargon-free, to develop storytelling capabilities), attitudes and beliefs (e.g., self-efficacy), among others (e.g. Yuan et al., 2022). Many of these outcomes are related to the communication training scientists receive (Dudo et al., 2021). Past scholarship has focused limitedly on communication outcomes that have been reported to be a function of people's identities, such as the feeling of being understood, communication satisfaction, and conversational effectiveness, which conceptually are related to self-efficacy (Bandura, 1977; Hecht & Choi, 2012). Interpersonal and intercultural communication theories explore these types of communication outcomes, providing an additional layer to our theoretical framework, which is described below. The present study expands dominant research in science communication that examines a narrow set of communication processes, practices, mediums, and contexts (e.g., storytelling, social media, media relations, etc.) (Dawson et al., 2022) by exploring interpersonal communication in academic contexts.

Science communication among junior faculty

Science communication scholarship has examined multiple groups, such as trainers, professional communicators, journalists, and public audiences. Perhaps most importantly, researchers have focused on scientists. There has been little focus given exclusively to pre-tenure faculty, who are among the most vulnerable faculty, particularly if they are not racialized as White. Pre-tenure faculty typically feel they are discouraged by their universities to engage with the public as it is not explicitly valued as part of the promotion process (Calice et al., 2022).

Scientists also feel they have limited institutional support, or that they lack confidence in their communication skills (Rose et al., 2020). These barriers might prevent many scientists, especially those from marginalized backgrounds from doing science communication, even if they feel it is an important part of their work. However, both pre-tenure faculty and graduate students appear to be driving a change in culture surrounding public engagement (Calice et al., 2022), and view their communication and engagement efforts to get people excited about science (Rose et al., 2020). For junior faculty interested in science communication to effectively do their research, teach, and engage, universities would need to rethink their approach to faculty expectations and provide more time and incentives for public engagement (Jamieson, 2020). The present study focuses on pre-tenure faculty from minoritized groups in the United States.

Theoretical considerations

To go beyond putting participants into pre-established identity categories, this study brings the perspective of border theories about identity. In “Borderlands/La Frontera: The New Mestiza,” Anzaldúa (1987) theorizes the experience of inhabiting a territory between two worlds. Anzaldúa describes identity as characterized by hybridity, flexibility, and plurality. This definition is focused on the experiences of Mexican American women, particularly Chicana and Mexican women who have mixed Native American and Spanish heritage.

Anzaldúa resisted traditional identity labels, calling them “boxes.” Anzaldúa brings the border as a physical matter but also as a metaphor, which makes this theory applicable to immigrants (people who literally crossed the borders), and people who identify as part of any minoritized group (and that may have the feeling of inhabiting metaphorical borders). If people are in constant transit and reimagining themselves, there can be no pretense of a fixed identity. As Nasser (2021) points out when revisiting Anzaldúa’s work, the coexistence of multiple identities as seen in Border-Crossing Theory, does not end with a “pacified” identity combination or a reconstruction. “It generates a consciousness which is not a sum of two ‘unreconciled strivings’” (p. 29).

Anzaldúa sees the possibility for a new consciousness, not an identity, to emerge from the split caused by this inner struggle, namely, a point of view and not an identity (Nasser, 2021, p. 29). The categories that constitute someone’s identity, from Anzaldúa's perspective, can refuse the definitions intended by the hegemonic culture. Having this theoretical framework in mind, this study asks:

This study establishes a dialogue between Border-Crossing Theory and Communication Theory of Identity (CTI), which is also informed by non-Western definitions of identity. CTI explains how individuals internalize social interactions, relationships, and a sense of self into identities through communication. At the same time, the theory postulates that identity is expressed and enacted through communication. The focus of CTI is on the communication outcomes of identity, but does not explicitly consider the intersections of multicultural identities. Border-Crossing Theory complements this framework by focusing on the intersections of cultures and the resulting effects.

People’s experiences are about moving across diverse borders, such as race, gender, and geography. Root (1996) argues that an individual can shift foreground and background identities to cross these borders. Using CTI and Border-Crossing Theory makes it possible to go beyond the pre-establish categories of identities, which can be helpful when organizing ideas and making sense of other peoples' lived experiences. This study’s theoretical contribution is the dialogue between these two theoretical frameworks. We combined the foundational aspects of CTI (e.g. organizing identity into categories) and the more subjective propositions of Border-Crossing

Theory that have their roots in the experiences of immigrants, which constitute the majority of our sample.

