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How to Be a Deaf Scientist: Building Navigational Capital

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Deaf individuals are disproportionately underrepresented in science, technology, engineering, and mathematics (STEM) careers, particularly those requiring doctoral degrees. The leakage in the STEM pipeline between undergraduate enrollment and the awarding of doctoral degrees to Deaf students may be attributed, in part, to a lack of Deaf individuals in academic mentoring roles. This study examines mentoring experiences of Deaf mentees and their Deaf mentors who help them navigate in the STEM community as future Deaf scientists. The experiences of 3 Deaf mentoring dyads (Deaf mentor/Deaf mentee) working in undergraduate research laboratories are captured in this phenomenological study. Informed by a Deaf navigational capital framework, participants described the nature of their mentoring dyad and the content of navigational capital extended to Deaf mentees. Three themes emerged from this study: (a) modeling how to be a Deaf scientist; (b) promoting and fostering self-advocacy skills through inclusion and access; and, (c) networking with a broader community of scholars. The building of navigational capital for Deaf mentees is discussed.

Keywords: mentoring, Deaf, higher education, STEM, undergraduate

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Navigating postsecondary education, especially for those students who aspire a career in science, technology, engineering, or mathematics fields (STEM) can be challenging, especially for Deaf[1] students. The Deaf population is of particular interest because they represent a linguistic and cultural minority who communicate using a visual-spatial language, American Sign Language (ASL). Culturally Deaf people have sets of social beliefs, behaviors, art, history, and values. Previous literature has suggested that the trajectory to STEM in postsecondary education is greatly influenced by Western hegemony, serving those who are hearing, abled, White, male, and middle class oriented (Blackwell, Snyder, & Mavriplis, 2009; Johnsrud & Sadao, 1998; Menges, & Exum, 1983; Rendón, Jalomo, & Nora, 2000; Schiele, 1990; Seymour & Hewitt, 1997). The claims are further punctuated by the overwhelming demographic rep-

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[1] When discussing Deaf people, it is important to address two competing ideological perspectives on deafness: the medical model and sociocultural model. The medical perspective of deafness focuses on the amount of hearing loss and negative social constructions of deafness, such as making deaf people appear "normal." From the sociocultural perspective, Deaf people are viewed as a cultural and linguistic minority group, rather than individuals with an audiological disability (Padden & Humphries, 2009). The competing ideological perspectives on deafness can greatly influence the process of social identity construction for Deaf people (Ladd, 2003). For this article, the authors purposefully utilize Deaf capitalized to refer to those who identify themselves as part of the Deaf culture with sets of shared social beliefs, social norms and values, and who American Sign Language (ASL) as their primary language. The word "deaf" with a lower case "d" refers to deaf people that do not identify themselves part of the Deaf community or culture.

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resentation of hearing White faculty and students in STEM fields (Committee on Equal Opportunities in Science and Engineering [CEOSE], 2012). Pathways to STEM careers may also be further obstructed by issues surrounding phonocentric hegemony, when institutional practices favor those with hearing privilege; that is, the ability to hear and communicate verbally in spoken English, and, the ability to participate in academic and social discourses with ease (Fernandes & Myers, 2010; Tuccoli, 2008). For example, hearing people can have direct conversations without requesting interpreters.

Consequently, systemic barriers are created, marginalizing Deaf students because they do not share the same advantages as hearing people. As a result, Deaf college students do not have the same equal playing field as hearing students in navigating postsecondary education, particularly in STEM fields. According to the National Science Foundation (2013), there is a leakage in the pipeline between undergraduate enrollment and earned doctoral degrees for Deaf students (CEOSE, 2012). While some students may opt out of pursuing graduate degrees, research does illuminate how undergraduate experiences in STEM fields contributes to students' desire to pursue careers in STEM (Adler, Jacob, Kurz, & Kushalnagar, 2014; Gregerman, Lerner, von Hippel, Jonides, & Nagda, 1998; Hurtado, Cabrera, Arellano, & Espionosa, 2008).

In university settings, Deaf students, faculty, and staff are often faced with communicative challenges, because of the availability of skilled sign language interpreters to support access to academic discourse and culture (Adler et al., 2014; Woodcock, Rohan, & Campbell, 2007). Approximately 45% of postsecondary Deaf students require sign language interpreters in the classroom (Walter, 2010). Despite key legislative measures such as the Americans with Disabilities Act (1990) and Section 504 of the Rehabilitation Act, which mandates equal access to education, Deaf students, faculty, and staff still face multiple challenges in postsecondary education, as some institutions do not fund interpreting services beyond classroom settings (Woodcock et al., 2007). Limited or no access to interpreter services can limit Deaf students' involvement in incidental learning opportunities such as peer-tutoring, faculty interactions, and access to verbally shared information (Hopper, 2011). Moreover, Deaf undergraduate students are often denied access to spoken discourse because they differ in communication modality and learning styles compared with hearing students (Woodcock et al., 2007).

Even with accommodations to support Deaf students in undergraduate classrooms, Deaf students struggle to fully participate because of challenges associated with simultaneously watching interpreters, processing instructor's lectures, and taking notes (Elliot, Foster, & Stinson, 2002). Those challenges may be the leading reasons why approximately only 30% of Deaf students graduate from 4-year programs compared with about 70% of their hearing peers (Marschark, Lang, & Albertini, 2002). For Deaf students in STEM fields, the issue is further compounded by interpreters who may not be familiar with expressing scientific terms in ASL (Lang, 2002).

