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Research Article

Parental Support and High School Students' Motivation in Biology, Chemistry, and Physics: Understanding Differences Among Latino and Caucasian Boys and Girls

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Abstract: Individuals are at an increased risk to drop out of the STEM pipeline if they are female or Latino, and during certain periods including high school. Families are a potential untapped resource of support for high school students. Based on the expectancy-value model, we examined if a variety of parental behaviors predicted students' ability self-concepts in and value they placed on biology, chemistry, and physics. Self-report surveys were collected from 988 9th grade Latino boys, Latina girls, Caucasian boys, and Caucasian girls. The findings suggest that, as early as the beginning of high school, students hold different motivational beliefs for biology, chemistry, and physics. Caucasian boys reported higher parental behaviors and motivational beliefs compared to Latino boys, Latina girls, and Caucasian girls. Latina girls reported the lowest parental behaviors and motivational beliefs. Parent education and Spanish language use partially explained some of these differences suggesting ethnic differences are in part due to differences among Caucasians and Latinos on parent education and language use. Parents' positivity, co-activity and school-focused behaviors predicted higher adolescent ability self-concepts and importance values in all three sciences for all adolescents in this study. Parents can support adolescents in science through a variety of behaviors at home. Many of these behaviors do not require parents to be science experts and thus may be attainable for a range of families.
Keywords: motivation; high school; families; adolescence; Latino; gender

Many talented and capable young people are turning away from careers in STEM (i.e., science, technology, engineering, and mathematics; National Science Board, 2014). The loss of science talent is particularly pronounced among females and Latinos in the physical sciences. For instance, the percentage of the Hispanic US population rose from 12% to 16% from 2000 to 2010 (Pew Research Center, 2012), but comparable gains were not realized in the percentage of college degrees. The percentage of science and engineering bachelor's degrees only increased from 7% to 8% during the same period (National Science Board, 2014). If left unchecked, this ethnic disparity for Latinos could worsen over time.

High school is the first time when students can drop out of science coursework. Adolescents who have minimal science coursework in high school can inadvertently close the door to STEM

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college majors and careers (Andersen & Ward, 2014; Chang, Sharkness, Hurtado, & Newman, 2014; Maltese & Tai, 2011). In fact, 45% of the 10th grade students interested in pursuing a STEM career lost that interest by the end of high school, making high school a pivotal point in the STEM pipeline (Aschbacher, Li, & Roth, 2010).

One of the strongest predictors of individuals' choices to pursue STEM through coursework and careers is their motivational beliefs (e.g., Britner, 2008; Else-Quest, Mineo, & Higgins, 2013; Maltese & Tai, 2011; Simpkins, Fredricks, & Eccles, in press; Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012). Motivational beliefs, like ability self-concepts and values, predict choices even after controlling for individuals' actual ability and achievement. A recent theoretical piece on STEM career choices stated that motivational beliefs are one of the central determinants of success throughout the STEM pipeline (Ceci et al., 2009; Ceci, Williams, & Barnett, 2009). Despite the importance of motivational beliefs, science education scholars have noted that there is a dearth of research on science motivation (e.g., Vedder-Weiss & Fortus, 2011).

If motivational beliefs are critical, what ignites and sustains youths' science motivational beliefs? Several pieces of evidence suggest that encouragement and experiences outside of school are critical in order to persist in science. Specifically, students who do not fit the stereotype of a Caucasian male scientist often do not find school to be a supportive environment in terms of science and rely more heavily on support outside of school (Andersen & Ward, 2014; Brown, 2006; Johnson, Brown, Carlone & Cuevas, 2011; Mutegi, 2013; Stake & Mares, 2001). Family is consistently mentioned as an instrumental source of support (Dabney, Chakraverty & Tai, 2013). Family support was one key difference between high school students who maintained their interest in pursuing a STEM career throughout high school compared to peers who lost that interest (Aschbacher et al., 2010). In fact, many established Latino STEM professionals proclaimed that having a supportive family was one of the central reasons they succeeded through the pipeline (Taningco, 2008). Aligned with NARST's charge to look beyond the classroom (Rennie, Feher, Dierking, & Falk, 2003), the broad goals of this study were (a) to examine high school students' motivational beliefs and parental support, and (b) to test differences across Latino boys, Latina girls, Caucasian boys, and Caucasian girls.

Theoretical Foundation on Adolescents' Motivational Beliefs

The study of youths' motivational beliefs has a long history within education and psychology resulting in multiple theories over the years (Wigfield, Eccles, Fredricks, Simpkins, Roeser, & Schiefele, 2015). Most theories focus on a specific aspect of youths' motivational beliefs, such as their beliefs about their abilities and expectancies, interest, basic needs, and achievement goals (e.g., Aschbacher et al., 2010; Beghetto, 2007; Harackiewicz et al., 2012Harackiewicz, Rozerk, Hulleman, & Hyde, 2012; Meece, Anderman, & Anderman, 2006). The theories differ in the extent to which they address two fundamental questions youth face in science: Am I good at science and do I value science? In line with previous scholars, we argue that to persist in STEM, youth must believe they are good at science (i.e., self-concept of ability) *and* believe science is important (i.e., value) (Aschbacher et al., 2010; Ing, 2014). The Eccles' expectancy-value model is the leading theory that includes youths' ability self-concepts *and* their value beliefs within the same framework. According to this model, ability self-concepts and value beliefs are two of the most immediate precursors of adolescents' achievement-related choices (see Figure 1 in Wigfield et al., 2015).