RQ 1: How do scientists from historically minoritized groups define their own identity?

Communication Theory of Identity defines identity as experienced at multiple levels or layers, as multifaceted and dynamic (Hecht et. al., 2004; Jung & Hecht, 2004). This theory focuses on mutual influences between identity and communication and conceptualizes identity as communication rather than seeing identity as merely a product of communication or vice versa (Hecht et. al., 2001; Hecht et al., 2004). As Jung & Hecht (2004) describes it, relationships and social roles are internalized by individuals as identities through communication. At the same time, individual identities are externalized as social behavior through communication.

There are four layers of identity within Communication Theory of Identity: 1) Personal identity (self-concepts or self-images); 2) Enacted identity (performed or expressed identity); 3) Relational identity (individual develops and shapes identity partially by internalizing how others view him/her/they and in relation to other people); and 4) Communal identity (deals with how collectivities define their identities) (Hecht et al., 2004). To investigate how the layers of identity interact with one another (interpenetrate), Jung & Hecht (2004) created the concept of identity gaps, which are defined as discrepancies between or among the four layers of identity proposed by the Communication Theory of Identity.

For example, there is a personal–relational identity gap when the idea that other people have of me does not correspond to what I think about myself. A personal–enacted identity gap occurs when the way I communicate does not correspond with how I see myself. Previous Communication Theory of Identity studies have focused on the communication experiences of immigrants (Urban & Orbe, 2010), Jewish communities (Hecht & Faulkner, 2000; Hecht et. al., 2002a), and Black people (Drummond & Orbe, 2009; Hecht et. al., 2002b) in the United States. These previous investigations show, for example, how individuals may experience discomfort in interpersonal communication in interracial social encounters that resulted mainly in personal–relational and personal–enacted identity gaps. In this study we explore the communication practices of scientists from racial and ethnic minoritized groups. Based on Communication Theory of Identity, we propose the following research question:

RQ 2: What identity gaps do scientists from a minoritized group describe in terms of their personal, enacted, relational, and communal layers of identity?

As previous research has shown, these gaps have a significant impact on effective interpersonal and intercultural communication (Jung & Hecht, 2004; Jung et al., 2007). We expect a relationship between identity gaps and communication outcomes (e.g., feeling understood, communication satisfaction, and conversational effectiveness), therefore we propose this research question:

RQ 3: What communication outcomes do scientists from minoritized groups attribute to their perceived identity gaps?

Addressing these research questions would provide a more nuanced understanding of the barriers to effective science communication that marginalized identities in science currently face.

METHODS

Sampling

In-depth, semi-structured interviews were conducted with 28 tenure-track faculty in the environmental sciences employed at U.S. universities between March 2022 and August 2022. This study focuses on junior faculty because they are more vulnerable than mid-career or senior faculty, and might engage in science communication differently than those colleagues (Dudo et al., 2021), and little scholarly attention has been given to this group. Junior faculty from marginalized groups are at risk of not having their public engagement and science communication activities rewarded in their promotion and tenure processes. The focus on environmental scientists responds to the scope of a larger project under which this study falls, as well as the intersection of activism and social justice and the environmental sciences in the US (Frickel, 2004; Nelson & Vucetich, 2009).

Participants self-identified as members of under-represented racial and ethnic minority (URM) groups within their respective STEM fields. They were not offered pre-established categories for demographics, resulting in a range of self-definitions of race and ethnicity that include, Black Americans, Africans from three different countries, Afro-Americans, Asian-Americans, Asians, Latinos and Latinas from six different countries, and Indigenous people in the sample. Interviewees represent 20 universities in the United States, including Puerto Rico. Most participants (75%) were foreign born, a limitation we address in the discussion section. Interviewees had a broad range of research interests connected to environmental sciences (e.g., microbiology, wildlife conservation, urban planning, anthropology of the future), and all of them related their work with issues of diversity, equity, inclusion, and social justice.

