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THE IMPOSTOR PHENOMENON AMONG BLACK DOCTORAL AND POSTDOCTORAL SCHOLARS IN STEM

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ABSTRACT

Aim/Purpose	This study examined experiences related to the impostor phenomenon among Black doctoral and postdoctoral scholars in science, technology, engineering, and mathematics (STEM).
Background	Research on the impostor phenomenon is usually focused on undergraduates, especially for Blacks, with sparse research on Black doctoral and postdoctoral scholars. This phenomenon was originally investigated among Whites. Due to fewer studies on Blacks, culturally-relevant understanding of the impostor phenomenon is limited.
Methodology	This study used surveys and interviews (convergent mixed-methods) to examine the impostor phenomenon among U.S.-based doctoral and postdoctoral scholars (together referred to as "trainees") in STEM. Participants took a survey (that used the Clance Impostor Phenomenon Scale or CIPS to individually compute impostor phenomenon scores) and a one-on-one, semi-structured interview. Survey (with CIPS scores) and interview data were converged from the same participants, who were recruited from a national conference focused on minorities in STEM (convenience sampling). Using constant comparative method and analytic induction, interview-data were categorized into themes.
Contribution	Findings documented race-based impostor-experiences, possibly culturally relevant to other groups of underrepresented minorities (URMs). Findings have implications for research, policy, and practice. These include future initiatives to broaden participation in STEM careers among the underrepresented groups, support those who might experience this phenomenon and transition challenges in academia, and create greater awareness of the challenges trainees face based on their background and life experiences.
Findings	Surveys indicated moderate to intense impostor phenomenon among 15 participants at the time data were collected. Interviews with the same participants found six themes linked to the impostor phenomenon: 1) Being the

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	only-one, 2) Lack of belonging, 3) Stereotyping, micro-aggression and judgment, 4) External appearances, 5) Feeling like the "diversity enhancers," and 6) Complications of intersecting identities.
Recommendations for Practitioners	Practitioners should consider the tensions and complications of Black identity and how it ties to training experiences in STEM as well as how race-based impostor phenomenon could shape an individual's interaction with faculty, mentors, and peers. This knowledge could be helpful in designing professional development programs for Blacks.
Recommendations for Researchers	Study findings could have research implications on the way doctoral and postdoctoral training is reimagined to be more inclusive and welcoming of diversity across multiple axes of gender, race/ethnicity, class, first-generation status, ability, sexual orientation, and country of origin, among others.
Impact on Society	Black trainees could be vulnerable to leaving STEM fields due to their underrepresentation, lack of critical mass, racial discrimination, and other unpleasant experiences. Conversations around training, development, and means to address psychological distress could focus on culturally-relevant experiences of the impostor phenomenon.
Future Research	Future research could look at the experiences of other underrepresented groups in STEM such as Native Americans and Hispanics as well as among faculty of color and individuals from other fields beyond STEM.
Keywords	impostor phenomenon, impostor syndrome, Black, STEM, doctoral training, postdoctoral training, higher education, STEM PhD, STEM postdoctoral scholar

INTRODUCTION

The impostor phenomenon encompasses a psychological condition with a pattern of beliefs held typically by accomplished people who secretly feel like frauds (Harvey & Katz, 1985). The term was first used by Drs. Pauline Rose Clance and Suzanne Imes, two psychotherapists, in 1974. The phenomenon was first explored while interviewing highly accomplished women who believed that they did not deserve their success, which they thought was achieved by deceiving others (Clance, 1985). Research conducted over more than 40 years since then shows that such insecurities are not restricted to successful women alone. People of all genders (Chakraverty, 2019) and professions experience this phenomenon, including those in the health professions – pharmacy residents (Sullivan & Ryba, 2020), medical students (Houseknecht et al., 2019; Villwock et al., , 2016), and dental and nursing students (Henning et al., 1998) – managers (Rohrmann et al., 2016), librarians (Barr-Walker et al., 2019; Clark et al., 2014; Martinez & Forrey, 2019), and science, technology, engineering, and mathematics (STEM) trainees (Blondeau & Awad, 2018; Chakraverty, 2019; Ivie & Ephraim, 2009). It is experienced by undergraduate students (e.g., Aycock et al., 2019), graduate students (e.g., Chakraverty, 2020a; Cohen & McConnell, 2019; Cope-Watson & Betts, 2010; Gibson-Beverly & Schwartz, 2008), and faculty members (Guillaume et al., 2019; Hutchins et al., 2018; Sims & Cassidy, 2019).

The impostor phenomenon is related to several outcomes that make it particularly problematic: outcomes such as concerns about mistakes signifying maladaptive perfectionism (Pannhausen et al., 2020), mental health issues (Sullivan & Ryba, 2020), psychological distress (Wei et al., 2020), anxiety and depression (Fraenza, 2016; Wang et al., 2019), fear of ridicule (Brauer & Proyer, 2019), and perceived feelings of competition (Canning et al., 2019). It is also related to academic under-preparedness (Cisco, 2020), self-doubt (Guillaume et al., 2019), lack of wellness (Houseknecht et al., 2019), burnout (Leach et al., 2019), lower self-esteem (Schubert & Bowker, 2017; Sonnak & Towell, 2001),

impaired motivation (Vaughn et al., 2019), inadequacy (Cope-Watson & Betts, 2010), fear of being isolated or singled out (Cohen & McConnell, 2019), questioning oneself (Stone et al., 2018), lower self-efficacy (Blondeau & Awad, 2018), and other self-limiting traits. The Clance Impostor Phenomenon Scale (CIPS; Clance, 1985) is a popularly used scale used to measure the extent of impostor-feelings an individual experiences. It was developed to psychometrically cover the three dimensions representing the phenomenon: luck/chance as compared to one's ability as an indicator of success, fakeness or fraudness one experiences thereof, and disregard of personal achievement (also termed as luck, fake, and discount) (Chrisman et al., 1995; French et al., 2008). Experiencing this phenomenon could impact academic training experiences for those obtaining doctoral degrees (specifically, Doctor of Philosophy or PhDs) (Chakraverty, 2020a) and postdoctoral scholars (Chakraverty, 2020b). In this study, the author used the term "trainee" for people in training (both PhD students and postdoctoral scholars).

Of particular concern is how impostor phenomenon affects the marginalized and vulnerable groups such as first-generation students (Canning et al., 2019) and students from lower socio-economic status (MacInnis et al., 2019). Particularly, Blacks or African Americans represent 12% of the overall U.S. population (That is expected to increase to 15% by 2060), yet their representation in science and engineering fields is proportionally lower (Hamrick, 2019). In 2016, Blacks earned 9% of bachelor's degrees in science and 4% of bachelor's degrees in engineering (Hamrick, 2019). Further, the graduate program enrollment in science and engineering (including both, master-degree and PhD-degree students) amounted to 7% Black women and 4% Black men (Hamrick, 2019). At 7.7% full-time employed and 12.1% unemployed Black scientists and engineers in 2017, there are more unemployed than employed, although the trend is reverse for Whites (Hamrick, 2019).