The model also specifies what aspects of youths' environments influence their motivation and how that influence unfolds (see Figure 1 in Wigfield et al., 2015). Parents are children's first and primary socializing agents and continue to be central throughout development though the nature of their support changes (e.g., homework help to providing advice on college; Simpkins, Fredricks, & Eccles, 2015). Parents can convey their beliefs about science through interactions with their children and by shaping children's exposure to science (Simpkins et al., 2015). Moreover, the larger cultural milieu, inclusive of gender roles, cultural practices, and ethnic stereotypes, is theorized to shape youths' motivational beliefs through its influence on youths' immediate environments (Wigfield et al., 2015). For example, societal gender role beliefs about whether science in general or specific areas of science are more appropriate for males than females influence parental beliefs, which in turn shape whether parents encourage science more for their sons than daughters (Simpkins et al., 2015). In other words, gender and ethnic differences in STEM are theorized to be partly the result of environmental and socialization differences at home and more broadly (e.g., school, media).

Although a number of researchers have used the expectancy-value model to guide their empirical work, a few significant gaps remain. First, in comparison to the wealth of research on gender, much less has been done on ethnic differences or differences at the intersection of gender and ethnicity. Second, most of the existing work on STEM motivation concentrates on math or science globally despite the fact that the pattern of disparities varies greatly across science subdisciplines (National Science Board, 2014). Third, the literature on parental supports is focused largely on students before high school (e.g., Crowley, Callanan, Tenenbaum & Allen, 2001; Vedder-Weiss & Fortus, 2011, 2012, 2013; Zimmerman, 2012). The work that does exist on parents of high school students has focused on science support broadly (e.g., Aschbacher et al., 2010; Ing, 2014). Though these studies point to the importance of parents for high school students, they provide little insight into what specific types of parental support matter.

Parents' Science-Related Support

Parents' support is integral to students' academic success across subjects, developmental periods, and demographic groups (for a review, see Simpkins et al., 2015). Scholars vary in how they conceptualize and measure parents' behaviors. Much of the work in science addresses parental support globally or focuses on detailed qualities of parent-child interactions. Family support or encouragement, defined at a global level, is an important factor in youths' science motivation (e.g., Archer, DeWitt, & Willis, 2014; Aschbacher et al., 2010; Dabney et al., 2013; Navarro, Flores, & Worthington, 2007; Stake, 2006; Turner, Steward, & Lapan, 2004). Children's science motivation and achievement are also related to the quality of parent-child science interactions, such as types of explanations parents use in museums or the extent to which interactions are intrinsically focused or emphasize mastery goals (e.g., Crowley et al., 2001; Ing, 2014; Vedder-Weiss & Fortus, 2013). Importantly, these studies suggest that how parents interact and talk with youth about science matters. They provide less insight, however, into the frequency in which parents engage in these behaviors and the multitude of ways that parents can support adolescents in science.

Several scholars have examined how often parents are involved in their child's school through a variety of behaviors, such as involvement in the PTA, attendance at parent-teacher conferences, and help with homework (Hill & Tyson, 2009). Although these traditional forms of family involvement predict youths' academic achievement from elementary through high school, they often occur on the school campus and focus on school-related tasks. Additional work is needed to provide a more comprehensive understanding of how parents support science specifically at home (Lee & Bowen, 2006) that incorporates the many meaningful ways ethnic minority families support their children academically (Zarate, 2007; Zimmerman, 2012). For example, parents' provision of enriching experiences at home, such as playing math games, hobbies, and activities around taking care of a family pets, were central to children's STEM interest, knowledge, and skills (Dabney et al., 2013; LeFevre, Skwarchuk, Smith-Chant, Fast, Kamawar, & Bisanz, 2009; Zimmerman, 2012). The emerging work on such relations in STEM suggests that parents' support of math or math/science (combined) predicts Caucasian children's motivational beliefs in elementary and middle school (Simpkins, Davis-Kean, & Eccles, 2005; Simpkins, Fredricks, & Eccles, 2012, in press). Unfortunately, few studies on science have taken such a comprehensive and complex view of parents' science-related behaviors, particularly in high school.

Group Differences in Measurement, Means, and Process

Group differences are a pervasive theme in STEM. Disparities based on gender and ethnicity/race exist in STEM motivation, achievement, coursework, and careers (e.g., Johnson et al., 2011; Mutegi, 2013; Wigfield et al., 2015). For example, Latinos and females tend to be at a disadvantage compared to Caucasians and males in terms of science motivational beliefs (e.g., Andersen & Ward, 2014; Beghetto, 2007; Bouchey & Harter, 2005; Fortus & Vedder-Weiss, 2014; Stake, 2006; Stake & Mares, 2001; see Britner, 2008; Else-Quest et al., 2013 for exceptions). Parent support often varies across demographic groups as well. In a hallmark study, parents were three times more likely to provide an explanation to boys than to girls at a science museum (Crowley et al., 2001). Although several inequalities based on gender and ethnicity have been identified, we argue that the previous work has failed to address the full scope of potential group differences.

One of the central weaknesses of previous research is that gender and ethnic inequalities largely have been examined independently. Recent work poignantly points out that gender and ethnicity do not function independently in young people's lives and that researchers need to consider the intersection of gender and ethnicity to truly understand individuals' pursuit of STEM (Aschbacher et al., 2010; Johnson et al., 2011). Students who do not fit the stereotype of a Caucasian male scientist and identify with demographic groups who have historically been treated as inferior in society are more likely to face challenges at school and question the extent to which science is an appropriate pursuit for them (Johnson et al., 2011; Mutegi, 2013). In addition, certain groups defined by both gender and ethnicity may be at-risk to face substantial challenges due to traditional cultural values. For example, Latina girls have reported feeling pressure to conform to traditional gender roles and did not receive family support to aspire to college or science specifically (Aschbacher et al., 2010).

