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Science Identity Predicts Science Career Aspiration Across Gender and Race, but Especially for White Boys

Kaitlin Bodnar[1], Tara L. Hofkens[2], Ming-Te Wang[1], Christian D. Schunn[1]

[1]University of Pittsburgh, [2]University of Virginia, USA

ABSTRACT

A recent approach to studying gender and race inequalities in science examines science identity: how strongly one associates oneself and identifies with the field of science. Since adolescence is an important time for identity development and when science disparities begin to emerge, we investigated how gender and race relate to science identity and science career aspirations using a dataset of diverse sixth, seventh, and ninth grade students across the United States (n = 930). While science identity is correlated with science career aspiration regardless of a student's gender or race, we found that the correlation is significantly stronger for boys who are white compared to girls who are white or girls who are black. By contrast, boys who are black with a high science identity are equally likely to aspire toward a science career as their white male peers. These gender differences in correlation strength go against findings among postsecondary students suggesting that science identity can completely offset gender differences in science outcomes. Therefore, these findings present opportunities for future study examining how gendered and racial factors influence science identity and career aspiration.

KEYWORDS

science identity, gender, race, science career aspiration

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Despite making up over half of the overall workforce, women only constitute 28% of science and engineering careers (National Science Board, 2016). Furthermore, racial disparities are also apparent. As recently as 2013, black men only occupied 3% of science and engineering careers and black women made up 2% of the science and engineering workforce (National Science Foundation, 2015; National Center for Science and Engineering Statistics, 2015).

These disproportionalities reflect deeper systemic inequalities. In the same way that STEM (i.e., science, technology, engineering, and mathematics) fields in the United States historically have only been open to men from Western backgrounds, other lucrative fields have also not been open to women and people of color until recently. If women and underrepresented minority racial groups are excluded from these fields, they will have less access to economic mobility. Therefore, interventions such as those focused on motivational factors to promote women and racial minorities to pursue STEM careers are an essential component to overcoming these systemic inequalities. As society becomes more driven by technology and scientific innovation, having a diverse group of people tackling issues in STEM fields is imperative in ensuring that other perspectives can be considered when making decisions (Wang & Degol, 2016).

Science Identity

These inequalities continue to persist as educators and researchers investigate the mechanisms by which these disparities happen (Ong, Wright, Espinosa, & Orfield, 2011). A relatively new approach to examining the representation gap in STEM fields is to study differences in science identity among female and racial minority students (Brotman & Moore, 2008). Tate and Linn (2005) examined how students highlighted that their race, ethnicity, or gender sometimes felt incongruent with their academic identity because they were often the only women of color in their engineering classes. Therefore, science identity may act as an essential internal factor contributing to the underrepresentation of women and racial minorities in the field of science.

Specifically, identifying with science is multifaceted. Science is a collective process which involves engaging with the rest of the scientific community, such as through peer review. When engaging with science, women and underrepresented racial minorities may have to navigate their sense of belonging in science as well their internal perception of themselves as a science person (Trujillo & Tanner, 2014). Undergraduate students who have a high science identity are more likely to report a sense of belonging in STEM, although women and underrepresented racial minorities report lower science identity and lower sense of belonging compared to their white and male peers (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018). While a sense of belonging is essential to students feeling like they fit into the scientific community, science identity is unique in that it measures if a student is recognized by themselves and others as a "science person". In this way, science

identity is less focused on how one sees themselves as part of the community, but how they view themselves as an individual and recognizing themselves as a competent member of the field. Likewise, one's science identity does not exist in a vacuum. All identities are a result of cultural influences and histories that previously determined who could be recognized as a member of the scientific community or not. Because of this historical effect, scholars studying science identity should be mindful of societal pressures and the culture around science that could hinder an individual from being perceived as a "science person," (Carlone & Johnson, 2007).

Carlone and Johnson (2007) studied science identity and stated that the general construct of a scientist in most people's minds is that of a white male. They found that women and people of color can feel excluded from science culture and must exert more energy trying to merge with the science community. Likewise, other studies have found that some women of color consider their race, ethnicity, and gender as hindrances in their ability to be perceived as serious scientists by others in the community (Beede et al., 2011).

