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Gendered Racial Stereotype Endorsement: A Theoretical Review and Implications for Black Girls' STEM Identity

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Recent indicators continue to highlight the underrepresentation of Black girls and women in science, technology, engineering, and mathematics (STEM), from advanced course enrollment and degree attainment to employment. In this paper, we consider the role of stereotypes as an underlying motivational mechanism that shapes Black girls' STEM identity and persistence. This theoretical review seeks to provide a conceptual foundation for research on gendered racial stereotype endorsement among Black girls and the differential ways girls may incorporate this knowledge as they navigate STEM learning environments. We define gendered racial stereotypes as widely held beliefs and depictions of Black girls (as a collective group) and their lived experience as perceived by broader society. Despite their awareness of stereotypes, Black girls frequently develop strategies to aid in their persistence. Although they may occasionally endorse these stereotypes, Black girls also use their understanding of stereotypes as a motivator to actively resist and disrupt deficit narratives. By utilizing process-oriented and culturally-informed approaches, we extend the current understanding of Black girls' stereotype development. Additionally, we provide practical recommendations for research, policy, and educational praxis to aid in the continued positive development of Black girls' identity in STEM learning environments.

Keywords: Black girls, stereotypes, identity, STEM

Women's science, technology, engineering, and mathematics (STEM) degree attainment has steadily increased over the past ten years. However, looking at women across all racial groups, we observe stark disparities in the number of STEM degrees awarded to Black women. In 2019–2020, only 3% of STEM bachelor's degrees and 1.1% of STEM doctoral degrees were awarded to Black women (National Center for Education Statistics, 2021). In 2019, Black women made up approximately 1.8% of those employed in science, engineering, and related career fields (National Science Foundation, 2021). In addition to evaluating postsecondary involvement and engagement in STEM, we must study earlier trends in STEM engagement among Black girls to identify meaningful points of intervention to broaden STEM participation among Black girls and women. For instance, noting a similar pattern to general STEM degree attainment, Black girls made up only 5% of all students enrolled in advanced placement mathematics and science courses, whereas white girls made up approximately 33% (Smith-Evans et al., 2014).

In a research synthesis of Black women and girls' intersectional experiences in STEM education, Ireland et al. (2018) asserted that it is necessary to consider the psychological meaning and experience attributed to being a Black girl in STEM, as it ultimately shapes Black girls' success in STEM. This review presents an important finding regarding the prominence of identity development, in particular STEM identity, revealing that it is a key psychological process that influences Black girls' self-beliefs, interest, and engagement in STEM. Utilizing Carlone and Johnson's (2007) model of science identity, this paper conceptualizes STEM identity as three overlapping dimensions:

a) *Recognition*: Seeing oneself and believing others also see you as a STEM person
b) *Competence*: Attaining knowledge and understanding of STEM content
c) *Performance*: Actively participating and engaging in STEM learning and related activities

As we acknowledge the underrepresentation of Black girls and women in STEM, we must consider the underlying motivational mechanisms that influence Black girls' STEM identity.

Theoretical frameworks, such as the Situated Expectancy Value Theory (Eccles & Wigfield, 2020) and the Phenomenological Variant of Ecological Systems Theory (PVEST) (Spencer, 1995), illustrate the motivational influence of stereotypes on youth's identity development and later persistence. For instance, Eccles and Wigfield (2020) posited that children's perceptions of societal beliefs, norms, and stereotype*s* are related to their perceptions of their abilities, future goals, and expectations for success. Although these models may consider racial and gender stereotypes independently, we propose that gendered racial stereotypes may operate similarly and be related to Black girls' STEM identity. These *gendered racial stereotypes* highlight societal perceptions about Black girls at the intersection of race and gender. Studies have called attention to Black girls' awareness of gendered racial stereotypes (Burnett et al., 2022; Gadson & Lewis, 2022; Opara et al., 2022; Rogers et al., 2021). For this review, we will focus on the effects of endorsement, as it shows an intentional commitment to these ideas. Once they begin to endorse that these stereotypes are true, whether positive or negative, it presents essential questions regarding how Black girls then incorporate these societal depictions into their self-perceptions and identity development. This paper reviews the theoretical foundations that have informed our understanding of gendered racial stereotype-related outcomes

and processes in the lives of Black girls. We assert that gendered racial stereotypes act as a salient motivational mechanism that shapes Black girls' identification in STEM.

Although the acronym STEM encompasses 4 domains (science, technology, engineering, and mathematics), this paper will focus primarily on the mathematics and science domains. Within the STEM Education policy sector, national committees have recommended increasing funds and accessibility for science and mathematics innovation in classrooms due to poor performance across the U.S., in hopes of diversifying the STEM workforce (Breiner, 2012). The Next Generation Science Standards (NGSS) have broadened scientific and mathematical knowledge by applying aspects of engineering and technology within K-12 education. However, not all states have implemented NGSS into their curriculums to expand student interest (Brophy et al., 2008). With science and mathematics being precursors to technology and engineering and the foundational courses that Black girls have greater access to at school, our paper focuses on the science and mathematics domains.