A second weakness of previous research is that the majority of research on inequalities focuses on mean-level differences, which address whether one group scores higher than another group on an indicator. Little is known concerning the two other ways groups can differ. First, it is important to test whether the constructs (e.g., self-concept of ability) have similar meaning and function similarly across groups. This is known as measurement invariance, and provides the foundation of all scientific research on group differences (Millsap, 2011). Without this, it is unclear if group differences reflect actual group differences on the same phenomenon or group biases in the instruments. Second, it is possible to have group differences in the processes, or that the predictors of adolescents' science motivation vary across groups. Scholars have speculated that science-related support may be more influential for youth who do not fit the stereotype of the Caucasian male scientist, such as females and ethnic minority youth (Andersen & Ward, 2014; Aschbacher et al., 2010; Johnson et al., 2011; Stake & Mares, 2001). According to this literature, Latina girls may benefit most as they do not fit the science stereotype in terms of both gender and ethnicity and in turn often face multiple challenges (Johnson et al., 2011). There also may be differences in the predictive power of parental support among the four specific groups, such as support being more influential for Latino boys compared to Caucasian boys. If there are differences in the predictors of adolescents' pursuit of STEM, interventions or programs need to be tailored specifically to each group to maximize effectiveness.

These types of group differences are independent. For example, Simpkins, Fredricks, and Eccles (in press) tested these three types of gender differences in math. Youths' math ability self-concepts and value, as well as parents' math-related behaviors had a similar meaning across girls and boys (i.e., measurement invariance). Girls and boys reported similar math values and parental supports, but girls often had lower math ability self-concepts than boys (i.e., mean-level differences). Despite that girls had lower math self-concepts than boys, having parental support predicted similar increases in girls' and boys' math ability self-concepts (i.e., lack of moderation based on gender). In other words, girls *and* boys were more likely to experience increases in their math ability self-concepts over time if parents provided high math-related support. However, testing group differences at multiple levels has only been studied systemically in math (Lazarides & Ittel, 2012; Watt et al., 2012). Examination of group differences at all three levels provides a more comprehensive description of the potential differences, which is necessary to provide appropriate advice to teachers and parents.

The Current Study

The goals of this study were to test if parental behaviors predict adolescents' motivation and whether there were group differences in terms of the measurement, means, and processes in parents' behaviors and adolescents' science motivation. Latino and Caucasian students were selected as the two ethnic/racial groups for this study because Caucasians account for the largest percentage of STEM majors and careers, whereas Latinos comprise one of the lowest percentages and may experience increasing STEM disparities in the future (National Science Board, 2014). Moreover, Latinos and Caucasians have received the least and most attention in previous research (respectively). By including Caucasians, we can understand if the measures and results follow expected trends. Our specific hypotheses were:

a Adolescents will differentiate between biology, chemistry, and physics in their ability self-concepts and their importance values, as well as between types of supportive parenting behaviors.

b We expect these indicators will have similar measurement properties across the four groups: Latino boys, Latina girls, Caucasian boys, and Caucasian girls.

c We expect Caucasian boys will have higher motivational beliefs in chemistry and physics and parental behaviors compared to Latino boys and Caucasian girls, who in turn will be higher than Latina girls. In addition, we expect Caucasian girls will have higher biology motivational beliefs compared to Caucasian boys and Latina girls, who in turn will be higher than Latino boys.

d We expect parents' behaviors will positively predict adolescents' motivational beliefs, and that these relations will be stronger for ethnic minority and female adolescents compared to Caucasian boys.

Methods

Participants

Participants were drawn from three public high schools in a large metropolitan area in the southwest. As shown in Table 1, each school had a large proportion of Caucasian and Hispanic students. School C was the smallest school, had a higher percentage of lower income students, and had lower science and math achievement rates on statewide tests compared to the other two schools. In all schools, the ninth grade honors science course was honors biology. The basic science course varied by school.

Table 1
School information[a]

	School A	School B	School C
Total student population	3,175	2,637	1,285
9th grade student population	841	746	331
Ethnic composition			
% Caucasian	43%	53%	36%
% Hispanic	39%	23%	48%
Eligible for free/reduced lunch	30%	17%	63%
4-year graduation rate	93%	91%	79%
10th grade students who passed the statewide test			
Science	68%	62%	29%
Math	72%	63%	38%
Reading	83%	83%	69%
Response rate	84%	71%	55%

[a]2012 AIMS Assessment Report, Arizona Department of Education; 2011 National Center for Education Statistics Common Core Data.

All ninth grade adolescents were invited to participate. Active consent was collected by sending letters home to parents in English and Spanish. In total, 1,324 ninth grade students completed the survey. Because the questions in this study focus on processes for Latino and Caucasian students, data from Latino and Caucasian students were retained for this paper. The sample included 988 students (51% Latino, 49% female). Participant demographic information is presented for each of the four focal groups in Table 2.

Procedures

Participants completed a self-report survey during class in fall 2012. Each participant received $5 in cash as compensation. Although Spanish surveys were available, all students completed the survey in English.