One means of potentially increasing the involvement of Deaf academics in graduate STEM fields, and the focus of this study, is mentored undergraduate research experiences. Deaf mentors can help support Deaf students to overcome challenges encountered in STEM programs. Given the lack of Deaf academics in graduate STEM programs and the belief that mentorship can increase those numbers, this study was guided by one overarching question: How do Deaf dyad mentoring relationships benefit faculty mentors and undergraduate mentees pursuing careers in STEM fields? To further examine this phenomenon, the following subquestions were posed: How do Deaf mentees with Deaf mentors describe their undergraduate mentoring experience? And, what is the nature of Deaf navigational capital shared between Deaf mentors and mentees? This study focuses on the experiences of Deaf STEM mentors and college students who use American Sign Language (ASL) as their primary language and English as a second language.

Review of Literature

Benefits and Impediments to Mentoring

A number of solutions have been posed in the literature to increase the enrollment and success of undergraduates from underrepresented communities, including African American, Latino,

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and students with different abilities (Burgstahler & Chang, 2009; Hurtado et al., 2008; Tsui, 2007). One such effort is the establishment of undergraduate research programs targeting underrepresented populations. These programs often pair undergraduates with faculty in STEM fields to foster research and career interests (Gregerman et al., 1998; Hurtado et al., 2008). For example, the National Science Foundation allocated grant funds and established support programs for mentored Undergraduate Research Experiences (UREs). Research laboratories, such as those sponsored by the NSF, have been recognized as a particularly effective strategy for increasing interest in STEM disciplines for a number of students, including those from minority communities (Gregerman et al., 1998; Hurtado et al., 2008). The availability of grant funds has sparked an increase in the number of mentored undergraduate research programs, but the growth has been gradual, and particularly so for programs targeting Deaf students (Mertens & Hopson, 2006).

Many colleges and universities have invested resources into developing their own undergraduate research programs and research related activities in an attempt to increase the number of underrepresented communities (Singer, Hilton, & Schweingruber, 2005; Strayhorn, 2010). Such efforts are undergirded by situated learning experiences, that is, programs designed to expose students to the experiences and practices of STEM researchers (Lave & Wenger, 1991). Situated learning opportunities within undergraduate research programs targeting students from underrepresented groups may further provide social and cultural contexts of STEM work in lab environments (Kardash, 2000). Increased retention, persistence, academic progress, and successful career attainment are also attributed to participation in undergraduate research (Boyle & Boice, 1998; Gandara & Maxwell-Jolly, 1999; Lopatto, 2003; Gregerman et al., 1998; Ragins, Cotton, & Miller, 2000). A number of benefits from involvement in undergraduate research have been highlighted in studies examining the experiences of underrepresented students, including effective navigation of institutional and cultural challenges (Tsui, 2007). As a result of participating in undergraduate research, students from underrepresented groups reported feeling better equipped to handle academic and social difficulties (Tsui, 2007). Frierson, Hargrove, and Lewis (1994), for example, found that African American undergraduate research participants gained positive attitudes toward research activities which also contributed to their desire to pursue graduate studies.

The involvement of research mentors can assist undergraduate students in improving research skills such as inquiry, writing, collecting, analyzing, and reporting data in scholarly venues. Additionally, students also learn how to engage in scholarly discussions (Hu, Scheuch, Schwartz, Gayles, & Li, 2008; Lopatto, 2003), experience an increase in both self-confidence (Campbell & Skoog, 2004; Phinney, Torres Campos, Kalleymeyn, & Kim, 2011) and self-esteem (Jonides, von Hippel, Lerner, & Nagda, 1992). In turn, mentored research experiences help undergraduate students build scientific identities, boost their career readiness, increase their scholarly productivity, and expose them to the culture of the academy (Johnson, 2010).

While the benefits of mentored undergraduate research experiences are numerous, the challenge for underrepresented students is that faculty members are predominantly White, traditionally able-bodied, and hearing (Blackwell et al., 2009; Johnsrud & Sadao, 1998; Menges, & Exum, 1983; Rendón et al., 2000; Schiele, 1990; Seymour & Hewitt, 1997). Consequently, this may create cultural incongruities because underrepresented students' "home culture" and "university culture" do not align (Gloria & Kurpius, 1996). The Western hegemonic university culture pervasive in higher education and STEM fields can lead to underrepresented students feeling isolated and culturally alienated from faculty members (Gloria & Rodriquez, 2000). As a consequence of cultural incongruity, Seymour (1995) found that underrepresented students have lower performance, self-efficacy, and academic confidence in STEM fields. Steele (1997) found that a perceived threat of stereotypes and the results from cultural mistrust can influence the evolution of relationships between people of two different social identities. One possible reason why this occurs is because mentors—traditionally from mainstream majority communities—are typically unfamiliar with underrepresented students' backgrounds, and therefore, may be unable to relate to the needs of students from identities different than their own (Moses, 1989).

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The process of pairing students from underrepresented populations with faculty mentors from similar backgrounds has been researched, with the literature highlighting the ways in which such matches can prove beneficial for both mentees and mentor (Dingus, 2008; Ensher & Murphy, 1997; Koberg, Boss, & Goodman, 1998; Patton, 2009; Ragins, 2007). Mentees develop a greater connection to mentors with whom they share important demographic characteristics such as sex, race, culture, and/or abilities. Mentees identify with mentors from the same background and who seemingly possess values, attitudes, and experiences that parallel their own (Whelley, Radtke, Burgstahler, & Christ, 2003). Mentors from shared backgrounds can provide mentees support needed to understand the rules and expectations of the academy, including psychosocial support (Koberg et al., 1998) and career development support (Ensher & Murphy, 1997).