Our review highlights five key areas for advancing research on gendered racial stereotypes and Black girls' STEM identities. First, we begin with an overview of the literature on gender and race stereotypes, both broadly and specifically among Black girls. Second, we describe the necessity of studying gendered racial constructs and expound on the ways studying gendered racial stereotype endorsement will augment our understanding of Black girls' gendered racial experiences. Third, we review the theoretical approaches and frameworks that collectively aid in our understanding of Black girls' development, with special attention to their navigation of stereotypes across mathematics and science contexts. Fourth, we explain how gendered racial stereotype endorsement is directly and indirectly related to Black girls' STEM identity and, subsequently, their STEM persistence. Underscoring the necessity of context, we then discuss the systemic and structural forces that Black girls must navigate on a daily basis in educational spaces and explain how they shape Black girls' STEM persistence. Taking these areas into consideration, we conclude by providing practical recommendations for research, policy, and educational praxis.

Gender and Race Stereotypes: A Developmental Perspective

Although key benchmarks of social identity development are often framed within the context of adolescence, studies indicate that the foundations of these identities and subsequent socialization emerge earlier in the life span. Studies have established that children are aware of both gender and race early on, and by early childhood, their awareness of gender and race map onto bias and stereotypical behaviors (Aboud, 1988; Augoustinos & Rosewarne, 2001; Kelly et al., 2005; Quinn et al., 2002). For instance, Augoustinos and Rosewarne (2001) found that children become knowledgeable of cultural stereotypes by the age of 5. Research also suggests that Black children are more aware of widely held racial stereotypes in middle childhood compared to their peers from academically nonstigmatized ethnic groups (McKown & Weinstein, 2003), and this awareness often increases significantly during this period (Copping et al., 2013; McKown & Weinstein, 2003). Recent studies indicate that children are able to not only conceive stereotypes about race or gender separately but can also consider race and gender simultaneously (Jaxon et al., 2019; Lei et al., 2020). In a racially and ethnically diverse sample of 5- and 6-year-old children, Jaxon et al. (2019) found that children associated white men with brilliance but did not associate Black men with brilliance. Interestingly, this study also revealed that the children in this sample were more likely to associate Black women with brilliance than Black men.

Although scholars have established that children are aware of gender and racial stereotypes, research indicates that children do not always endorse that these stereotypes are true (Nasir et al., 2017). Furthermore, evidence suggests that children's endorsement of stereotypes is linked to broader developmental processes (e.g., adolescence). Kurtz-Costes et al. (2014) found that youth in the 4th and 6th grades were more likely to show in-group gender bias in academic domain competency measures rather than endorse traditional gender stereotypes. However, in the sample, the 8th graders were more likely than the 4th and 6th graders to endorse traditional gender stereotypes in verbal academic domains. Scholars have also found that Black and white middle school students often support traditional academic stereotypes that favor white children (Copping et al., 2013; Nasir et al., 2017; Okeke et al., 2009). In Copping et al.'s (2013) investigation, across domains, grade level, and belief source, Black children in their sample of 4th, 6th, and 8th graders endorsed more traditional race stereotypes than white children. Burnett et al. (2020) found that traditional academic race stereotype endorsement continued to increase among Black youth from 7th grade to 12th grade.

Interestingly, Black girls endorsed traditional academic race stereotypes regarding Black youth's mathematics and science abilities at higher rates than Black boys (Burnett et al., 2020). This is particularly important because longitudinal research has found that negative academic race stereotype endorsement predicts lower cognitive engagement (one year later), fixed mindsets, and lower test scores in mathematics among Black girls (Wang et al., 2022). Though critical to our understanding of Black girls' racialized perceptions, little is known about Black girls' familiarity with stereotypes regarding Black girls' mathematics and science abilities as a group. In a racially diverse sample of middle school students, Way et al. (2013) found that students' ethnic and racial identity expressions were informed by multiple intersecting stereotypes (e.g., race, gender, sexuality). The youth in the study acknowledged that stereotypes are intersecting and often are not tied to one specific group membership, and that collections of group memberships (e.g., being both Black and female) evoke different stereotypes and responses to those belonging to each group (Way et al., 2013). Future work should employ a gendered racial approach to understand further stereotype development and potential differences in operation across outcomes.

Calling for a Gendered-Racial Approach to Stereotype Research

Research has demonstrated that gender and racial stereotypes are linked to academic outcomes (e.g., self-perceptions, identity, and performance; Master, 2021; Starr & Leaper, 2019; Starr & Simpkins, 2021; Wang et al., 2022). Thus, scholars must continue to explore how stereotype endorsement impacts thought processes and behaviors. This is particularly critical because students may limit their efforts or disengage from an academic domain altogether if they feel less likely to succeed. Steele and Aronson (1995) demonstrated the significant impact of racial stereotype awareness on the academic performance of African American students—a concept they called "stereotype threat." Importantly, this work highlighted the potentially detrimental effects on people who are afraid of confirming a negative stereotype of a group to which they belong. The way youth process and integrate knowledge of stereotypes into their self-perceptions may vary greatly. Black girls share a distinct experience of being a double minority (being both Black and female). As research demonstrates the potentially intersecting nature of stereotypes, being both gendered and racialized simultaneously (Burnett et al., 2022; Gadson and Lewis, 2021; Rogers et al., 2021; Townsend et al., 2010), there should be careful consideration of the impact of gendered racial stereotypes on Black girls' identification with STEM.

