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That's not me: (Dis)concordance between pSTEM nerd-genius stereotypes and self-concepts predicts high school students' pSTEM identity

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Abstract

Nerd-genius stereotypes about people in the physical sciences, technology, engineering, and mathematics (pSTEM) are barriers to getting many adolescent girls interested in pSTEM. Endorsing these stereotypes may undermine youths' pSTEM identity especially when they are incongruent with their self-concepts—possibly more likely for girls than boys. Conversely, pSTEM identity may strengthen when stereotypes are congruent—possibly more for boys than girls. We tested these premises among 310 adolescents. Novel contributions of the study include the separate evaluation of youths' endorsement of four stereotypes about persons in pSTEM (geniuses, awkward, unattractive, unsuccessful at dating) and the separate consideration of two facets of self-concepts (competence and importance) in each stereotyped domain. Factor analyses confirmed the four-factor structure for self-concepts but indicated a two-factor structure for stereotypes (nerd [awkward, unattractive, unsuccessful at dating] and genius). Students' pSTEM identity was based on their felt typicality with persons in pSTEM fields. Our results generally confirmed our hypothesized model for self-perceived competence but not for importance. Congruence predicted higher pSTEM identity. Conversely, incongruence predicted lower pSTEM identity.

Keywords Academic achievement motivation · Belonging · Self-concept · Occupational attitudes · Stereotyped attitudes · Gender

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1 Introduction

Nerd-genius stereotypes about professionals in the physical sciences, technology, engineering, and mathematics (pSTEM) may undermine adolescents' interest in these fields. For example, computer scientists are commonly viewed as geniuses or nerds (Cheryan et al., 2013). As explicated in balanced identity theory (Greenwald et al., 2002), negative stereotypes about a subject or profession may affect students' identity when those beliefs are discrepant with students' self-concepts. For example, adolescents who stereotype pSTEM professionals as nerdy may steer away from pSTEM if they prioritize appearing socially competent (Starr & Leaper, 2019). Moreover, research suggests that adolescent girls and young women may be especially likely to find pSTEM stereotypes as discrepant with their self-concepts, which may partly account for the gender gap in these professions (Cheryan et al., 2013).

In the present research, we assessed U.S. high school students' stereotypes about pSTEM in four domains: genius, social competence, physical attractiveness, and dating success. In this regard, we distinguished among three facets of the nerd stereotype. We also assessed whether students' endorsement of these stereotypes aligned with two facets of their self-concepts (self-evaluated competence and importance to the self) in each of the same domains. In our hypothesized balanced-identity model, we predicted that the degree of concordance (vs. discordance) between endorsing stereotypes and self-concepts in each domain would predict their sense of identity in pSTEM. Moreover, we examined whether students' gender moderated these potential effects.

Understanding how nerd-genius-stereotypes affect students' pSTEM identity is particularly relevant during the high school years. Adolescence is a period when youth are exploring their identities—including their social and sexual-romantic identities. Concerns with their popularity, attractiveness, and romantic success because salient concerns (Harter, 2012a; Zurbriggen, 2018). Viewing pSTEM as incompatible with these identity-related concerns may undermine students' interest in pSTEM subjects (Starr, 2018). In addition, many adolescents are concerned with their academic success and are beginning to consider future college majors and possible occupations (Farkas & Leaper, 2016; Kalakoski & Nurmi, 1998). Several longitudinal studies indicate substantial stability in occupational or vocational interests from adolescence into adulthood (see Low et al., 2005). As we review later, many students hold stereotypes about the kinds of persons in pSTEM that may conflict with their social, sexual-romantic, or academic concerns. Stereotyped expectations about pSTEM subjects may affect academic decisions during high school such as whether to enroll in pSTEM-related advanced courses or extracurricular programs (Master et al., 2016; Simpkins et al., 2006; Wang & Degol, 2017). In addition, average gender differences in adolescents' pSTEM interest often precede gender gaps in achievement and persistence (Eccles & Wang, 2016).

In the next section, we review the premise of balanced identity theory and our hypothesized model regarding the concordance or discordance of students' pSTEM stereotypes and self-concepts in relation to their pSTEM identity. Afterwards, we describe the four domains of pSTEM stereotyping and their corresponding self-concepts. Finally, we consider the potential role of gender as a moderator in the hypothesized model. We acknowledge that most of the research on these topics has been conducted in Western countries.

1.1 Balanced identity theory and pSTEM identity

As emphasized in social identity theory, individuals derive a sense of belonging when they are members of a group (Turner et al., 1987). Academic identities have been found to predict students' motivation and success (e.g., Cohen & Garcia, 2008; Oyserman et al., 2006). Research indicates identification with pSTEM enhances youths' motivation in those subjects during middle and high school (e.g., Lewis et al, 2017; Master et al., 2016; Myint & Robnett, 2023). Students gain this sense of belonging or identification with a group when they perceive themselves as similar to people associated with a subject area. Conversely, if students feel like they are different from others in a subject area, they are more apt to disidentify with that group (e.g., Kessels et al., 2014; Master et al., 2016; Starr & Leaper, 2019). Prior research has largely examined how stereotypes relate to STEM value or expectancy beliefs (e.g., Levine & Pantoja, 2021). However, theorists have argued that stereotypes lead people with discordant self-concepts to feel that they do not identify with domains, resulting in decreased motivation (Inzlicht & Schmader, 2012; Steele et al., 2002). Indeed, prior research indicates that pSTEM identity may be an important mediator between stereotypes and motivation. Hence, clarifying these processes both increases our understanding and points to potential targets for interventions (e.g., Cundiff et al., 2013; Starr, 2018). Hence, in the present study, we used students' felt typicality with persons in pSTEM to evaluate their pSTEM identity as our outcome measure.

The dynamic interaction among individuals' group identity, self-concepts, and stereotypes are further elaborated in balanced identity theory. The theory's fundamental premise is that people seek balance (i.e., congruence or concordance vs. incongruence or discordance) among their self-concepts, stereotypes, and group identity (Cvencek et al., 2012; Greenwald et al., 2002). These three components can reciprocally influence one another. Among the possible patterns, one postulate is that people are more likely to form ties with groups in which they see themselves fitting—referred to as *the identity construction hypothesis* (Tobin et al., 2010). That is, individuals are more likely to identify with a group (e.g., "I feel similar to other people in pSTEM") when their self-concepts match their stereotypes about a group (e.g., "People in pSTEM are geniuses, and I think of myself as a genius"). Conversely, individuals are more likely to disidentify with a group ("I do not feel similar to people in pSTEM") when their self-concepts conflict with group stereotypes (e.g., "People in pSTEM are unattractive, and I am attractive"). Prior research supports the basic premises of balanced identity theory that people tend to seek consistency among their self-concepts, stereotypes, and group membership (see Cvencek et al., 2012; Tobin et al., 2010). Accordingly, we tested whether the congruence or incongruence between adolescents' stereotypes of persons in pSTEM and their self-concepts predicted youths' pSTEM identity—particularly their sense of belonging or felt typicality in pSTEM. As explained in a later section, many stereotypes about pSTEM may be more incongruent with traditional self-concepts associated with girls while more congruent with traditional self-concepts associated with boys.

2 Nerd-Genius stereotypes about pSTEM and related self-concepts

As described below, we assessed adolescents' pSTEM stereotypes in four domains. Also, we separately assessed two facets of their self-concepts—self-evaluated competence and importance—in the same four domains.

2.1 Nerd-genius stereotypes

Based on prior research, we identified four key stereotypes that are commonly associated with people in STEM occupations. These include the views that persons in pSTEM are geniuses, socially awkward, physically unattractive, and unsuccessful at dating. We refer collectively to these as *nerd-genius stereotypes* about pSTEM. First, pSTEM fields are often stereotyped as requiring *genius* (brilliance or natural ability). This trend has been documented in studies of children (Bian et al., 2017), adolescents (Hannover & Kessels, 2004; Starr & Leaper, 2019), and emerging adults (Cheryan et al., 2013; Meyer et al., 2015; Starr, 2018). In addition, three more stereotypes reflect socially undesirably attributes often associated with persons in pSTEM fields. People in pSTEM may be stereotyped as *socially awkward*, *physically unattractive* (i.e., "geeky looking" or disheveled), and *unsuccessful at dating* as documented in studies of adolescents (Garriott et al., 2017; Hannover & Kessels, 2004) and adults (Cheryan et al., 2013; Park et al., 2011). Although these three social domains are related, Harter (2012a, 2012b) has documented in multiple studies that youth generally form distinct self-concepts in each area (also see Orth et al., 2021 for a related meta-analysis).