A primary challenge to purposefully pairing mentors and mentees in STEM disciplines based on shared social characteristics, is the overwhelming lack of racial/ethnic, sex, and ability diversity among STEM faculty across U.S. postsecondary institutions. Past research has found that women and members of minority racial/ethnic groups are underrepresented in STEM fields, as demonstrated in Table 1 (Blickenstaff, 2005; National Center for Education Statistics, 2001; National Science Foundation, 2013). For Deaf students, the challenge of purposeful pairing with Deaf mentors is even greater, given the limited numbers of Deaf scientists across U.S. higher education. This study examined mentoring relationships between Deaf mentors and Deaf mentees. Specifically, this study attempted to conceptualize the building, sharing, and exchange of cultural capital between Deaf mentors and Deaf undergraduate mentees.

Table 1
STEM Doctorate Holders Employed Full Time in Universities and 4-Year College, by 2005 Carnegie Classification of Academic Institutions, Sex, Race, Ethnicity, and Disability Status

Sex, race, ethnicity, and disability status	All academic institutions
Total	280,300
Female	99,200
Male	181,000
White	204,300
Asian	48,500
Black	10,300
Hispanic	12,600
American Indian or Alaska Native	700
Native Hawaiian or Other Pacific Islander	300
More than one race	3,600
Without disability	259,000
With disability	31,300

Note. STEM = science, technology, engineering, and mathematics.

Conceptual Framework

Yosso's (2005) theory of community cultural wealth (CCW) provided a means of understanding how marginalized communities possess sources of knowledge that are shared among members. CCW emerges, in part, when communities are excluded from hegemonic forms of cultural capital including social networks and social expectations (He, Bettez, & Levin, 2015; Yosso, 2005). The concept of navigational capital is just one facet of CCW, which speaks to the ability of marginalized people to maneuver across and within varying social situations. Yosso argues that members of communities of color share strategies of social maneuvering allowing them to leverage social skills, knowledge, and ways of being needed to successfully navigate hegemonic institutions.

For the purposes of this study, Yosso's concept of navigational capital was extended to members of the Deaf community. Garrow, Fleischer, Eugster, and Love (2014) acknowledge that Yosso's work speaks exclusively to the experiences of communities of color, specifically on race. However, as previously noted, Deaf individuals frequently encounter practices of audism in hegemonic institutions that serve to marginalize their worldviews and experiences (Bauman, 2004; Hauser, O'Hearn, Mckee, Steider, & Thew, 2010; Humphries, 1975; Lane, 1992). In the context of social inequality in postsecondary education, Deaf people face similar, yet, different experiences as communities of color which led Garrow et al. (2014), to apply Yosso's framework as Deaf Community Cultural Wealth (DCCW). Navigational capital, as articulated by Garrow et al. (2014), acknowledges forms of subjugated knowledge that emerge from and within members of the Deaf community, that is, knowledge that provides a

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means of understanding social positioning and maneuvering among marginalized people (He et al., 2015). Social tools and skills are shared to support others to navigate and survive micro and macro oppressions in educational institutions influenced by Western hegemony, as opposed to withholding valuable forms of knowledge (Garrow et al., 2014; He et al., 2015; Yosso, 2005).

When applied to this study, navigational capital provides a means of understanding the forms of knowledge, information, and social strategizing that is shared, built, and transmitted between Deaf mentors and mentees to succeed in a phonocentric society (Arellano & Padilla, 1996; Garrow et al., 2014; Solórzano & Villalpando, 1998; Solórzano & Yosso, 2002; Stanton-Salazar, & Spina, 2000). Navigational capital further encompasses skills that are leveraged in educational institutions to ensure the success of community members including but not withstanding social competencies, cultural strategies, and stories (He et al., 2015; Listman, Rogers, & Hauser, 2011).

Scholars have emphasized the importance of Deaf adults in Deaf students' lives as an important source and means of transmitting language and experiences as forms navigational capital (Listman et al., 2011; Miller, 2010; Wilkens & Hehir, 2008). However, many Deaf students come from hearing families that may not be able to transmit navigational capital because they themselves have not experienced phonocentrism and audism. In higher education, most mentors are likely to be hearing and nonsigning, making transmission of navigational capital relatively inaccessible because of language barriers.

Although scholars have suggested that mentors with similar social backgrounds as mentees can serve as role models because they themselves have successfully navigated the educational system, there is limited research that applies the concept to how Deaf mentors transmit navigational capital to Deaf mentees (Blake-Beard, Bayne, Crosby, & Muller, 2011; Cole & Espinoza, 2008). Thus, for purposes of this study, a singular focus on Deafness as a shared cultural background provided a purposeful means to better understand the building of navigational capital between Deaf mentors and mentees. We recognize that Deaf identity is one of many aspects of intersecting social identities including sex and race. We also acknowledge that intersectionality influences Deaf mentoring relationships and the nature of navigational capital, particularly since the dynamics of race, sex, and socioeconomic status impacts who enters and stays in STEM fields. This study explored the nature of navigational capital extended to Deaf mentees to become resilient Deaf scientists in predominantly hearing STEM fields. Thus, the study's data collection and data analysis attended to the forms and sharing of navigational capital between Deaf mentors and mentees.