Further, in science, engineering, and health, in 2017, Black doctoral and postdoctoral trainees comprised 3.5% (n=9,483) and 1.6% (n=1,019) of the overall number of doctoral and postdoctoral trainees respectively among U.S. citizens or permanent residents (National Science Foundation [NSF], 2017). In science and engineering alone, there were 2,409 Black PhD recipients in 2017, a jump from 1,961 in 2008 (all Black U.S. citizens or permanent residents) (NSF, 2018). International scholars (foreign-born, temporary visa holders in the U.S.) comprise of 34.7% and 35% respectively of the overall doctoral and postdoctoral population in science, engineering, and health-fields respectively; however, data on their racial/ethnic background is not available (NSF, 2017). In other words, we do not know what proportion of the international scholars training in the U.S. are Black. However, according to the National Center for Science and Engineering Statistics, there were 532 foreign-born, Black PhD recipients in science and engineering in 2017, a jump from 431 in 2008 (NSF, 2018). All international scholars (including Black international scholars) face additional challenges in the acculturation process (Burt et al., 2017) and limitations imposed by their visa status, such as being ineligible to be on training grants, fellowship (F) grants, get career development awards (including most K awards), and apply to most of the federal grants (Pickett, 2019; Stephan, 2012).

Thus, Blacks continue to be underrepresented in many STEM fields at various stages of higher education and training. Although Black women are somewhat better represented than men, women face many challenges including academic exclusion (Rosa & Mensah, 2016), especially exclusion due to the combined effect of their race and gender (also known as "double bind") that leads to racism, sexism, and bias (Ireland et al., 2018; McGee & Bentley, 2017). Black males also find it challenging to persist in STEM fields, with college-going Blacks in engineering and other STEM fields reporting isolation, invisibility, lack of preparation prior to entering college for succeeding in STEM, and lack of peers and professors from the same background and race (Strayhorn et al., 2013). While Blacks face many unique challenges to thriving in STEM careers, there is a dearth of professionals trained for STEM jobs along with the lack of equity, inclusivity, and diversity. This challenges the development of cultural competence and opportunities to benefit from diverse life experience and ideas that engender innovation (Ireland et al., 2018).

Black trainees could be experiencing race-based or general impostor phenomenon along with stress due to their underrepresentation and minority status, lack of critical mass and role models, and discriminatory experiences, among others, being at-risk of leaving their field. Yet, race-based, culturally-relevant experiences of the impostor phenomenon due to racism, discrimination, and marginalization is an understudied area. Experiencing the impostor phenomenon could be one of the many reasons for the lack of demographic diversity in STEM with a history of underrepresentation of Black scholars at all levels including in doctoral training. The purpose of this study was to examine experiences of the impostor phenomenon among Black doctoral and postdoctoral scholars in STEM.

LITERATURE REVIEW

Impostor phenomenon is one of the many challenges that Blacks experience in STEM training (Chakraverty, 2013). Prior research with predominantly White STEM PhD students experiencing this phenomenon has shown some generic challenges in their training that extends across all genders and race/ethnicities in the U.S. (Chakraverty, 2020a). Reluctance to engage in scientific communication through public talks and academic writing, reluctance to collaborate and apply newly learnt skills, comparing oneself unfavorably with peers, and getting stressed about achieving PhD milestones or public recognition are some of them. However, there could be specific challenges that Black trainees experience due to impostor phenomenon. The following section critically examined U.S.-based research examining this phenomenon among Blacks in STEM.

FRAMEWORK FOR UNDERSTANDING IMPOSTOR PHENOMENON AMONG BLACKS

This section examined impostor phenomenon research conducted with Black undergraduates and graduate students. Overall, there are 20 U.S.-based studies summarized below. To the author's understanding, no study has yet looked at Black postdoctoral scholars. Study insights from both undergraduate and graduate literature contributed to a well-rounded understanding of the impostor phenomenon, helping in implementing the current study to add new knowledge and address some of the identified research gaps.

Studies of Black undergraduate students

Sixteen (80%) of the 20 studies identified focused on undergraduates (eight with a mixed sample including Blacks and eight with just Black undergraduates). All the studies used a quantitative methodology. Among those with a mixed sample, all except one (Li et al., 2014) collected data from one university each, although Li et al. (2014) did not specify how many universities were represented in their sample (See Table 1 for a detailed summary of literature about a mixed-sample). The other eight studies focused on just Black undergraduates, using cross-sectional surveys with self-reported data collected across one time-point. These studies mostly focused on mental health issues and race-based stress. In summary, most of these studies pointed to several ramifications of experiencing mental health distress among undergraduates (See Table 2 for a detailed summary of literature about Black undergraduates).

Table 1. Summary of literature examining the impostor phenomenon among a mixed-sample of undergraduates (organized chronologically)

AUTHORS	SAMPLE	FINDINGS (The impostor phenomenon was correlated with-)
N. S. Bernard et al., 2002	n=190; 20% Black	High neuroticism and low conscientiousness
Castro et al., 2004	n=213; 34% Black	Parentification styles
Cokley et al., 2013	n=240 minorities; 21% Black	Poorer mental health and stress due to minority status
Li et al., 2014	n=506; 17% Black	Lack of parental care and parental overprotection
Cokley et al., 2015	n=491; 22% Black	Gender stigma consciousness
Peteet, Montgomery, & Weekes, 2015	n=161 minorities; 73% Black at one large PWI	Low psychological well-being, first-generation status, and low ethnic identity
Cokley et al., 2017	n=322 minorities; 34% Black	Perceived discrimination and mental health issues
Cokley et al., 2018	n=468; 14% Black	Lower self-esteem and maladaptive perfectionism

Table 2. Summary of literature examining the impostor phenomenon among a sample of just Black undergraduates (organized chronologically)

AUTHORS	SMAPLE	FINDINGS
Austin et al., 2009	n=97 from one historically Black university	Impostor phenomenon mediated survivor guilt and increased signs of depressive behavior
Peteet, Brown, et al., 2015	n=112, conducted all across the country	Higher impostor phenomenon correlated with lower self-esteem and higher psychological distress
McClain et al., 2016	n=218 from multiple universities, numbers unknown	Both impostor phenomenon and stress due to minority status associated with poorer mental health
D. L. Bernard et al., 2017	n=157 (69% women) from one PWI	Impostor phenomenon related to mental health issues and psychological distress among women who also experience racial discrimination. Highlights the role of gender-based and race-based discrimination in increasing impostor phenomenon
Lige et al., 2017	n=112 from at least two PWIs	Self-esteem mediated the relationship between impostor phenomenon and racial identity. A sub-sample (~31%) of these 112 undergraduates were from STEM (specifically, physical sciences and engineering)
D. L. Bernard et al., 2018	n=157 (58% female)	Both racial identity and race-based discrimination increase impostor phenomenon. Indicates the role of gender-based and race-based discrimination in increasing impostor phenomenon

AUTHORS	SMAPLE	FINDINGS
Walker, 2018	n=113 female STEM majors from two public universities in one U.S.-state	Academic self-efficacy was a statistically significant predictor of the likelihood of an individual persisting in STEM. A significant negative relationship between impostor phenomenon and academic self-efficacy points to the potential relationship between impostor phenomenon and persistence in STEM
Graham & McClain, 2019	n=117 from one PWI	Undergraduates with a stronger sense of belonging to one's university had lower impostor phenomenon; class performance (indicated by grade point average) not significantly predicted by experiencing impostor phenomenon; the authors however warranted more research to support their findings

Studies of Black graduate students

There were four (20%) identified studies examining impostor phenomenon among Black graduate students. The only survey-based study conducted about 25 years ago with 103 participants found that academic self-concept was the strongest predictor of all the variables (including graduate school environment) for impostor phenomenon, even more than racial identity (Ewing et al., 1996). Further, an Afrocentric worldview also predicted this phenomenon. The study did not specify if the participants (graduate students) were doctoral students.

The other three studies used a qualitative methodology. Craddock et al. (2011) found that impostor phenomenon was linked to feelings of inadequacy and academic under-preparedness, stress due to first-semester coursework, one's racial identity, family expectations, and fear of failure. The study used semi-structured interviews and a focus group with a mixed sample of six doctoral students in a higher education program at one research-university where only one or two (number unspecified) were Black (the study mentioned including two persons of color with Black/Latina/Native-American identity).

