"Scientists Can't Really Talk to People": Unpacking Students' Metacommentary on the Racialized and Gendered Science Nerd Trope.

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ABSTRACT: Mass-media representations of the stereotypical science nerd position scientists as white, male, and largely English-speaking. Teachers and students who state a desire to work in equitable science learning communities may nonetheless reproduce inequities through their classroom practices which either embody or validate the science nerd stereotype. This study compares secondary students' metacommentary on the science nerd trope in a mass-media representation to their metacommentary on their own and their peers' classroom practices and sheds light on design elements for Critical Race Media Literacy (Yosso, 2002) tasks that may promote equity in science education spaces.

KEYWORDS: Critical Media Literacy, Science Education, Metacommentary, Identity

> *I don't usually know how to do it [use the lab computer] and there are some people who're like um no, 'I want to do everything by myself. I want to do everything for myself. I'll be the leader and I'll do everything.'… I feel like there is sometimes, I really want to do it but then others I don't know exactly what I want to be doing. I don't know if I could do it actually*. (Rose, Individual Interview).

Rose[1] is a Spanish-English bilingual 9th grade student in a physics class at a science-focused US school serving grades 6-12 (ages 11-18). Over the year that I spent in the classroom getting to know Rose, she described herself as a science

person and she cited medicine as one of her career aspirations. Rose grew up in the US speaking Spanish and English at home and in school, and at times traveling to Mexico to visit family. At the time of the vignette shared here, Rose, like many other ninth-grade students, had been at the school since the 6th grade. Rose's comment demonstrates that despite her experiences in a science-focused school, her interest in science, and her motivation to pursue a science career, she nonetheless expressed uncertainty about her abilities working in science lab groups. Rose contrasts herself with "some people" who want to lead by taking control of the lab and working largely alone. In this paper, I explore how Critical Race Media Literacy (CRML) tasks may be designed to engage students like Rose and the "leaders" she mentions above in critical reflection on how their classroom practices might support or constrain their own learning opportunities and those of their peers. To achieve this, I analyze interview data stemming from a year-long linguistic ethnography of one physics classroom community. I compare ninth grade students' descriptions of the science nerd stereotype in media to their descriptions of their own and their peers' science classroom practices.

Underrepresentation in STEM

The underrepresentation of traditionally marginalized students in Science, Technology, Engineering, and Mathematics (STEM) degree programs in the United States and globally is a social justice issue with economic implications. Global gender-based statistics reveal that women remain underrepresented in STEM fields internationally (UNESCO, 2017) and they are significantly underrepresented in particular STEM subfields in the US and Europe (e.g., physics and computer science; Funk & Parker, 2018; Nimmesgern, 2016). In the US context, Black and Latinx students are less likely to earn STEM degrees and enter the STEM workforce than their white peers (Funk & Parker, 2018) and STEM workforce members in the US consistently earn higher salaries than non-STEM workers (Funk & Parker, 2018). Similar patterns exist in the UK where non-white students are less likely to enter STEM professions, and when in STEM fields are overrepresented at the lowest and highest levels[2] (Royal Society, 2014). To address the underrepresentation of women and people of color in STEM degrees and fields, researchers in the US have moved away from "skills-based" deficit-oriented narratives that lay the blame for STEM disenfranchisement on minoritized students, and towards approaches that examine equity in STEM education by acknowledging the social, political, and institutional factors that shape students' engagement with STEM education (Carlone, Haun-Frank, & Webb, 2011; Tan & Calabrese Barton, 2008a, 2008b, 2010; Tan & Faircloth, 2017).

As part of this movement, Sheth (2019) has called for science teachers at the secondary level to be trained to examine how race and racism in STEM impact their "goals, mental activities, and physical activities" (p. 55) as science teachers. Sheth (2019) terms this practice, "grappling with racism" (p. 37), and suggests that this grappling must cover the processes of *desiring*, *knowing*, and *doing* in science. There have been similar calls for explicit conversations about discrimination, bias, and racism to be included in physics curricula with students at the secondary

(Rifkin, 2016) and undergraduate (Daane, Decker, & Sawtelle, 2017) levels[3]. However, more research is needed to demonstrate how teachers and researchers might structure such conversations about racism and sexism with learners in STEM education if those conversations are to lead to more equitable outcomes for participating learners. I argue here that engaging youth in the analysis of mass-media products that present a stereotypical racialized and gendered trope of the science nerd offers one possibility for structuring the critical conversations Sheth (2019) calls for.