Previous scholarship has illustrated the diverse ways Black girls perceive their belonging in STEM and, subsequently, the ways they choose to engage in STEM (Butler-Barnes et al., 2021; Collins et al., 2020; Morton & Smith-Mutegi, 2022; Wade-Jaimes et al., 2021). For instance, utilizing focus groups with adolescent Black girls, Butler-Barnes et al. (2021) found that Black girls perceived their Blackness to be a barrier to their success in mathematics classrooms, with one participant expressing that they needed to "turn their Blackness off" to be taken seriously by mathematics teachers. Additionally, the Black girls in this investigation felt that they had to prove themselves academically to show they belonged in these educational settings, underscoring the heightened tension of being a Black girl engaging in STEM. Similarly, in Wade-Jaimes et al.'s (2021) study, middle school aged Black girls stated that even when engaging in science learning and enjoying science activities, they still could not see themselves as a science person or as a future scientist. Yet, many Black girls actively resist negative academic stereotypes and are fueled by their desire to succeed (Burnett et al., 2022; Butler-Barnes et al., 2021; Joseph et al., 2017). In this paper, we note that although stereotype awareness or endorsement does not always result in deficit, we must expand our scholarship regarding how stereotype endorsement influences the future thoughts and behaviors of Black girls in relation to STEM. Despite indications that gender and race stereotypes are related to academic outcomes, additional studies that focus solely on Black girls and their relationship with gendered racial stereotypes are needed.

Gendered Racial Stereotypes and Black Girlhood

As a response to studies that do not examine within-group variation among Black youth and adults, a growing body of literature has highlighted the gendered racial experiences of Black girls and women. These studies also underscore the connected influence of stereotypes and their implications for identity-related processes among Black girls and women (Brown et al, 2017; Gadson & Lewis, 2021; Lewis & Neville, 2015; Settles, 2006; Stokes et al., 2020; Thomas et al., 2011; Williams & Lewis, 2021). Building upon their previous work, Thomas et al. (2013) found that Black girls expressed specific gendered racial stereotypes about Black girls and women that were often evident in their lived experiences (e.g., negative school encounters). Through individual interviews, adolescent Black girls (ages 14–19) shared the gendered racial stereotypes that they believed defined Black girlhood (e.g., ghetto, loud) and explained the particular ramifications of these stereotypes on Black girls' ability to express themselves authentically (Rogers et al., 2021).

In a separate study, focus groups with Black girls (ages 14–18) revealed their understanding of stereotypes that portray Black girls as overly sexual, aggressive, or angry, often resulting in detrimental mistreatment of Black girls in their schools and broader community (Opara et al., 2022). Similarly, Burnett et al. (2022) revealed Black girls' awareness of stereotypes specific to Black girls, as well as their perception of how these stereotypes shaped their school experiences. For instance, one participant expressed that stereotypes of Black girls held by her teachers prevented her from being recommended for advanced courses (Burnett et al., 2022). The implications of gendered racial stereotypes on Black girls' ability to thrive warrants an in-depth study of these constructs. Although these studies provide important empirical contributions, they do not evaluate which specific stereotypes Black girls endorse as true in addition to examining the antecedents and consequences of this endorsement. Thus, we must develop a gendered racial stereotype measure that captures Black girls' endorsement of

stereotypes as we extend theoretical understandings of the relationship between gendered racial stereotypes and Black girls' identity development.

Guiding Theoretical Frameworks and Conceptual Models

Decades of theoretical and empirical research spanning across numerous disciplines have informed our understanding of gendered racial stereotype endorsement and how it may shape Black girls' STEM identity. Ireland et al.'s (2018) call to action emphasized three key areas of interdisciplinary integration: a) intersectionality scholarship generated in the field of STEM education and workforce development, b) gender psychology scholarship produced in the field of psychology, and c) psychological significance of race scholarship developed in the field of psychology. With this call to action in mind, this review highlights the guiding theoretical approaches and frameworks that have helped to inform research on Black girls' stereotype endorsement. Synthesizing and situating these literatures in conversation with one another will contribute to a more integrative understanding of how gendered racial stereotypes operate within the lives of Black girls and influence STEM-related identities. These frameworks and models, individually and collectively, speak to the intersectional, developmental, and STEM-related processes that may underlie Black girls' awareness and endorsement of societal stereotypes. Although empirical studies have used these frameworks to illuminate the experiences and resulting outcomes of Black girls, we are mindful that many of these theoretical foundations, while attentive to development, were not originally conceptualized to address specific developmental processes. Considering the broader discussions about the continued adultification of Black girls (Carter-Andrews et al., 2019; Epstein et al., 2017), it is necessary to underscore that Black girls' experiences are not synonymous with Black women's experiences. The primary goal of this overview is to emphasize how these theoretical approaches can help us understand the processes related to gendered racial stereotype endorsement. Furthermore, it outlines the implications for Black girls' learning experiences in STEM spaces.