Burt et al. (2017) interviewed nine "Black men in engineering graduate programs … who self-identified as foreign-born [i.e., born outside the U.S.] and/or identified ethnically as other than African American" (p.929) (perhaps some or all were doctoral students). The authors identified racialized impostor phenomenon including stress-inducing factors in graduate school such as lack of belonging in classes, departments, engineering field, or the larger Black community, identified as a stressor while transitioning to a new, unfamiliar cultural environment. This lack of belonging was partly due to their racial underrepresentation that made participants question their place in engineering or in a graduate program, feeling like an outsider during professional interactions. These racialized experiences were predominantly due to others' reaction (surprise or questioning their place in a competitive PhD program), leading to experiencing race-based othering and impostor phenomenon. Othering refers to the "set of dynamics, processes, and structures that engender marginality and persistent inequality across any of the full range of human differences based on group identities" (J. A. Powell & Menendian, 2016). Students felt like they had to constantly prove to others that they deserved to study in predominantly White institutions (PWIs), leading to stress, burnout, anxiety, and lack of confidence. Lastly, Stone et al. (2018) examined culturally relevant factors such as race and racism using multiple focus groups with 12 Black graduate students (including five doctoral students) at PWIs and found five key factors connecting impostor phenomenon to one's identity as a Black student: lower representation in PWIs as students and faculty, self-imposed and externally-imposed expectations in academia, questioning intelligence by self and others, the psychological cost of being a Black student, and attributing one's success to outside factors.

Gaps in Current Literature and Methodological Decisions in the Current Study

Existing impostor phenomenon research among Blacks has several limitations. Most research has focused on undergraduate education. Those focusing on graduate education often included both master and PhD students, although the nature of PhD training is different from master's training because it is longer and usually mandates producing original research as a dissertation. Postdoctoral trainees are an overlooked group, none of the identified studies focused on them. Further, most studies used quantitative designs to test for associations or correlations between impostor phenomenon and other variables. Qualitative studies are few, although they help us develop an in-depth understanding of a phenomenon (Marshall & Rossman, 2014; Stange et al., 2006). Also, most studies collected data from one or few PWIs. To address these limitations, the author conducted a mixed-method study (Creswell & Clark, 2017) examining impostor phenomenon among Black doctoral/postdoctoral trainees in STEM. Participants were from across different U.S. institutions. These methodological considerations were based on the gaps in the four studies with Black graduate students described above.

METHODS

Data Collection

Following IRB approval from a large, public university in the U.S., this study used convergent mixed-methods design (Creswell & Clark, 2017) and conducted one-time surveys followed by semi-structured interviews among the same sample of 15 individuals. In this study, participants (doctoral and postdoctoral scholars) are jointly referred to as "trainees" since they are still undergoing training in STEM. Methodological limitations in prior literature among Black doctoral students includes dearth of quantitative and qualitative (and lack of mixed-method) studies, data collected at one or few PWIs, and small sample sizes in qualitative studies between one and nine participants. Other than one survey study with 103 participants (Ewing et al., 1996), the other three studies used qualitative methods including semi-structured interviews with one or two Black doctoral students as a part of a mixed sample (Craddock et al., 2011), semi-structured interviews with nine foreign-born, Black, male, engineering graduate students (perhaps some or all of whom were doctoral students) (Burt et al., 2017), and multiple focus groups with five Black doctoral students (Stone et al., 2018).

In the current study, the first-step of data collection through surveys helped obtain demographic information about individual participants (Table 3) as well as compute how intense was their impostor phenomenon through the CIPS (Clance, 1985), a scale popularly used to measure the impostor phenomenon (described above). The survey was also a means to inform participants about an upcoming interview as a second step of data collection, thereby employing a multi-mode, multi-step data collection process (Creswell & Clark, 2017).

The author attended a national conference in 2018 about broadening participation and encouraging minorities to pursue research-based science careers. This conference was attended by a few hundred principal investigators, faculty, postdoctoral scholars, and doctoral students in Baltimore, MD. At this conference, the author distributed business cards with her contact information and the link to participate in the survey. Those identifying as Black took the online survey; the author did not individually solicit their participation and did not personally or professionally know any one of them.

Table 3. Participant Demography

TOTAL	N=15
Age (years)	20-29: 8 30-39: 7
Sex	Female: 13 Male: 2
Position	PhD student: 10 Postdoctoral scholar: 5
Citizenship	Foreign-born: 3
Field	Life sciences and medicine: 8 (including biology, biomedical sciences, cell biology, computational biology, microbiology, and physiology) Chemistry and biochemistry: 2 Engineering: 3 Geosciences: 1 Mathematics: 1
University affiliation	15 different R1 universities (including two Ivy League universities) in the following U.S.-states: Alabama, Arizona (two), California, Florida, Georgia, Indiana, Maryland, Missouri, New Jersey, New York (two), Texas, Virginia, Washington
Clance Impostor Phenomenon Scale (CIPS) scores (0-100)	Moderate (41-60): 2 High (61-80): 8 Intense (81-100): 5 Mean: 72.33; Std. dev.: 13.86; Range: 53-92

Eligibility

Those fulfilling the following criteria were eligible to participate: 1) Identify as Black, 2) Currently a PhD student or postdoctoral scholar in STEM at a U.S.-institution, and 3) Familiar with the impostor phenomenon and experienced it recently (verified by some preliminary interview questions). Participants from all genders, ages, nationalities, generation status, and U.S. locations were welcome to participate as long as they fulfilled the above three criteria.

Surveys

First, interested participants filled out an online survey (7-8 minutes) hosted by the author's university webpage. The webpage defined and clarified that the study was being conducted to expand understanding of the impostor phenomenon (Clance & Imes, 1978). The survey had demographic questions to determine eligibility. Additionally, the 20-item scale (CIPS; Clance, 1985) was used with permission as a popular validated Likert scale to measure the extent to which impostor phenomenon occurred at the individual-level. Each of the 20 items had five options (1 = not at all, 2 = rarely, 3 = sometimes, 4 = often, 5 = very true) and it was mandatory to answer every item. Participants also provided their email address to be contacted for an interview as the next step.

Interviews

Next, individual interviews were conducted on phone with the same survey participants. However, the survey results did not determine the nature of interview questions asked. The author scheduled and conducted all the interviews based on mutual availability following a semi-structured format. Questions included probes to ensure that participants had a good understanding of the impostor phenomenon. Each interview started with the author asking the participants to explain what they understood of the impostor phenomenon, preferably using personal examples. Then, the interviews probed into the following aspects: 1. How did racial identity as a Black person in STEM shape their experiences and make them feel like an impostor? 2. What were some of the personal and environmental factors that contributed to this phenomenon? 3. What were the day-to-day manifestations of this phenomenon? 4. Were there other identities they held that contributed to this phenomenon? Due to a semi-structured format, additional questions emerged when participants elaborated on certain experiences. The author developed the primary interview questions based on gaps in current research and inputs from another colleague whose research focused on underrepresented minorities in STEM. Each interview lasted between 45-60 minutes. The interviews were transcribed through a professional transcribing agency and shared with individual participants. Participants were invited to read the transcript to ensure transcription accuracy and add more information if they felt necessary or delete anything that made them uncomfortable.

Data Analysis

Given the limited understanding of how impostor phenomenon affects Black STEM trainees, the author used a combination of surveys and interviews to collect data in contrast to extant literature that has focused on surveys (see Tables 1 and 2) and some interviews. For the quantitative component, the CIPS scores (Clance, 1985) were calculated individually by cumulatively adding up individual scores allocated to each scale item. According to individual scores, participants were classified as experiencing low (less than 40), moderate (41-60), high (61-80), or intense (81-100) impostor phenomenon. A higher score indicated higher impostor phenomenon.