Parents' Behavior. Family support was collected using a 23-item measure developed from two existing measures and adapted to ask about supportive behaviors specific to science (Bouchey & Harter, 2005; Price & Simpkins, 2011; "Help you feel better when science is hard" and "Look at science websites with you;" 1=*never*, 5=*always*). Because such a large number of items can create identification problems in structural equation models, we created 11 parcels to use as indicators in the analyses (Little, Cunningham, Shaher, & Widaman, 2002). Each parcel was the average of the two items that comprised the parcel. The parcels were based on two criteria. We first identified potential parcels that included homogenous items tapping theoretically similar parental behaviors. Second, we confirmed and adjusted the parcels based on factor analysis. The factor analysis suggested there were three types of parent behaviors: (a) positivity with four parcels (b) co-activity with three parcels, and (c) school-focused behavior with four parcels. The full list of scales, parcels, and individual items can be found in Table S1 in the supplementary material. Table 2 includes information on reliability and descriptive statistics.

Self-Concept of Ability. Adolescents reported their beliefs about their abilities in biology, chemistry, and physics with four items in each subdiscipline on a 7-point scale (see Table S2 in the supplementary material for the items and Table 2 for reliability and descriptive statistics; an example item is "How good at (biology/chemistry/physics) are you?" 1=*not at all good*, 7=*very*

Table 2
Participant information

	Latino boys	Latina girls	Caucasian boys	Caucasian girls
Participant information				
N	268	251	231	238
Adolescent information				
% U.S. born	88%	88%	98%	99%
% Honors science course	23%	31%	45%	45%
Science grade [*M* (SD)][a]	2.81 (1.06)	2.89 (1.01)	3.09 (.93)	3.13 (.86)
Parent information				
Language [*M* (SD)][b]	2.88 (1.22)	2.97 (1.28)	4.89 (.41)	4.89 (.31)
% College education[c]	51%	49%	87%	87%
% U.S. born	53%	58%	95%	97%
Family information				
% 2-parent household	68%	68%	77%	72%
Scale statistics M (SD) [alpha]				
Parent behaviors				
Co-activity	2.16 (.90) [.86]	1.93 (.70) [.73]	2.25 (.89) [.85]	2.04 (.73) [.74]
Positivity	2.58 (1.02) [.87]	2.46 (1.01) [.88]	2.85 (.99) [.85]	2.70 (1.02) [.87]
School-focused	2.90 (.97) [.80]	2.81 (.99) [.80]	3.12 (1.00) [.79]	3.05 (.97) [.75]
Ability self-concepts				
Biology	4.23 (1.08) [.85]	3.99 (1.11) [.88]	4.61 (1.21) [.89]	4.52 (1.14) [.88]
Chemistry	4.18 (1.25) [.91]	3.81 (1.28) [.92]	4.62 (1.22) [.92]	4.25 (1.26) [.92]
Physics	4.28 (1.33) [.93]	3.73 (1.30) [.93]	4.70 (1.35) [.95]	4.22 (1.39) [.95]
Importance values				
Biology	4.70 (1.34) [.81]	4.74 (1.32) [.84]	4.70 (1.42) [.88]	4.80 (1.32) [.84]
Chemistry	4.58 (1.39) [.89]	4.39 (1.47) [.90]	4.70 (1.34) [.89]	4.38 (1.47) [.91]
Physics	4.74 (1.43) [.91]	4.38 (1.55) [.91]	4.90 (1.40) [.93]	4.26 (1.49) [.93]

[a]The response scale was 0 = F/E, 1 = D, 2 = C, 3 = B, 4 = A.
[b]The response scale was 1 = *only Spanish*, 2 = *More Spanish than English*, 3 = *Both equally*, 4 = *More English than Spanish*, 5 = *only English*.
[c]This is the percent of youth who had one or two parents with at least some college education.

good). The scales have excellent face, convergent, and discriminant validity, as well as strong psychometric properties (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002).

Importance Value. Adolescents reported how much importance they placed on biology, chemistry, and physics with the same three items in each subdiscipline on a 7-point scale (see Table S2 for the items and Table 2 for reliability and descriptive statistics; an example item is "How useful is what you learn in (biology/chemistry/physics) ?" 1= *Not at all useful*, 7= *Very useful*). The scales have good reliability and excellent convergent and discriminate validity (e.g., Jacobs et al., 2002).

Demographic Controls. Demographic characteristics about the adolescents and their parents were collected (see Table 2 for descriptive statistics). Adolescents' science class (0 = *basic*, 1 = *honors*) and self-reported science grade (0=*F/E*, 4=*A*) were collected. We also included indicators of parental socioeconomic status (i.e., SES) and language use as they are important predictors of children's science outcomes (e.g., Archer et al., 2014; Carlone, Scott, & Lowder, 2014; Crosnoe & Lopez Turley, 2011). Parent education was selected as the indicator of family SES because scholars have raised concerns about adolescents' ability to accurately report family income (Ensminger et al., 2000). Adolescents reported their mothers' and fathers' level of education (0=*less than high school*, 5=*more than a college degree*) and Spanish language use (i.e., one item; "what language does your mom mostly read and speak"; 1 = *only Spanish*, 5 = *only English*; Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). In order to include information on both parents in the analyses, we created summary variables across mothers and fathers. For parent education, we created an indicator noting if one or both parents had at least some college ($r = .65$, $p < .001$; 0=both parents had a high school degree or less, 1 = 1 or both parents had at least some college education). For parent Spanish language use, we took the mean of the one item across mothers and fathers ($r = .82$, $p < .001$). Finally, adolescents reported the number of parents living in the home (0 = *1 parent*, 1 = *2 parents*). These demographic indicators were included in the analyses to control for differences due to socioeconomic status as well as other parent and adolescent characteristics known to predict parent behavior and adolescent motivational beliefs.

Plan of Analysis

Before we discuss the specific analysis used to address each question, we need to describe some general information applicable to all analyses. We calculated design effects because we were concerned with non-independence of the data decreasing the size of the standard error and increasing the likelihood of a Type I error (Muthén & Sattora, 1995). Our design effects were less than .05 which is lower than the 2.0 cutoff suggesting that the non-independence of the data was ignorable (Muthén & Muthén, 1998-2010).