Participants were recruited via scientific societies and associations (e.g., American Indian Science and Engineering Society (AISES), Association for Women in Science, National Action Council for Minorities in Engineering (NACME), Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS), Society of Women Engineers), snowball sampling, social media, and personal networks. The lack of a sampling frame for this population required this multi-pronged approach. The original strategy relied almost exclusively on sharing the request for participants via the online media channels of the associations listed, who agreed to assist in this process. This resulted in a small number of responses that led us to pivot and rely on the other strategies listed above. Although this strategy was not ideal, we were not expecting to make any generalizations from this sample but to provide a first exploration of the roles of identity in science communication in the United States.

Interview protocol

A semi-structured approach was used with an interview script developed based on key elements of Communication Theory of Identity. Interview questions first covered background information such as demographics, personal upbringing, and social relations to get a comprehensive picture of the participant's self-identity. Interviews were conducted in English, lasted approximately one hour, and were conducted via Zoom and recorded. Recordings were transcribed by a professional for analysis.

The first part of the interviews aimed at getting respondents to reflect on the personal and professional trajectories that led them to their current academic position. Specifically, questions inquired about the decision to pursue a science career, graduate school, relationship with mentors, instances of discrimination, or challenges (e.g., financial) they faced. Respondents were also asked to describe their identities. Other topics discussed include teaching, mentoring, and participants' feelings of belonging in their departments and professional organizations. Finally, participants were asked about their conceptualizations of science communication, and their past and present communication practices (e.g., interactions with journalists, social media use, public engagement in schools, etc.).

Analysis

Transcripts were first analyzed by the first author using the qualitative software NVivo. This process led to the first codebook created in NVivo that was shared and discussed by four of the authors during multiple meetings. Transcripts were analyzed using an iterative process based on the four identity layers of Communication Theory of Identity. However, an inductive approach was also used to explore emergent themes from the data. A total of 27 codes were created to investigate the most relevant themes. Codes were related to Personal identity (every time they mentioned how they see themselves), Relational identity (their interpretation of how other people see them), Enacted identity (performed or expressed identity) and Communal identity (every time they mentioned being part of a group). We also coded for communication outcomes as described by Communication Theory of Identity (e.g., feeling understood, communication effectiveness).

Codes and themes were then examined by all co-authors and discussed collectively to determine the most relevant ones in relation to the research questions. We used an approach oriented by constructivist–interpretivist research paradigm (Ponterotto, 2005, as cited in Bennett et al., 2022) instead of the traditional quantitative approach to intercoder reliability. This alternative paradigm uses meaning-oriented methodologies to produce scientific knowledge, instead of focusing on measurements as quantitative research analysis does. As Ponterotto (2005) describes it, the researcher and the participants "jointly create (co-construct) findings from their interactive dialogue and interpretation (p. 129)." This process of co-constructing meanings happened during the interviews. After that, the authors worked together during research team meetings to discuss and analyze these findings.

Participants were asked to define their own identities to allow for an exploration of a broader understanding of the concept of identity in this context (RQ 1). The analysis of the results promotes a dialogue between Communication Theory of Identity and Border-Crossing Theory, two theories that have in common the notion that identity is fluid, layered, and complex. These theories, however, differ on the issue of labels used to talk about identity. Participants' definition of identity — not always according to pre-established labels (e.g. Hispanic, African American)— showed the need to go beyond the Communication Theory of Identity and to establish a dialog with Anzaldúa's work. All the terms used when mentioning race or ethnicity (e.g., Black- American, Latin, Mexican-American) in the analyses are based on how the participants define themselves. The objective here is to extrapolate pre-established labels in the interpretation of the results, promoting a more complex and nuanced portrait of the reports obtained in this study.

In the second stage of analysis, the authors identified and analyzed identity gaps experienced by the participants. Situations in which respondents themselves mentioned a disconnect between layers of identity as determined by the Communication Theory of Identity were interpreted in this section to answer RQ 2.

Finally, the coded data were analyzed to explore communication outcomes resulting from these identity gaps (RQ 3). These outcomes are shown in the form of reactions or communication strategies created by the interviewees when they felt misunderstood or discriminated against, for example. Communication outcomes do not necessarily need to be negative, as determined by the

Communication Theory of Identity, but in this sample, examples that involve an unfolding of negative situations that the participants defined as “microaggressions” — subtle everyday experiences of racism (Sue et al., 2007) — prevailed.