Researchers previously observed negative relations between students' endorsements of nerd-genius stereotypes and pSTEM interest (Bian et al., 2017; Cheryan et al., 2013; Garriott et al., 2017; Hannover & Kessels, 2004; Starr, 2018). However, we identified only three prior studies testing whether the concordance between students' endorsement of science or STEM stereotypes and their self-concepts predicted their STEM identity-related outcomes. One investigation of high school students utilized a composite measure of science-related stereotypes (Taconis & Kessels, 2009). Incongruence between students' stereotypes and self-image predicted lower preference for physics courses. A second study of high school students separately evaluated endorsements of the nerd stereotype and the genius stereotype about STEM (Starr & Leaper, 2019). Incongruence between stereotypes and self-concepts predicted lower STEM ability beliefs or task values. Finally, a third study of undergraduates looked at discrepancies between students' self-concepts and their stereotypes of scientists as communal, agentic, or scientific in relation to their pSTEM career interest (McPherson et al., 2018). Stereotype/

self-concept discrepancies, particularly in the scientific domain (similar to the genius stereotype), predicted lower pSTEM interest. The latter two studies highlighted the potential benefits of investigating different facets of pSTEM stereotypes. Accordingly, we extend the prior research by considering four different stereotyped domains. Moreover, as reviewed next, we further extended prior balanced-identity research by examining two facets of students' self-concepts in these four domains.

2.1.1 Nerd-genius self-concepts

We expected that the relations between adolescents' endorsement of nerd-genius pSTEM stereotypes and pSTEM identity would depend on whether the stereotypes were incongruent or congruent with students' self-concepts in the four nerd-genius domains. Our assessment of self-concepts was guided by Harter's (2012a) model of the self-system. According to this model, self-concepts are comprised of people's *self-evaluations* of competence in a domain as well as the *personal importance* of the domain. For example, two persons might view themselves as strong in a domain but differ in how important they view a domain. Alternatively, two persons might attach similar importance to a domain but differ in their self-evaluation. These two facets of U.S. adolescents' academic self-concept independently predicted their engagement and grades in math and science (Bouchey & Harter, 2005).

Separately considering self-evaluated competence and perceived importance reflects a novel approach in testing the balanced-identity model. These two facets are related but distinct (Neeman & Harter, 2012a, 2012b). For example, one might see oneself as traditionally attractive (high self-evaluations) but not place high priority on it (low personal importance). Similarly, persons may see themselves as socially inept (low evaluation) but wish that they were popular with their peers (high importance). Although both facets may relate to pSTEM identity, it is possible that one is significantly related while the other is not. On the one hand, self-evaluations may be more strongly related to adolescents' identification with a domain because they more directly reflect the degree of concordance between the self-evaluation ("I am smart" or "I am not smart") and stereotype endorsement in a domain ("People in STEM are geniuses"). Alternatively, there is some evidence to suggest that importance could be more influential. For example, in one previous study, researchers observed that mastery goals were better than self-perceived competencies in predicting students' academic identity (Yeung et al., 2012).

Prior research guided by balanced identity theory has focused on the self-evaluative facet of the self-concept (see Cvencek et al., 2012). In the present study, we expected that the congruence or incongruence of self-perceived competence and personal importance to pSTEM stereotypes would similarly predict students' pSTEM identity.

2.2 Gender as a moderator

Overall, we predicted that concordance or discordance between nerd-genius stereotypes and self-concepts would predict pSTEM outcomes in girls and boys. However, we speculated that the impact might be stronger for girls. First, the genius stereotype may tend to be more threatening to girls than to boys. Researchers have found children were less likely to attribute intellectual brilliance to females than males (Bian et al., 2017); also, girls were more likely than boys to underestimate their intelligence (Bian et al., 2017; Schoon & Eccles, 2014). Also, adolescents' belief in innate math ability was negatively related to self-perceived math ability and value among girls—yet these stereotypical beliefs were unrelated to these math outcomes in boys (Heyder et al., 2021).

Second, studies of adolescents indicated greater average emphasis among girls than boys in sociability, physical appearance, and dating success (e.g., Eccles & Wang, 2016; Fredrickson & Roberts, 1997; Zurbriggen, 2018). As with the genius stereotype, girls may be affected more when they experience discordance between their self-concepts in these domains and pSTEM stereotypes. For example, stereotypes of persons in pSTEM as socially undesirable may be especially problematic for many girls and young women given cultural emphases on their appearance and sexual attractiveness (Cheryan et al., 2013; Kessels, 2005; Park et al., 2011). In addition, the definition of what being attractive or sexually appealing may differ on average between girls and boys. For example, cultural definitions of being attractive for girls often emphasize sexualization, which some girls see as incompatible with intelligence and appearing competent (Brown, 2019) as well as being a scientist (Starr & Zurbriggen, 2019). Conversely, attractiveness for boys typically emphasizes muscularity, which confers strength and agency. Moreover, the higher likelihood of other barriers for girls—such as gender bias and absence of role models (see Cheryan et al., 2017; Leaper et al., 2012)—may additionally compound the effects of stereotype incongruence for adolescent girls, given that identity threat and belonging uncertainty are more likely to occur in environments with lower social support (e.g., Lee et al., 2015).

Accordingly, we tested students' gender as a moderator in our hypothesized model in regards to the predictor variables (stereotypes, self-concepts, and their interaction) and pSTEM identity. We expected more negative associations between stereotype incongruence and pSTEM identity for girls than for boys. Conversely, we expected more positive associations between stereotype congruence and pSTEM identity for boys than for girls.

2.3 Present study

We investigated whether the balance between high school students' endorsement of nerd-genius stereotypes of pSTEM and their self-concepts (self-evaluation or perceived importance to the self) in similar domains predicted their pSTEM identity. Based on the identity construction hypothesis (Tobin et al., 2010), we predicted that adolescents who endorse nerd-genius stereotypes with incongruent self-concepts in the domain would demonstrate lower pSTEM identity (especially girls), while those who endorsed pSTEM stereotypes with congruent self-concepts would have higher pSTEM identity (especially boys).

Our study builds on prior research in multiple ways: First, the possible effects of stereotype/self-concept balance were evaluated in four different pSTEM domains. Second, we separately examined two facets of self-concepts (self-evaluated competence and perceived importance)—a distinctly novel approach in balanced-identity research. We explored, but did not posit, whether there would be a better fit in the balanced identity model for one facet than another. Finally, we tested whether gender was a significant moderator regarding how the predictor variables (i.e., the stereotype, self-concept, and their interaction) were related to pSTEM identity. In this regard, we speculated that congruence might predict positive pSTEM identity more strongly among boys than girls; whereas incongruence might predict negative pSTEM identity more strongly among girls than boys. (As explained in the analysis plan section of our results, it is possible to have one pattern but not the other.)

In all analyses, we controlled whether adolescents had taken pre-calculus to partly control for variations in prior attainment when assessing the relation of our predictors to pSTEM identity. We used pre-calculus given the importance of mathematics in many pSTEM subjects such as physics and computer science (see Eccles & Wang, 2016; Watt et al., 2017, for similar approach).

3 Method

3.1 Participants

Participants were 310 students enrolled in physical science classrooms in seven northern California high schools. We targeted a sample size of 300 to achieve a power of 0.80 based on a power analysis guided by prior research (Starr, 2018). The majority of participants were either sophomores ($n=136$, 43.9%) or juniors ($n=137$, 44.2%). Also, there were 31 seniors (10%) and 1 first year student. The majority of the students were either 15 years old ($n=107$, 34.5%) or 16 years old ($n=154$, 49.7%). The remaining students were 17 years ($n=41$, 13.2%) or 18 years ($n=8$, 2.6%). Half of participants self-identified as a girl ($n=155$, 50%, including one student who self-identified as a "gender non-binary girl") and half self-identified as a boy ($n=155$, 50%).