Although women, particularly women of color, have reported struggling to identify with society's image of a scientist, those who are able to have a strong science identity have been shown to benefit from this identity in science fields. Particularly, having a high science identity predicted intentions to continue engaging in scientific research and lower stereotype threat in women in undergraduate physics laboratories (Smith, Brown, Thoman, & Deemer, 2015). Hazari, Sadler, and Sonnert (2013) found that while undergraduate women were less likely to identify as a physics person overall, women who did identify with physics were equally as likely as men to want to pursue a career in physics, engineering, or computer science. However, white men were still remarkably more likely to identify with science than all women and black and Hispanic men surveyed. A study looking at black and Latino undergraduate students in STEM fields, found that having a higher science identity was related to entering a science-related career (Stets, Brenner, Burke, & Serpe, 2017). Espinosa (2011) found that identity was crucial to undergraduate women of all races and ethnicities in predicting whether they would continue on with STEM in college. While science identity has been shown to promote science career aspiration across gender (Hazari, Sadler, & Sonnert, 2013) and race (Stets et al., 2017) in undergraduate students, how science identity functions in career aspiration in adolescents is not as thoroughly studied.

Gender and Race

Furthermore, while gender and race have been found to be significant predictors of science identity, how race and gender intersect to predict science outcomes is unclear. Some reports suggested no gender or race differences in students' self-perceptions about science (Aschbacher et al., 2014), while other studies found that boys who were black reported negative attitudes and self-efficacy in science compared to their white peers (Perry, Link, Boelter, & Leukefeld, 2012). However, when examining gender, most of the negative ideas about science prevailed in boys who were black, with girls who were black reporting similar scores of school self-esteem to boys and girls who were white.

One possible explanation for why women and underrepresented minority students might have more negative views about science than their white male peers is that

young students are aware of the social construct of a scientist being a white male. Through his semi-structured interviews of British middle schoolers of diverse ethnic backgrounds, Wong (2015) found that the majority of young people interviewed expressed that science was either "for men", or "for White people", regardless of the students' own background. Moreover, many students reported very gendered views of scientists, saying that it was a masculine field. These viewpoints can potentially have a huge impact on the type of careers to which children aspire. For example, women who identified with more feminine gender roles were less likely to aspire to a traditionally male field, such as STEM (Beutel, Burge, & Borden, 2018). Additionally, when undergraduate women in STEM feel that their identity as a science student and their identity as a woman interfere with each other, they have been shown to be more likely to perceive their academic climate as negative (Settles, O'Connor, & Yap, 2016).

While these studies suggest that gender and race play a role in science identity, more research regarding intersectionality would help educators better know how to support youth if we knew how science identity functions across gender and race. Some studies have suggested that boys who were black fare worse than their peers who were white and their peers who were female (Perry et al., 2012), while other studies have shown that girls who are white have the lowest scores in science outcomes (Riegle-Crumb, Moore, & Ramos-Wada, 2011). Meanwhile, Aschbacher et al., (2014) found no effects of race or gender in their study. However, since Wong (2015) showed that children have gendered and racial associations with science, these biases could influence factors such as science identity or career aspirations differentially by race and gender. Currently, the literature does not show a clear picture as to how gender and race interact in relation to different science career and education outcomes, so further studies should aim to clarify how these demographic factors interact. Additionally, many studies specifically examining science identity either only look at gender (Smith et al., 2015), or only investigate race (Chemers et al., 2011). Since women of color specifically report that their gender and race hurt them in science (Beede et al., 2011), further research cannot continue to ignore the overlap of gender and race.

Science aspirations in adolescents

While studies have shown that women and underrepresented races are less likely to pursue STEM, early adolescence can be a particularly important time for the development of career intentions of young women. Salder, Sonnert, Hazari, and Tai (2012) showed that while men's interests in STEM remained stable throughout high school, women started high school with less interest in STEM careers compared to their male peers. In fact, aspirations only continued to decrease as high school went on for women. The authors suggested that because STEM aspirations continually decreased throughout women's secondary school career, interventions at the beginning of middle school might hold the key to advance diversity in STEM fields. Similarly, how students from underrepresented races performed in high school, as well as other pre-college measures, has been shown to also influence if they persist in science majors through college (Bonous-Hammarth, 2000).