To support this argument, this linguistic anthropological study demonstrates how 9th grade physics students of various racialized, linguistic, and gendered backgrounds reacted to a video clip from an internationally popular TV show representing stereotypical physicists called *The Big Bang Theory* (TBBT). I then compare these same students' reactions to the stereotypical scientist persona in the TV show with their commentary and metacommentary (Rymes, 2014) about themselves and each other. Linking the ideological positions and semiotic resources found in students' reactions to the trope in media with those invoked as they discussed their own science practices and participation reveals the need for instruction that explicitly links students' awareness of *issues* – e.g., the existence of stereotypes in media-- to their understandings of *how their own actions may reproduce or challenge those stereotypes*. The analysis adds to the literature by showing factors that instructional designers implementing CRML (Yosso, 2002) tasks might consider to achieve the equity-based outcomes they hope for.

Mass-media Stereotypes of Scientists

The science nerd stereotype circulates widely in US society in part through television characters such as *Sheldon* and the other scientist characters on *The Big Bang Theory* (2007-2019), as well as in other TV programs and cultural artifacts. While TBBT was consistently one of the most watched television shows in the US during its 12-year run from 2007-2019 (Watson, 2019), the show also achieved international acclaim as the most popular TV show in the world in 2014 (Lang, 2014). The popularity of this show demonstrates the wide reach and cultural acceptability of the science nerd trope.

Characteristics of the science nerd stereotype exemplified by the characters in TBBT include intelligence, obsession with technology, interest in sci-fi or fantasy, social and physical awkwardness, lack of attractiveness, and lack of sexual prowess (Bednarek, 2012). Linguistic and communicative practices, such as the use of impoliteness, along with gesture and dress, play a large part in signifying these characteristics (Bednarek, 2012). This science nerd trope is racialized (Willey & Subramaniam, 2017) and gendered (Bucholtz, 1999; Steinke, 2005) with the unmarked values being white and male. In their analysis of TBBT, Willey and Subramaniam (2017) argue that the character *Sheldon* epitomizes the science nerd identity and reifies connections to maleness and whiteness because of the ways in which script writers contrast his theoretical physicist persona with those of

astrophysicist *Rajesh Koothrappali*, nicknamed *Raj,* and aerospace engineer *Howard Wolowitz*:

> Similarly to gender, race is strategically deployed and everywhere — the whiteness of Leonard and Sheldon, the Jewishness of Howard, the brownness and Third-Worldness of the South Asian Raj all shape the show's construction of the inverse relationship of brilliance to worldly concerns. Indeed, race, gender, and sexuality are at the heart of the show as its plots make comic use of the character's identities through popular stereotypes about racial and ethnic difference, masculinity and femininity, and homophobic conjectures about Raj and Amy's desires for Howard and Penny respectively. Race, gender, and sexuality become vehicles of meaning-making that naturalize reverent disdain. The more "brilliant" (white, male) the scientist, the less relevant the social. (p. 20)

This passage describes the semiotic contrasts through which script writers construct *Sheldon* and *Leonard* as White, heterosexual, male, and scientifically brilliant. The co-occurrence of these signs is not accidental or idiosyncratic – these intertextual cues signal a science nerd persona precisely because they are part of a larger semiotic pathway recognizable to viewers where displays of science expertise are achieved partially as a result of entanglements with race and gender.

Stereotypes in Practice

The racialized and gendered nerd genius stereotype is not mundane and harmless; rather, its embodiment by white male students in STEM education spaces can inform moment-to-moment interactions that cumulatively serve to marginalize traditionally underrepresented students (Bucholtz, Skapoulli, Barnwell, & Lee, 2011). Women in the US are less likely to enroll in degree programs when they associate the degree with a "nerd-genius" stereotype (Starr, 2018). Even when women of color in the US are successful in persisting in STEM degrees and careers, they are consistently reminded that they do not fit the stereotypical identity position others around them look for as indicators of brilliance in STEM (Johnson, Brown, Carlone, & Cuervas, 2011). The racialized and gendered science nerd trope, like other tropes perpetuated in the mass media (Yosso, 2002), is an ideological construct that has material impacts in the world through structuring the moment-to-moment interactions of real people. For women and people of color, these interactions may dissuade them from entering or persisting in STEM.

Theoretical Framework

In developing CRML, Yosso (2002) argued that "the school system and the media are closely related and continually transmit their delusional ideas about race back and forth" (p. 53). Language, particularly metacommentary (Rymes, 2014), provides a powerful medium for this transmission of ideas. Various forms of discourse including social interactions, mass-media products, and historical documents represent opportunities for authors (including everyday people) to

recreate, challenge, or problematize majoritarian narratives (Solórzano & Yosso, 2002), racialized storylines (Nasir, Snyder, Shah, & Ross, 2012), or stereotypes and in so doing craft their own momentary identities. This view of language fits well with scholarship in Critical Race Theory (CRT; Solórzano & Yosso, 2002), because analyzing discourse in this way can reveal layers of *how* racism and other -isms are perpetuated through momentary interaction in US institutions (e.g., sexism; Baxter, 2014). In CRT, counterstories offer a powerful means of combating erasure. However, in focusing primarily on narratives told to researchers by participants in interviews, at the exclusion of in-depth analyses of how these stories are told, we miss a layer of complexity in our larger understanding of how these narratives are ideologically constructed in daily social interactions. The analysis of metacommetary, an approach widely used in linguistic anthropology but infrequently applied in CRT research, offers a fruitful lens for critical scholarship to examine and counter various forms of institutional erasure (Leone-Pizzighela & Rymes, 2018). The analysis of metacommentary fits well in CRML because CRML tasks inherently involve eliciting students' metacommentary. Understanding what this metacommentary *does* in the moment for participants, as well as what it *reflects* about them, their histories and socialization, can deepen scholars' understandings of how to develop CRML as a field.