Next, interviews were qualitatively analyzed (Patton, 2014) using a phenomenological approach (Kvale & Brinkmann, 2009; Moustakas, 1994) to understand how racial identities could contribute to one's impostor phenomenon through participants' narratives of current and past experiences (Giorgi & Giorgi, 2003; Marshall & Rossman, 2006; Seidman, 1998). The purpose of the in-depth interviews was to leverage on rich descriptions to make meaning of the impostor phenomenon along with the participants through thematic development (Creswell, 2012; Gall et al., 2007).

The author (coder one) and a graduate student (coder two) analyzed all interviews with a set of initial codes developed by the author based on existing literature and preliminary review of the interview transcripts. Codes included "racism," "minority stress," "Black identity," "environment," and "other identity." Each interview was open-coded line-by-line to create a list of additional emergent codes. Then, new codes were discussed, and coding disagreements were resolved through discussion until a consensus was reached. Some of the codes that were not a part of the original coding list but emerged after data analysis included "diversity," "belonging," "isolation," "self/peer evaluation," and "mental health." By using a constant comparative method (Glaser, 1965; Pope et al., 2000) and analytic induction (Pope et al., 2000; Thomas, 2006), the codes were compiled into themes about the impostor phenomenon experienced as a Black person in academia.

The author and coder two accounted for how their worldviews were different from study participants although they both were persons of Asian origin, considered minorities in academia. Additionally, the author's identity as a foreign-born researcher added to her understanding of the struggles of foreign-born participants. Both remembered that their collective identities reflected in the way data were collected, analyzed, and managed (Antin et al., 2015). They maintained reflective journals to note down reflections and any disconfirming evidence. Their background in STEM also contributed to the way the study was envisioned. The CIPS scores helped establish that those interviewed in this

study indeed experienced the impostor phenomenon; the interviews further clarified in detail what aspects of Black identity contributed to their impostor phenomenon following a constructivist approach (Creswell & Clark, 2017). The themes that emerged from interview analysis are listed below with participant quotes.

FINDINGS

Fifteen Black trainees (PhD students or postdocs in STEM) completed a one-time survey followed by a semi-structured interview conducted by the author. The study presents findings from 15 participants through both quantitative (demographic data and CIPS scores; Clance, 1985) and qualitative (Miles & Huberman, 1994) data. Surveys were used to compute impostor phenomenon scores. Interviews were used to develop themes that more deeply explored the impostor phenomenon.

QUANTITATIVE: SURVEY RESULTS

Two, eight, and five participants scored moderately, highly, and intensely in CIPS, with a mean of 72.33 ± 13.86 and a range between 53 and 92. The CIPS scores indicated that there were no low scorers. Everyone experienced between moderate to intense levels of impostor phenomenon at the time of the study. Participants were in their twenties and thirties and mostly female. There were three foreign-born Black participants. Participants were largely from the field of life sciences and medicine, with some representation from other STEM fields. Each participant belonged to a different research-focused (R1) university in the U.S. based on the Carnegie classification (The Carnegie Classification of Institutions of Higher Education, n.d.) (See Table 3).

QUALITATIVE: INTERVIEW FINDINGS

The impostor phenomenon for Black trainees related to the following six themes: 1) Being the only-one, 2) Lack of belonging, 3) Stereotyping, micro-aggression and judgment, 4) External appearances, 5) Feeling like the "diversity enhancers," and 6) Complications of intersecting identities. These are listed in Table 4 followed by a discussion of each.

Table 4. Themes linked to the impostor phenomenon among Black doctoral and postdoctoral scholars in STEM

THEMES	QUOTES
Being the only-one	I have issues with imposter syndrome on a regular basis, just looking around and not seeing anybody that I identify with, particularly as a Black female, wondering whether or not I have enough authority, enough experience to be in that space at that time.
Lack of belonging	As a Black woman, it's a rare thing for me to inhibit this space, there's not a lot of Black people in science. As a Black woman, I should have been weeded out a long time ago. I shouldn't have made it as far as I made it. I somehow always manage to achieve despite statistics telling me that I shouldn't.
Stereotyping, micro-aggression and judgment	I have too many constant micro-aggressions that are coming at me, that validate that awful voice inside that causes doubt.
External appearances	If you're not a very White looking, White male, everything is harder for you in academia. I feel like an impostor in a room full of people who do not look like me.

THEMES	QUOTES
Feeling like the "diversity enhancers"	I even felt when I got my offer letter [for an internship] from [name of company] that I was just a quota, like a number, because I'm a Black. My interview, I'm still shocked how easy it was. Maybe they made it easy to make sure I got in. I thought it was because of the diversity quota.
Complications of intersecting identities	As a woman, also Africans, and a first-generation African American, it's like you don't fit in the African world; you don't fit in the American world. Sometimes, you're too American to be African, but you're too African to be American, but you're still Black, and you're in America. I'm not really part of the African community or part of the African-American community.

Being the only-one

Being the only Black or only Black woman in class, research group, or cohort reinforced impostor phenomenon. A postdoctoral scholar shared that none of the friends she grew up with went into academia, adding, "That's kinda how it [impostor phenomenon] started. I thought, 'why am I in here?'" She wondered what are the odds that she would succeed in her doctoral program if she did not see other Black people. She felt that having greater representational diversity "would do a lot for combating impostorism, because you wouldn't be seeing yourself as such a unicorn, because there'd be other people like you."

There were many issues of being the only Black person in a professional setting. One, trainees may not have access to mentoring from same-race peers or professors, if desired. A student, until her final year of PhD, had not met another African American woman with a PhD in chemistry. It was limiting for her because "you don't realize where you can go if you don't see anybody else like you in those positions succeeding. I don't necessarily have somebody who I can identify with on all my levels, like professionally and personally." Another student could not find a Black, female mentor in her field. It made her wonder what are the odds that she would succeed in her field.

Two, being the only-one reinforced impostor-like feelings due to the isolation and social exclusion it caused. An only Black student shared that others in her class never offered to collaborate, study together, or participate in ongoing research with her because those students had their own cliques. She added, "You're never really invited to the table. I don't know if they don't respect what I can do, or if it's the fear that I'm not good." Another student similarly shared that she never got invited to sit at the lunch table by her White labmates. "You feel out of the loop. You don't get invited to these things. They don't care that they're basically making that clear."

Three, being the only Black person in a White, male-dominated field eroded one's self-confidence. As an only Black female in the room frequently while presenting her research, a student regularly wondered, "It's the imposter syndrome where I'm thinking, am I really the best one to be the one actually leading this or talking about this, even if I've prepared for it?"

Four, it increased one's fear of being singled out or be misunderstood. It made a student feel "more likely to be put on the spot because everyone realizes that you're the only one that's different." She felt like people had higher expectations from her, and it contributed to her impostor phenomenon. A postdoctoral scholar added that her non-Black peers did not understand her insecurities around being Black and feeling like an impostor. She added, "I don't think people can understand it, to me it's too much hassle, and too much worry to try to justify to you why I feel the way I feel." On receiving a grant, she wondered "did they really mean to give it to me," and one of her peers said, "'You just got $50,000, I don't understand why you're complaining.'" She was not able to explain that she

wasn't complaining but "have the insecurities and this impostor syndrome, but they won't ever understand that."