Students' self-identified ethnic backgrounds included Asian ($n=159$, 51.3%), White ($n=72$, 23.2%), and Latinx ($n=25$, 8.1%). The remaining participants identified as Middle Eastern ($n=9$, 2.9%), Black ($n=2$), Native American ($n=1$), or multiethnic ($n=36$, 11.5%). The latter included Asian and White ($n=14$, 4.5%), Latinx and White ($n=6$, 19%), Black and White ($n=3$, 1.0%), or other multiple ethnicities ($n=16$, 5.2%). Based on students' reports of their mothers' education level, 26.5% ($n=82$) had not completed 4-year college, 39.7% ($n=123$) had completed a 4-year college degree, and 27.0% ($n=83$) had attained an advanced degree.

3.2 Procedure

Institutional Review Board approval for this study was obtained from the second author's university. Teachers were recruited via the school district science coordinator, and teachers then recruited students in their classroom. Teachers gave the online survey to students in their classroom during school and were compensated for their time with a $100 gift card. The survey took an average of 35 min to complete and included the following sections: (1) questions about students' demographic backgrounds; (2) definition of pSTEM and examples of pSTEM courses and careers; (3) measures of motivational beliefs and career interests in pSTEM; (4) measures of pSTEM-related identity, nerd-genius stereotypes, and self-concepts; and (5) questions about views of pSTEM. Excluding demographic questions, questions were presented in random order on each page throughout the survey. All scale items (with directions) used in the present analyses appear in Supplementary Tables S1 and S2.

3.3 Measures

SPSS version 26 was used to conduct all analyses. Analysis of the patterns of missing data revealed that less than 3% of values for all cases were missing, and 92.94% of the items were not missing data for any case. Considering individual cases, 70.16% of participants had no missing data, and no item had 10% or more of missing values. Scale items from the attractiveness and dating self-concept scales were the most commonly missing. When there was incomplete scale, missing data was imputed via mean imputation.

3.3.1 Background variables

Students were asked to report their gender, ethnic/racial background, maternal education level, age, and year in high school. For gender and ethnic/racial background, participants were asked to write in their preferred identity and were given a list of categories and asked to select as many as applied to them.

3.3.2 Pre-calculus enrollment

Students reported whether they had taken or were currently enrolled in pre-calculus. Given the prevalence of grade inflation can reduce the reliability of grades as an indicator of attainment, enrollment in advanced courses can be a useful indicator math attainment because of prerequisites necessary to enroll (Kostal et al., 2016). We used pre-calculus enrollment as a covariate, given that prior research found that prior math attainment was highly correlated with STEM motivational beliefs and identity (e.g., Chang et al., 2014; Schoon & Eccles, 2014; Starr, 2018).

3.3.3 Nerd-genius stereotypes about people in pSTEM

To assess participants' stereotypes about people who work in pSTEM, four subscales with five items each were used that built upon Starr's (2018) nerd-genius stereotypes scale. Some items were modified and items were added. Stereotypes were assessed in the following domains: (1) people in pSTEM are geniuses (e.g., "People who work in pSTEM are geniuses.", $\alpha = 0.78$), (2) socially awkward (e.g., "People who work in pSTEM are socially awkward.", $\alpha = 0.88$), (3) physically unattractive (e.g., "People who work in pSTEM are unattractive.", $\alpha = 0.88$), and (4) unsuccessful at dating (e.g., "People who work in pSTEM find dating difficult.", α = 0.91). Participants were asked to rate each item on a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*). Although the socially awkward, physically unattractive, and unsuccessful at dating subscales were conceptualized as three individual scales, a factor analysis determined that they fell onto a single construct (see Supplementary Table 3). Thus, they were combined into a single "nerd stereotype" scale (α = 0.96).

3.3.4 Self-concepts

Self-concepts were measured separately for self-evaluated competence and perceived importance in four domains: pSTEM genius, social competence, physical attractiveness, and dating success. The construction of items was guided by the self-evaluation and importance scales in Harter's Self-Perception Profile (Harter, 2012b). Participants rated each item on a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*).

3.3.4.1 Self-evaluated competence Five questions each were used to assess individuals' self-evaluated competencies in each of the following domains: genius in pSTEM (e.g., "I am naturally gifted in pSTEM"; α = 0.89), social competence (e.g., "I am at ease in social situations"; α = 0.89), physical attractiveness (e.g., "I spend time working on my physical appearance, and it shows"; α = 0.85), and dating success (e.g., "If I'm interested in dating someone, it's likely that they'll also want to date me"; α = 0.89).

3.3.4.2 Importance Another set of five questions assessed the importance placed on each domain: genius in pSTEM (e.g., "Being gifted in pSTEM is important to me"; α = 0.92), social competence (e.g., "I value being socially competent over many other importance"; α = 0.79), physical attractiveness (e.g., "It's important to me that I look my best"; α = 0.84), and dating success (e.g., "Having a dating partner is important to me"; α = 0.92). One reverse-scored question was dropped from each subscale due to low factor loadings (< 0.50; see Supplementary 1).

3.4 pSTEM Identity

Based on prior research (e.g., Leaper et al., 2012; Tobin et al., 2010), students' pSTEM identity was assessed in terms of their felt typicality with people in pSTEM (e.g., "I feel like I'm just like people who are good at pSTEM"). Participants were asked to indicate their agreement with six items on a 6-point scale (1 = *strongly disagree* to 6 = *strongly agree*). Two reverse-scored items were dropped due to low internal consistency ($\alpha = 0.66$); and excellent internal reliability was indicated with the remaining four items ($\alpha = 0.83$; see Supplementary Table 1 s for list of items that were dropped and retained).

4 Results

4.1 Preliminary analyses

4.1.1 Confirmatory factor analyses of scales

Three sets of factor analyses were conducted with all of the respective items from the self-evaluation scales, importance scales, and stereotype scales (see Supplementary Tables S1, S2, and S3). The two factor analyses with self-evaluation and importance confirmed our four expected constructs (genius, social, attractive, and dating). These factor loadings are consistent with prior research on self-concepts (see Harter, 2012a; Orth et al., 2021). The factor analysis with the stereotype items, however, indicated a two-factor structure. Besides the genius stereotype factor, there was a single nerd factor comprised of the items for socially awkward, unsuccessful at dating, and unattractive. This finding is similar to recent research (Starr, 2018). In contrast, the factor analyses confirmed a four-factor structure of the self-concept domains (both for self-evaluations and importance). Therefore, we retained the four self-concept domains. When testing for self-concept/stereotype concordance we examined the following: genius self-concept and genius stereotype; social competence self-concept and nerd stereotype; attractiveness self-concept and nerd stereotype; and dating self-concept and nerd stereotype.

4.1.2 Descriptive statistics, correlations, and group comparisons

Descriptive statistics and bivariate correlations across all of the scales investigated in the present analyses are presented in Tables 1 and 2, respectively. An inspection of the overall means reveals on average that students tended to endorse the genius stereotype while slightly disagreeing with the nerd stereotype. Nonetheless, there was variability in scores, and neither skewness nor kurtosis were indicated for any of these variables. In addition, independent samples *t*-tests were conducted to assess potential gender group differences in the major variables (see Table 1). Significant average gender differences occurred with the nerd stereotype (boys higher) and dating importance (boys higher).

A majority of our student sample self-identified as having Asian ethnic backgrounds. We consider this a welcome improvement upon the historical overreliance on samples from White backgrounds. Preliminary analyses did not reveal any significant ethnic group differences in the measures tested in our later analyses measures. Also, there were no Ethnicity × Gender interactions. Therefore, students' ethnic background was not included as a factor in any subsequent analyses.