All analyses were estimated with structural equation models in MPlus v7.11. Structural equation models (SEM) allow researchers to test complex models and statistics like those posed in this study and to examine relations among indicators where measurement error has been removed (Little, 2013). We used several indicators of model fit, including the CFI (comparative fit index), RMSEA (root mean squared error of approximation), SRMR (standardized root mean square residual), and chi-square. Models that fit the data well are indicated by a CFI $\geq .95$, RMSEA $\leq .05$, and SRMR $\leq .05$ (Millsap, 2011). Adequate models are indicated by a CFI $\geq .90$, RMSEA $\leq .08$, and SRMR $\leq .08$.

In addition to these overall model statistics, we examined the difference between nested models to test three of our four hypotheses. In order to test whether the difference between two nested models is meaningful, scholars traditionally have used the change in chi-square (i.e., ΔX^2). However, when sample size is large as is true in this study, the change in X^2 can be statistically significant when the change in the model is relatively small. Experts have recommended also using the criterion of a change in CFI that is less than .010 (i.e., ΔCFI $< .010$) to indicate if the findings are similar across groups (Little, 2013). We determined that two models were *not* similar if (a) the overall model fit was poor or (b) the $\Delta X^2$was statistically significant *and* the ΔCFI $\geq .010$.

Because our missing data were negligible (i.e., every student had data, only 0.2–1.8% of the items were skipped across students), we retained cases with missing data and used a maximum likelihood estimator. To identify each latent variable, we fixed the loading of one indicator to 1.0. Following recommendations on estimating models that have the same items across content areas, we estimated the covariances between the unique variances of the same measured indicator across the three science subdisciplines (Little, 2013). For example, the three covariances between the item "I am good at (biology/chemistry/physics) ?" across each of the three science subdisciplines were estimated. Finally, we estimated separate models for individuals' ability self-concepts and importance values to avoid statistical problems associated with multicollinearity and because our goal was to test if adolescents differentiated between the three subdisciplines of science within each motivational belief.

Results

Do Adolescents Differentiate Across Parental Behaviors and Science Disciplines?

In order to address this first question, we tested if a model with three latent variables did a better job describing the data than a model with one latent variable. For example, in the first model, all 12 items measuring adolescents' ability self-concept were fixed to load on a single science latent variable. In the second model, the same 12 items were divided among three latent variables that differentiated between biology, chemistry, and physics ability self-concepts. Two similar models were estimated for adolescents' importance values. The models with parents' behaviors examined (a) if parents' behaviors formed one general type of science support or (b) if there were three different types of science support. These models were estimated on the full sample. In each case, we examined overall model fit of each model and the difference in model fit across the two nested models.

The overall model statistics shown in Table 3 suggest that the models with one overarching indicator were not as good as the models differentiating multiple indicators. The models with a single latent variable did not describe the data well, as noted in the poor overall fit statistics (i.e., CFI = .67–.88, RMSEA = .12–.29, SRMR = .05–.11). In contrast, the models with three latent variables represented the data well (i.e., CFIs = .95–.99, RMSEA = .04–.08, SRMR = .01–.03). The significant differences in the overall model fit between the two models also confirms that the models with three latent variables were better than the models with one latent variable (i.e., ΔX^2 (Δdf = 3)=426.05–3297.32, $p < .001$; ΔCFI = .07–.25). In other words, the statistics suggest that adolescents differentiate between the three parental behaviors (see Table S1 for the items and scales), their ability self-concepts in the three science subdisciplines, and their importance values in the three science subdisciplines. This is evidence of discriminant validity that parents' behaviors included three broader types of behaviors and that adolescents' motivational beliefs are separate for the three science subdisciplines.

Do the Scales Function Similarly for Latino Boys, Latina Girls, Caucasian Boys, and Caucasian Girls?

To address this second question, we tested for measurement invariance in parents' behaviors, adolescents' ability self-concepts, and adolescents' importance values (Millsap, 2011). Testing for measurement invariance is important to understand if bias exists in the measurement tools. If the scales are not invariant and include bias that varies across the groups, we would be unable to make group comparisons. It would be akin to the common phrase "comparing apples to oranges."

Table 3
Model fit indicators for the 1- and 3-latent variable models

Model	(df)X^2	CFI	RMSEA	SRMR	(Δdf)ΔX^2	ΔCFI
Parents' behavior						
1-latent model	(44) 742.93***	.884	.127	.055		
3-latent model	(41) 316.88***	.954	.083	.037	(3) 426.05***	.070
Adolescents' ability self-concept						
1-latent model	(42) 3526.20***	.670	.290	.117		
3-latent model	(39) 228.88***	.982	.070	.024	(3) 3297.32***	.258
Adolescents' importance values						
1-latent model	(18) 1453.00***	.804	.284	.075		
3-latent model	(15) 45.00***	.996	.045	.018	(3) 1408.00***	.192