Lack of belonging

The stereotypes around being minority made it hard to develop a sense of belonging. Sometimes, lack of belonging was triggered because there was no one in the family in academia or no one with a PhD, compared to their White peers. This was especially for first-generation college students. During conversations, a postdoctoral scholar shared that others talked about well-known researchers "on a first-name basis, who are at other institutions and the research they did, and all these people I had never heard of." This led to doubts about "I don't know why I'm here, this is not my world, this is the world for these people. It's all been a mistake. I'm not White. I don't think I fit in anywhere." The postdoctoral scholar worried that her impostor-feelings would not go away "even if I got the degree, even if I published. I now have 10 papers, but it's just always there." Another postdoctoral scholar shared that her impostor phenomenon was triggered due to her double-minority status as a Black woman, and "in terms of not belonging, it's not a new sensation [feeling like an impostor]. It is actually the norm." Similarly, a student shared how prevailing stereotypes affected the way people thought about minorities. He added:

> You always have to battle that and try to prove that you're not an imposter. Like you belong there, despite what people may think. And the more stress or pressure there is in that situation, the more stressed you feel about being an imposter.

The student shared that graduate school academic systems were built to have a disproportionate disadvantage for Blacks. "Some of them [disparities] are subtle and some of them are not so subtle. These disparities, they're cumulative. They widen over time. They have a multiplier effect and you never get caught up."

Participants wondered how well they fit in the academic culture, making them question why they were there. As an only Black woman in the entire program, a participant "felt like my classmates were thinking, maybe, that I wasn't adequate because I was Black. Being a minority, a double minority actually, definitely adds to it. I felt all the time that I'm representing an entire race." Another student shared that although she never failed a test, "it still doesn't take away that inner questioning. [that why am I here]. It's a constant struggle internally."

Stereotyping, micro-aggression and judgment

Students who received minority fellowships for doctoral studies were singled out by those who did not. A student (also a recipient of a minority fellowship) described that she felt othered and her impostor phenomenon was triggered when a fellow student "got in my face one day and said that it's not fair that I was making more [money] than some of the other graduate students. He had no idea what my background was." Unintended stereotyping and judgment was a part of routine lab conversation among peers. A student shared that her White lab mates had a perception that it was easier to get a National Science Foundation (NSF) grant as a Black person. One lab mate had remarked, "Black people rule NSF." As a result,

> That's a driving thing behind my feelings of being an imposter. I feel like I need to show that I deserve to be here, regardless of my color. If I don't feel like I'm living up to that, I feel like I am not doing justice to the fact that I got this NSF fellowship and that I got into this program at all.

When she received the grant and it was announced in the department, she felt "embarrassed, like I didn't want people to know that I got it, because I didn't feel like I should have. I worried that people would think I got it because of my color." She added that she barely felt qualified to be in graduate school, and receiving the NSF grant did not make it better because she felt it was given to her because of her color.

Another student saw that other senior Black PhD students were judged more harshly during their dissertations compared to White students. "In my second year of graduate school, another African American woman gave a presentation in front of the department, and they ate her alive. I felt like she was being attacked." The participant internalized this incident and started doubting herself after that. "I felt like the least qualified in the room. I always feel like I can't ask questions, because people are gonna make fun of me or they're gonna ask me, 'Why are you even here?'"

A student who got her undergraduate degree at a Historically Black College and University (HBCU) was now at a PWI where she met people who felt like due to her HBCU background, her work wasn't as high of a caliber and she wouldn't be successful. She shared, "I knew that some people were counting me out, those who had this perception that people of certain groups are not qualified for certain positions just because they belong to a group." This made her feel like an impostor.

While applying for a PhD program in a medical school, a student who asked for a recommendation letter from her college professor was told:

> she [the college professor] didn't believe I had what it took to be a scientist, but she thought I was a nice enough person, so instead of writing me a letter to keep me out of medical school, she just wanted to tell me that she didn't think I was capable, and she thought I would make a very nice social worker, but really nothing beyond that.

She added, "I had received one of the highest grades in her class. I had received a scholarship from the School of Medicine to go to college. But there were people that didn't think I was very intelligent or capable." This left her devastated.

A student explained that a lot of judgment she faced was institutionally reinforced and had a historical background. Institutions of higher education in the U.S. weren't set up for African Americans but predominantly for White males. "We are interlopers. You are challenging a lot of tradition. You're different in a different way and that's just threatening to people who don't like difference." In her doctoral training, she met people who questioned if she was smart enough because earlier,

> there were laws that prohibited people who look like me from even learning how to read. There are still perceptions that we're not competent because, in order to justify that system, there were narratives about the inability of people who look like me to learn or who even had the intellectual capacity to learn.

A postdoctoral scholar shared that in every new position where she had to learn a new role, she questioned whether or not she should be there. "There were very few women of color who were achieving these roles." This made others wonder how she got her postdoctoral position and if she was competent enough to be there. She added, "I was questioning myself because other people were questioning me too." She heard comments like she must be in academia due to affirmative action laws "and not because you're smart. It was told to me, and not just on one occasion, by older White males."

External appearances

Black participants were judged on their looks, clothes, external appearances, and voice intonations that made them experience impostor phenomenon. A postdoctoral scholar shared that she had to be careful about "the way you sound, say things, wear your hair, smile, you can't be too threatening." She felt that her achievements are because she did not sound Black when talking.

> When I talk, you can't tell what my race is. I have a high-sounding voice. I sound pleasant, apparently. I don't have an accent. I'm not too dark, so I'm not too threatening. I'm not too tall. I'm not too big.

A student did not see any advantage to smiling, looking pretty, and being docile, and the way she was perceived in her department bordered "on the shrill, assertive, aggressive side of things. That may

not be a sustainable professional image." A faculty once commented to her about her drawl. "Some people automatically assume, if you have a southern drawl, that you're not intelligent. I often find trying to make myself sound as neutral as possible." These factors contributed to her impostor phenomenon. Trying to keep up a personable appearance was sometimes overwhelming. A postdoctoral scholar shared:

> It sucks. Because often you feel like you have to smile, be careful of your facial expressions. They might say something that's so out-of-pocket, but you are very cognizant of the fact that as an African American, any time you speak, you are a representative of all African Americans.

Often, participants were mistaken as assuming other roles based on their skin color such as custodians, janitors, the technical person, the help, a receptionist, administrative staff, or one in charge of the audio-visual system. A student shared, "sometimes people automatically assume that you're undereducated or uneducated just because of what you look like, not for anything you said or anything you've done. … I had a lot of people challenging things I said in class."

A student was mistaken as a technical person in class, and months later, a White, male peer commented to her, complimenting, "you actually know your stuff." She described that she had to force herself to believe that she was supposed to be in graduate school getting a PhD. She added:

> They can't conceive that this person walking down the hall who looks a certain way belongs here in the academy. It's like imposters are people who feel challenged being in a place, so should I really be here? Then there are those people who create the environment for that.

Another postdoctoral scholar was mistaken as a help and again as a receptionist. She explained to the person in the department who mistook her identity: "I'm a scientist and I work upstairs. Why would I as a receptionist be asking about the pipette and the microscope? People just having this moment of shock, like, 'Oh, you're part of the team?'"

A student would be mistaken for the custodian while working in her lab many times, and on being corrected, "it would be this shock that I'm the person with that title, that I just told them. Okay, you don't know who I am, but you could ask me, verses making the assumption. I'm a fifth-year grad student." Similarly, a student once walked into the seminar room. A faculty in her department asked her in front of everyone if she was in charge of the audio-visual system. She added:

> It never occurred to him that I was a graduate student, and at that point, I had been in the department for three years. It was just interesting that I knew who he was but he didn't know who I was. His inclination was that I was staff and not a student, I assume because of my race and gender.