Method

The purpose of this phenomenological study was to examine the phenomena of Deaf scientists serving as mentors to Deaf undergraduate students. The pairing of Deaf scientist mentors and Deaf undergraduate mentees provides a context to further understand mentoring relationships between individuals from shared cultural backgrounds, in this case, Deaf mentors and mentees. The use of qualitative research methods illuminated how navigational capital is built among marginalized populations in STEM fields.

Participants

Three Deaf mentor-Deaf mentee dyads from two universities were selected to participate in this study. Both universities are in the northeast region of the United States with a critical mass of Deaf college students and Deaf faculty. Pseudonyms were used for the participating institutions and participants to protect identities. Thoreau College, one of the nine colleges at Emerson University, is the world's first and largest technological college for students who are Deaf and hard of hearing. Thoreau College serves over 1,500 students, 1,323 are Deaf students, 29% are minority students and 2.7% are international students from 20 countries. Thoreau College conducts a wide variety of science, technology, engineering, and mathematics research. Approximately 35% of Deaf students at Emerson University enrolled in STEM programs (Thoreau College Annual Report, 2010). Thoreau College also has multiple research-based laboratories in the fields of psychology, technology, and biology that have Deaf under-

graduate and graduate students in a variety of research support roles.

Hawthorne University (HU), a liberal arts institution, serves 1,100 deaf students studying at the associates, baccalaureate, masters, and doctoral levels. More than 25% of HUs students are from underrepresented racial/ethnic groups. HU has multiple research-based laboratories in linguistics, education, psychology, and biology that have undergraduate, graduate, and doctoral students in a variety of research support roles (Hawthorne University, Annual Report, 2011).

Participant Recruitment

Purposeful sampling criterion was used to identify participating mentors and mentees from both institutions (Creswell, 2009). The participating mentees met the following criteria: (a) Deaf and fluent American Sign Language user; (b) enrolled as an undergraduate student in a STEM discipline; and, (c) received mentorship from a Deaf scientist for at least 1 year. The participating mentors met the following criteria: (a) Deaf and fluent ASL user; (b) conducted laboratory-based research for at least 1 year; (c) employed at least one Deaf undergraduate research assistant; (d) holds a masters or doctoral degree in a STEM discipline; and, (e) is a current employee at the university with at least 1 year of experience. Professional networks were used to contact prospective mentees and mentors for the study. Additionally, mentees were asked to identify their current or former mentor to be part of the study. Once a mentor was named, participants were contacted via email asking them to participate in this study.

Participant Demographics

Three Deaf participating dyads from two universities, Thoreau College (2 dyads) and Hawthorne University (1 dyad), participated in this study. All participating mentors had substantial experience with leading research laboratories, mentoring undergraduates, strong publication records, and numerous professional conference presentations. The participating mentees were undergraduates pursuing BS degrees in STEM fields. Mentees worked with mentors in laboratory settings with duties including data collection, coordinating research projects, crafting literature reviews, and conference presentations.

The first dyad included John, a White male mentor with more than 5 years' experience at Thoreau College. His undergraduate mentee, Ashley, identified herself as African American, Latino American, and Native American. Ashley was hired by John to work as a laboratory assistant during her senior year. She returned to his laboratory as a graduate research assistant the following year. At the time of data collection, John had served as Ashley's mentor for 2 years.

The second mentor/mentee dyad consisted of Walter, a White male with more than 5 years of research experience at Thoreau College. His mentee, Joey, is also White. Joey was initially hired to work with Walter during a summer internship. At the conclusion of the internship, Walter asked Joey to continue his research assistantship, as he was pleased with Joey's performance during the summer. The pair worked together a full year at the time of this study.

The third dyad consisted of researcher, Michael and his mentee, Melissa. Both are White. Michael was the most seasoned mentor in the study, with over 7 years' experience running his own Hawthorne University laboratory. The mentor/mentee dyad worked together for a year at the time of data collection. All participating mentors and mentees identify as Deaf.

Data Collection

Semistructured in-depth interviews with individual mentors and mentees were conducted in ASL, followed up by shared semistructured in-depth dyad interviews. Individual interview protocols for mentees included questions related to the formation of mentoring relationships, reciprocity in mentoring relationships, assistance received, and general reflections on mentorship received from a Deaf mentor. Mentees were also asked to reflect upon the ways in which Deaf mentors assisted in navigating the challenges of STEM undergraduate studies. Similarly, interview protocols for mentors were constructed to yield reflections on the mentoring relationship from the mentors' perspective with attention to the sharing of knowledge and experiences. Mentors' interview questions also focused on strategies used to build mentees' navigational skillsets.

Semistructured dyad interviews occurred in the weeks after individual interviews. Dyad in-

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terviews, which were also an hour in length, yielded additional data on the mutual benefits of the mentoring relationships. For example, mentor/mentee dyads were asked to describe the progression of mentoring relationships. All interviews were videotaped and conducted by Listman, a bilingual Deaf professor in the field of ASL and Interpreting Education and a member of the Deaf community. An interpreter then viewed and transcribed each interview. To further ensure accuracy of the video-recorded interviews, Listman reviewed the transcripts and videos carefully to ensure that participants' messages were translated accurately into English. The transcripts were also examined by a hearing colleague in the field of Higher Education, fluent in both ASL and English, who made any necessary changes to ensure all English word choices matched participants' true intent. Completed transcripts were shared with participants as a form of member checking to further ensure accuracy and establish credibility. Other data sources included a demographic form, descriptive field notes, and a document collection that included curriculum vitae, lab related brochures, and websites.