RESULTS

How do scientists define their own identities? As fragmented, fluid, and layered

The first research question asked how scientists from historically minoritized groups defined their own identities. The communal aspect of their identity was the most mentioned among Communication Theory of Identity layers (28 participants). Participants constantly spoke in terms that included a notion of collective identity, using words like “us” and “we,” when talking as a representative of a group: “Us that are born in Latin America, everybody classifies us as Latinos, but for me, we are not Latinos. We are from Latin America. That is a little bit different. That is my category (Interview 6).”

Participants also refused the idea of a communal layer of identity as something positive. Being seen as a monolithic category was also mentioned as a source of discomfort and irritation: “You know, it's like we’re like this representative of the whole (f*****), you know, group. Like I don't know. And I’m like, ‘I don't represent all Hispanics. I don't represent all Mexicans’ (Interview 20).”

The personal layer of identity was mentioned 18 times. Participants tend to have an intersectional view of identity and describe more than one aspect of their identity when asked about how they identified themselves. Some of the expressions they used are congruent with the labels traditionally used when defining identity (e.g., ethnicity, race, gender). But the sample used in this study is composed of a very heterogeneous group of scientists that mentioned, for example, being a mother, being a husband, being a first-generation college student, being artistic, being religious, and being a mentor as essential aspects of who they are. Still, more examples are needed to create a pattern to be analyzed, which is why we will focus on the predominant themes mentioned by the interviewees.

Being Latino(a) (12 participants), being an immigrant (7 participants), being biracial (6 participants), and being a woman (5 participants) were the most reoccurring aspects of identity mentioned in the interviews. The intersections of these identities were also described by some respondents: "What makes me who I am is not necessarily the color of my skin, more so like age and being a female (Interview 19)." Similarly, another respondent played down her professional credentials in favor of other aspects of identity: "I'm not like, 'I'm a professor. I have a Ph.D.' That's not my identity. Like that is part of me. I'm also just an immigrant, sometimes. Now I'm a mom. (Interview 21)."

Participants' descriptions of identity also connect to the essence of Border-Crossing Theory (Anzaldúa, 1987) that rejects the concept of identity as fixed categories. For Anzaldúa, the concept of who we are is in a constant state of transition, depending on political, geographic, and social context. Participants defined identity not only as layered, but also as fluid and socially constructed. The way they identify depends on cultural aspects and even on the geographical location they are in at that moment. As we can see in these examples: "I was never before called 'Brown' until I joined the university, like when somebody told me, 'You are Brown.' 'I am, what?' And it's very strange because when I am in Colombia, I'm White" (Interview 6). Similarly, another respondent said: "In Mexico, I think I'm unambiguously White but, in the U.S., I think it's much more ambiguous what people perceive me as and how they interact with me, and it depends on the context" (Interview 5).

Other participants defined that a communal identity and the experiences shared by people considered part of a minority group affected the way they identify: "I didn't use to say that I'm a woman of color because, in Mexico, I'm White. But here (in the United States), I'm a woman of color because I go through the experiences that other women of color go through" (Interview 7). Another respondent said: "I've always held the identity of being a Muslim-African-American male. But I think as sort of time has gone on, I started to discover the other identities just because of the context that I'm in academia" (Interview 23).

This sense of identity as fluid can lead to the sensation of being "between two different worlds" (Interview 5) or being unable to be more than one thing: "You know, before moving to the States, I was always very, very proud to be a Puerto Rican scientist. And then I moved to the States and I felt like I had to choose between being a scientist and being Puerto Rican. I felt like I couldn't be the two things. (Interview 18)."

Name as enacted identity

Faculty who are immigrants mentioned name as an important identity symbol, a feature central to their personal and enacted identity. They talked about how they use their enacted identity to make statements and reduce the gap between their personal identity and STEM identities. A person who identifies as a Mexican woman described her discursive process of introducing herself by saying her name with a Spanish accent, and not with an English accent. She does that as a statement of resistance against White supremacy. By pronouncing her name as she would normally do in Mexico, she tries to reinforce her STEM identity and sense of belonging to that space (an academic setting in this example), as seen below:

> When they refer back to me, it's like they don't acknowledge the way I said my name. It was just about a year and a half ago that my department had started trying. They'll be like, "(her name)," right? You can tell it's uncomfortable for them. It's just that no one actually ends up saying my name - how I want, you know (Interview 20).