A student shared that as a female and minority in STEM, her department expected her to do a lot of outreach work which her White male peers are not expected to. She shared it being a "huge time sink" when she is expected to mentor all the children in the neighborhood but "my White male peers are just sitting at their desks studying." In her lab, she would be often "caught up in a lot of administrative work that occupies a lot of my time. It really bothers me when people start to treat me like administrative staff or staff instead of a student."

Such instances often rendered the person experiencing it invisible. A postdoctoral scholar explained:

> I feel like an impostor when ignored and overlooked at professional meetings and conferences, especially when I was the supposed 'expert' in the room on the topic. Academia suffers from unconscious bias and most folks find it hard to accept information from a dark-skinned woman.

Feeling like the "diversity enhancers"

One of the characteristics of those experiencing impostor phenomenon is disbeliefs in one's abilities following an achievement. Those who felt like impostors sub-consciously believed that their achievement was because they are Black, and not because they are able. This was validated by others, for example, a student who shared, "My mother has always pointed out me being a Black female has made me more attractive to schools." A postdoctoral scholar did not believe that she received a competitive, doctoral-level award and immediately questioned, "Was I the only person in this category? Or did you need a Black person? Is that how I won?" She added, "Usually, if I don't get something, then it'd be because I didn't deserve it, but if I do get something, it was because of luck, or accident, like it's rare that it has to do with me."

Another postdoctoral scholar who went to an HBCU for undergraduate training could not believe her acceptance into an Ivy League school for doctoral studies. She added:

> That was when I first started to experience this phenomenon. I went from a "not great" school from one of the poorer states in the country, as a Black female, to this Ivy League PhD program. You just have this underlying sense of disbelief that I'm only here because they needed to fulfil the quotas with women of color. It's all been some great big mistake.

A student raised similar concerns saying that although she was okay with being perceived as more appealing because she came from a diverse background, she also wanted to be treated equally with the others in the department. "I just worry that people see me and think I'm only here because I'm Black and a female, and that I'm not as smart as them."

A postdoctoral scholar submitting an F31 diversity grant (a pre-doctoral fellowship) as a racial minority underrepresented in STEM and received it felt anxious, "I've gotten an F31, but is it a real F31, because it's the F31 diversity. I kept thinking, well, I only got it because I submitted it from the diversity one." She further worried, "The fact that I improve the department's demographics substantially is not lost on me, and may have played a role in their willing to accept me."

Participants questioned themselves on getting into a competitive PhD program or summer internship at a prestigious tech company. A student shared, "I was the only African American male in my anatomy lab group and felt I was only accepted to diversify my class. I asked myself, were they doing me a favor, affirmative action stuff, or do I really deserve it?"

These feelings of insecurity were often borne out of comments made by others regarding one's race. When highlighted for outstanding achievement in the department, a student had a large poster of her work and her picture displayed in the hallway. She overheard someone in the hallway look at her picture and say, "'Oh, I guess they were trying to hit all the demographic groups.' Some of it comes from hearing stuff like that and asking myself, 'Why did I get selected?' Maybe cuz they have to have a certain quota."

Other students shared similar concerns when they overheard someone make inappropriate comments. A participant shared that Black students were viewed by their White peers as those who got into the program to enhance diversity. While applying for her PhD program, a peer recommended, 'They're desperate for Black people. Just apply,' adding, "I worry people think I only got in because of skin color. Maybe that's why they wanna interview me. Maybe they have to. Some of the peers think I'm only here because of quotas. I'm overrated or something."

Another student shared similar concerns when it came to awards and fellowships. Due to the initiatives at her university to promote diversity, she met people who treated her like an imposter, making her feel like she would win awards because she is a minority. She added, "That's why people sometimes look at us underrepresented students and they're like, 'Oh, you know, you're an imposter. You don't really belong here.' Other people feel as if you're getting an advantage in the competition."

Complications of intersecting identities

Impostor phenomenon experienced due to Black identity was multifaceted and included gender (being a woman in STEM), being biracial, and being foreign-born. The intersection of multiple identities could also result in a sense of not belonging (theme two), leading to impostor feelings.

Gender: Black women faced double-penalty due to their gender and race. A student felt what she called "double imposterism" because "it is the hardest to be a Black woman in science." She got comments about how well she spoke and how articulate she was despite being a Black woman, compliments that felt like people didn't expect her to be intelligent or articulate otherwise. She believed that she was accepted into the program due to her gender and race. "I noticed the importance given to admitting women and minorities," which made her believe that she was admitted because she was a Black woman and not necessarily because she was deserving. She was not the only one. Another participant shared that she was aware that being a Black female helped her get into graduate school. It made her an attractive PhD candidate, "a more desirable student than if I had been the exact same thing but White." This made her worry that a chance was taken on her for being "an unconventional student because I'm a Black female, and that if I had the same application as a White male, I wouldn't have gotten in." On another note, a postdoctoral scholar shared that her colleagues assumed a level of informality because she was a Black woman, calling her by her first name while others were addressed as "Doctor So-and-So," and this made her feel like an impostor.

Biracial: Being biracial or of mixed-race added another aspect of impostor phenomenon. A student felt like an outsider in her department and in academia because she is biracial and was thus unable to fit in:

> When I'm around White people, I'm dark-skinned and I have curly hair. When I'm around Black people, I'm light-skinned and have long, wavy hair and talk like a White person. It feels like it's [skin color is] hindering my progress, because I worry about it.

She felt like her Black peers sometimes inadvertently made her "feel bad for being too White. I've been conditioned to expect to be judged by Black people for not being Black enough. I'm minority [biracial]. Thus I look one way to society, and society treats me one way." But during minority student lunches, "I don't feel better to see people who look more like me. If anything, I feel like an imposter there, like I don't really belong or understand some of the things a lot of these students go through." She used the term "social impostor" to describe her experiences and felt anxious "looking, feeling, or talking different than the other Black students."

Foreign-born: This study included three participants who were foreign-born Blacks and did not identify as African American. A foreign-born student was called a "good Black" by a White faculty. "They're making a distinction between being first-generation and being African American generational. You just have to smile, politely, and try to not flip out," she added, and, "there's a certain ideology that some faculty have about what it means to be African American, but because I'm not, they don't associate that with me, so therefore, I'm a good one. Yes, that I got from faculty." Another postdoctoral scholar was told by a Black colleague, "'You're not regular Black.' … It is very complicated to be Black." She found it hard to mingle with other African Americans in her group because their "personality, hobbies, cultural identity is that of mainstream White America," that made her feel like an outsider and an impostor. Of Caribbean descent, the postdoctoral scholar grew up among people where "racially and gender wise, I was not a minority. When I got to grad school, I started to feel like, 'Okay, am I really supposed to be here?' There were not as many Black people around." A postdoctoral scholar further shared that she often met people in the department who were surprised about her success. "Then when they understand that you're an international, they're like, 'Oh, now that makes sense, 'cause if you're Black and American, then you wouldn't be here.'"

A non-model minority: A student explained that not all minorities were treated equally, and her impostor phenomenon arose when she heard conversations of being compared to model minorities (e.g., immigrants from Africa). The model minorities were typically financially better-off, and she saw

others "point to these folks [the model minorities] and say, look what they've done with their lives and look what you've done or haven't done, but nobody points to the structural inequalities. Certain minorities are okay but not others." She added, "You can be Black if you're from outside the United States, but deep held convictions about the intrinsic unfitness of domestic Black folks is so deeply ingrained that even educated White people talk like that."