An analysis of metacommentary relies on theories of language that challenge the separability of linguistic structure and social function (Agha, 2007; Carter, 2013) and instead reveal that all discursive interactions are multivoiced (Bakhtin, 1981) and involve the crafting of identities (Wortham, 2006). In this linguistic anthropological case study, I draw on the notion that "the communicative signs people use are engaged in social projects, motivating and sometimes transforming their activities – not only commenting on them" (Gal & Irvine, 2019, p.1). In the context of education, researchers have applied this lens to examine how – through what communicative, linguistic, and other semiotic resources – learners become marginalized as they participate in racialized and gendered pathways of socialization (Norton & Toohey, 2011; Reyes 2009, 2011, 2017; Wortham, 2006). This work reveals how the models of personhood (Agha, 2007), or personae (identities) dialogically (Bakhtin, 1981) crafted by learners, have local flavors that gain their meanings from models of personhood circulating across other socio-historical "timescales" (Lemke, 2000).

Rather than representing durable and stable artifactual "truths," these personae are crafted and recrafted through language gaining and losing dimensions over time. In particular, "metapragmatic discourse" (Silverstein, 1993) or metacommentary (Rymes, 2014) represents one of the means through which speakers explicitly ("*scientists can't really talk to people*"- Alexis) or more implicitly ("*I always get that feeling that they are always judging people*"- Rose) comment on social types and thereby position themselves, at the same time that they add local flavor to the persona they are commenting on. With these statements the linguistic anthropologist does not analyze the content of the utterance to give "voice" (St. Pierre, 2008) to participants' spoken truths or narratives (although this can be part of the analysis), but rather to analyze the utterances in context to understand the ideological stances and "poetics" (Silverstein, 2004) simultaneously reflected and

constructed in those utterances. Examining how multiple levels of context (e.g., the immediate social context, US race relations, etc.) are talked into existence by participants enables critical scholars to unpack how "delusional ideas about race" (Yosso, 2002, p. 53) are continuously (re)constructed in social interactions.

Context

Science for All Academy (SFAA) is a small district-run science-focused charter school in a western US city serving middle and high school students. It was not uncommon for scientists from the local university to be present in the school to work with students on small class projects and larger research projects. The largest ethnic/racial groups reported by the school were Caucasian, 47%, and Hispanic, 37%, and the student population was socioeconomically diverse[4]. The science teachers at the school were all white. I conducted a year-long classroom ethnography in one section of 9th grade physics with 22 out of 24 students participating in the study along with the teacher. All appropriate institutional (IRB), school district, school, and family approvals (parent consent and student assent) were followed. Teachers at the school were vocal about their desire to promote and create equity. While this is a school where one might walk past a bulletin board created by students that included scientists of color displayed for their accomplishments, it is also a space in which Latinx students who were predominately Spanish-English bilingual experienced marginalization from the activities of learning physics in their classroom community (Braden, 2017; Braden & Christison, 2018; Braden, 2019).

Data Sources and Collection

The larger ethnography contained approximately 25 individual interviews (students & the teacher), over 200 hours of video and audio recorded classroom interactions, artifacts of student work, and hundreds of pages of field notes taken during the 1-3 days per week I spent as a participant-observer in the classroom. For this analysis, four 30-minute individual interviews serve as the primary data. The interviews were conducted for member-checking purposes at the conclusion of the larger study in which I examined the language socialization pathways of the three bilingual Latina students in the class. This lab group was selected for in-depth analysis due to the presence of two of the focal Latina students (Rose and Lucila). During the interviews, students responded to two video clips. The first video clip came from TBBT and is described below. The second video was of students' own participation in a physics lab group. Henry and Alexis viewed themselves in this lab group; Rose and Lucila viewed themselves in a different lab group that occurred later in the school year. The interview concluded with a question about how students may have experienced marginalization at the school (see interview protocol in Appendix 1).

Participants

Alexis, Henry, Rose, and Lucila were all 15 years of age at the time of the interview. Throughout my time working with the students, they identified their racial, ethnic, and national identities using the labels in Table 1.