Participants highlighted name as an important part of their identity many other times: "People don't understand how Latin Americans have two last names and where they come from. That's not my problem. It's them." (Interview 21).

> A colleague nicknamed me, "Yola" because he couldn't understand "Yola" for a young lady because back in the day, he was like, "You give talks and nobody will just say, "Thank you, (her name)" or "Thank you, (her last name) or Dr. (her last name)." No, just say your name. They'll be like, "Thank you, young lady. You could go sit down now. (Interview 20)

What are the identity gaps between personal, enacted, relational, and communal layers of identity? "I wanted to be seen as I had always seen myself"

Personal-ascribed relational gap

The second research question explores the identity gaps scientists from minoritized groups experienced in their roles as tenure-stream faculty members. We followed Communication Theory of Identity precepts to explore respondents' personal, enacted, relational, and communal layers of identity.

The main identity-gap identified in the interviews was the personal-ascribed relational gap (15 respondents), a recurring theme especially among scientists who immigrated to the United States and who represent the majority (75%) of this sample. Respondents described a range of situations in which their view of themselves is incompatible with other people's interpretation of them.

Participants said they just started seeing themselves as part of a minority group after interactions with people who labeled them in certain ways. A Black American woman who was raised in what she calls an “international household” — because her mom is a White immigrant and her father a Black American man — describes how she constructed a racialized perception of herself based on how other people labeled her: “I wasn't the first person who told me I was Black. White people were the first people that reminded me that I was Black” (Interview 3). Another participant described how she made sense of the inequalities present in her work by looking at other people and establishing a communal identity: “I realized like, ‘Oh, there's a certain type of people (Black or/and low income) that is always in these situations that has to work in construction, that doesn't have other options.” She also described how these perceptions are related to the way she looks at science in her work: “I mean climate change is very real and it's because we have not talked to the people impacted the most” (Interview 3).

Another example of this gap was articulated by a scientist that self identifies as an Asian-American woman and described a personal-ascribed relational gap starting during childhood, at school, and enduring until her adult life, at work:

> When I was pretty young, I never saw myself as any different than my White classmates. It wasn't really until they pointed it out to me like, “Oh you did that because you're Asian.”

> And I was like, “Oh? Oh, I do? Okay. I guess so.” I wanted to be seen as I had always seen myself, which was just like everybody else. (Interview 29)

Race, racism, and related issues were dominant and central themes in the personal-ascribed relational identity gap. A Haitian-American woman who was adopted as a baby and raised in what she calls a “White American household,” talks about being perceived at school and workspaces as an African-American based on her appearance. She describes the process of internalizing a racialized identity:

> The identity piece is interesting just because I do feel like I’m more… Like I was raised to be culturally White. But as an adult, as a Black-American, I do… Like society views me as a Black individual and so that certainly influences just how I identify as well. (Interview 19)

Another Black scientist who experienced growing up in spaces that he defines as White and who was homeschooled for the most part of his childhood, only in recent years started to come to grips with the gap between his cultural identity (as White) and how others see him (as Black):

> Growing up, the White side of my identity was really, really a heavy part of who I was and what I understood and what I understood myself to be. And the other aspect of my identity, the Black part of my identity, has been growing much more recently. But at least, if we're talking up through like high school, I very much identified… I would have told you that I was biracial or Black, but I very much identified as very White. (Interview 10)

This participant talks about how a relational-identity (his relationship with his mother) was central in this process of internalizing a racialized identity: “I was raised by a White mother that understood that there were serious threats to Black men and to raising a Black child. And in her work to protect me, she taught me very early and very explicitly to be very White." Only in the recent years of his academic and professional formation, he started to see himself as a Black man, influenced by interactions with other people. "People identify me as not being White by all means, but throughout my life, people immediately will follow that up with, "He's Black but not really (Interview 10)."

Personal-enacted gap

The second most common gap was the personal-enacted gap (seven participants). This result was expected, according to Jung and Hecht (2008). The authors define a personal-enacted gap as an experience that precedes the personal-relational gap. People can automatically notice if they are not accurately representing their authentic selves in a conversation, for example: "I think when English is not your first language and you're about to give a talk and someone starts remarking about your accent right before your talk, it really plays that on your insecurities [laughter] or things like that (Interview 5)."