Data Analysis

Data analysis followed Miles and Huberman's (1994) model, which consists of three concurrent flows of activity across all data forms: data reduction, data display, and conclusion drawing/verification. First, a priori codes derived from relevant research literature including previous research on navigational capital, STEM undergraduate research, and mentoring were applied to data. Examples of a priori codes include *subjugated knowledge*, *role of the mentor*, and *resilience*. Open coding then allowed new codes to emerge without the constraints of preconceived categories. Codes established during the open coding stage captured elements of mentoring relationships, career preparation, and illuminated discreet components of navigational capital.

During the process of axial coding, previously coded data was reassembled to build larger themes, making connections between categories (Miles & Huberman, 1994). Some smaller codes, including modeling, self-advocacy, and networking evolved into larger study themes across the various coding stages. Throughout data analysis, the researcher then engaged Dingus, a hearing African American woman who was Listman's dissertation chair, as a critical friend, that is, a skilled qualitative expert who "questions the researcher's analysis" and application of codes to data (Marshall & Rossman, 2011, p. 253). During the last stage of data analysis, cross-case analysis was utilized to compare responses received independently from mentees and mentors. The same analytical process was applied to the dyad interviews. The combination of coding and categorization strategies across all data forms resulted in larger study themes.

Results

Three themes were identified in the data that expound upon shared navigational capital between Deaf mentors and mentees. Study themes demonstrate mentors' responses to behavioral norms and professional expectations of STEM researchers, specifically countering hearing-centric norms. Mentors shared their own experiences dealing with audism to empower and prepare mentees for careers in STEM research. Mentees acquired navigational capital via mentors modeling how to be a Deaf scientist, promoting and fostering self-advocacy skills through inclusion and access, and networking with a broader community of scholars.

Theme 1: Modeling How to Be a Deaf Scientist

Participating mentors acknowledged that modeling how to become a Deaf scientist underscored their desire to serve as mentors. As highlighted by the mentors, academic culture is influenced by phonocentric hegemony, particularly in STEM fields, with limited awareness about Deaf culture and ASL. Mentor John described the dominance of hearing individuals in the academy by saying, "It is a struggle being Deaf in a hearing academic setting. STEM fields are generally dominated by hearing people and [the social norms] are less transparent to Deaf people." Similar sentiments were expressed by other participating mentors, which is why they strongly believed in socializing mentees as a means of preparation for the academy. Socialization, as described by mentors, exposed mentees to the tacit social norms of the academy

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and served as a strategy to develop up and coming Deaf scientists.

Mentors exposed mentees to these social norms of while demonstrating strategies of navigating systemic barriers. For example, mentor Walter described socializing his mentee, Joey, by bringing him to business meetings. The experience of interacting with vendors, as reported by Joey, demonstrated negotiation and communication skills, while also illuminating that scientific work necessitates interfacing with a variety of people. The instance also taught Joey that scientists must be responsive to the needs of their research team. Joey witnessed how Walter and other team members counted on each other to decipher what the hearing representatives were saying during the meeting. The interaction left an imprint on Joey, who commented that the business meeting,

> . . . helped me see how you [Walter] deal and interact with the hearing world. [Walter] had the experience, knowledge and resources to succeed. Even when [Walter] couldn't get an interpreter, [he] tried [his] best to interact with a representative from the company.

Walter too, felt having Joey present at the business meeting was important to his socialization as a Deaf scientist. He said,

> It was a nice opportunity for [Joey] to see my real life experience. It is not as easy for me to tell him, or describe to him how to navigate. It is better to see it live. He can see and learn from this opportunity, and why it is important [for him in the future].

The business meeting provided an opportunity to model strategies Deaf scientists can utilize as a linguistic and cultural minority in a field dominated by phonocentric cultural norms and spoken/written English.

Mentors in this study also stressed that sharing personal stories is an important strategy to model how to become Deaf scientists. Personal stories shared by mentors embodied wisdom, victories, and mistakes learned on their journeys to becoming Deaf scientists. John said in his individual interview, "My job as a mentor is to navigate [mentees] through that darkness, like a flashlight guiding the way, and eventually to give them the ability to see a path for their own successes." By doing so, John expressed that, "I try and talk about my personal life, how I cope, my frustrations, and I think a big part of their education is me giving them that information."

Although sharing these stories exposed parts of their personal lives, including mistakes and victories, John explained the importance of sharing his personal narrative. "So that's what I consider the more informal mentoring. I repeatedly talk about my life, academia, my experiences, and each time I discuss it, it seems to digest and settle a bit deeper into the thinking of my mentees." In turn, Ashley felt that John's stories of fighting for access helped her to navigate her own challenges.

> I can take the information [stories and experiences] and apply it to my own issues at school. I am able to think about my approach using the ways John or the [Deaf scholars] have approached things [communication barriers]. Knowing their stories and experiences has allowed me to consider what is worth fighting for and what I can let go.

In this instance, mentors believed that sharing personal stories imparted strategies and tools on how to navigate as Deaf scientists. Mentors viewed themselves as important models of how to maneuver in phonocentric academic culture and understand the tacit social norms needed to become Deaf scientists. Mentees recognized the value of mentors modeling how to be Deaf scientists and were able to apply mentors' knowledge, tools, and strategies as a means of building their navigational capital.