4.2 Hierarchical regression analyses

Separately examining each domain (genius in pSTEM, social competence, physical attractiveness, and dating success), we conducted four hierarchical regressions with

Table 1 Descriptive statistics and gender group comparisons for major variables ($N = 310$)

	Scale alpha	Scale range	All ($n = 310$) M (SD)	Girls ($n = 155$) M (SD)	Boys ($n = 155$) M (SD)	t(df)	d
Math attainment	n/a	0–1	0.37 (0.48)	0.39 (0.49)	0.35 (0.48)	$\chi 2(df) = 0.535$ (*1*)	0.08
pSTEM identity	0.83	1–6	3.10 (1.07)	3.00 (0.98)	3.21 (1.14)	-1.76^{+} (*300.83*)	0.20
Genius stereotype	0.78	1–6	3.71 (0.94)	3.75 (0.89)	3.68 (1.00)	−0.61 (*307*)	0.07
Nerd stereotype	0.96	1–6	2.69 (.98)	2.55 (.90)	2.86 (1.05)	**2.77 (*307*)****	**0.31**
Genius self-evaluation	0.89	1–6	3.03 (1.16)	2.90 (1.11)	3.15 (1.19)	-1.88^{+} (*301*)	0.22
Genius importance	0.92	1–6	3.38 (1.25)	3.33 (1.28)	3.42 (1.23)	−0.63 (*302*)	0.07
Social self-evaluation	0.89	1–6	3.95 (1.06)	3.98 (1.06)	3.92 (1.06)	0.51 (*300*)	0.06
Social importance	0.79	1–6	3.79 (1.01)	3.89 (0.84)	3.68 (1.15)	1.80^{+} (*303*)	0.22
Attractive self-evaluation	0.85	1–6	3.40 (0.98)	3.42 (0.95)	3.38 (1.02)	0.38 (*301*)	0.04
Attractive importance	0.84	1–6	3.36 (1.04)	3.36 (1.00)	3.35 (1.08)	0.11 (*291*)	0.02
Dating self-evaluation	0.89	1–6	3.11 (1.05)	3.06 (0.96)	3.16 (1.13)	−0.84 (*297*)	0.10
Dating importance	0.92	1–6	3.13 (1.24)	2.94 (1.17)	3.32 (1.29)	**-2.63^{**} (*289*)**	**0.33**

"Genius" refers to stereotypes or self-concepts regarding being gifted in pSTEM. Significant average gender differences are in bold

$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 2 Bivariate correlations ($N = 310$)

	1	2	3	4	5	6	7	8	9	10	10	11	12
1. Grade level	–	$.45^{**}$	-.07	-.01	.02	$-.16^{**}$	$-.12^{*}$	-.05	-.02	-.02	-.10	-.07	-.02
2. Math attainment		–	$.13^{*}$	$.12^{*}$	.08	$.15^{**}$	$.16^{**}$	-.01	.06	.00	.01	-.03	.01
3. pSTEM identity			–	.00	-.01	$.64^{**}$	$.61^{**}$	$.16^{**}$	$.26^{**}$	$.14^{*}$	.02	$.22^{**}$	.11
4 Genius stereotype				–	$.42^{***}$	-.02	.08	.101	.09	.00	.08	$.12^{*}$	.00
5 Nerd stereotype					–	.11	.04	-.01	.05	$.12^{*}$	$.15^{*}$	$.22^{***}$	$.17^{**}$
6. Genius self-evaluation						–	$.64^{**}$	$.23^{**}$	$.33^{**}$	$.30^{**}$	$.20^{**}$	$.31^{**}$	$.22^{**}$
7. Genius importance							–	.03	$.26^{**}$	$.17^{**}$	$.16^{**}$	$.21^{**}$	$.15^{*}$
8. Social self-evaluation								–	$.55^{**}$	$.54^{**}$	$.33^{**}$	$.46^{**}$	$.22^{**}$
9. Social importance									–	$.46^{**}$	$.55^{**}$	$.36^{**}$	$.43^{**}$
10. Attractive self-evaluation										–	$.62^{**}$	$.70^{**}$	$.38^{**}$
11. Attractive importance											–	$.43^{**}$	$.59^{**}$
12. Dating self-evaluation												–	$.38^{**}$
13. Dating importance													–

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

self-perceived pSTEM identity. Mean substitution was used for any missing values (see Methods for details). In the first step, whether a student had taken or was currently enrolled in pre-calculus (math attainment) was entered. In the second step, domain-specific STEM stereotyping was added. (e.g., pSTEM = genius). In the third step, domain-specific self-evaluations or goals were entered (e.g., self-perceived genius in pSTEM and importance of being a genius in pSTEM). In the fourth step, the 2-way interactions between stereotyping and each self-concept measure were introduced. Finally, in the last step, 2-way and 3-way interactions between students' self-identified gender and the factors introduced in the second and third steps were entered. (The latter step did not significantly add to the model.) The results are summarized below (also see Tables 3, 4, 5, and 6 for hierarchical regressions with self-evaluation outcomes; and see Tables 4–8 in Supplementary Materials for hierarchical regressions with for importance outcomes). Math attainment positively and significantly associated with pSTEM identity in the first step of all of the regression analyses (and therefore is not repeated below).

In summarizing the results below, we first describe the findings regarding main effects of our regression from the second step. We then discuss the hypothesized interactions between self-evaluations and pSTEM stereotyping in the four domains (genius, social competence, physical attractiveness, dating success). Afterwards, we review the results regarding hypothesized interactions between personal importance and pSTEM stereotyping in the four domains. With each set of interactions, we hypothesized that congruence would predict strong pSTEM identity or incongruence would predict weaker pSTEM identity. If the interaction was significant, we probed the interaction using the PROCESS macro for SPSS (Hayes, 2012).

4.3 Main effects of gender, self-concepts, and stereotypes

Gender was consistently and negatively related to pSTEM identity across the regressions (i.e., girls tended to score lower than boys). Both self-evaluations and importance had several significant main effects on pSTEM identity. Genius and social self-evaluations and importance both had significant and positive relations to pSTEM identity. Additionally, the attractive and dating self-evaluations (but not importance) had a significant and positive relation to pSTEM identity. Thus, endorsing the social, attractive, and dating self-concepts may have a positive relation to pSTEM identity when not paired with nerd stereotype endorsement. Furthermore, the genius and nerd stereotypes were never significant at the second step, indicating that endorsing the stereotypes on their own may not relate to pSTEM identity unless they are paired with a non-matching self-evaluation.

4.4 Concordance between self-evaluations and pSTEM stereotyping

Support for the hypothesized balanced identity model was indicated in the pSTEM genius, social competence, and dating success domains (see Fig. 1 for a visual representation of the expected interaction). This was not indicated for

Table 3 Hierarchical regression for genius stereotype and genius self-evaluation with STEM identity

Model	1		2		3		4	
Predictor	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß
Constant	4.619 (.559)***		1.187 (0.560)*		2.082 (0.651)**		2.009 (0.730)**	
Math attainment	0.454 (.137)***	0.206	0.055 (0.114)	0.025	0.021 (0.114)	0.009	0.007 (0.114)	0.003
Year in high school	-0.275 (.101)**	-0.170	0.024 (0.083)	0.015	0.036 (0.083)	0.022	0.031 (0.083)	0.019
Girl	-0.267 (0.119)*	-0.126	-0.080 (0.096)	-0.038	-0.060 (0.095)	-0.028	0.407 (0.902)	0.191
Genius stereotype			0.009 (0.051)	0.008	-0.249 (0.110)*	-0.220	-0.255 (0.143)	-0.226
Genius self-evaluation			0.584 (0.044)	0.628***	.251 (0.134)	0.270	0.353 (0.165)*	0.380
Stereotype x Self-evaluation					.089 (0.034)**	0.441	0.073 (0.042)	0.360
Girl x Self-evaluation							-0.337 (0.284)	-0.516
Girl x Stereotype							-0.056 (0.228)	-0.104
Girl x Stereotype x Self-evaluation							0.068 (0.072)	0.399
F_{model}	5.576		41.212		36.160		24.593	
F_{change}	5.576***		89.810***		6.902**		1.267	
R^2_{change}	0.052		0.352		0.013		0.007	

$N = 310$ with mean substitution for missing values

$^{\dagger}p = .06$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 4 Hierarchical regression for nerd stereotype and social self-evaluation with STEM identity

Model	1		2		3		4	
Predictor	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß
Constant	4.619 (0.559)***		4.050 (0.632)***		2.763 (0.752)***		2.115 (0.898)*	
Math attainment	0.454 (0.137)***	0.206	0.459 (0.136)***	0.208	0.479 (0.135)***	0.217	0.481 (0.135)***	0.218
Year in high school	-0.275 (0.101)**	-0.170	-0.263 (0.100)**	-0.163	-0.290 (0.099)**	-0.179	-0.280 (0.099)**	-0.173
Girl	-0.267 (0.119)*	-0.126	-0.284 (0.119)**	-0.134	-0.295 (0.118)	-0.139	0.314 (0.409)	0.147
Nerd stereotype			-0.040 (0.060)	-0.037	0.474 (0.178)**	0.439	0.574 (0.225)**	0.532
Social Self-evaluation			0.157 (0.056)***	0.154	0.169 (0.056)**	0.166	0.249 (0.075)***	0.244
Stereotype x Self-evaluation					-0.130 (0.042)**	-0.506	-0.152 (0.055)**	-0.590
Girl x Self-evaluation							-0.194 (370)	-0.117
Girl x Stereotype							-0.157 (0.101)	-0.310
Girl x Stereotype x Self-evaluation							0.037 (0.088)	0.097
F_{model}	5.576		5.062		5.907		4.235	
F_{change}	5.576***		4.120*		9.429**		0.904	
R^2_{change}	0.052		0.025		0.028		0.008	