DISCUSSION

This research study aimed to examine impostor phenomenon experienced by Black trainees in STEM due to their race-based background. Due to a dearth of research studies among Black doctoral students (only four were identified), the current study chose to use a mixed methodology to leverage on both quantitative and qualitative aspects of race-based impostor phenomenon. While individual surveys found that 15 Black trainees in STEM experienced between moderate to intense impostor phenomenon, semi-structured qualitative interviews identified six themes related to the impostor phenomenon based on narratives from doctoral and postdoctoral scholars. Theme one related to being the only minority among a larger group, theme two related to experiencing a lack of belonging in the department, program, or field, and theme three was related to facing stereotyping, micro-aggression and judgment. Theme four examined the impostor phenomenon in relation to external appearance (looks, clothes, and voice tone) and when one's identity as a student or postdoctoral scholar was mistaken because of that. Feeling like the "diversity enhancers" of the department or program also contributed to the impostor phenomenon (theme five) while the complications of intersecting identities such as gender and race, being biracial, foreign-born, or not from a model minority group (theme six) were also explored in relation to the impostor phenomenon. Identity-based tensions that led to impostor feelings not only came as a result of judgment from Whites, but sometimes, also from other Blacks (for example, judgment from an African American towards a foreign-born Black). Conversations offered a broader perspective on the impostor phenomenon experienced during academic training in STEM.

Theme one illustrated how being the only one of a certain identity among a larger group of people holding a different identity contributed to impostor phenomenon. This was due to lack of guidance from same-race mentors, fear of isolation or exclusion, self-confidence issues, and the fear of being singled out or misunderstood. Challenges to improving biomedical research diversity include inherent challenges to the recruitment and retention of the underrepresented minorities (URMs) due to racial discrimination and lack of critical mass of same gender or same race/ethnicity PhD students, postdoctoral scholars, and faculty, among other factors (Butts et al., 2012). Cross-cultural and culturally-relevant mentoring plays a crucial role in the training, retention, and professional development of doctoral and postdoctoral trainees of color (Davidson & Foster-Johnson, 2001), something that institutions with predominantly White faculty struggle to achieve. Challenges to effective cross-cultural mentoring include lack of acknowledgement of cultural differences of URMs (that, in turn, affects URM student performance) as well as many doctoral programs not acknowledging cultural pluralism and instead, focusing on integrating or assimilating URM students into the dominant (White) academic culture (Davidson & Foster-Johnson, 2001). Lack of cultural understanding could be one of the factors for the leaky pipeline in terms of women and URMs obtaining STEM PhDs in the U.S. not being proportionally represented as faculty or in higher administrative ranks (K. Powell, 2007). This is despite many well-prepared URMs wanting to pursue STEM careers (Summers & Hrabowski, 2006). Thus, cultural isolation that discourage URMs from STEM careers could also be contributing to their impostor phenomenon. Isolation, lack of mentoring, and lack of networking are considered challenges to minority faculty persistence as well (Nivet et al., 2008). Morehouse and Dawkins (2006) highlight the importance of specific doctoral fellowship programs that support doctoral students in each phase of training through academic, social, financial, and motivational support directed towards increasing the number of Black doctorates. Same-race connections are important in providing better mentoring support and socializing experiences among Black doctoral students (Barker, 2011; Felder, 2010; Felder & Barker, 2013; Felder et al. 2014).

Theme two indicated that lack of belonging contributed to impostor phenomenon where one felt like they did not fit in academia. Prior research has also found connections between lack of belonging and the impostor phenomenon among students of all race/ethnicity, including Blacks (Burt et al., 2017; Graham & McClain, 2019; Ivie & Ephraim, 2009). Lack of belonging could occur due to one's family background (or the lack of it) in science. While many scientists have been interested in science or STEM fields from an early age due to family and school factors (Chakraverty et al., 2020; Chakraverty & Tai, 2013), not everyone has equal access to entry or retention in STEM fields; once in the field, some may be more vulnerable to feeling like an impostor than others due to their race, gender, and other social attributes. Developing a sense of belonging is essential to success and persistence for women of color in STEM fields (Carlone & Johnson, 2007). Studies highlighting the importance of developing a sense of belonging for Black in both college and graduate school underscore its importance for academic success in STEM (Johnson, 2007; O'Meara et al., 2017; Strayhorn, 2011, 2018). Those experiencing impostor phenomenon could be especially vulnerable to lacking belongingness in their research group, department, university, or STEM field, in general, that can have long-term implications for Black doctoral students' persistence in STEM. Lacking critical mass and feeling alienated due to being numerical minority (theme one) could also contribute to lack of belonging.

Theme three discussed how stereotyping, micro-aggression and judgment made Black participants vulnerable to feeling like an impostor. Interestingly, institutional discrimination, bias, segregation, and negative stereotyping related to race/ethnicity and gender reduces career satisfaction and creates challenges to retaining URM faculty in the healthcare professions (Nivet et al., 2008). Stereotype threat or the fear of being judged because of a negative group stereotype impacts minority college students disproportionately compared to their White peers and increase their likelihood of departure from STEM majors (Beasley & Fischer, 2012). Other groups like Asian Americans are also susceptible to both positive and negative stereotype threat (e.g., Shih et al., 1999), although due to a long history of racial discrimination and marginalization, African Americans are vulnerable to being adversely affected due to negative stereotyping and judgment (Steele, 1997; Steele & Aronson, 1995). Black students are also vulnerable to negative socializing experiences and psychosocial mal-effects due to stereotyping (Steele & Aronson, 1995), not only in STEM but in other fields such as education (Taylor & Antony, 2000). Black students' self-confidence to engage in science-based work, self-efficacy, and scientific identity are important to their success in STEM careers along with a strong academic background (Carlone & Johnson, 2007; Russell & Atwater, 2005). Prejudice and discrimination negatively impact social integration, persistence, and intellectual development among Black college students (Nora & Cabrera, 1996). Racial micro-aggression is experienced by all students of color in academia including African Americans (Solorzano et al., 2000) and Chicana/Chicano students (Solorzano, 1998) and negatively impacts the perception of campus climate (Solorzano et al., 2000). The current study provides evidence that along with a negative perception of academic or campus environments, experiencing stereotyping, negative judgment, and micro-aggression due to one's race could very well be linked to impostor phenomenon, possibly because of the othering effect described below.

Theme four (experiencing impostor phenomenon due to one's external appearances such as looks, clothes, and voice tone) could be related to the theory of othering. Drawing from previous literature on othering, Peteet, Brown, et al. (2015) explained how the process of othering comes from hierarchical power differences in the society, which in this case would be the power differentials between Whites (considered the norm) and Blacks (considered as others). This othering, both by the self and by someone else, could influence one's mental health, self-esteem, and increase the perceptions of feeling like a fraud, precisely what experiencing the impostor phenomenon entails. Othering happened to Black participants due to feeling like the only Black among others (theme one), facing stereotyping, micro-aggression and judgment due to one's race (theme three), and due to one's looks, clothes, and vocal tone (theme four). A qualitative analysis enabled us to go beyond monolithic assumptions of othering (White versus Black) and more deeply understand the nuances that othering entails.

Theme five illustrated how feeling like a "diversity enhancer" could contribute to one's impostor phenomenon. The phenomenon of experiencing tokenism (symbolic inclusion) is discussed by Blacks (especially Black women) in graduate school (e.g., Robinson, 2013). Tokenism occurs when URM students are recruited into doctoral programs with no real effort of integrating them or helping them develop a sense of belonging (Ridgeway, 2018), which could lead to the cycle of feeling alienated, internalizing racial experiences, and experiencing the impostor phenomenon, as documented among Black faculty (Dancy & Jean-Marie, 2014). This could impact academic achievement and mental health as well as lead to race-based invisibility, marginalization, and isolation (Malone & Barabino, 2009). Overall, issues of racism, marginalization, tokenism, and alienation could be closely intertwined, perpetuating impostor phenomenon.