Critical Race Theory (CRT) operates as an important framing that challenges us all to consider the historical context that shapes our world (Bell, 1980; Bell, 1992; Crenshaw, 1990; Delgado & Stefancic, 2001). Of particular relevance is the guiding tenet that emphasizes the relevance of race and racism as an everyday occurrence in American society and its institutions. Seeing education as an institution that upholds oppressive systems in both its established values and its actions, researchers must situate their scholarship within a framework that acknowledges race and racism in school contexts not as individual exceptions, but as a persistent and permanent reality that manifests in the educational experiences of Black students (Decuir & Dixson, 2004; Ladson-Billings & Tate, 1995). For instance, in Annamma et al.'s (2019) investigation into the overrepresentation of Black girls in school disciplinary data, the authors found CRT to be a necessary tool in understanding how Black girls' historical representation in society (e.g., deficit narratives, stereotypes) is connected to the way race and racism operate in school policies. Black girls' experiences are distinct from other groups and are informed by the larger societal power structures often dictated by race, class, gender, and sexuality. Intersectionality expands upon the foundations of CRT by acknowledging these intersections as it contends with the overlapping systems of power (e.g., racism and sexism) that Black women and girls must navigate (Crenshaw, 1989, 1991). Patricia Hill Collins (2019) called for a reimagining of intersectionality that recognizes its full potential as a critical social theory that both explicates and criticizes the present landscape of social injustice, while also seeking to disrupt these systems to promote positive change.

Relatedly, the Critical Race Feminism (CRF) framework (Wing, 1997) was developed as a necessary extension of CRT and traditional feminist discourse that not only advances theory, but also aims to empower women in praxis. CRF centers women of color and their experiences, arguing that women of color face discrimination against multiple aspects of their identity (e.g., based on race, gender, class) and that these factors interact within a system of white male patriarchy and racial oppression (Wing, 1997). Of relevance to this review, CRF asserts that Black girls' experiences are fundamentally different from boys of color and white girls. Thus, it is important to consider how Black girls' distinct social experiences shape their perception of societal stereotypes. Although originally rooted in legal scholarship, the uses of CRF are multidisciplinary and applicable in various settings, including studying Black girls' school experiences (e.g., Annamma et al., 2019; Evans-Winters & Esposito, 2010; Hines-Datiri & Carter-Andrews, 2020). For example, Evans-Winters and Esposito's (2010) work provides a compelling case for why CRF is the most useful theoretical application for studying Black girls' educational experiences. A key argument is that CRF allows for discussion around multiple consciousness. For example, Black girls must negotiate their multiple identities while also considering the best practices to navigate learning spaces safely and successfully (Evans-Winters & Esposito, 2010). Highlighting scholarship that centers Black girls' voices within STEM education, King and Pringle (2019) build upon CRF and Counterspaces (Solórzano et al., 2000) to develop the "Multidimensionality of Black Girls' STEM Learning: A Conceptual Framework." This conceptual framework informs our understanding of how Black girls navigate informal and formal learning contexts. Further, gendered racial stereotype endorsement and identities may be shaped by these contexts and experiences. Acknowledging the intersection of race and gender for Black girls, we also heed the related tenets of Black Feminist Thought, which emphasizes the experiences and knowledge production of Black women and girls solely (Collins, 1989; Collins, 1998).

Centering Black adolescent girls' voices is necessary as we seek to extend our knowledge on their continued navigation of gendered racial stereotypes in mathematics and science environments. Scholars have argued that though these theoretical and methodological frameworks are useful for examining Black girls and women's experiences in STEM, they have not fully explicated the psychological processes that may be at play. Moreover, these approaches may not fully integrate a developmental and life span perspective, and thus, may not fully engage with the processes that emerge early, continue, and accumulate across one's lifespan.

Some developmental psychological frameworks have been utilized to highlight processes that shape Black girls' development and well-being, with attention to variation in pathways and impacts. For instance, process-oriented developmental theories such as the Integrative Model for the Study of Developmental Competencies in Minority Children and PVEST promote the varied and adaptive responses of marginalized youth across contexts (e.g., home, school, neighborhood; Garcia Coll et al., 1996; Spencer, 1995, 2006; Spencer et al., 1997). Emphasizing developmental process rather than just outcomes, Garcia Coll et al.'s (1996) model underscores the importance of the sociohistorical context in understanding Black girls' lived experiences. More specifically, our understanding of child development cannot be separated from Black girls' social position and the realities of racism and sexism, which shape how they encounter and interpret their world. PVEST gives specific attention to youths' meaning-making of their social position and lived experiences in response to stereotypical beliefs and bias. Velez and Spencer (2018) share a necessary critique of developmental theories, in which many foundational developmental theories neglect how power structures and lived experiences coincide and intersect in identity

formation processes. In response, the authors argue that insights from intersectionality are complementary and interconnected to the goals of PVEST, and, thus, should be leveraged in our approaches to understand variation in identity development across time and within ecological contexts. This review expands upon this work as we suggest that how Black adolescent girls make meaning of and subsequently navigate gendered racial stereotypes in academic spaces will be associated with their STEM identity. To navigate their academic spaces safely and successfully, Black youth must adapt to mainstream ideals and behaviors that directly contradict cultural traditions and values. As Boykin's (1986) Triple Quandary Theory mentions, Black youth must constantly consider three realms of being in their school settings: Mainstream, Black cultural, and Minority. Building upon this work, we consider how Black girls in mathematics and science classrooms may reckon with the multiple realities of their experience and how that may inform their continued navigation of gendered racial stereotypes. Since mathematics and science domains are typically regarded as white and male-dominated, the way Black girls process this sociohistorical context determines whether persisting in these domains is of continued interest. While empirical studies have applied these frameworks to examine factors related to Black girls' identity development broadly, including stereotype awareness and endorsement (Burnett et al., 2022; Rogers and Butler-Barnes, 2022; Rogers et al., 2021), research that explicitly describes processes related to *how* societal messages shape Black girls' STEM identity development is needed.