Table 1. Descriptors for Student Participants in Their Own Words (Self-Descriptors) and From Other Ethnographic Data Gathered From and About Them From My Perspective as a Researcher

Name	Self-Descriptors	Additional Descriptors & Information
Alexis	Biracial (Black & white)	English dominant student learning Spanish
Henry	Caucasian	English dominant student learning Spanish
Rose	Mexican, Latin	Spanish-English Bilingual, US citizen
Lucila	Spanish	"English Language Learner" (label from school), Spanish-English Bilingual, from Dominican Republic

Additional details about the participants, their interactions with each other, and the *raciolinguistic ideologies* (Flores & Rosa, 2015) circulating and under construction in this lab group can be found elsewhere (Braden, 2017, 2019; Braden & Christison, 2018).

Methods

This section describes the primary sources of data for this analysis, the video clip of TBBT viewed by students, and my data analysis process.

Description of the Video Clip from the *Big Bang Theory*

The clip from the *Big Bang Theory* was selected because I had found that students in this classroom appeared to orient to a local version of the "science expert" persona that to me contained stereotypical features (e.g., impoliteness, using scientific terminology beyond the confines of the lab topic). I was interested in how students might react to viewing a stereotypical science nerd persona embodied by the characters of *Sheldon* and *Leonard*. Particularly, I wanted to understand how the students' localized notion of "science expert" related to and drew from the stereotypical model of the science nerd. Students were asked to watch a 3-minute clip from episode 18 season 6 in which *Leonard*, *Sheldon*, and *Howard* visit an all-girls high school class[5] to talk to them about pursuing careers in science. The girls appear disinterested in the presentation, as indicated by lack of eye contact or blank stares, lack of verbal commentary for most of the presentation, and engagement in other tasks (e.g., looking at nails or cell phone).

The collection of signs crafting science nerd identities for the scientists in this video include dress, nasalized speech (*Leonard*), lack of understanding of social cues and social norms, enthusiastic and unnecessary use of science vocabulary words, awkward physical gestures, and exaggerated (*Leonard*) or blank (*Sheldon*) facial expressions. A weblink to the video is included in Appendix 1.

Data Analysis Process

Interviews were transcribed following common conventions in linguistic anthropology (a modified version of Du Bois, Cumming, Schuetze-Coburn, & Paolino, 1992). Transcripts were then subjected to an iterative analysis following "discourse analysis beyond the speech event" (Wortham & Reyes, 2015). The first phase included visually mapping the narrated events of the conversation which included topics and social roles explicitly stated by participants. The second phase included selecting, configuring and construing indexicals (linguistic signs) across events. In this phase the analyst unpacks metapragmatic discourse by examining deictics (Silverstein 1976), reported speech, and other linguistic cues that contribute to voicing (Bakhtin, 1981). Finally, I identified how the signs used across contexts related to each other and accomplished social actions such as crafting identities and communicating ideologies. While these four interviews serve as the primary data analyzed in this paper, the findings were examined in relation to the larger data set for the ethnography to ensure trustworthiness. Following the analysis, exemplars were selected for inclusion and description in this paper and reformatted for readability.

Analysis

This section is organized to interpret students' metacommentary on the science nerd trope presented in TBBT and to relate it to students' commentary and metacommentary on their own and their peers' science classroom practices. The analysis reveals consistencies and discrepancies in the ideological identity-work students engage in while crafting and commenting on science identities.

Students' Metacommentary on the Stereotypical Scientist Persona in TBBT

I asked each student if the presenters in the video (*Leonard & Sheldon*) seemed like scientists. Rose, Henry and Alexis immediately responded to my question positioning the performances as stereotypical. Alexis said, "They do really emphasize that stereotype," Rose said, "It's kind of hard to tell like who would be a scientist and not just because you don't--it's just a stereotype people make," and Henry said, "I think anyone could be a scientist. Neither of them are very good educators." Henry then elaborated:

> They have science backing what they are saying….I am pretty open minded that everything you do has some relation to science, and it's specific people that pick up on that and enjoy it I guess.

Henry typifies scientists as people that "pick up on" the idea that "everything you do has some relation to science," and that scientists are people who "enjoy" this way of thinking. Henry also comments on *Sheldon's* and *Leonard's* uses of evidence to support their claims using the verb "backing." These comments simultaneously index Henry as a science person or local science expert by signifying his knowledge of science and scientists while also revealing his ideas about additional characteristics of this persona. In other words, Henry achieves the "social project" (Gal & Irvine, 2017) of signifying himself as a local science expert at the same time that he comments on, and in so doing adds dimension to, this social type.

Unlike the other students who pointed out the stereotypical nature of the performances in the TBBT clip, Lucila responded that she thought *Sheldon* seemed like a scientist. While the other students had already experienced three years of education at this science-focused school where students regularly interact with actual scientists from the local university, Lucila was new to the school and had had limited exposure to scientists in the US[6]. Regardless of this distinction, all students identified the signs listed in Table 2 as indicative of the (stereotypical) scientist persona presented in the TV show.