$N = 310$ with mean substitution for missing values

$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 5 Hierarchical regression for nerd stereotype and attractive self-evaluation with STEM identity

Model	1		2		3		4	
Predictor	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß
Constant	4.619 (0.559)***		0.463 (0.136)***	0.210	4.184 (0.612)***		3.704 (0.666)***	
Math attainment	0.454 (0.137)***	0.206	-0.272 (0.100)***	-0.168	0.455 (0.136)***	0.206	0.457 (0.136)***	0.207
Year in high school	-0.275 (0.101)**	-0.170	-0.289 (0.119)**	-0.136	-0.268 (0.100)**	-0.166	-0.249 (0.100)**	-0.154
Girl	-0.267 (0.119)*	-0.126	-0.060 (0.061)*	-0.056	-0.276 (0.119)*	-0.130	-0.221 (0.867)	-0.104
Nerd stereotype			0.159 (0.061)	0.145	-0.066 (0.061)	-0.061	0.017 (0.076)	0.016
Attractive self-evaluation			0.463 (0.136)**	0.210	0.174 (0.061)**	0.159	0.213 (0.080)**	0.195
Stereotype x Self-evaluation					-0.095 (0.047)*	-0.112	-0.063 (0.057)	-0.074
Girl x Self-evaluation							0.131 (0.250)	0.224
Girl x Stereotype							0.077 (0.294)	0.103
Girl x Stereotype x Self-evaluation							-0.077 (0.082)	-0.398
F_{model}	5.576		4.851		4.759		3.683	
F_{change}	5.576***		3.621*		4.052*		1.484	
R^2_{change}	0.052		0.022		0.012		0.013	

$N = 310$ with mean substitution for missing values

$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Table 6 Hierarchical regression for nerd stereotype and dating success self-evaluation with STEM identity

Model	1		2		3		4	
Predictor	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß	*B* (*SE*)	ß
Constant	4.619 (0.559)***		4.026 (0.601)***		3.312 (0.707)***		3.386 (0.832)***	
Math attainment	0.454 (0.137)***	0.206	0.470 (0.134)***	0.213	0.462 (0.134)***	0.210	0.460 (0.135)***	0.209
Year in high school	-0.275 (0.101)**	-0.170	-0.253 (0.099)**	-0.156	-0.247 (0.098)**	-0.153	-0.242 (0.099)**	-0.149
Girl	-0.267 (0.119)*	-0.126	-0.278 (0.118)*	-0.131	-0.282(0.117)*	-0.133	-0.460 (0.348)	-0.216
Nerd stereotype			-0.093 (0.061)	-0.086	0.151 (0.142)	0.139	0.138 (0.197)	0.128
Dating success self-evaluation			0.233 (0.058)	0.224***	0.248 (0.058)***	0.239	0.220 (0.075)**	0.212
Stereotype x Self-evaluation					-0.082 (0.043)*	-0.251	-0.059 (0.060)	-0.181
Girl x Self-evaluation							0.004 (0.288)	0.002
Girl x Stereotype							0.061 (0.109)	0.094
Girl x Stereotype x Self-evaluation							-0.048 (0.089)	-0.093
F_{model}	5.576		6.825		6.335		4.392	
F_{change}	5.576***		8.299***		3.594*		0.561	
R^2_{change}	0.052		0.049		0.031		0.005	

$N = 310$ with mean substitution for missing values

$^+p < .10$. $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

Expected interaction: Stereotype by Self-Self-Concept Predicting pSTEM Identity.

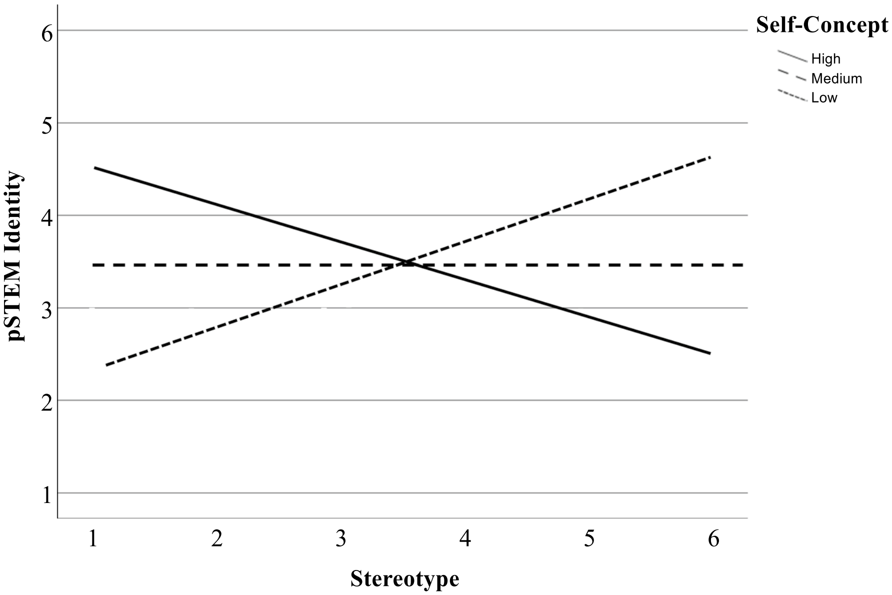

Fig. 1 Expected interaction: Stereotype by Self-Self-Concept Predicting pSTEM Identity. *Note.* This is the expected interaction for the nerd stereotype. The black line (high social, attractive, or dating self-concept) indicates a mismatch with the stereotype, while the short-dotted line (low self-concept) indicates a match with the stereotype. For the genius stereotype (and self-concept), those with mismatching genius self-concepts would be those with low genius self-concepts. Thus, we expected on this graph the solid black and short-dotted lines would be switched so that those with high genius self-concept would have the highest pSTEM identity when they endorsed the genius stereotype

the physical attractiveness domain. Unexpectedly, there were no significant 2- or 3-way interactions with gender in any of the analyses.

First, there was a significant Genius Stereotype × pSTEM Self-evaluation interaction (see Table 3 for the hierarchical regression and Fig. 2 for a visual representation of the interaction). Follow-up tests revealed that students who evaluated themselves as a genius in pSTEM and endorsed the pSTEM = genius were *more* likely to view themselves as typical in STEM, $B = 0.166$, $SE = 0.070$, $t(297) = 2.387$, $p = .018$. Additionally, those who did not evaluate themselves as a genius in pSTEM and endorsed the stereotype were marginally less likely to view themselves as typical in pSTEM, $B = -0.111$, $SE = 0.065$, $t(297) = -1.712$, $p = .088$.

Second, a significant Nerd Stereotype × Social competence Self-evaluation interaction occurred (see Table 4 for the hierarchical regression and Fig. 3 for a visual representation). Follow-up tests indicated that students who evaluated themselves as high in social competence tended to be lower in pSTEM identity when they endorsed the nerd stereotype, $B = -0.167$, $SE = 0.078$, $t(297) = -2.144$, $p = .033$.