Other respondents also described instances where they had to accommodate their communication style and referred to it as part of the "identity game (Interview 10)": "I'm going to approximate whiteness to the extent that I can because it'll protect me...I played the identity game well enough that that would not be what would challenge me (Interview 10)."

The codes they use to accommodate their communication in different spaces were also highlighted:

> There's also the words that I choose to use. I turn to be more colloquial (when talking to local communities in Puerto Rico). And I, you know, kind of…No, I wouldn't say "revert"

but I kind of go back to my roots, you know. I imagine I'm talking to the people I grew up with."

The necessity of being "louder," in a figurative way, which can be interpreted as speaking up more and positioning oneself, was mentioned as strategic communication behavior: "You have to be louder because you are trying to create awareness for all of the people who are not in that room with you (Interview 21)."

Some respondents argued that it takes time to process the perception that other people do not see them the same way they identify themselves (the personal-relational gap), as described by this respondent:

> The process of identity building into who I am started when I moved to an American state in 2015 but definitely was cemented in 2020 when it was just like, unapologetically, you know, "This is how people see me. I can't pretend--" In my mind, I can think, "Oh, but I'm from Panama. Oh, it's different. Oh, I'm mixed." But in practice, I'm seen here in the States as this particular identity (Black). (Interview 25)

Personal-communal identity gap

Four people mentioned experiencing this identity gap. A Mexican-American woman (born in the United States and the daughter of Mexican immigrants) described her difficulties in feeling like part of a community in the United States. She describes spending her entire life trying to connect her perception of herself, her values, and a communal identity:

> I identify as a Latina, but I speak a minimal amount of Spanish. A big part of that comes from… I do not identify as a White American. I do not feel that I have those values. I

have a very different aesthetic sense. I feel that my values don't resonate... And I found a very easy resonance with the Latin identity. We went to El Salvador several times and I felt very comfortable there. It felt right. (Interview 16)

Some participants found it hard to feel as part of a communal identity in the United States, even if they were born in the country or had a permanent status as a resident, as described by the same respondent:

> I don't have a sense of patriotism because I'm very cynical about how this country has treated people differentially in terms of access to education, housing, medical care. I mean you name it -- jobs, anything. If you're a minority, you basically have to be better than just to meet a certain standard. (Interview 16)

Respondents also mentioned finding it hard to identify with a communal identity inside academia and in their departments: "I felt very out of place. There were some Latinos, but they were very young" (Interview 16). She mentioned that the space where she felt more comfortable during her career was in community colleges that had a more diverse student body in terms of ethnicity and race. In other institutions, because of the lack of diversity, she experienced feelings of not being understood.

Another participant, a Colombian woman, described feeling disconnected to the communal identity in her field of work because of the lack of representation. "You know, it's as biology departments go...So mostly White. I think when I got here, the diversity was my mentor, who's Chinese."

The analysis did not reveal examples of other identity gaps, such as enacted-communal and communal-ascribed identity gaps.

Communication outcomes and perceived identity gaps: “Tortilla chips” and communication strategies

The third research question inquired about the extent and ways in which scientists’ identity gaps are related to communication outcomes.

Five participants described the communication outcome related to the personal-enacted gap. A Mexican woman who has been in the United States for 11 years described how the way people negatively reacted to her colorful clothes and to her tone of voice, for example, made her change her communication practices:

> I found it really hard, that it felt a kind of very cold approach and it felt like I needed to tone down my Mexican-ness in some ways to sort of be around without…And I think sometimes…Not so much that it gets judged, but I don't think everyone understands what I’m doing. (Interview 5)

Personal–enacted identity gap can affect one's confidence when communicating. Language was mentioned eight times as a central element in communication outcomes. Participants mentioned frequently questioning themselves during a conversation about how they sound and being constantly worried about saying the right thing in English. Expressing yourself in a language that is not your mother tongue can make you feel like you are not being yourself completely and, as a result, experience the communication outcome of feeling misunderstood, as this respondent describes: “I have an accent. There's a lot of trying to place me where I belong in their... And so it does make you wonder if, when I’m giving a talk, they're doing the same thing instead of paying attention to what I’m saying (Interview 5).”