Table 2. Students' Comments Describing *Sheldon* and *Leonard* Which Index a Stereotypical Scientist Persona

Student	*Line*	*Signs of (Stereotypical) Scientist in Students' Metacommentary*
Rose	1 2	Glasses; lab coat; weird clothing style; the collar; they are corny; putting in numbers and saying that's how cool it is
Lucila	3 4 5	He is like boring; the things he talks about are in his language; how he calls the girls; the teacher kind of reminds me of (science teacher) cause she is like ya and everyone is just quiet.
Henry	6 7 8	The first guy, he referenced absolute zero. Which you it would only be someone really interested in science that I think would find that funny or even realize that that is absolute zero.
Alexis	9 10 11 12 13	Scientists can't really talk to people, like speak English so to say, I feel like that is the case sometimes but not necessarily always; he doesn't understand how to make them laugh or how to make them be really interested in what he is saying; a little bit of social awkwardness coming through.

The students collectively identify the lack of socially appropriate communication strategies as indicative of the (stereotypical) scientist. Lucila's and Rose's descriptions of *Sheldon's* language characterize scientists as poor communicators who don't know how to use shared language that would engage all of the people present for the interaction. Lucila explicitly compares the TV show performance to her science teacher. Alexis characterizes *Sheldon's* language by articulating, "scientists can't really talk to people, like speak English," and points out that this is a "sometimes but not necessarily always" (Line 10) true stereotype. This phrasing sets up a contrast between "people" and "scientists;" rather than being people,

scientists are characterized as something else – non-human and unable to communicate in "English." While all people, including scientists, are complex beings each with their own identity repertoire, crafting an identity in practice through language often occurs through speakers invoking binaries (Bucholtz & Hall, 2004; Gal & Irvine, 2017). In addition to the scientist-people binary, Alexis' comment sets up another ideological binary, a separation between "people" who are defined as speaking "English," and those who communicate in other ways. This binary between English speakers and those who are non-human because they do not speak English, takes on additional meaning in this classroom context in which Spanish is often spoken in the *underlife* (Goffman, 1961) of or *counterscript* (Gutierez, Rymes, & Larson, 1995) to the official business of science learning. Thus, Alexis' comment represents an instance in which the inhumanity of scientists is ideologically linked to their lack of specifically *English* language skills, thereby positioning speakers of other languages as similarly inhuman.

However, this ideological work is unidirectional. That is, the result is not that Spanish-speaking students become elevated to positions of science expertise in the classroom because of their perceived lack of English ability, but rather that their identities as Spanish-speakers continually act as a liability to being interpreted as lacking the humanity of the "people" (in this case non-Latinx, mostly white students) in the classroom. The reason for this, I believe, is evidenced by Henry's performance of science expertise during the interview. When he describes the joke *Leonard* tells which falls flat with the youth in the classroom in the video clip, Henry describes the joke as appealing to "someone really interested in science that I think would find that funny or even realize that that is absolute zero" (Ln 7-8). Absolute zero is not mentioned in the TBBT clip; by using this term Henry indexes his own science expertise through dexterity in using science jargon in English at the same time that he offers metacommentary on the stereotypical scientist persona. Willey and Subramaniam (2017) use the term *reverent disdain* to describe how the field of science and scientists are both revered for their knowledge of the world and disdained for their rejection of the social world. As will become clear in the next section, Alexis' reverence and disdain for Henry's behavior in their lab group and his repeated positioning as the local science expert in the group help to link the performance of the science nerd stereotype in TBBT to its embodied performance by Henry.

Students' Metacommentary on Their Own and Their Peers' Science Practices

In this section I interpret metacommentary from the four students after they reviewed a video of their own science lab group practices and participation. Near the end of each interview, I also asked students if they felt certain groups of students were stigmatized or treated differently at the school based on income, languages they spoke, and race. Taken together, these data demonstrate the ways in which their science practices and metacommentary both reflect and construct a racialized and gendered context.

Lucila

When asked how she would describe her lab group participation and the participation of her peers depicted in the video, Lucila offered a description of each participant's activities: "She [*Constance*] is getting the data…I think I am recording I don't know and Rose I don't know she is doing something with the ruler…I like being the recorder." I then asked Lucila if she was ever the person to control the lab computer, to which she replied, "Sometimes…It depends on the people maybe. Like who is in my group…like who knows how to use it better." In this comment Lucila reveals that there are different kinds of "people" in her class and that there are those who "know how to use it [*lab computer*] better" than her. In this lab group, Lucila had been controlling the lab computer until Constance, a white female student, joined the group and took over its use when Lucila had asked how to perform a particular function. Rather than showing Lucila how to use the computer and returning it to her, Constance maintained control of the device for the entire data collection. In this classroom community, the people who "know how to use it better" were frequently white male monolingual English-speaking students, with Constance as a notable female exception.