Scholars have made the case for frameworks that specifically describe STEM-related identity development and related outcomes, paying particular attention to the way gendered racial stereotypes may influence this process. Martin's (2000) Multi-level Framework for Analyzing Mathematics Socialization and Identity Among African Americans emphasizes the role of context and the messaging that Black youth receive regarding their mathematical learning potential. The messages Black youth receive are from various contexts (e.g., sociohistorical, community and family, school and institutional, and intrapersonal), are internalized, and ultimately shape their mathematics identity. Additionally, Carlone and Johnson (2007) provide a model of science identity that acknowledges the role of ethnic, racial, and gender identities on women of color's perception of competence, performance, and recognition in science. Considering the need to focus on the gendered racial experiences in STEM identity formation, Collins (2018) proposed a conceptual model of Black students' STEM identity that incorporated gender-based racial identity as a core theme. This conceptual model posits that Black youth's STEM identity is influenced by self-concept, perceptions of cognitive ability, sense of belonging, and interest with gendered-based racial identity influencing each of these perceptions. Building upon this conceptual model's integration of gendered racial identity into STEM identity, we propose that gendered racial stereotypes may influence STEM identity and later STEM persistence among Black girls. Our review also utilizes tenets from Joseph's (2021) Black Feminist Mathematics Pedagogies (BlackFMP) framework, which centers on Black girls' intersecting identities (e.g., culture, sexuality, class, femininity) and acknowledges the complexities found in the development of 'robust mathematical identities 2.0.' This conceptualization of mathematics identity proposes an integration of positive self-perceptions, in which Black girls see themselves as learners/doers of mathematics, while also emphasizing their strength, resistance, and agency. This reimagining of mathematics identity encourages Black girls to show up in mathematics spaces with full authenticity, redefining and challenging what it means to be a mathematics person. Though we highlight the mathematics identity dimension of the framework for the purposes of this review, we acknowledge the interrelated and

interdependent nature of the other framework dimensions (e.g., ambitious mathematics instruction, critical consciousness and reclamation, academic and social integration) in shaping Black girls' mathematics experiences. We argue that this framework, while centering mathematics, has considerable implications for Black girls' sense of belonging in STEM in general and can be a useful tool for unearthing the theoretical connection between gendered racial stereotype endorsement and Black girls' STEM identity.

Gendered Racial Stereotype Endorsement and Black Girls' STEM Identity

Prior investigations have called attention to the ways in which gendered racial stereotype endorsement may be connected to Black girls' STEM identity. Existing theoretical models (Eccles et al., 2020; Garcia Coll et al., 1996; Spencer et al., 1997) suggest an existing relationship between stereotypes and youth's academic identity and achievement. This relationship has also been supported by empirical work that examines the relationship between stereotypes and the motivational beliefs of Black youth and young adults. For example, for Black middle school students, for whom race is highly central to their identity, Okeke et al. (2009) found that racial stereotype endorsement was negatively related to academic self-concept, with the students reporting lower confidence in their own academic abilities. Consistent with this work on the influence of stereotypes, the term "stereotype vulnerability" refers to the likelihood that someone is conscious of and would be influenced by negative stereotypes of their own social group (Aronson & Good, 2002). Exploring the influences of stereotype vulnerability in Black students, Aronson and Inzlicht (2004) found that those high in stereotype vulnerability were more likely to have unstable academic self-efficacy.

Further advancing this scholarship, McGee and Martin (2011) introduced the concept of stereotype management to emphasize the process through which Black undergraduate and graduate students understand and navigate their knowledge of stereotypes within mathematics and engineering spaces. The participants revealed that their minority status and related stereotypes suggested that they were incapable of performing at high levels in mathematics. However, their knowledge of these stereotypes often motivated them to exceed the low expectations of their teachers and peers, and for some, even resulted in a stronger mathematics identity (McGee and Martin, 2011). Black girls' persistence despite many of the adversities they encounter in academic spaces further underscores the reality that Black girls are aware of their marginalized identities but find ways to navigate unwelcoming spaces and maintain their positive identities in mathematics domains (Joseph et al., 2017). Despite being aware of stereotypes, Black girls frequently elicit strategies that aid in their persistence, often utilizing their understanding of stereotypes as a motivator to actively resist them and disrupt deficit narratives (Joseph et al., 2017; McGee & Martin, 2011; Morton & Parsons, 2018; Way et al., 2013). A more nuanced understanding of the role of stereotypes in STEM learning is necessary, with special consideration given to the systemic and structural influences that shape Black girls' STEM persistence (e.g., sustained interest, active engagement, and involvement in STEM).