Additionally, career aspirations in science have been found to change based on race and gender in middle schoolers. Some studies have shown that eighth grade boys who were black were equally as likely to report wanting a career in science as their peers who were male and white. Meanwhile, girls who were black and girls who were white were less likely to want a science career compared to boys who were white. This suggests that science career aspiration may be influenced by students' gender more than their race. This difference only remained in girls who were white when accounting for test scores (Riegle-Crumb et al., 2011). Comparatively, a study examining science attitudes on achievement in tenth graders did not find any interaction between gender and race on science value (Else-Quest, Mineo, & Higgins, 2013).

While the positive relationship between having a strong science identity and choosing a STEM career has been established in undergraduate students (Hazari, Sonnert, Sadler, & Shanahan, 2010), findings in secondary school students have been mixed. In high-performing ninth graders in math, gender did not predict plans to persist in STEM. However, achievement in math predicted STEM persistence plans in students who were black, but not students who were white (Andersen & Ward, 2014). Meanwhile, Aschbacher, Ing, and Tsai (2014) surveyed secondary school students about if they perceived themselves as being a science person or not. In that study, gender and ethnicity were found to not impact students' self-perception in science.

Overall, while various factors often pull girls and racial minorities away from science (Barton et al., 2012), science identity might be a key variable in influencing younger students' decisions to pursue STEM in the future. Since science identity has been shown to predict positive STEM outcomes in undergraduate women (Hazari et al., 2010), the development of that identity at a young age may be paramount to closing the gender gap in STEM fields (Salder et al., 2012). Buschor, Berweger, Frei, and Kappler (2014) found through their mixed methods study that women who chose a STEM career recalled having a strong science identity as children. The authors called for elementary and middle school teachers to foster science identity particularly in their female students, linking them to their future career aspirations.

Summary

Overall, the gender and race make-up of STEM fields in the US does not reflect the diversity of American society (National Science Foundation, National Center for Science and Engineering Statistics, 2015) and young children have been shown to be very aware of this disparity (Wong, 2015). Because women's interest and aspiration toward STEM has been shown to continue to drop throughout secondary school (Salder et al., 2012), adolescence could be an ideal time in helping prevent at-risk populations from losing interest in STEM fields (Buschor et al., 2014). One key variable that has been linked with career aspiration is science identity (Hazari et al., 2010). Therefore, studying science identity in secondary school students while noting differences in race and gender could have far-reaching implications in increasing diversity in STEM fields. As society shifts to one focused on science and dependent on technology, underrepresented populations in these fields should be studied to help increase their representation so that many different voices can be heard. In particular, studying younger adolescents could aid in the development of

interventions to help increase retention of women and black individuals in science classes and eventually science careers.

Current Study

The aim of the current study is to explore how science identity and career aspirations in science differ by race and gender in secondary school students. It examines whether science identity and science career aspiration are correlated stronger for students based on their gender and race.

Gender and race differences in science identity

Because boys generally have higher interest in STEM (Salder et al., 2012), and young students have been found to consider science to be a masculine field (Wong, 2015), we were interested to see if this gender difference was also prevalent in students who reported having a high science identity. Likewise, because white individuals are overrepresented in STEM fields (National Science Foundation, National Center for Science and Engineering Statistics, 2015), we also sought to establish if this difference in race was also found in science identity.

Hypothesis 1a & 1b: We expect to find main effects of gender and race on reports of science identity. Boys will be more likely to report a high science identity than girls. Likewise, students who are white will have a stronger science identity than their peers who are black.

Gender and race differences in science career aspiration

To verify that our sample aligns with findings showing gender and race underrepresentation in science fields (National Science Board, 2016; National Science Foundation, National Center for Science and Engineering Statistics, 2015), we also wanted to examine how science career aspiration changed based on students' race and gender.