When asked about whether or not she felt groups in the school were marginalized, Lucila said, "I think last year it [*feelings of marginalization*] was like stronger cause I came from a different school….This year I like know the teachers and the people and it's easier." She also commented on her desire to stay in her "ESL" class despite recently testing out of the requirement to take the course. Lucila said:

> I still need it [*ESL class*]. Cause we were talking about our score, our test score, and like I am out of it like I am not supposed to be taking it but like I feel like I need to cause of my like- you know like- cause we are with people that like talks in like Spanish and we're going through the same thing and like the teacher and it's just a place where I can be more open.

Despite the school telling Lucila that she is "not supposed" to be in ESL class anymore, labeling her as "proficient" within their reductionist system, Lucila is choosing to continue participating in the "ESL" community. This metacommentary about ESL class implicitly stands in contrast to science class, where Lucila does not experience those same feelings of comradery and support. The identity that matters to Lucila in this moment of speaking is the shared identity of being a Spanish-speaker, regardless of her perceived or measured proficiency in English. Looking at these utterances together, the people afforded positions of science expertise in the classroom, the "people who know how to use [the lab computer] better," are not the same as the people who "talk in Spanish and we're going through the same thing." Ideologically and in-practice in this classroom community, the local embodiment of the science nerd trope and by extension science expertise was largely unavailable to Spanish-speaking students.

Rose

In the opening vignette, Rose contrasts her lab group participation with other students who want to be the "leader" of the group and in so doing take over the lab activities. Rose expresses some ambiguity about whether or not she wants to or could occupy that subject position. Additional comments from Rose's interview illuminate why she may hold this ambivalent stance:

> I don't know I feel kind of like I want to say outcasted with some people…some of my American friends are like really open and like so friendly but there's like the same group that like I don't know. I feel they are always judging people. I don't know why I get that I always get that feeling that they are always judging people... And there is sometimes in that group and in like our honors and some of them are in that little area I don't know I feel more close to like the people I talk to everyday or like I'm more used to talking to everyday. And then there isn't that many people in that- in the honors that are in that type of category so it's just like eh.

Rose's comment here demonstrates that she often feels judged by "American" students who are in "honors" and not the "people I talk to everyday." "American" stands here as a euphemism for white and English monolingual and contrasts with Rose's identity as a person of color and Spanish speaker, despite the fact that she is also a US citizen. This dichotomy between white American, English monolingual students who are in science honors, and Latinx, by implication non-American, Spanish-speaking students points to the science classroom as an ideologically racialized space. The alignment of whiteness and English monolingualism with science expertise in the classroom (re)constructs and mirrors the portrayals of scientists offered in TBBT and other mass-media representations.

Alexis

Alexis described Henry as taking "the leadership spot" when she watched the video clip of her lab group participation. She said that he "was um like the main person that kind of had the best idea of what was going on." Alexis then described her own practices by stating, "I think I was trying to put something together that's why I didn't talk a whole lot," and Rose as "just trying to understand what Henry was doing." Alexis then elaborated, "Which kind of makes sense cause sometimes Henry isn't the best at communicating what he is doing." Alexis then comments, "Then Lucila didn't really talk. So, she was probably putting something together." These characterizations from Alexis tell us about the social roles she ascribed to herself and her peers as they worked on a science lab. Critically here, Henry, the only white male student in the group, is perceived to be the valid leader because he "had the best idea," despite the characterization that Henry is also not "the best at communicating." While Alexis gives Henry credit for his intellectual contributions to this lab group, ultimately the group struggled to collect useful data even after operationalizing Henry's plan for the lab. The comments on Henry's intellect and poor communication skills exemplify the quality of *reverent disdain* (Willey & Subramaniam, 2017) and represent a link in the semiotic pathway that both reflects and constructs the science nerd persona.

When I asked Alexis about the marginalization of students in the science classroom and school, she offered the following comment:

> In class I feel like it's just like um the way that I joke around with people is very different especially when they are people of color. Just because I feel that is something that happens among people of color. They are more willing to joke about race and like throw that out there. But um as far as like my schooling and academics no one ever says like that if I don't know the answer to a question it ever has to do with the fact that I am a woman or anything like that.

Alexis stated that she did not feel marginalized in science classes as a result of being a woman. Alexis' comments about the way that she communicates with and jokes with other students of color demonstrate one way in which she describes experiencing race in her science classroom. However, it is unclear whom Alexis categorizes as "people of color" from this utterance. Alexis did not have an overtly antagonistic relationship with Rose and Lucila; however, she socially distanced herself from them by uses of Mock Spanish (Hill, 2008) and other affiliative moves to align with Henry during lab group interactions (Braden, 2019). In so doing, Alexis participated in the "co-naturalization of linguistic and racial borders" (Rosa, 2019, p. 5) which placed speaking Spanish in opposition to expertise in science.