***p <.001.

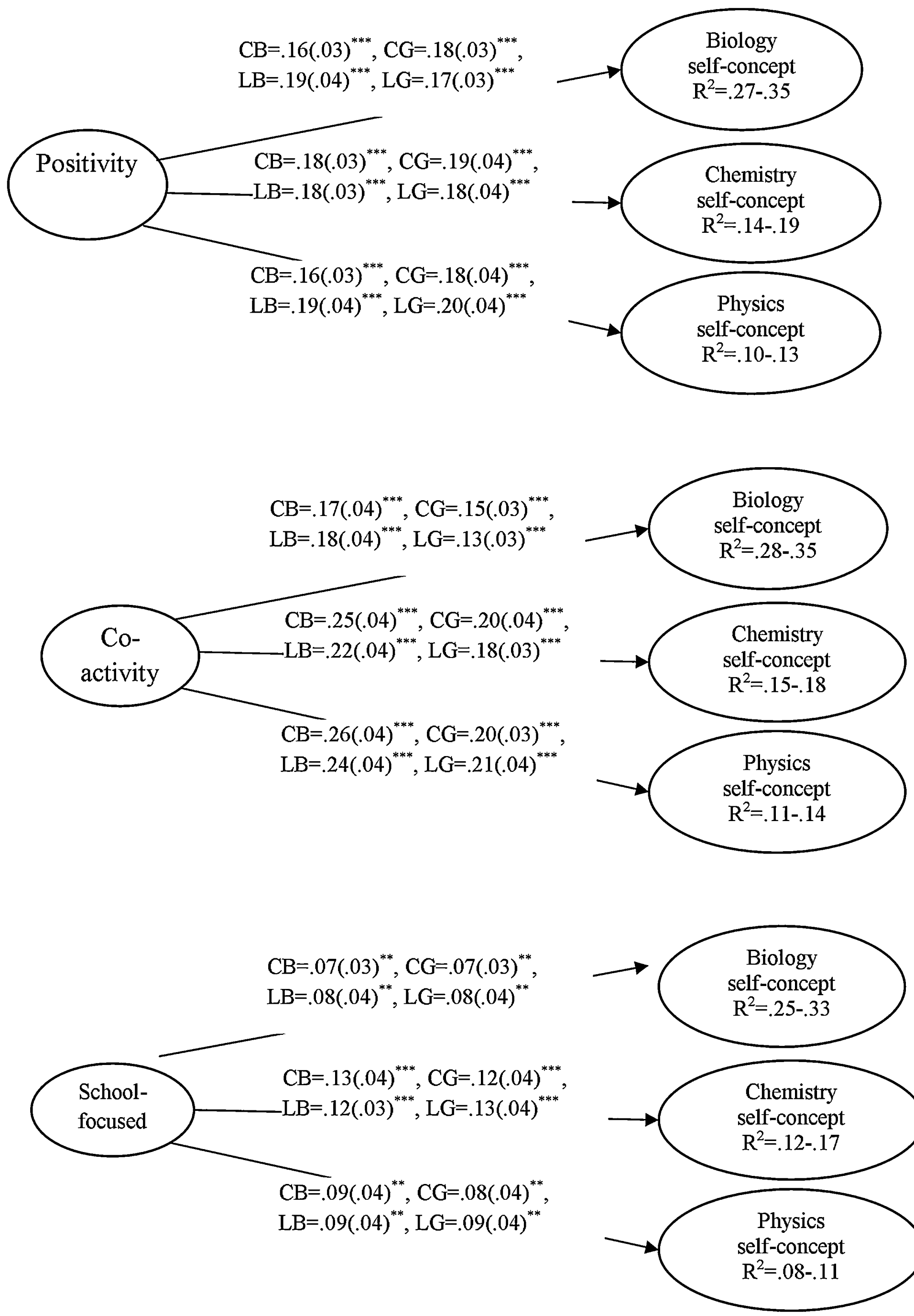

Figure 1. Results showing whether parents' behaviors predict adolescents' ability self-concepts. The standardized path estimates and (standard errors) are presented for each group: CB, Caucasian boys; CG, Caucasian girls; LB, Latino boys; LG, Latina girls.

A full description of the results including the table with model fit statistics (see Table S3), a conceptual figure (see Figure S1) are presented in the supplementary material. Here, we provide a brief overview. Overall, the data suggest that adolescents' reports of parents' behaviors, ability self-concepts, and importance values are similar across Latino boys, Latina girls, Caucasian boys, and Caucasian girls. The specific tests suggested that the same items represented these constructs for each group (i.e.,configural and weak invariance) and that the item intercepts were similar across groups (i.e., strong invariance). These findings suggest that the constructs are similar across all groups and gives confidence that differences across groups are *not* the result of measurement bias.

Are There Mean-Level Differences in These Constructs Across Groups?

We tested if there were mean-level differences across the four groups by examining the differences in the latent means. Testing differences through latent means is optimal compared to traditional analysis of variance techniques as measurement error should be removed from the latent variable. We estimated several models to calculate all possible comparisons across the four groups. To provide a more comprehensive examination, we tested mean-level differences two ways: (a) differences without any control variables, and (b) differences that existed after controlling for parent education and Spanish language use. In each model, the means for one group were set to zero. The means for the other three groups were estimated, which make the numbers presented in Table 4 the relative differences.

The most consistent differences in parents' behaviors emerged when comparing Caucasian boys to Latino boys and Latina girls. In the models where we did not account for parent characteristics, Caucasian boys reported higher parent co-activity, positivity, and school-focused behavior than Latino boys and Latina girls. These differences were small to moderate in size. However, all but one of the differences diminished when we accounted for parent education and Spanish language use. Specifically, the size of many of these differences (i.e., the d statistics in Table 4) was cut in half once we accounted for parents' characteristics. These changes suggest that the differences among these groups are largely the result of differences in parent education and Spanish language use rather than differences in ethnicity.