Third, there was a significant nerd stereotype by attractive self-concept interaction (see Table 5 for the hierarchical regression and Fig. 4 for a visual

Interaction: Genius Stereotype by Genius Self-Evaluation Predicting pSTEM Identity

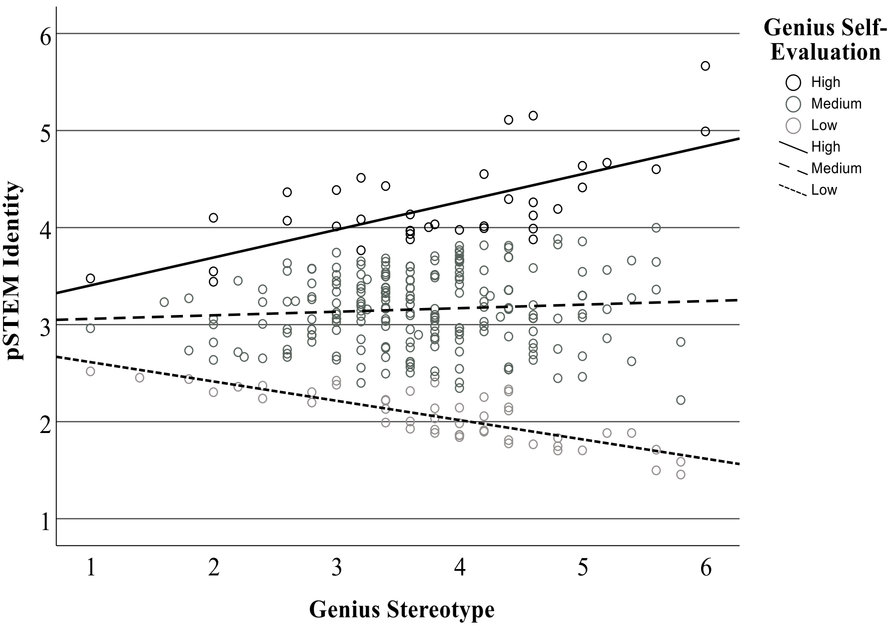

Fig. 2 Interaction: Genius Stereotype by Genius Self-Evaluation Predicting pSTEM Identity. *Note.* Interaction significant at high genius self-evaluation (black line, matching self-concept)

representation of the interaction). Further tests indicated that endorsing the nerd stereotype predicted lower pSTEM identity among students who evaluated themselves as attractive, although the effect was only marginal, $B = -0.154$, $SE = 0.082$, $t(297) = -1.902$, $p = .058$.

Finally, there was a significant Nerd Stereotype × Dating Self-evaluation interaction (see Table 6 for the hierarchical regression and Fig. 5 for a visual representation of the interaction). Further tests showed that endorsing the nerd stereotype predicted lower pSTEM identity among students who evaluated themselves as successful at dating, $B = -0.173$, $SE = 0.083$, $t(297) = -2.078$, $p = .039$.

4.5 Concordance between personal importance and pSTEM stereotyping

There were no significant interactions between personal importance and pSTEM stereotyping; thus, support was not found for balanced identity theory regarding personal importance. Furthermore, there were no significant interaction effects with gender.

4.6 Summary

According to the hypothesized balanced identity model, students would be less likely to identify as typical of persons in pSTEM if their self-concepts and pSTEM

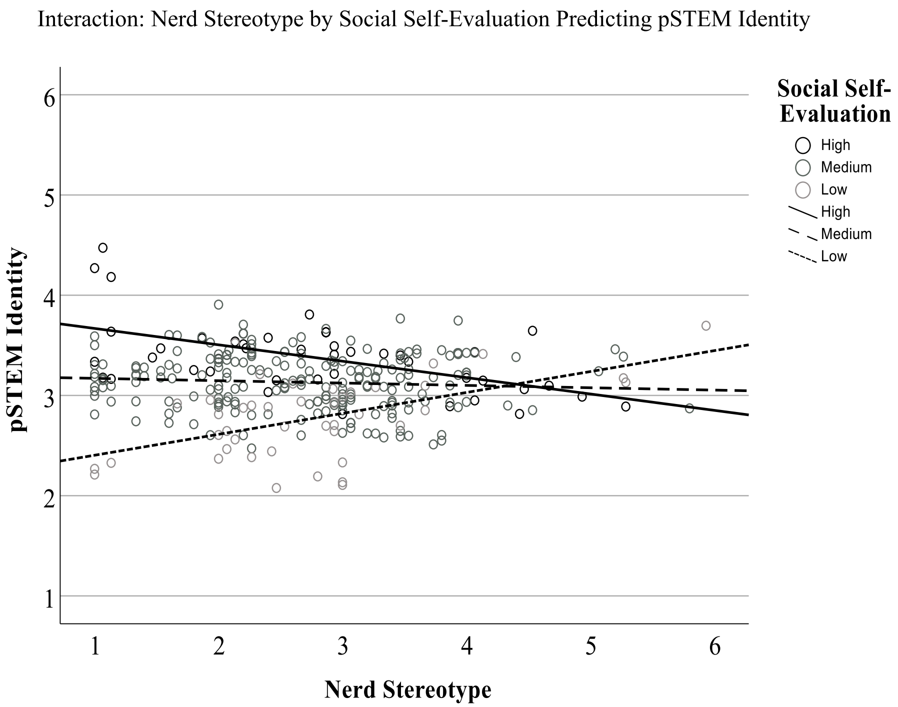

Fig. 3 Interaction: Nerd Stereotype by Social Self-Evaluation Predicting pSTEM Identity. *Note.* Interaction significant at high social self-evaluation (black line, mismatching self-evaluation)

stereotypes were discordant. Conversely, they would be more likely to view themselves as typical of pSTEM if their self-concepts and stereotypes were concordant. Partial support of this hypothesized model was indicated—especially when the self-evaluation (vs. importance) facet of self-concept was examined—particularly regarding genius, social, and dating self-evaluations.

5 Discussion

According to balanced identity theory (Cvencek et al., 2012; Greenwald et al., 2002), individuals seek to attain balance or consistency among their self-concepts, group stereotypes, and group identities. When congruence occurs, individuals may be more likely to see themselves as belonging to the group. We applied this model to understand some of the processes that may affect adolescent girls' and boys' identification in pSTEM based on their identification with persons in those professions.

In our study, we discovered that high school students' self-evaluations, but not personal importance, moderated the associations between pSTEM stereotyping and their pSTEM identity. Our research indicates pSTEM stereotypes may hinder some students' pSTEM identity and motivation when they are incongruent with their

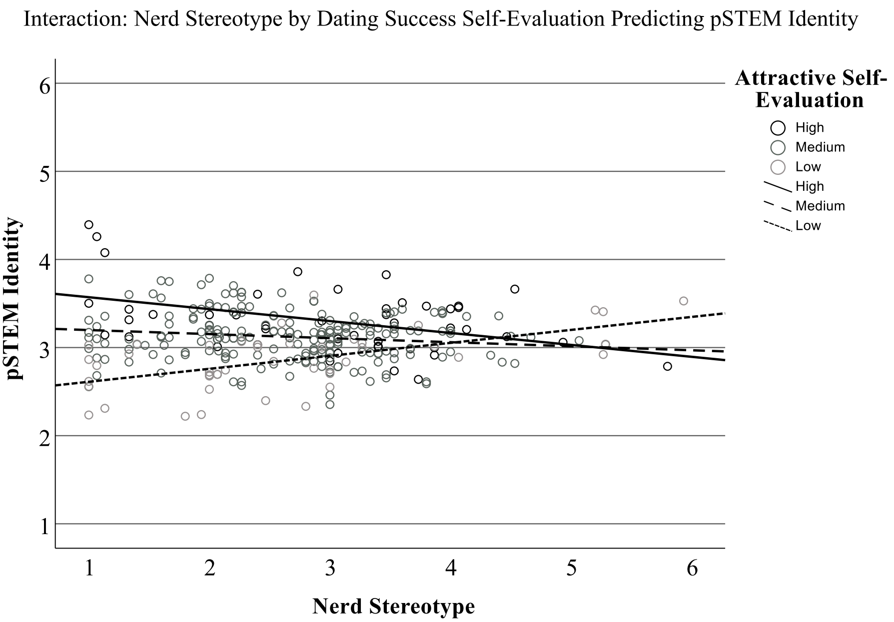

Fig. 4 Interaction: Nerd Stereotype by Dating Success Self-Evaluation Predicting pSTEM Identity. *Note.* Interaction significant at high attractive self-evaluation (black line, mismatching self-evaluation)