Interviewees also narrated how they create communication strategies to deal with identity gaps and the feelings of not being understood or taking seriously in academic settings because of who they are, as we can see in this example:

> I think this goes back to like, "Oh, you have a tortilla chip on your shoulder" …I think one of the things that happened pretty quickly on by being in an academic space so much was like, "Okay, they don't believe me" or like, "I don't have the legitimacy." Like I'm getting the unconscious bias, right -- like the classic little things that happen in those spaces. And so, I was like, "All right, I'm going to puff up. I'm going to be a little bit more dominating and I'm going to basically be a little bit more confrontational. (Interview 20)

Participants also described positive communication outcomes (feeling understood and respected) because of positive representation: "I would say that I feel very respected by my colleagues. I feel like my voice is heard. And it helps that I'm not the only underrepresented… I'm not underrepresented. I'm not the only like minoritized person in this department" (Interview 11). Another respondent said: "Seeing other people like you in your field is so important. And I realized, "Oh hey, there's more of us." And we all do these cultural things, and I can culturally be a Black woman as well as still be a scientist and that can exist at the same time" (Interview 3).

Finally, this respondent expressed surprise when experiencing diversity:

> I think there was an initial shock of just being in a room with all like people of color just because that's like not what happens in most of my professional kind of spaces. But it was comforting to be able to connect with people that actually look like me in kind of an academic setting. (Interview 19)

Participants were asked about their communication practices both in interpersonal (face to face) and mediated communication (e.g., social media). Respondents' identity was more important as part of interpersonal communication than in mediated communication. All the participants use social media, with different levels of interaction on different platforms. They repeatedly mentioned Twitter as a space they use to talk about their science, publications, and awards, but not to express issues related to identity or talk to the public: "Twitter ends up being a really siloed sort of system and so you end up sort of preaching to the choir, mostly (Interview 11)." Another respondent said: "I'm pretty active on Academic Twitter. I use it primarily to speak to academics again. (Interview 10)." In two different occasions they mentioned Twitter as space where power dynamics can be challenged. "Twitter is a tool. I often use it as a tool to leverage power (Interview 18)."

The main reason not to use social media more actively for talking about identity related topics or putting inequalities in the spotlight is fear of the consequences. A scientist who identifies as a Mexican man describes not only his experience but a collective discomfort with potential consequences of what they say on social media:

> As a scientist in the minority group or marginalized group, I think there's some consideration about going to… like a media that's going to attract a lot of spotlights because there's a... They may not like to go on the media to talk about those controversial sensitive things just because they feel that they probably don't have a lot of power or if something happened to them, they feel they don't get supported (Interview 15).

On the other hand, respondents mentioned public engagement 23 times and talked about being involved in town hall public engagement deliberative discussions, "community science" (discussing science with kids at schools), working with science in museum spaces and making documentaries and songs about science. A Mexican-American woman described herself as a "cultural knowledge broker," a scientist that translates the meanings of science for public audiences and engages with the communities they are studying:

> So, you are somebody who is from the communities which you're aiming to serve as well as the scientific understanding. And that when you have those together, you become this cultural knowledge broker that can add rigor and relevance and translational capacity to, in this case, environmental health research (Interview 20).

Participants explained their interpersonal communication practices and their motivations to do this kind of work, which is mostly related to their identity and involvement in social justice: "It's just a sense of moral obligation to make a positive difference in any way that I can. And I don't feel like I'm necessarily doing that directly with my research" (Interview 11). Another respondent said: "These are ongoing processes in real time, in real life that affect people every day. And I think the general public needs to be aware of it so they can have a say in it. They can have an opinion about it" (Interview 14).

Five participants also referred to social justice as a structural matter related to power unbalances, as in Interview 4: "The reality of the situation is the way the power is distributed within our society is not random and it does sit around very specific power structures." And in Interview 7: "I am motivated, and it is a thought process I have, and it is a way that I want to use that power. And it is something I am thinking about now of my responsibility for getting into that rank[1] as quickly as I can so that I can help shift that balance."

[1] Refers to being promoted with tenure.