Theme 2: Promoting and Fostering Self-Advocacy Skills Through Inclusion and Access

Mentors felt compelled to teach mentees self-advocacy skills related to appropriate access to communication inside and outside academia. For example, mentors emphasized the importance of requesting quality interpreting services to better communicate with hearing professors. Michael, who served as Melissa's mentor, pointed out how gaps in interpreting services sometimes escalated his need to be more assertive. His assertiveness was most often expressed when dealing with not being provided interpreters, or receiving poor quality interpreting services. He added,

> The interpreting office . . . sometimes I tell the students the best thing to do is go complain to them. And other times, it's better to go another route. In theory, we fill out a form and get an interpreter and all is well. In practice, we sometimes have to fight for something or argue or be more resistant. It really depends on the situation.

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Michael continued by describing what he hoped his mentees would learn from him when considering their needs for interpreting and access. "I hope they get the information from watching me, and use it to their advantage as these issues appear in their lives. This way, they will know what to do." Michael's mentee, Melissa, described how she discerned what accommodations to fight for and what issues to release. Michael provided Melissa advice she could use in academia and in the workplace. She said,

> One thing I was told [by Michael] that I thought was important was, 'If those people are not willing to provide you an interpreter or access services or other accommodations, you do not want to work for them anyways, because they do not really want you.' Sometimes it is hard to deal with and can be a blow to your ego, but do you want to work with them if that is how they are going to treat you?

Ashley, John's mentee, discussed the challenge of access to highly qualified interpreters in her individual interview as well. According to Ashley, access was something she struggled with on a daily basis. To better advocate for her needs, John helped strengthen her self-advocacy skills. She commented:

> My mentor helped me to become active in regards to receiving a high quality education. He told me that if my interpreters in my courses are not qualified to interpret, I have to be the one to say something. No one else will. I have to take the responsibility of my access to learn.

Thus, mentees reported acquiring improved self-advocacy skills specific to their communication needs at the urging of mentors. Mentor John framed self-advocacy as an issue of rights, in that quality interpreting provided improved access to navigational capital. He affirmed this position by stating that, "[mentees] need to be able to explain what they need to get it and fight for their accommodations." John emphasized the importance of showing mentees how to advocate for their rights to receive appropriate access to information, an important form of navigational capital. For instance, during the same interview he described experiences dealing with requests for good interpreters, "Sometimes, I don't get a good interpreter and they [mentees] see how I cope with that situation. Sometimes, I request an interpreter and I am told no, so they learn how I handle that situation as well."

Walter and Joey extended advocacy into STEM realms outside of the lab, including meetings with business executives in support of a scientific agenda. According to Walter, mentees need the navigational capital of good communication via quality interpreters to garner respect among hearing professionals. Thus, he stressed to Joey the importance of having full access to interpreters in the workplace. Interpreters, as emphasized by Walter, were important to communicating the value of scientific work conducted by Deaf scientists. He stated:

> That's really key to do; you have to show that you are valuable to the company and then they will do things for you. I never asked for a full time interpreter. I only needed them for specific things, but, they told me I earned it and gave it to me . . . because I proved myself the communication barrier became a secondary issue . . . so that is something I teach, that you have to show that you're a contribution in order for those communication issues to be reduced.

The ability to watch mentor Walter in a business setting provided Joey the opportunity to see the value of advocating for interpreting services. Joey said:

> I was curious on how Walter communicated with everyone who was hearing [at work], and I learned that he was granted a designated interpreter that stayed with him all of the time. It showed me that if you work hard enough, you can become valuable and [the company] will provide things like a full-time interpreter.

In this instance, mentors emphasized that self-advocating for access was a necessary skill. By doing so, mentors illuminated that Deaf scientists make significant contributions that employers cannot ignore, thus, necessitating access to quality interpreting services. Teaching ways to advocate for their access and accommodation needs was another tool when building mentees' capital in navigating their futures as Deaf scholars. Mentees were provided the opportunity to learn from their mentors' successes and frustrations when managing access and accommodations. Advocacy, in this light, was contingent upon one's ability to impact knowledge and contribute to the overall success of the organization.

Theme 3: Networking With a Broader Community of Scholars

Participating dyads highlighted the ways in which the mentorship of Deaf scientists pro-

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vided Deaf students much needed entrance into important scientific social communities. Mentees were provided opportunities to meet other researchers, scholars, and STEM professionals, as well as hearing allies who could be important advocates for Deaf scholars. According to mentors, the ability to foster relationships with Deaf and hearing allies across the STEM community formed a critical part of their mentoring relationships. For instance, John believed his mentoring responsibilities entailed providing introductions to scholars and graduate students in the field. He took great care to, "show [mentees] who the players are. That's why I introduce my students to people; some Deaf, some hearing, some that sign. That allows [mentees] to build their network, and to be familiar with the players."

The opportunity to network with other Deaf scientists, however, was important, as Joey noted:

> In Walter's lab, I really enjoy being able to work there and talk to Walter or other people who come into the lab. It is also in [an area with a concentration of Deaf professionals], so there are more Deaf people around in general. I had the opportunity to engage in conversation and build network[s] with other Deaf professors and engineers while working there, which was really great.

While John indicated that networking with other Deaf colleagues in the STEM community was important, he recognized that the Deaf STEM community was limited by geographical distance:

> For Deaf [people], they aren't going to be able to identify a diverse network of people with different information and who sign fluently or who will take the time to connect with a Deaf colleague within one single university. So, Deaf students must think beyond an institutional network to a national network and even an international network.