Henry

After watching a clip of himself when he refused to allow Rose to handle the lab apparatus, Henry described himself as "mostly in control, which is why you are showing me this video." He then elaborated:

> I would have totally approached that in a different way, explaining that to Rose. But uh it makes sense right? Though doesn't it? Subtract point two from the other ones? But I would have explained it a different way now… I think this is a very specific case where I am adamant about the project, because it's really cool. And that's probably why I was so into it… I said what I was doing instead of kind of letting her figure it out for herself. I was just saying look this happens, that's what it was. I wasn't using very descriptive words.

This quote demonstrates the way in which Henry perceived himself to be a leader, but he also showed ambivalence about the appropriateness of his actions. Henry claims that he would behave differently now, and he points out that he did not allow Rose to "figure it out for herself." However, he also focused on his own verbal performance his use of "descriptive words," and the way he thought about whether or not his comments had made "sense." Henry's over-enthusiasm for the project and his potential inability to communicate his ideas effectively both link to the science nerd persona students identified in their metacommentary of TBBT. Henry's concern related to his verbal performance in the video brings about another *dialogical* (Bakhtin, 1981) performance – a moment to re-voice and re-signify his science expertise, "subtract point two from the other ones." This moment

of speaking not only re-voices Henry's prior speech but also re-voices those who have come before him to establish this speech as talking science.

When I asked Henry about students in the science class and school being marginalized, he said the following:

> I think, because like, kind of, it's, we're pressured into including everyone…Now if there is someone in your group that is not doing a lot it is really easy to include them. I think we have gotten really good at that… but when you're in class and it is the whole class and let's say you are asking questions or you're learning a new topic or something like that um I think it's more common that people will be left out. I am the worst at this I probably talk way too much in class. My hand is almost always raised. I don't know what that means about me or other people but it's easier to-- I don't know if this is a good thing-- it's easier to kind of steal the experience when it's a lot of people and it's a whole classroom and we're just talking whole classroom instead of just small groups.

This quote from Henry shows his positioning of himself and certain other students as leaders in science and his self-awareness in terms of dominating whole class conversations. He mentioned later in the conversation that he had told his teacher that he wouldn't be upset if the teacher didn't call on him when he had his hand up because he knew he had a tendency to dominate conversations. However, Henry also characterizes other peers, the ones who are not leaders, as people who are "not doing a lot," in a way that dismisses his own possible role in co-constructing that lack of participation. Henry's comment "we're pressured into including everyone" invites a question of *whom* students like Henry would be "pressured into including." And, *what* criteria mark students as part of the "we," the ingroup with Henry? Viewed through the other data shared in this analysis, and taking into consideration Henry's position as a white male English-speaking student, and the subject positions of the three female students described above, I argue that the unspecified *others* implied here includes students of color, female students, and those who speak Spanish outside of school.

Discussion and Implications

This analysis reveals that students' ability to describe and problematize the science nerd stereotype when presented in a mass-media form does not prevent those same students from participating in its reproduction over time through embodying it or validating the embodiments of their peers. While students critiqued the trope they did not explicitly label the science nerds' practices as racialized and gendered. However, their metacommentary constructed and reflected various race and gender-related positionings. Revisiting Rose's comment in the opening vignette in the context of the analysis reveals that her ambivalence about her own science expertise is not neutral, but rather the result of her participation in a racialized and a gendered science learning environment.

To enable students to push back on the re-creation of the science nerd trope in their science classrooms, teachers must engage students in explicit conversations about the trope and its racialized and gendered dimensions. In her conceptualization of CRML, Yosso (2002) draws on Freire's (1973) three-phase pathway for moving towards critical consciousness, describing the participants in her study as moving from *magical* to *naïve* thinking, but not necessarily reaching a *critical* stance in which they interrogated structural and systemic forms of oppression. The data analyzed here reinforce the notion that the absence of opportunities to critically evaluate the systems, practices, and norms of science education spaces can lead students to struggle to overcome stereotypical representations of who can be a scientist. And, furthermore, data show that this struggle is not experienced only in the consumption of media, but that it has material consequences in the day-to-day interactions of youth learning science in school. While there are multiple ways to engage youth in CRML, including equipping them with the capacity to generate their own multimedia counterstories (e.g. Doerr-Stevens & Buckley-Marudas, 2019), I believe the analysis presented here supports two sets of tasks to conduct with youth in science classrooms. Appendix 2 offers a set of reflective and analytical questions to use with youth after they watch an episode of TBBT. Once a foundational conversation grappling with these questions has taken place, it could serve as a reference point for future conversations about science classroom practices.