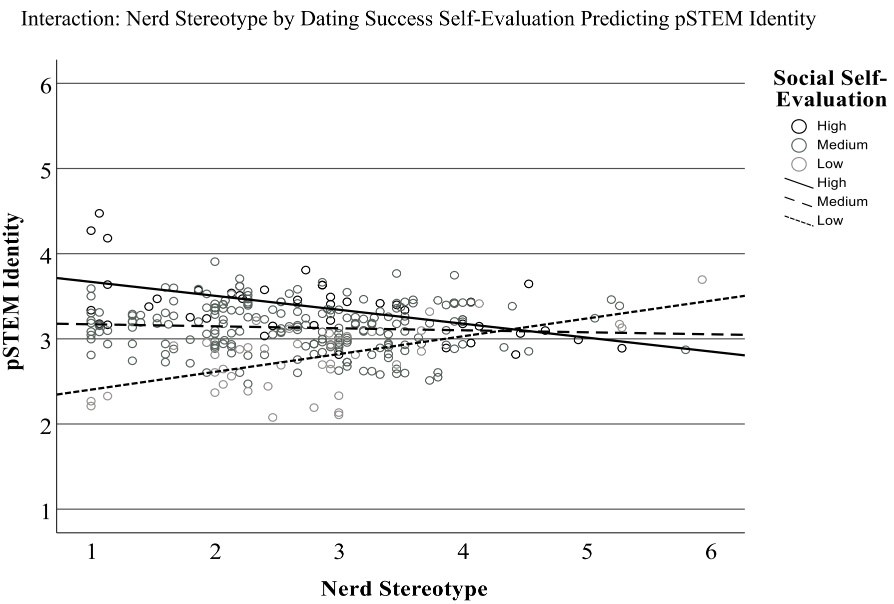

Fig. 5 Interaction: Nerd Stereotype by Dating Success Self-Evaluation Predicting pSTEM Identity. *Note.* Interaction significant at high dating self-evaluation (black line, mismatching self-evaluation)

self-concepts. Conversely, some stereotypes may bolster students' pSTEM identity when they are congruent with their self-concepts.

Building on prior research and theory, there were several novel features of our investigation. First, we separately analyzed four stereotyped domains related to persons in pSTEM as well as self-concepts in the same domains as predictors of high school students' pSTEM identity. Prior studies looked at composites of pSTEM (or STEM) stereotyping (e.g., Taconis & Kessels, 2009) or a few stereotypes (McPherson et al., 2018; Starr & Leaper, 2019)—but nothing this comprehensive. Whereas our factor analyses revealed a four-factor model of self-concepts (genius, social competence, attractiveness, dating success), they indicated a two-factor model for pSTEM stereotyping (genius and nerd). Therefore, we tested concordance between each of the three nerd-related self-concepts with the composite nerd stereotype.

Second, we separately tested two facets of self-concepts—self-evaluations and importance—with each domain. This approach was based on Harter's (2012a) theoretical model of the self-system, which distinguishes between self-evaluated competences and personal importance in particular domains. Prior balanced-identity research has focused on the self-evaluation facet (see Cvencek et al., 2012, for a review). The results lent support to the balanced identity model regarding self-evaluations but not personal importance. This was seen in three of the four self-evaluation domains.

Finally, we examined if the students' gender moderated the relations of concordance or discordance to their pSTEM identity. However, we did not see evidence of gender as a moderator in the analyses. However, we did observe that pSTEM identity tended to be lower among girls than boys.

We more fully discuss the above findings. In doing so, we consider their theoretical and practical implications.

5.1 Self-concepts in stereotyped domains

Adolescence is an especially critical period when many youths are developing their sense of possible selves in educational, occupational, and other domains (Farkas & Leaper, 2016; Kalakoski & Nurmi, 1998). These possible selves are known to predict the likelihood of later career choices (Low et al., 2005). Moreover, average gender differences in these possible selves appear related to the development of gender gaps in pSTEM motivation and achievement (Eccles & Wang, 2016).

We tested two facets of the self-system in our balanced identity models. Based on Harter's (2012a) theoretical model, these included self-evaluations in a domain (e.g., viewing oneself as attractive) as well as the personal importance placed in excelling in a domain (e.g., wanting to appear attractive). Both facets were related to pSTEM identity. However, the interaction between stereotype endorsement and self-evaluations significantly related to more outcome variables than the interaction between stereotyping and importance. Also, self-evaluations were more likely than importance to have direct links to pSTEM identity. One prior study of high school students similarly found academic self-evaluations were a better predictor than academic importance in predicting academic achievement (Seaton et al., 2014). However, the latter study did not test concordance between self-concepts and stereotyped beliefs.

Perhaps discordances between self-evaluations (vs. personal importance) and stereotypes were more consistently related to pSTEM identity in our investigation because they informed individuals view their suitability for pSTEM. That is, high school students may anticipate being included or excluded in pSTEM based on their self-perceived competence but not on whether they find it personally important. The importance facet of the self-concept may possibly become more influential as students get older and they are deciding to commit to a particular major. This may be especially pertinent for young women. Research indicates a greater breadth of verbal and mathematical skills among women than men (Wang & Degol, 2017). Hence, if young women encounter sexism in pSTEM majors (e.g., Leaper & Starr, 2019) or view these fields as incompatible with other goals (e.g., Weisgram et al., 2010), they may opt to pursue non-pSTEM occupations.

5.2 Balance or imbalance between self-concepts and stereotypes

5.2.1 Stereotypes and self-evaluations

We found the best support for our hypothesized model with the genius, social competence, and dating success domains—particularly regarding the self-evaluation facet of their self-concepts. First, we found stereotype/self-evaluation *congruence* in the genius domain was related to stronger pSTEM identity. Because successful professionals in pSTEM are often stereotyped as geniuses (see Cheryan et al., 2013), endorsing this stereotype may have bolstered pSTEM identity in students with congruent self-evaluations.

Conversely, we discovered that stereotype/self-evaluation *incongruence* predicted weaker pSTEM identity in the social competence and dating success domains. That is, students who were more apt to view pSTEM professionals as nerdy were less likely to identify with pSTEM when they viewed themselves as socially competent or successful at dating, respectively. Social acceptance and dating are commonly among the primary concerns of adolescents (Gorrese & Andrisano-Ruggieri, 2013; Meier & Allen, 2009). Hence, if they view pSTEM as incompatible with being seen as popular or romantically desirable may undermine their identification with those fields if they contradict their self-perceived strengths in those domains (e.g., Kessels, 2005).

In the patterns discussed above, we saw congruence predicted stronger pSTEM identity with the genius domain (but not the other domains) whereas we found incongruence predicted weaker pSTEM identity with the social competence, and dating success domains. Each of these patterns were consistent with balanced identity theory. However, we did not observe evidence for the potential impacts of both congruence and incongruence with each domain. We speculate next on the possible reasons.

According to the genius stereotype individuals in pSTEM fields are expected to have superior talent that allows them to succeed. In the bivariate correlations, self-evaluations of pSTEM competence indeed were strongly associated with pSTEM identity (see Table 2). Additionally, endorsing the pSTEM = genius stereotype may further bolster students' felt belonging in pSTEM. In contrast, having congruent self-evaluations did not positively relate to pSTEM identity for the socially awkward and romantically unattractive domains. Unlike the genius stereotype, the nerd stereotypes of persons in pSTEM do not necessarily preclude a person from being capable of succeeding in pSTEM. Instead, these stereotypes reflect views of the social traits believed to characterize many of the persons in these fields. Hence, the impact of pSTEM identity (felt typicality) may be stronger when one experiences incongruence ("That's not me") versus when they experience congruence. Avoiding peer rejection can be a powerful motivator during adolescence (Gorrese & Andrisano-Ruggieri, 2013). Conversely, if one evaluates one's social or romantic competences as similar to others in pSTEM, that may have a relatively neutral impact—perhaps not a boost but also not a threat. The nerdy stereotype significantly interacted with attractive self-evaluation; however, the probe was only marginally significant. It was marginally significant at high attractiveness self-evaluation, which is consistent with the social and dating self-evaluation findings. Perhaps the pattern would have been significant with a larger sample size.

5.2.2 Stereotypes and personal importance

The foregoing discussion focused on the results regarding the relative concordance between stereotype endorsement and students' self-evaluations in particular domains. As previously mentioned, the balanced identity model was better supported using the self-evaluation than the personal importance facet of self-concepts. It is possible that self-evaluations are more salient than importance when considering pSTEM identity, given students are directly thinking about how they see themselves. As we previously noted, prior research on balanced identity theory has largely focused on self-evaluation rather than importance. However, although the importance interactions with stereotypes did not significantly relate to pSTEM identity, both genius and social importance were positively related to pSTEM identity. Thus, importance may affect pSTEM identity even if their congruence with stereotypes might not. Furthermore, as we discussed earlier, congruence between domain importance and stereotypes may have a stronger impact at older ages, such as when undergraduates are choosing a major or future career.