Mentors attempted to position mentees among a broader community of Deaf and hearing scholars. Introduction to the STEM community, according to John, also served as a scholarly coming-out. The act of introducing a student to the scientific community made a statement, ordaining the mentee, in some ways, as worthy of attention. Doing so allowed the scholarly community to become familiar with the mentees, who, by virtue of age and experience, formulated the next generation of scholars. John believed that, "Networking is not only good for my students to see the players, but for those at the conference to be able to see my students as well. The conference leads to many opportunities [for continued research and growth]."

Given the limited numbers of Deaf scientists, mentors highlighted the importance of cultivating hearing allies, specifically imparting ways to identify hearing allies. For example, Michael mentioned the significance of networking and finding the right players in the STEM community. Not only was he focused on Deaf colleagues, but also on the development of hearing allies. Michael attempted to teach Melissa, "how to identify the Deaf friendly people as opposed to those who are not Deaf friendly. I have the ability to help her to effectively evaluate individuals in our field." He further explained the importance of identifying hearing allies by saying,

> [I teach my mentee about] who we pick as friends. What I mean by "friends" are [hearing] allies. [Mentees] have to learn how to identify hearing people who have negative perspectives about Deaf scholars. Those are the people to ignore, but there are others that are Deaf friendly. If I can identify them, they are the ones that generally become my allies. They are the people that if I need a favor I can ask them, not the other [hearing] people who are unfriendly to Deaf colleagues.

Mentees were provided the opportunity to meet other researchers, scholars, and STEM professionals, as well as hearing allies who could be important advocates for Deaf needs in some circumstances. Mentors viewed introduction to the larger scholarly community as an opportunity for mentees to become known outside their institutions, especially for future research and learning opportunities.

Discussion

Findings from this study of Deaf mentoring dyads in STEM fields revealed consistencies with previous studies outlining the general importance of mentoring in STEM-focused undergraduate research experiences. This study, however, sought to better understand the mentoring relationship of Deaf mentors and mentees involved in undergraduate research. The focus on Deaf mentors and mentees provided a means of better understanding the nature of navigational capital in the context of social norms within

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STEM fields. Across study participants, it was reported that participants gained and developed skills necessary to navigate the academy, specifically as Deaf scientists in phonocentric STEM campus environments and other professional settings. Consistent through all themes was a shared expression of the importance of participants' shared Deaf cultural and linguistic background in achieving access. The study's themes are consistent with literature reviewed on mentoring in undergraduate research experiences, the impact of same background mentoring, and contributions to undergraduate students' success.

Much of the mentoring literature indicates that mentorship can be especially successful for minority mentees when shared social characteristics such as race and sex within the mentoring dyad are present (Dingus, 2008; Ensher & Murphy, 1997; Koberg et al., 1998; Patton, 2009; Ragins, 2007). Mentors serve as role models for members of underrepresented groups, inspiring them to overcome challenges and become resilient in system of oppressions (Lockwood, 2006; Whelley et al., 2003). Mentors with shared social characteristics are noted throughout the literature as assisting mentees from minority communities in navigating through challenges they—as mentors—have already overcome (Blake-Beard et al., 2011). The arena for these navigational strategies included both psychosocial (Koberg et al., 1998) and career development support (Ensher & Murphy, 1997). As result of shared social identities in this study, Deaf mentors connected with Deaf mentees on several meaningful levels.

Study findings on Deaf undergraduate mentoring experiences demonstrate the importance of Deaf navigational capital. Participants further contributed to the understanding of how Deaf mentors share knowledge to "fill in the gaps," assisting Deaf mentees in developing Deaf identity. Although this study did not specifically focus on intersections of race and sex, it does contribute to the literature by highlighting how Deaf mentors learned to "be" or develop identities within the realm of academia, specifically, the STEM fields. The featured mentors emphasized that Deaf undergraduate mentees needed models of how to be Deaf, in addition to helping them develop their identities as STEM researchers. One skill in particular that benefited mentees was the recognition that strong STEM preparation made them valuable commodities in Deaf and hearing settings. By observing mentors interact in professional settings, mentees developed navigational strategies for audistic and phonocentric society. Mentors emphasized that although mentees were being trained in largely Deaf environments, preparation for professional settings outside their institutions was necessary. Drawing upon modeling of networking, storytelling, and imparting self-advocacy skills were ways in which mentors attempted to prepare mentees for STEM settings.

Navigational capital was essential for Deaf mentees to shape and foster their scholarly progress and identity in the STEM communities. The systems, structures, and expectations necessary for success as a scholar require access to that which is often learned by identifying cues and nuances of communication and behavior in the environment. These remain distant and inaccessible to Deaf students when raised in predominantly hearing environments. Deaf mentors, uniquely equipped with knowledge and tools acquired through their experience, prepare mentees for their pursuits in graduate school and the STEM workforce by sharing stories and exposing them to professional settings.

Recommendations

The mentoring experiences featured in this study provide a detailed view of how to optimize mentoring experiences for Deaf undergraduates. Mentors integrated self-advocacy skills, STEM knowledge, and professional preparation into various socialization experiences, exposing students to STEM careers. Based on the findings of this study, Deaf scientists and scholars should consider creating a national coalition that focuses on STEM, using networks to expand knowledge bases, expand professional networks, and recruitment of Deaf graduate students. Such a coalition could include a central online presence for the purpose of creating and sharing resources, developing and informing readers about mentoring strategies and models, educating Deaf and hearing faculty about cultural mentoring practices, and helping to standardize and legitimize ASL STEM signs by sharing them virtually. Resources to be shared could include informative videos, an interactive series of vlogs, and links

to useful websites. One component of this online presence could be tailored to serve "mentors of Deaf undergraduates" and another to serve "Deaf undergraduates" with access to resources in each area appropriately designed to support each constituency. A coalition of this nature provides mentors the opportunity to create partnerships with one another, which could ultimately lead to the development of new mentoring models better suited for the particularities of Deaf students' experiences. Such efforts could most certainly expand professional networks of Deaf STEM scientists and undergraduates aspiring to STEM careers. These efforts could also enrich interpreting services by providing purposeful exposure to STEM related discourse, an area that as noted previously, may prove daunting for some interpreters.