DISCUSSION

This study examined the role of identity and identity gaps of environmental scientists who are part of historically marginalized groups in their science communication practices. We focused on communication outcomes — “feelings of being understood” was the dominant outcome — in the context of interpersonal communication and mediated forms of communication such as social media use. The results show that through communication, respondents put layers or fragments of identity together not to form a fixed identity, but an evolving consciousness about who they are and how they communicate. As predicted by the Communication Theory of Identity, the analysis shows the importance of communication as an identity-forming element and not just as a way of expressing it. Regardless of the use by respondents of established racial or ethnic labels such as Black or Hispanic, many described identities that included aspects such as culture shock and language (particularly for immigrants), name, family upbringing, racist encounters, motherhood, among many others.

Respondents expressed being more comfortable in engaging with audiences and communities in interpersonal settings compared to mediated spaces such as social media. On the other hand, interpersonal communication experiences within academic settings varied, with many respondents expressing discomfort due to microaggressions or exclusionary practices.

This study builds on previous work examining science communication as culture and identity (e.g., Davies & Horst, 2016; Davies et al., 2019; Stewart, 2023; Stewart et al, 2023) by using a theoretical framework grounded in the Communication Theory of Identity and Border-Crossing Theory. We argue that future research should expand on this work and apply cultural perspectives to the lived reality of scientists involved in communication and public engagement practices. Situating scientists as active actors within their professional and cultural networks would allow for a comprehensive understanding of their motivations and beliefs related to science communication. Future research could explore the identity negotiation processes that scientists of color experienced when they navigated different science and non-science spaces, and how their communication accommodated to those different circumstances.

The results of this study have important implications for science communication training. Most training programs, from short-term skills-based training (Baram-Tsabari & Lewenstein, 2017) to year-long fellowships (Bennett et al., 2022; Roca et al. 2020), do not fully embrace participants' identities to develop culturally tailored training. Science communication training should consider, based on the results of this study, the priorities of people from different cultural and ethnic backgrounds as opposed to a one-size fits all approach. Practically this would require trainers to review their assumptions of what training needs practitioners have, intentionally diversify both trainees and trainers, design trainings that are culturally relevant, and rigorously evaluate the training using a social justice and inclusion lens that would allow for iterative revisions of training materials and approaches. The barriers identified in this study need to be dismantled to stop the systematic exclusion of people of color from trainings and other science communication spaces (Dawson, 2018). Science communication looks different when these considerations are included, from research agendas to how they teach and engage with communities.

This study has some limitations. First, the study examined US-based faculty, making the results only applicable to that context. Some of the findings could provide guidance to future studies in contexts that have similar academic structures and systems in place. Second, the sample skewed towards immigrants and Latino(a)s and included only a few Indigenous or Asian/Asian American faculty members. Some of the themes described largely originated from these respondents. Extensive efforts to recruit a more diverse sample were unsuccessful, which is partly a reflection of the small population of environmental scientists of color, in general, and on the tenure track, specifically (Taylor, 2018). Future research could explore in more detail individual racial/ethnic groups to explore attributes unique to those groups. A related limitation is that members of different minoritized groups (e.g. Hispanics, Blacks) likely have differentiated experiences related to identity and communication, something we did not explore in the study. Finally, although research team members spoke Spanish and Portuguese, interviews were conducted in English to maintain a common language for analysis. Interviewing participants in their native language might have resulted in different outcomes.

CONCLUSION

Judd and McKinnon (2022) in their review of 40 years of science communication scholarship stated: "despite being aware of the white, Western, ableist and patriarchal nature of science communication (Canfield and Menezes, 2020), our theory and practice to date still largely reinforce these characteristics." The present study addresses this issue by contributing a perspective largely missing in science communication scholarship in the US. It presents evidence of the challenges scientists from marginalized groups face in various settings when they communicate about their work or science more generally. It also highlights the importance of considering individual and social identities in understanding communication outcomes. The results are unique to the US context and in no way represent larger trends across other contexts; however, some commonalities with contexts such as the UK exist, including the marginalization of minoritized ethnicities (Dawson et al., 2022). This requires further research that examines other contexts as well. Science communication scholars of color and other minoritized and marginalized groups can and should contribute to this scholarship by fully embracing theoretical considerations that expand and shift the dominant paradigm described above. Nathasha Jones (2021), in a poignant criticism of science communication scholarship from her personal experiences and a Black feminist perspective, examines the testimonial quieting and self-censorship that scientists of color in the United States experience because of fear of retribution, of offending, of not being heard, or getting things wrong. We hope that readers of this article will come to a greater understanding of some of the sources of these fears.

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