My second instructional recommendation is to engage students in collaborative classroom discourse analysis to better understand their own communicative repertoires (Rymes, 2009, 2010, 2020) and how they use them in their lab groups. Students might be asked to regularly reflect on their participation in lab groups using the reflection questions listed in Appendix 3. Video may be used to support students in this task. New classroom discourse analysis tools aimed at helping teachers to analyze student learning (Lee & Irving, 2018) and equity (Equity Quantified in Participation (EQUIP) https://www.equip.ninja/) could serve as resources to facilitate students' analysis of their own practices. Asking students to think about and discuss their science classroom participation through a lens that honors not simply how they present their own ideas, but also how they serve as listening subjects (Inoue, 2006) for their peers, would give them the opportunity to consider how they participate in (re)creating a racialized and gendered science classroom. Teachers can collect student reflections and assist students in communicating with each other about how they are validating or invalidating the contributions of their peers.

Engaging students in iterative reflective analysis of their own actions as part of CRML tasks could lead teachers to productive ways of grappling with racism across the practices of *desiring, knowing, and doing* (Sheth, 2019). This two tiered approach – evaluating externally produced media and classroom internal media and experiences – may enable science teachers to bridge the gaps between students' and teachers' desire for equity, their knowledge of how (in)equity is created in their classroom, and their ability to achieve equity in practice.

Notes

1. All personal and place names are pseudonyms.
2. UK data indicates that STEM workers identifying as "black" are underrepresented at the highest levels while workers identifying as "Asian" are overrepresented at the highest levels (Royal Society, 2014).
3. In the United States, students in K-6 education generally receive their science instruction from their elementary teacher who may have limited expertise in science. At the secondary level, beginning in 7th grade, students often have science teachers who have specialized degrees in STEM or STEM education. As a result of these contextual differences, this paper which may also have implications at the elementary level, is situated more firmly in the secondary science education literature.
4. The school held Title I status with 50% of the students qualifying for free or reduced price lunches.
5. The school in the video was co-ed but the purpose of the visit was to promote women in science. The character *Howard* was also present in the video, however, I ended the clip before he enters the scene.
6. Lucila had attended one other school prior to SFAA, an arts-focused charter school. In an interview she mentioned she felt she had received almost no science instruction at that school. Her parents were not employed in STEM fields.
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Appendix 1 - Member Checking Interview Questions

Introductory Questions

1. How are you?
2. How is your research project going?
3. Who are you working with for your research project?
4. How is that collaboration going?

Video 1 Instructions:

Today's interview will be a little different from the other interviews you participated in as part of this study. Today I'm going to ask you to watch and respond to two short video clips.

For the first clip, we'll watch it and then I'm going to ask you a couple of questions.

Watch clip

1. What did you think about while watching the clip?
2. What did you notice while watching the clip?
3. How would you describe your participation in this video?
4. What are your classmates doing in this video?
5. Do you feel like this video shows a way that you normally participate in science class? Why or why not?

Video 2 Instructions

https://www.youtube.com/watch?v=PzwTxVncWrI

Now we'll watch a short clip from a TV show and I'll ask you to respond to it.

1. Do these characters seem like scientists? Why or why not?
    a. Follow up: What are they doing/saying that makes you say that?
2. What do you like or dislike about the characters or this clip?
3. Have you seen this show before?
4. Do you watch it regularly?
    a. Follow up: What do you like or dislike about the show?
5. Does it surprise you to know that this is the most popular TV show in the US?
    a. Follow up: Why do you think it's so popular?

Concluding Question

Some students in the past mentioned feeling treated differently at SFAA based on being part of a group. [It could be because of income, race, languages they speak, different factors]. Do you feel like there are any groups that are treated differently here?

Appendix 2 – View and Critically Evaluate

an Episode of *The Big Bang Theory*

Questions for critical reflection

1. What do you like or dislike about the characters in this show? Why?
2. Do you notice any stereotypes? What are they and how do you feel about them?
3. How, if at all, do you think race matters in the stereotypes you identified?
4. How, if at all, do you think gender matters in the stereotypes you identified?
5. Are there any other "-isms" you notice in the stereotypes?
6. Do you feel like you are like any of the characters? If yes, how? If no, why?
7. Would you want to work in a science lab group with someone acting like any of these characters? Why or why not?
8. If scientists were really like the characters on this show would this make you more or less likely to want to be a scientist? Explain.
9. How can we make sure that we don't reproduce these stereotypes in our own science classroom?

Appendix 3 – Critically Evaluate my own Classroom Participation

1. How well did I make space for other people's ideas to be heard and discussed today? (1 not well → 5 very well)
    a. What did I do well as an active listener or leader? (evidence for my rating)
    b. Did I use any "shut downs" or "put downs" when responding to others today? (evidence for my rating)
    c. What could I do to improve how I listen in the future? (plan for action)
2. Were my ideas heard and discussed? (1 not at all → 5 very much)
    a. What did I do well to share my thoughts? (my own actions)
    b. What could my partners have done better to hear and respond to my ideas? (call for action from others)
    c. What could I do to improve how I'm heard next time? (plan for action)