Although this study focused on the pairing of Deaf mentors and Deaf mentees, it is not unlikely that Deaf undergraduate students currently receive mentorship from hearing mentors, given the limited numbers of Deaf scientists. Thus, for those hearing mentors of Deaf students, it is recommended that they provide appropriate and quality access services to support Deaf students' learning experiences in undergraduate research laboratories. For instance, hearing mentors should communicate with their institutional disability services office to ensure that Deaf students receive appropriate accommodations such as qualified ASL interpreters to mitigate the cultural and language differences in the lab. Hearing mentors can provide effective mentorship and advocacy in partnership with Deaf undergraduates.

Limitations

This study was conducted at two higher education institutions designed to support the educational needs of Deaf students. Given the institutional mission and student population of the two universities included in the study, the STEM context for Deaf researchers and undergraduates may vary greatly in institutions without a strong Deaf cultural presence. This study followed only three mentoring dyads. Their experiences are unique and cannot be generalized to other Deaf researchers and undergraduates.

Another limitation is the lack of racial and sex diversity among the participants. Participants in this study were primarily White males, with the exception of two female mentees, one of whom identified as a Student of Color. Although this study focused exclusively on shared Deaf cultural backgrounds, we recognize that a more nuanced treatment of intersectionality is needed. The participants featured in this study responded to questions in individual and dyad interviews that focused almost exclusively on Deaf social identity within the context of STEM fields. Attention to the intersection of race, sex, and Deaf social identity could provide increased understandings of how social constructions of difference impact students' and mentors' experiences in STEM. For example, questions considering an awareness of intersectionality could further complicate mentors' and mentees' experiences, specifically around issues of access and equity. Stapleton (2014), for example, provides an analysis of African American Deaf undergraduates' experiences with racially and audistically motivated microaggressions at a predominately White institution.

A more in depth analysis can demonstrate the ways in which race may serve as a mitigating factor in the building of navigational capital. A singular focus on Deaf social identity presumes that race and sex do not impact the socialization experiences or building of navigational capital among Deaf mentees who may be women of color in STEM spaces largely populated by White males. Thus, the lack of racial and sex diversity among the study's participants limited the identification of any findings or recommendations regarding social identities above and beyond shared Deaf identity. A contrasting study strength, however, is that it provides insights of how mentoring relationships are established between Deaf mentors and mentees in Deaf-serving institutions. Additionally, despite the limitations, this study remains valuable for informing higher education regarding the importance of matching mentoring dyads and the growth of individuals entering STEM fields.

Recommendations for Future Research

The participants in this study were situated at institutions for the Deaf, that is, institutions where Deaf culture is the majority culture and ASL is part and parcel of the campus communicative norms. Recognizing that such settings are unique, future research should extend the examination of Deaf undergraduates in STEM

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fields in campus environments where exposure to Deaf culture and Deaf mentors is not readily available. Such an examination could further extend the notion of building navigational capital for Deaf students by hearing mentors. Additionally, such a study could further understandings of how hearing mentors, or mentors who represent majority cultures and groups, build, extend, and share navigational culture. This line of research is especially important in the areas of STEM, where mentoring of women, students from underrepresented groups, and first generation students is critical (CEOSE, 2012).

A study using focus groups to gather information about the experiences of Deaf mentoring dyads could be built using information and themes from this study. Creating focus groups for Deaf participants may allow more dialogue and interaction, with participants adding to each other's insights, resulting in a richer narrative. Deaf community members are recognized as a collectivistic group, valuing cohesion and the open exchange of information with each other (Padden & Humphries, 2009), making focus groups an interesting methodological strategy for this community.

Applying quantitative methods to examine the benefit of Deaf mentoring relationships in STEM fields could be another approach to looking at this phenomenon. For example, measures of psychosocial related outcomes including resilience, self-esteem, and quality of life could be applied to better understand the impact of Deaf mentoring dyads. Finally, future studies should purposefully include more women and individuals of color as participants, to generate a greater understanding of the intersectionality of social identities including race, sex, ability, and institutional context.

Conclusion

Deaf mentors in this study supported the professional socialization and personal development of Deaf undergraduate mentees. In return, mentees developed navigational skills by watching mentors work across settings including labs, meetings, and professional conferences. The resulting relationships empowered mentors as role models, while giving mentees the tools necessary to become resilient Deaf scientists in a phonocentric society. The Deaf mentoring dyads featured in this study provide a response to the national call to increase STEM study and success through shared cultural mentoring relationships. The findings suggest that the efforts of Deaf mentors in building navigational capital in their mentees offers a unique alternative model for the general scientific community seeking to increase and support STEM undergraduates. For Deaf and hearing scholars mentoring Deaf students, and for all STEM scientists working with the broad community of emerging scholars, there is much to be learned from the success of Deaf dyads, and much to be gained for a national STEM agenda.

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