5.2.3 Gender moderation

We did not find that gender moderated the potential relation of self-concept and stereotype concordance to pSTEM identity belonging. However, being a girl was negatively related to pSTEM identity, even after other factors were added into the model. If girls have lower average pSTEM identity, then stereotype/self-concept discordance may further undermine their sense of belonging in these fields. In addition, average gender differences in self-concepts or stereotyping may affect the likelihood of experiencing identity discordance (e.g., Bian et al., 2017; Heyder et al., 2021). For example, prior research has documented girls were less likely than boys to view themselves as geniuses or brilliant in pSTEM subjects (e.g., Bian et al., 2017). In our sample, there was a nonsignificant trend with a small effect size toward boys more likely than girls to self-evaluate themselves as a genius in pSTEM (see Table 1).

5.3 Limitations and future directions

In closing, we acknowledge some limitations in our study and recommend directions for future research. First, our study has several methodological limitations. Our study was correlational and no causal conclusions can be drawn. We speculate that the degree of stereotype/self-concept concordance in pSTEM-related domains may strengthen or weaken students' pSTEM identity and motivation over time. This should be investigated longitudinally. Relatedly, more studies are needed to determine possible developmental changes in the effects of balanced identities (e.g., see Patterson & Bigler, 2018). Furthermore, we combined three sub-stereotypes about people in pSTEM (socially awkward, physically unattractive, and unsuccessful at dating) into one composite nerd stereotype. This was done because our factor analysis determined that high school students did not differentiate among them. However, students did differentiate among the related self-concepts (social, attractive, and dating). The composite nerd stereotype measure was used with each of the related self-concepts in separate regressions. Future studies might explore whether older adults might differentiate among the three nerd sub-stereotypes and whether there is a single nerd self-concept or multiple facets. Similarly, future studies might simultaneously examine the influence of nerd and genius stereotypes and related self-concepts on pSTEM identity in a single model (e.g., via structural equation modeling).

Second, our sample was limited in its ethnic and socioeconomic diversity. Nearly three-fourth of students in our study identified as either Asian (51%) or White (23%). Given Asian Americans are not well represented in psychological research, we consider this an improvement upon prior studies of primarily White samples. Also, most youth reported their mothers had attained at least a bachelor's degree; the students were in a school district near Silicon Valley in California with its many pSTEM-related industries. Consequently, this may explain why students in our sample on average did not endorse some of the pSTEM stereotypes (e.g., see Riegle-Crumb & Moore, 2014). In contrast, underrepresented groups—such as Black, Latinx, Indigenous, or low-income students—may be more likely to experience incongruent self-concepts with some pSTEM stereotypes. For example, students from these minoritized backgrounds may be less apt to view themselves as naturally talented in pSTEM (Steele, 2010). The prevalence of these stereotypes also may vary internationally depending on the representation of women in pSTEM fields in a given country (Miller et al., 2015).

A third recommendation for future research is to assess both explicit stereotypes and implicit associations. Our study measured students' self-reported (i.e., explicit) endorsements of nerd-genius stereotypes. A complementary approach involves using methods such as the Implicit Association Test to measure implicit stereotyped associations (e.g., Cvencek et al., 2014; Dunlap & Barth, 2019; Starr & Leaper, 2022). In their original paper advancing balanced identity theory, Greenwald et al. (2002) noted stronger support for the model using implicit than explicit attitudinal measures.

Fourth, we suggest testing the balanced identity model separately for different pSTEM subjects. Similar to many prior studies, we assessed students' stereotypes and identities regarding pSTEM overall. Given the number of other dimensions that we examined, testing the model in specific subjects was not feasible. However, we are left wondering if the nerd-genius stereotypes might be more common regarding some pSTEM fields more than others (e.g., see Leslie et al., 2015). Also, we wonder whether there might be more or less congruence between stereotypes and self-concepts depending on the pSTEM subject.

A fifth recommendation is to consider identity congruence/incongruence with other pSTEM stereotypes beyond those we investigated. Two notable examples are the expectations among many children, adolescents, and adults that persons in pSTEM fields are commonly male (e.g., Carli et al., 2016; Cundiff et al., 2013; McGuire et al., 2020; Starr et al., 2022) and either White or Asian (e.g., Cvencek et al., 2014; Rowley et al., 2007; Starr & Leaper, 2022). To examine the two self-concept facets for this stereotype, researchers might use self-perceived gender or racial-ethnic typicality (e.g., Martin et al., 2017; Wilson & Leaper, 2016) to tap into the self-evaluation facet and to use gender or racial-ethnic centrality (e.g., Turner & Brown, 2007) to get at the personal importance facet.

Sixth, it is important to devise and to evaluate potential interventions that challenge students' internalization of pSTEM stereotypes and other biases undermining the motivation of girls and students from other underrepresented groups (e.g., Zhao et al, 2018). Schools are one context for these interventions (Leaper & Brown, 2014). Additional targets include family, peers, and the media (see Cheryan et al., 2017; Dasgupta & Stout, 2014).

Finally, we encourage researchers to consider possible places for integration across theoretical models (see Leaper, 2011). Although balanced identity theory guided our hypotheses, we recognize this model is similar to or overlaps with other approaches (e.g., Kessels et al., 2014; Turner et al., 1987). One example of an effort to bridge theories is the gender self-socialization model, which merges balanced identity theory with social identity theory, gender schema theory, and other approaches (Tobin et al., 2010). Furthermore, we see the balance identity model dovetailing with the premises of stereotype threat theory (Steele, 2010). Research in this area has documented that negative stereotypes about one's gender or racial-ethnic ingroup identity regarding a particular achievement domain can hamper confidence and performance in the domain; conversely, positive stereotypes about one's ingroup may boost confidence and performance (see Steele, 2010). Experiencing stereotype/self-concept incongruence or congruence may reflect the extended effects of stereotype threat or boost, respectively. In sum, across each of the theoretical models cited above, there is an emphasis on processes underlying the formation of group identities in relation to stereotyped views of the group and individuals' own self-concepts.

5.4 Practice implications

Our study indicates that stereotypes about people working in pSTEM may discourage some adolescents while encouraging others depending on the concordance of these stereotypes with their self-concepts. Considering this, it might be useful for teachers and parents to be mindful of perpetuating these stereotypes. Stereotypes may be highlighted via classroom artifacts (such as posters of Einstein) or popular media (e.g., *The Big Bang Theory*). Teachers and parents also may directly challenge these stereotypes about pSTEM, perhaps in combination with efforts to confront gender stereotypes (e.g., Weisgram & Bigler, 2007; Zhao et al., 2018). Additionally, educators may actively contradict these stereotypes by showcasing exemplars of pSTEM workers who do not fit the stereotypes (e.g., O'Brien et al., 2017). Importantly, our study indicates that endorsing self-concepts such as being attractive, social, or successful at dating do not alone diminish adolescents' pSTEM identity—in fact, we found they are positively related to pSTEM identity when adolescents do not endorse the nerd stereotype about people in pSTEM. Similarly, endorsing these stereotypes alone is not enough to diminish pSTEM identity. Instead, it is the congruence or incongruence between the two that may diminish pSTEM identity among a subgroup of adolescents. Finally, we found that being a girl was consistently negatively related to pSTEM identity even after controlling for other factors. However, there were no significant gender and stereotype interactions. This may indicate that other stereotypes, such as the stereotype that pSTEM is a male domain, may impact girls more than nerd-genius stereotypes.

6 Conclusions

We found evidence to support the balanced-identity model whereby the impact of stereotypes on pSTEM identity may depend on the extent they are congruent or incongruent with individuals' self-concepts (e.g., Greenwald et al., 2002; Hannover & Kessels, 2004; Niedenthal et al., 1985). Our model separately considered self-evaluations and importance as two facets of self-concepts, and discovered greater support for the balanced-identity model with the former facet of the self-concept. Trait-based stereotypes about pSTEM, such as that people in these fields are geniuses or socially awkward, may steer some individuals away from pSTEM if these views are incongruent with their self-concepts. At the same time, some trait-based stereotypes about pSTEM may bolster the interest of those who see themselves as similar to the stereotype.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11218-023-09851-6.

Declarations

Conflict of interest The authors have no conflicts of interests.

Ethical approval Institutional Review Board approval for this study was obtained from the University of California, Santa Cruz.

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