Adolescents' ability self-concept in biology, chemistry, and physics varied across groups. Caucasian boys had higher ability self-concepts in all three science subdisciplines compared to every other group when we did not account for parents' characteristics. These differences ranged from small to large depending on the comparison group. Latina girls had lower ability self-concepts than all other groups, many of which were moderate to large discrepancies. Caucasian girls only differed from Latino boys in their biology self-concept, where girls were higher. Some of these differences became non-significant and diminished in size in the models controlling for parent education and language. Specifically, the differences across ethnic groups within the same gender changed in their level of significance and many of the effect sizes were reduced by half. All of the differences among Caucasian and Latino boys became non-significant once parent characteristics were account for. All of the differences among Caucasian and Latina girls either diminished or became non-significant as well. The gender differences within each ethnic group, such as Latina girls reporting lower means than Latino boys, remained.

In comparison to ability self-concepts, there were not many differences among the groups for importance values. Most of the differences emerged in physics. In the models without parent characteristics, Caucasian and Latino boys had higher physics importance values than Caucasian and Latina girls. The inclusion of parent characteristics did not change the size of these differences in physics importance, except for the differences between Caucasian girls and Latino boys became smaller.

Table 4
Relative mean differences without controls (top half) and with controls for parent education and language (bottom half)

	Caucasian boys compared to Latino boys		Latina girls compared to Latino boys		Caucasian girls compared to Latino boys		Latina girls compared to Caucasian girls		Caucasian girls compared to Caucasian boys		Latina girls compared to Caucasian boys	
Indicator	B (SE)	d[a]	B (SE)	d[a]	B (SE)	d[a]	B (SE)	d[a]	B (SE)	d[a]	B (SE)	d[a]
Mean differences with no controls												
Parents' behavior												
Co-activity	.27 (.01)**	.29	−.09 (.09)	.10	.10 (.09)	.11	.20 (.10)	.21	−.15 (.10)	.17	−.35 (.10)***	.38
Positivity	.21 (.09)*	.22	−.19 (.08)*	.22	−.06 (.09)	.07	.13 (.08)	.15	−.26 (.10)**	.29	−.38 (.10)***	.44
School-focused	.25 (.09)**	.29	−.09 (.08)	.10	.06 (.09)	.07	.15 (.09)	.18	−.17 (.09)	.21	−.33 (.09)***	.37
Adolescents' ability self-concept												
Biology	.45 (.11)***	.38	−.23 (.10)*	.21	.36 (.11)***	.32	−.60 (.11)***	.51	−.09 (.12)	.07	−.68 (.12)***	.57
Chemistry	.48 (.11)***	.39	−.38 (.11)***	.30	.11 (.11)	.09	−.48 (.12)***	.39	−.38 (.12)***	.31	−.86 (.12)***	.69
Physics	.48 (.11)***	.37	−.52 (.12)***	.41	.01 (.12)	.01	−.54 (.12)***	.43	−.47 (.13)***	.35	−1.01 (.12)***	.79
Adolescents' importance values												
Biology	−.02 (.12)	.02	.03 (.11)	.02	.12 (.12)	.10	−.09 (.12)	.08	.14 (.12)	.23	.05 (.12)	.02
Chemistry	.10 (.13)	.08	−.22 (.13)	.16	−.19 (.13)	.14	−.03 (.13)	.02	−.29 (.13)*	.46	−.32 (.13)*	.17
Physics	.16 (.13)	.11	−.37 (.14)**	.24	−.46 (.13)***	.32	−.10 (.14)	.06	−.62 (.14)***	.43	−.53 (.14)***	.46
Mean differences after controlling for parent education and language												
Parents' behavior												
Positivity	.03 (.12)	.03	−.05 (.09)	.06	−.11 (.11)	.12	.63 (.11)	.07	−.12 (.10)	.13	−.06 (.12)	.06
Co-activity	.11 (.11)	.11	−.15 (.08)	.18	−.16 (.11)	.18	.02 (.10)	.03	−.25 (.10)	.28	−.22 (.11)*	.26
School-focused	.03 (.11)	.04	−.05 (.08)	.06	−.13 (.11)	.15	.08 (.11)	.10	−.14 (.09)	.17	−.05 (.11)	.07
Adolescents' ability self-concept												
Biology	.18 (.14)	.16	−.20 (.10)*	.18	.12 (.13)	.11	−.31 (.14)*	.28	−.06 (.12)	.05	−.38 (.14)**	.32
Chemistry	.12 (.14)	.10	−.39 (.11)**	.29	−.27 (.14)	.22	−.09 (.14)	.08	−.36 (.19)***	.32	−.48 (.15)***	.39
Physics	.30 (.15)*	.23	−.49 (.12)***	.39	−.19 (.15)	.14	−.31 (.15)*	.24	−.49 (.13)***	.37	−.79 (.15)***	.63
Adolescents' importance values												
Biology	.04 (.15)	.03	.07 (.11)	.05	.19 (.14)	.16	−.12 (.14)	.10	.15 (.12)	.12	.03 (.15)	.02
Chemistry	.05 (.16)	.03	−.19 (.13)	.14	−.24 (.16)	.18	.05 (.17)	.03	−.28 (.13)*	.21	−.24 (.16)	.17
Physics	.35 (.17)*	.25	−.33 (.14)*	.23	−.28 (.17)	.19	−.06 (.18)	.04	−.62 (.14)***	.43	−.68 (.17)***	.46

A negative value suggests that the first group has a lower mean than the second group whereas, a positive value suggests that the first group has a higher mean than the second group.
[a]Effect size (d): small effect ≥ 0.2, and medium effect ≥ 0.5.
*$p < .05$.
**$p < .01$.
***$p < .001$.

Do Parents' Behaviors Predict Adolescents' Motivation for All Four Groups?