Systemic and Structural Influences on Black Girls' STEM Persistence

Educational Access and Opportunity

As we consider Black girls' active persistence and resistance, it is important to also contextualize their school experiences by highlighting the systemic and structural factors they must navigate (e.g., access to quality instruction, advanced mathematics and science offerings, disproportionate teacher referrals). Although prior literature has focused on deficits and

underachievements, this paper contributes to the growing scholarship that illuminates how Black girls continue to persist and thrive despite stark inequities in their schools. Black and Latinx students nationwide have less access to high-level mathematics and science classes (Office for Civil Rights, 2016). For example, in the 2013–2014 school year, 28.4% of Black girls reported attending a school with no calculus classes, 28% attended a school with no chemistry classes, 18.6% attended a school with no physics classes, and 4% attended a school with no biology classes (Onyeka-Crawford et al., 2017). If Black girls cannot enroll because these courses do not exist, they are at an even greater disadvantage, further contributing to leaks in the STEM pipeline. Moreover, they are underrepresented in these courses even when they are offered in their schools.

Additionally, Black and Latinx students made up 42% of student enrollment in schools that offered gifted and talented education programs, but only 28% of these students enrolled in the accelerated programming (Office for Civil Rights, 2016). Beyond the lack of advanced placement course offerings, evidence suggests that many mathematics and science teachers are not confident in teaching mathematics and science curriculum (Cogan et al., 2013; Wolf, 2015), with students in high minority schools being more likely to have novice or less experienced mathematics and science instructors (Smith-Evans et al., 2014; NSF, 2021; Office for Civil Rights, 2016). Incoming mathematics and science instructors in high minority and poverty schools reported feeling less prepared to teach the subject matter (NSB, 2016). This often results in Black girls being more likely to be taught by teachers who have far less training and preparation (e.g., fewer years of teaching, less likely to be certified), impacting the quality of instruction (Darling-Hammond, 2013; Young et al., 2017). Moreover, Black girls are often put in schools that primarily serve marginalized students and are low-resourced (Smith-Evans et al., 2014; NSB, 2016), which further exacerbates the opportunity gaps regarding engagement in high-quality mathematics and science experiences.

School Contexts, Experiences, and Interactions

For many Black girls, mathematics and science classrooms are not safe spaces, and teachers frequently fail to recognize their students' academic curiosity, engagement, and humanity (Joseph et al., 2019; Gholson & Wilkes, 2017). Black girls are overpoliced in school settings and classrooms in ways that do not allow them to even laugh, exude joy, or socialize with their classmates as they engage with classroom material. Joseph et al. (2019) suggested a shift in pedagogy, in which mathematics teachers allow Black girls to be humanized in their curriculum by creating space for play and active engagement in mathematics spaces. Prior research has found that Black girls' active engagement with class material (e.g., asking questions) is often misconstrued as a lack of ability or potential to succeed academically (Morris, 2007; Campbell, 2012). Furthermore, data from Campbell's (2012) Education Longitudinal Study found that mathematics test scores were not related to teachers' recommendations for advanced course enrollment for Black girls. Instead, teachers' subjective educational expectations about Black girls were a significant contributor to teachers' decision to recommend them for advanced mathematics courses, even after controlling for achievement.

Similarly, Pringle et al.'s (2012) investigation of 5th grade mathematics and science teachers' perceptions revealed teachers' low educational expectations for Black female students, with many doubting the girls' ability to pursue mathematics or science in higher education. When prompted, staff expressed difficulty envisioning their Black female students in mathematics and science careers. Furthermore, the teachers voiced stereotypical messages that

suggested Black girls were better suited for more social or verbal domains than more traditionally male domains, such as mathematics and science (Pringle et al., 2012). This is particularly relevant as Black girls are underrepresented in gifted education, which requires referral from teachers (Ford, 1998; Ford et al., 2021). Thus, considering the role of teachers and school support staff (e.g., counselors) is imperative when discussing the structural factors that influence Black girls' engagement in mathematics and science.

Exclusionary School Discipline Policies

In conjunction with lower educational expectations, research has documented the negative stereotypical portrayals of Black girls held by teachers that often characterize them as loud, argumentative, disrespectful, and defiant (Archer-Banks & Behar-Horenstein, 2012; Morris, 2007; Morris, 2016; Pringle et al., 2012; Smith-Evans et al., 2014). Through a two-year ethnographic study, Morris (2007) found that teachers and administrators most commonly associated Black girls with being loud, aggressive, and confrontational. Criticism of Black girls was tied to what the author described as Black girls being perceived as "prematurely adult"—a notion that teachers in this study sought to rectify through verbal reprimanding and discipline referrals in hopes that Black girls would become more ladylike (Morris, 2007). In this case, Black girls' outspokenness in class, even as evidence of their engagement in the course material, was deemed inappropriate and disruptive.

These characterizations detrimentally affect Black girls' learning capacity, as they are often pushed out of the classroom due to discriminatory and inequitable discipline policies that primarily rely on subjective judgements (Annamma et al., 2019; Blake et al., 2011; Cooper et al., 2022; Morris, 2016; Morris & Perry, 2017). For instance, Annamma et al.'s (2019) investigation found that Black girls were most likely to have their behavior labeled disobedient or defiant compared to girls of other races and significantly more likely to be referred for disciplinary action due to behavior deemed detrimental. Black girls who reported greater inequities in school discipline also reported lower educational aspirations (Cooper et al., 2022), further demonstrating the ways Black girls are harmed by systemic oppression within educational settings. Exclusionary school discipline policies also have direct implications for STEM learning, as research has found being suspended (both in-school and out-of-school suspensions) by the first semester of 10th grade considerably lowered students' mathematics scores in their senior year, even after controlling for previous mathematics test scores (Ibrahim & Johnson, 2020). Further, Ibrahim et al. (2021) found that in-school suspensions were associated with less mathematics course enrollment in high school among Black girls.