Hypothesis 2a & 2b: We expect to also find main effects of gender and race on science career aspiration. We predict that girls who are black will be the least likely to aspire to a science career and boys who are white will be the most likely to aspire to a science career.

Gender, race, science identity, and science career aspiration

While studies have shown that students at various levels of education have differential views of science based on gender and race, few studies have investigated how demographic characteristics influence the relationship between science identity and aspiration to pursue a science career. We were interested in how this relationship changes when accounting for students' race and gender.

Hypothesis 3: We predict that science identity and science career aspiration will be most strongly correlated for boys who are white.

METHODS

Procedure

Data for this study comes from a recent wave as part of the ALES15 dataset (Activated Learning Enables Success 2015). The recent dataset was collected by a research team from the Activation Lab (activationlab.org) in order to gather

information about learning in secondary school children, defined as sixth through twelfth grade. Participants were strategically sampled from various public schools in two different regions in the United States: a mid-Atlantic urban mid-sized city with a high proportion of black residents, and the Bay Area in the Western United States with a high proportion of diverse and recent immigrants. Schools were also chosen to represent a variety of secondary schools, such as middle schools, high schools, or schools that had sixth through twelfth grade. Socio-economic status varied widely across schools and regions, with the percentage of students from low-income families eligible for free or reduced lunch at school ranging from 26-84%. Every student was given a passive consent permission slip that explained the research project and its implications and students were allowed to opt-out from participating in the surveys. Sample sizes varied across measures due to student absence across multi-day data collection points and from skipped questions.

Participants

Surveys were administered to sixth, seventh, and ninth graders from various secondary level urban schools from the East and West coast of the United States.

Race. We were interested in a comparison of experiences in students who were black and students who were white. Therefore, we only included students who either self-identified as only African American or only white. Participants who self-identified as other races or ethnicities were removed.
Gender. Students were asked, "Which of these best describes you": boy, girl, do not identify as girl or boy, and prefer not to answer. Ninety-nine percent of students selected "boy" or "girl" and were kept in the analyses for this paper. Of those participants who reported their race or ethnicity as either African American, or white, about half reported their gender as male, with the remaining reporting their gender as female.

Measures

Career aspiration. All participants were asked, "In general, would you like to have a job related to: science", to which students responded on a four-point Likert scale (4 = YES!, 3 = yes, 2 = no, 1 = NO!). Students were asked this measure in the spring of the 2015-2016 school year. This measure was validated for this age group by Dorph, Bathgate, Schunn, and Cannady (2018).

*Science identity***.** Science identity was assessed with four items that indicated how much students considered themselves a science person. Items included how much students agreed with the statements "I am a science person," "My parents see me as a science person," "My friends see me as a science person," and "My teachers see me as a science person". Students responded to these items on a four-point Likert scale (4 = YES!, 3 = yes, 2 = no, 1 = NO!). The average was taken of students' responses to each question which gave them a score between 1-4, as per the development and recommended use of the instrument (Vincent-Ruz & Schunn, 2018, 2019). This measure was asked in the fall of the 2015-2016 school year.

RESULTS

We found how white boys, white girls, black boys, and black girls scored on average on their reports of science identity (Table 1) and career aspiration (Table 2). We used two two-way ANOVAs to test Hypotheses 1a-2b.

Table 1. *Average science identity across gender and race*

	n	M	SD
White boy	309	2.34	0.81
White girl	247	2.23	0.70
Black boy	108	2.33	0.78
Black girl	266	2.20	0.79

Note. Science identity was reported on a 4-point Likert scale. Students who were male were significantly more likely to have a higher science identity than their female peers. This pattern was not found for race.

Table 2. *Average science career aspiration across gender and race*

	n	M	SD
White boy	246	2.78	0.92
White girl	220	2.55	0.97
Black boy	91	2.62	1.06
Black girl	110	2.40	1.04

Note. Science career aspiration was reported on a 4-point Likert scale. Male students were significantly more likely to have a high science career aspiration than their female peers. Students who were white were also more likely to report a high science career aspiration than students who were black.