Theme six described complications of intersecting identities (e.g., being Black, being a Black woman, being a foreign-born Black, being a Black scientist, etc.) among participants. While higher impostor phenomenon was correlated with higher distress and lower self-esteem, examined using a framework of othering (Peteet, Brown, et al., 2015), the current qualitative study found that othering can happen through multiple axes of power such as gender (Black woman versus White man/woman), race (White versus Black, White or Black versus bi-racial), nationality (African American versus foreign-born Black), and minority status (model versus non-model minority). All these identities contributed to the impostor phenomenon. In fact, prior research among PhD students of different race/ethnicities revealed the reasons for experiencing impostor phenomenon such as after attaining academic milestones, getting publicly recognized, comparing oneself with peers, and not feeling confident with some of the doctoral training competencies as a result of which, students hesitated to apply knowledge or ask for help, fearing that it would reveal their incompetence (Chakraverty, 2020a). Findings from Black PhD students were more closely aligned to Black identity and othering.

As pointed out by Stone et al. (2018), the construct of the impostor phenomenon was originally conceptualized in the 1970s with a sample of Whites (Clance & Imes, 1978), and due to the sparseness of research on Black students, trainees, and professionals, culturally-relevant manifestations or contributors of the impostor phenomenon have not been deeply explored (including how racism, racial discrimination, and other factors could contribute to Black individual's impostor phenomenon). All the participants in the current study belonged to predominantly white, research-focused institutions (with a history of marginalizing and discriminating experiences of Black students at these places; Milner, 2004). Even this could influence the impostor phenomenon as compared to those at HBCUs. Whether Black participants' impostor phenomenon is always race-based is something that could be investigated in future research. Understanding some of the culturally relevant experiences of the impostor phenomenon among Black trainees in STEM and extending the original framework of the impostor phenomenon are some of the literature gaps the current study fills. A similarly designed study with 12 Black graduate students (including five PhD students) found that the impostor phenomenon was triggered by issues of low representation at White-majority academic institutions and a combination of self-perceptions and other's perceptions (Stone et al., 2018). The current study found additional culturally relevant factors related to the impostor phenomenon not explored before.

Strengths and Limitations

There are several methodological strengths of this study in terms of a larger sample size with 15 participants compared to other qualitative studies on the impostor phenomenon among Blacks, accounting for in-depth experiences of both PhD students and postdoctoral scholars (postdoctoral scholars are an overlooked group). Doctoral and postdoctoral participants were clubbed together due to their similarity in training compared to undergraduates. A mixed-methodology provided a unique perspective compared to prior literature of quantitative studies among Black undergraduates and predominantly qualitative studies among Black graduates. Interviews offered an in-depth understanding of different facets of being Black in relation to experiencing the impostor phenomenon. This analysis included only Black participants, focusing on the unique experiences compared to studies where

Blacks were only a part of a larger sample. This investigation was further enriched by including three foreign-born Black participants who migrated to the U.S. from other African countries and provided unique perspectives about how their foreign-status contributed to the way they experienced othering. All the participants belonged to STEM fields that are demographically and culturally different from other non-STEM fields. While Burt et al. (2017) focused on participants from engineering at mostly PWIs, none of the other studies on graduate students focused on STEM fields. The current study included participants from a variety of STEM fields from different research-focused institutions all across the U.S. Lastly, using a semi-structured interview format also facilitated the development of diverse themes organically.

However, this study has certain limitations. The study sample was a self-selected group of predominantly female STEM trainees who were familiar with the impostor phenomenon; there was selection bias due to using purposeful, non-random sampling (Patton, 2014). Male participants were underrepresented in the sample. Each participant was interviewed only once, and the study did not include those who left training because of feeling like an impostor. Findings should not be generalized across the larger population of Black trainees in STEM in the U.S.

Recommendations for Future Research

Proposed recommendations based on insights from the current study includes reimagining doctoral training to be more inclusive and welcoming of diversity across multiple axes such as gender, race/ethnicity, class, first-generation status, ability, sexual orientation, and country of origin, among others. Greater awareness and recognition of symptoms of the impostor phenomenon and developing a social network of peers, friends, mentors, or university staff to talk to would be important. Future research could look at the experiences of other underrepresented groups in STEM such as Native Americans and Hispanics, with wider implications on broadening participation in STEM careers. The lack of research studies with the underrepresented groups are a limitation of the current literature. Second, future research could look into the experiences of STEM faculty experiencing the impostor phenomenon. Third, examining the impostor phenomenon in disciplines outside STEM could also yield interesting results. Lastly, as also discussed previously (Chakraverty, 2020b), our understanding of the impostor phenomenon is based on mostly cross-sectional data collected at a single time-point. Longitudinal analyses of this phenomenon measured at multiple time points could add important insights into whether it is short-term or long-term. While our understanding of the phenomenon is expanding, there are many avenues of future research that could add meaningfully to this understanding.

Conclusion

This mixed-methods study examined the impostor phenomenon among 15 Black trainees from a variety of STEM fields and geographical locations in the U.S., with three of them being foreign-born. Survey-based CIPS scores (Clance, 1985) indicated moderate to intense impostor phenomenon at the time of study. Interview findings revealed six themes as a result of experiencing impostor phenomenon as a Black person: 1) Being the only Black among a larger group, 2) Lack of belonging due to one's racial membership, 3) Stereotyping, micro-aggression and judgment, 4) External appearances such as looks, clothes, and voice intonations, 5) Due to feeling like the "diversity enhancers," and 6) Intersecting identities, including gender, being biracial, being born outside the U.S., or not belonging to a model minority group and hence being judged by others.

Recommendations for STEM trainees from the underrepresented backgrounds (including Blacks) include developing culturally relevant advising and mentoring relationships that could be key to persistence in academia (Milner, 2004). The same factors of culturally-relevant mentoring and role modelling could reduce alienation, psychological distress, and Black students' experience of the impostor phenomenon due to othering and feeling discriminated against. However, the onus of creating op-

portunities to develop culturally relevant mentoring relationships should occur not only at the individual level, but at the program-, departmental-, or university-level as well. It needs an understanding of how the tensions and complications of Black identity relate to training experiences in STEM fields and how race-based impostor phenomenon could shape individual interaction with faculty, mentors, and peers. While designing professional development programs for Blacks is one way of supporting them, research shows that developing closed-mentorship triads could be another way of support (Chakraverty et al., 2018). Although used in undergraduate life science education (Aikens et al., 2016, 2017), mentoring triads of PhD students, postdocs, and faculty from the same or related research group could be beneficial for STEM trainees. Academic transitions are especially vulnerable points for STEM trainees when they may be at a risk of feeling alienated (Chakraverty et al., 2018; Dabney et al., 2016) or feeling like impostors (Chakraverty, 2020b).

While conceived as an internal experience (Clance, 1985), the impostor phenomenon is deeply tied to one's racial identity that influences the nature of one's academic interaction and socializing experiences (Kong et al., 2013) as well as ways in which Blacks are perceived by members of another group (typically a majority group or Whites in this case). Thus, the impostor phenomenon is best seen as an unpleasant experience largely shaped by one's interactions and explicit/implicit cues from others. Study findings would be important as conversations continue on ways to improve demographic diversity in doctoral education as well as the larger STEM workforce to improve cultural competence. It is hoped that departments and administrators will find this study useful in terms of finding ways to support and nurture their minority students to provide a holistic academic training and experience. While larger-level conversations focus on how to get more students interested in STEM careers, it is noteworthy that these individuals are already in STEM fields due to their ability but may not be performing their best or experiencing their doctoral training in best possible ways due to impostor phenomenon. Any initiative to address and mitigate the phenomenon would help in the overall persistence and success of individuals in STEM.

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