Recommendations

This review highlights several implications for research, policy, and educational praxis. First, we provide future directions of study for researchers that emphasize the need for scale development regarding gendered racial stereotype endorsement that is multidimensional in nature and attends to the needs and experiences of Black girls across developmental stages. Next, we discuss the ways current policy has neglected the gendered racial experiences of Black girls and propose actions to begin prioritizing Black girls' development generally as well as in STEM learning environments. Lastly, we propose recommendations for educators that not only addresses Black girls' treatment in K-12 educational settings but discusses the ways educators may function as key socialization agents who can promote positive STEM identities and persistence among Black girls.

Multidimensional Scale Development Across Developmental Stages

Our first recommendation is that scholars participate in additional qualitative inquiry with Black girls to understand how they make meaning of and process stereotypes in formal and informal learning contexts. Qualitative inquiry is especially critical to this process as it captures the developmentally appropriate language youth are utilizing to describe stereotypes related to their age group. Stereotypical depictions of Black women as being the "strong Black woman," "angry Black woman," "Mammy," "Sapphire," and "Jezebel," among others, have been critical to understanding the stereotypical messaging received by Black women. However, the messaging youth are receiving requires additional study to inform future survey development. Through individual interviews, Burnett et al.'s (2022) investigation began to provide some initial language provided by adolescent Black girls (ages 11–17), citing stereotypes depicting Black girls as loud, ghetto, uneducated, and ratchet. Likewise, in a sample of adolescent Black girls ages 14–17, focus groups illuminated three distinct stereotypes projected on Black girls that Gadson & Lewis (2022) characterized as expectations of: 1) the angry Black girl (angry and aggressive in tone and action), 2) the ghetto Black girl (being called ghetto, assumptions of criminality, and assumptions of lower-class status), and 3) the Jezebel (promiscuous and hypersexual). As current gendered racial stereotype research has been conducted with adolescents and adult women, less is known about how Black girls in early and middle childhood understand these constructs. Thus, there remains a need for a developmentally appropriate measurement adapted for younger Black girls, such as abbreviated measures that still allow for multidimensionality and intersection.

When developing a scale that measures Black girls' endorsement of gendered racial stereotypes, researchers must prioritize contextual variation. Though stereotypes are rooted in broader societal perceptions, an individual's impression of and further engagement with stereotypical messaging is shaped by their varied life experiences within their unique social context (e.g., school racial composition, quality of peer relationships, discrimination experiences). PVEST as a theory encourages scholars to consider the multiple ecological contexts that exist and intersect when considering identity development and the subsequent meaning-making youth ascribe to this process (Velez & Spencer, 2018). Prior literature has established that educational settings are a critical context that informs Black girls' identity development, particularly as they navigate stereotypical notions regarding their academic potential (Burnett er al., 2022; Morris, 2007; Pringle et al., 2012). By creating a multidimensional scale that incorporates social and academic capacities, researchers will produce a more comprehensive picture of Black girls' awareness and endorsement of gendered racial stereotypes. Additionally, domain-specific academic stereotypes should be explored because previous research suggests a difference in perceptions and stereotype endorsement among Black girls for traditionally stereotypical white and male domains (e.g., mathematics and science; Burnett et al., 2020). However, to our knowledge, no empirical studies have examined stereotype endorsement regarding Black girls' mathematics and science abilities as a group. Future studies should incorporate all four dimensions of STEM in their examination of perceptions of gendered racial stereotypes regarding Black girls' abilities in STEM.

Policies that Attend to Gendered-Racialized Schooling Experiences

For the past decade, national policies have focused on the needs of girls and Black boys regarding academic-related outcomes and exclusionary discipline. However, these policies have neglected to address the needs of Black girls (Annamma et al., 2016). Nationwide, 36.3% of girl suspensions and expulsions are Black girls, and Black girls are 5.5 times more likely to be suspended compared to white girls (U.S. Department of Education, 2021). According to the National Women's Law Center 2022 report, girls of color, but especially Black girls, disproportionately received suspensions and expulsions, with Black girls more likely to be suspended compared to white girls in every state in the 2017–2018 school year. As many disciplinary infractions for which Black girls are reprimanded are based on subjective teacher evaluations (e.g., defiant, disruptive, aggressive) steeped in stereotypes and bias, policymakers should reevaluate and expand current guidelines and intentions to be more inclusive of Black girls in school settings. Further, by implementing mandatory bias training, educators can recognize when they are consciously or unconsciously biased towards Black girls. As current education structures and policies do not focus on race and gender jointly, a particular emphasis on improving conditions for the resilient but ignored Black girl is necessary. Addressing implicit and explicit biases, cultural norms, and generational effects of the views of Black femininity and sexuality (Crenshaw, 1989) can improve conditions for Black girls who often use resilience strategies to persist despite negative schooling experiences.