To examine how the correlation between science identity and science career aspiration changed based on students' gender and/or race, we compared correlations across gender and race identities (Table 3).

Table 3. *Comparisons of the correlations between science identity and science career aspiration among gender and racial groups using the Fisher r-to-z transformation. Significant Z values are indicated in bold.*

	White boy (*n*=208) (*r*=.56***)	White girl (*n*=214) (*r*= .36***)	Black boy (*n*=75) (*r*=.48***)
White boy			
White girl	**2.67 (*p*=.004)**		
Black boy	0.88 (*p*=.189)	-1.03 (*p*=.151)	
Black girl (*n* = 93) (*r* = .40***)	**1.71 (*p*=.044)**	-0.36 (*p*=.359)	0.60 (*p*=.273)

In examining whether there is a significant difference in science identity based on gender or race, we ran a two-way ANOVA on science identity to look for main effects of gender and race. We found support for Hypothesis 1a. Boys were significantly more likely than girls to report a high science identity, $F(1, 690) = 5.80$, $p = .016$. Students who were white were not significantly more likely to report a high science identity than students who were black, $F(1, 690) = .68$, $p = .411$. No significant interactions were found between race and gender, $F(1, 690) = 1.20$, $p = .274$. Boys who were white had the highest science identity, which supports Hypothesis 1b.

When examining students' reports of aspiring to pursue a career in science, we found similar results supporting Hypotheses 2a and 2b. A two-way ANOVA showed that students who were girls were significantly less likely to report science career aspirations than students who were boys, $F(1,593) = 8.76$, $p = .003$. Students who were white also were significantly more likely to report aspiring toward a science career than students who were black, $F(1, 593) = 4.70$, $p = .027$. There was no significant interaction between race and gender, $F(1, 593) = .02$, $p = .882$. As with science identity, boys who were white reported the highest science career aspirations and girls who were black reported the lowest (Table 2).

To examine how gender, race, science identity, and science career aspiration were related, we first found the correlation between science identity and science career aspiration in boys who were white, $r(206)=.563$, $p < .001$, girls who were white, $r(212)=.359$, $p <.001$, boys who were black, $r(73)=.475$, $p < .001$, and girls who were black, $r(91)=.398$, $p < .001$. To compare the strength of the correlation based on students' race and gender, we used the Fisher r-to-z transformation to compare the correlation coefficients for each gender and race subcategory. We found that science identity and science career aspiration were correlated significantly stronger for boys who were white than for girls who were white as well as for girls who were black (Table 3). One-tailed significance tests were used to coincide with our hypotheses that white boys would have higher correlations than their peers.

DISCUSSION

The findings of this study highlight gender and race inequities in science identity and science career aspiration. Our study aims to investigate science identity during secondary school, which is when many young women begin to lose their interest in science (Salder et al., 2012). By examining the relationship between science identity and career aspiration at this age, educators can begin to tackle the underrepresentation of women and people of color in science before these students even reach higher education.

As predicted, we found that science identity and science career aspirations were highest in male students who were white and lowest in female students who were black. This is in line with previous findings showing that children tend to associate scientists with men who are white (Wong, 2015). Our results add to the array of mixed findings from previous studies showing varying relations between gender, race, and science outcomes (Aschbacher, Ing, & Tsai, 2014; Perry, Link, Boelter, & Leukefeld, 2012; Riegle-Crumb et al., 2011). Our results did not support our prediction of a significant effect of race on science identity. While the field of science has been shown to have both racial and gendered expectations (Carlone &

Johnson, 2007), our findings suggest that the masculine view of science (Beutel, Burge, & Borden, 2018) is influencing how strongly science identity and science career aspiration are related in girls who are white as well as girls who are black.