Moving forward, supporting equitable STEM learning is imperative to increase the representation of Black girls in STEM. Additionally, because of the unique racialized and gendered experiences of Black girls, programming that centers their lived experiences in formal and informal learning environments is warranted. For instance, the Minority Male STEM initiative seeks to increase the recruitment and retention of minority males in STEM (Toldson & Esters, 2012). However, despite the underrepresentation of minority women in STEM, specifically Black women, there remains a need for targeted funding opportunities and programming that promotes recruitment and retention of Black girls and women in STEM. Scholars have noted the invisibility of minority women as a STEM priority despite the underrepresentation in STEM fields and careers (Alfred et al., 2019; Obiomon et al., 2007). Further, recent scholarship has highlighted the ways educators in formal learning contexts have acted as spirit murderers, robbing Black girls of opportunities to engage in high quality STEM learning and subsequently dissuading Black girls from believing they belong in STEM through their negative perceptions of Black girls (i.e., stereotypes) and biases (King, 2022). In response, King (2022) recommended community-based programming that engages Black girls in a rigorous and culturally relevant curriculum while also validating their existing brilliance. Research exploring informal STEM learning communities has demonstrated the positive impact these spaces have on Black girls' STEM interest, self-efficacy, and identity (King & Pringle, 2019; Morton & Smith-Mutegi, 2022; Pinkard et al., 2017). Therefore, increased funding and policy support for both formal and informal STEM learning spaces that serve Black girls must be prioritized.

School Experiences and Black Girls' Gendered Racial Stereotype Endorsement

Lastly, we recommend that educators reflect on how Black girls' schooling experiences may shape their perceptions of gendered racial stereotypes and, subsequently, their sense of belonging in STEM. As previously mentioned, long-standing inequities in school policies and academic opportunities continue to adversely impact Black girls disproportionately. Considering Black girls' awareness of these practices (e.g., discipline, academic tracking and

recommendation inequities), these experiences may function as socializing agents that inform their views on how Black girls are perceived by broader society (Archer-Banks & Behar-Horenstein, 2012; Burnett et al., 2022; Cooper et al., 2022; Epstein et al., 2017). Current and prospective educators must address the negative stereotypes and deficit ideologies in science and mathematics education that cater to biases and, ultimately, the exclusion of Black girls in these fields. With this in mind, Morton et al. (2022) advocated for a Black Liberatory K-12 Science Education (BLKSE) that will challenge educators in formal and informal learning spaces to reimagine their current praxis not just within science education but across all disciplines. Of particular importance to BLKSE is the naming of anti-Blackness in science education that actively harms Black students through pedagogy that prioritizes controlling students' behavior and engagement over culturally responsive, inclusive, and equitable teaching approaches that acknowledge students' strengths (Morton et al., 2022). By intentionally adapting instruction to meet the learning needs of Black girls, teachers can provide equitable experiences that lead to higher achievement, positive identity, and greater self-efficacy (Wright et al., 2021).

Moreover, addressing the gaps in teacher training and resources in schools has a trickle-down effect among large populations of Black students. Despite efforts within public schools across the nation to improve instructional strategies and training among educators in science and mathematics, interest amongst girls has not improved significantly. These gaps are even larger for Black girls due to stereotypes and feelings of isolation (Fletcher et al., 2017). Low persistence of Black girls in STEM classes and careers has been tied to a lack of STEM course offerings in low-income schools (Smith-Evans et al., 2014). Only 57% of predominantly Black high schools offer a full range of science courses (i.e., biology, chemistry, physics), compared to 71% of predominantly white high schools. Fewer Black girls are enrolled in advanced placement courses than any other female population (Smith-Evans et al., 2014). This does not position Black girls well to succeed in STEM fields in later collegiate settings. Increasing representation of Black girls in advanced STEM courses and providing community-based informal programming (outside-of-school and afterschool) that focuses on cultural capital and culturally-relevant techniques that center the individuality and knowledge of Black girls is needed. Within engineering and technology (particularly computer science), hands-on applications, creativity, and resource allocation in each field make them vastly different from science and mathematics. While experiences in engineering and technology can provide spaces for Black girls to use their intellectual property to improve their own communities, inequitable structures, such as the digital divide caused by racial and economic resource gaps in schools, limit access for Black girls (Braswell et al., 2021; Bullock et al., 2017). Due to the considerable influence that K-12 education experiences have on the predictive nature of postsecondary education and future career trajectories, researchers and educators should consider how systemic barriers, such as curricula that cater to white knowledge and disproportionate policies, influence Black girls' sense of belonging in STEM. By evaluating the relationship between school experiences and gendered racial stereotype endorsement, targeted intervention efforts can simultaneously be established at both the school and individual levels.

Conclusion

This theoretical review challenges scholars, policymakers, and educators to consider how gendered racial stereotype endorsement influences Black girls' STEM identity and persistence over time. We argue that gendered racial stereotype endorsement is a distinct motivational

mechanism that shapes the lives of Black girls broadly and within STEM learning environments. Black girls are not a monolith; thus, how they process gendered racial stereotypes will be vast in the conceptualization and subsequent implications for STEM-related outcomes. Incorporating process-oriented and culturally informed theoretical approaches in our continued study of Black girls' educational experiences is imperative to create space for Black girls to show up authentically, make meaning of their identity, and retain agency in mathematics and science spaces. Future research, studying both the motivational and systemic deterrents that impact STEM identity development, would be vital in determining ways to further improve the pipeline for Black girls who desire to learn and enter STEM fields.

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