For both science identity and career aspiration, girls who were black reported the lowest scores out of our sample. Women who are black are often at a particular risk for discrimination known as "double jeopardy", which means that they are more likely to experience stigma in science related to both their race and their gender (Hanson, 2007). While previous studies have suggested that women who are black are less susceptible to the gendered expectations around STEM (O'Brien, Blodorn, Adams, Garcia, & Hammer, 2015), our findings highlight the double bind that girls who are black often face in science. On one hand, social factors such as greater perceived career barriers (Fouad & Byars-Winston, 2005) could be disproportionately impacting their career aspirations because of their race. Furthermore, they are impacted not only by factors related to their race, but to their gender as well (Ong et al., 2011). We found that science identity and career aspiration were not correlated as strongly for girls who were white or black compared to boys who were white. This highlights that girls may face unique challenges on the pathway to career aspiration regardless of race.

Essentially, there can be various interpretations as to why science identity and career aspiration are not as strongly correlated for girls who are white or girls who are black compared to boys who are white. On the one hand, the findings reveal that even adolescent girls with a high science identity are not able to completely overcome the gendered influences hindering their science career aspiration. Since previous findings suggested that white undergraduate women with physics identities were equally as likely as undergraduate men with physics identities to pursue physics (Hazari, Sadler, & Sonnert, 2013), our findings could reveal a key difference in science identity in secondary school girls compared to their older peers in college. As girls' interest in STEM continues to decrease throughout secondary school (Salder, Sonnert, Hazari, & Tai, 2012), the connection between science identity and science career aspiration could strengthen so that by the time they are undergraduates, the correlation between science identity and science career aspiration might be the same regardless of gender. Essentially, girls with a high science identity who do not have high science career aspirations in secondary school could have a lower science identity by the time they reach college.

Alternatively, girls in secondary school with higher science identity may be aspiring to science careers at lower rates than their male counterparts, not because of a disinterest in science, but because they might have more choices. A longitudinal study examining participants in twelfth grade, and then at age 33, found that individuals with high verbal and math abilities were more likely to be female and were less likely to pursue STEM careers (Wang, Eccles, & Kenny, 2013). Therefore, future studies could closely profile girls with high science identities to see if they have other identities or interests outside of STEM that are influencing their choice of career.

Limitations

This study has several limitations. It does not control for differences between grade levels. This could be a focus of a future study that closely examines differences

within secondary school, as opposed to secondary school more broadly. Also, because science identity and career aspiration were assessed at different time points, there is only moderate overlap among participants who answered both questions, which led to varying sample sizes among tests. Additionally, while the career aspiration measure is clear, it is very general. Differences surrounding science career aspirations by gender and race likely vary by each scientific discipline given the large differences in participation across biology and physics, for example. Future studies can explore how science identity relates to specific types of science careers. Another interesting topic for future studies could look more closely at the relationship between sense of belonging and science identity, while examining gender and race differences. Likewise, the scope of our study only focused on students who only identified as white or black. Further research could investigate mixed-raced students or races other than white and black to see if results differ. Finally, the study focused on gender as a binary. This approach, based on the way gender was assessed and the low frequency of other responses, fails to capture the ways in which gender is multi-dimensional.

Conclusion

Since women and people who are black are underrepresented in STEM fields (National Science Board, 2016; National Science Foundation, National Center for Science and Engineering Statistics, 2015), studying potential factors that could influence their career choices during a critical time in development such as early adolescence (Barton et al., 2012; Salder, Sonnert, Hazari, & Tai, 2012) is essential to developing interventions targeted at these populations. Our results suggest that science identity is strongly tied to aspirations toward a science career regardless of gender or race. Therefore, interventions aiming to increase science identities in students who are female and students who are black have the potential of increasing science career aspirations. However, while male students who are black with high science identities are equally as likely to pursue a science career as their peers who are white, science identity does not influence girls as much as it does boys. Likely, the culture surrounding masculinity and science weakens the connection between identity and aspirations for girls. Since elementary school students have been shown to already view science as being a field for white men (Wong, 2015), girls in secondary school might already view the field as being exclusive. Therefore, earlier interventions could be crucial in promoting science in girls, before they develop beliefs about the inclusivity of science. Overall, educators should consider larger societal and cultural pressures on students that could impact career aspirations.

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