One central goal of this study was to examine whether parents' behaviors predicted adolescents' motivational beliefs and whether these relations varied across the four groups. These multi-group models included the measurement models with the invariance constraints based on the earlier analyses. In addition, we included parents' behavior and the predictive paths from parents' behavior to adolescents' motivational beliefs. Models for each parent behavior had to be estimated separately as parents' behaviors were highly correlated ($r = .68–.73$, p's $< .001$). Models including all three parental behaviors had issues with multicollinearity.

We also included a series of control variables that predicted parents' behaviors and adolescents' motivational beliefs. The control variables included students' science grade, and whether they were in a basic versus honors science course; parents' education and Spanish language use; and number of parents in the home. Initially, we estimated the path from each control variable to predict each latent variable included in the model. Following recommendations to not over control (Little, 2013), we dropped paths when a control variable did not significantly predict a particular latent variable at the $p < .10$ level. If a control variable did not significantly predict any of the latent variables in a particular model, it was dropped from that model. The specific findings concerning the control variables are available from the first author.

First, we examined if the predictive paths from parents' behaviors to adolescents' motivational beliefs varied across groups. To test this, we examined the difference between two nested models through a multi-group analysis: (a) a model in which the predictive paths were freely estimated across groups and (b) a model in which the predictive paths were constrained to be equal across all four groups. A path was considered significantly different across groups if the change in chi-square was significant at $p < .001$ (Little, 2013). The model fit statistics are presented in Table 5. The change in chi-square for every model except one was less than our criteria of $p < .001$ suggesting that parents' behaviors predicted adolescents' motivational beliefs in a similar way across all four groups. The one exception was that the predictive power of parents' positivity in predicting adolescents' importance values varied across groups (as noted with the significant change in chi-square in Table 5). Follow-up tests revealed that the path from positivity to the importance adolescents placed on biology was different for Caucasian boys compared to the other three groups who were similar to each other. Specifically, positivity predicted adolescents' biology importance values for all groups, but this relation was stronger for Caucasian boys compared to the other three groups.

Figures 1 and 2 display the results for the models with ability self-concepts and importance values respectively. As shown in Figure 1, parents' positivity, co-activity, and school-focused behaviors predicted adolescents' ability self-concepts in biology, chemistry, and physics. All of the paths were statistically significant and positive suggesting that parents who engaged in more of these behaviors had adolescents with higher ability self-concepts in all three science subdisciplines. The r-squared statistics (i.e., R^2) are presented in the figures as well. Those suggest that the parental behavior and control variables accounted for 8–35% of the variance in adolescents' ability self-concepts.

The results in Figure 2 suggest that parents' positivity, co-activity, and school-focused behavior predicted the value adolescents placed on biology, chemistry, and physics. Parallel to the ability self-concept models, all of the paths were statistically significant and positive suggesting that parental behaviors predicted higher value of biology, chemistry, and physics. These parental behaviors predicted even after controlling for adolescents' science class and grade, as well as parent education, Spanish language use, and whether they lived with their partner. These parental

Table 5
Model fit indicators for the models in which the paths from parents' behaviors to adolescents' motivational beliefs are freely estimated and constrained across groups

Model	(df)X^2	CFI	RMSEA	SRMR	(Δdf)ΔX^2
Models predicting ability self-concept					
Co-activity					
Paths free	(702) 1004.74***	.975	.042	.053	
Paths constrained	(711) 1021.04***	.975	.042	.059	(9) 16.30
Positivity					
Paths free	(703) 1084.92***	.971	.047	.056	
Paths constrained	(712) 1097.79***	.971	.047	.061	(9) 12.87
School-focused					
Paths free	(627) 865.77***	.979	.039	.053	
Paths constrained	(636) 873.40***	.980	.039	.056	(9) 7.63
Models predicting importance values					
Co-activity					
Paths free	(486) 678.72***	.979	.040	.057	
Paths constrained	(495) 690.35***	.979	.040	.059	(9) 11.63
Positivity					
Paths free	(487) 697.71***	.979	.042	.051	
Paths constrained	(496) 726.03***	.977	.043	.055	(9) 28.31***
Final model[a]	(495) 710.20***	.978	.042	.054	(1) 15.83***
School-focused					
Paths free	(423) 521.88***	.988	.031	.047	
Paths constrained	(432) 528.53***	.989	.030	.049	(9) 6.65

These models include controls for youths' science grade, and whether they were in a basic versus honors science course; parents' education and language; and number of parents in the home.
[a]In this model, the path from positivity to adolescents' beliefs about the importance of biology was estimated separately for Caucasian boys compared to the other three groups (who were similar to each other).
$^{***}p<.001$.

behaviors and the control variables accounted for 7–31% of the variance in adolescents' importance values.

Discussion

Theories on adolescent motivation and STEM careers posit that individuals' STEM choices throughout the life-span are largely based on their motivational beliefs (Ceci et al., 2009; Wigfield et al., in press). The expectancy-value model also states that families, and parents in particular, are one of the key socializers of youths' motivational beliefs (Wigfield et al., 2015). The findings from this study extend existing work by providing a richer understanding of high school students' motivational beliefs within three core science subdisciplines, the complexity of group differences, and the potential of parental support.

Adolescents Do Differentiate Between Science Subdisciplines

Although scholars have often measured individuals' science choices (e.g., coursework, college major, careers) in specific science subdisciplines, youths' motivation traditionally has been measured in terms of science broadly (e.g., Beghetto, 2007; Britner, 2008). These data suggest that adolescents at the beginning of high school have unique motivational beliefs in biology, chemistry, and physics. Certainly, adolescents' motivational beliefs across these science subdisciplines are related, but assessing adolescents' beliefs in multiple science subdisciplines

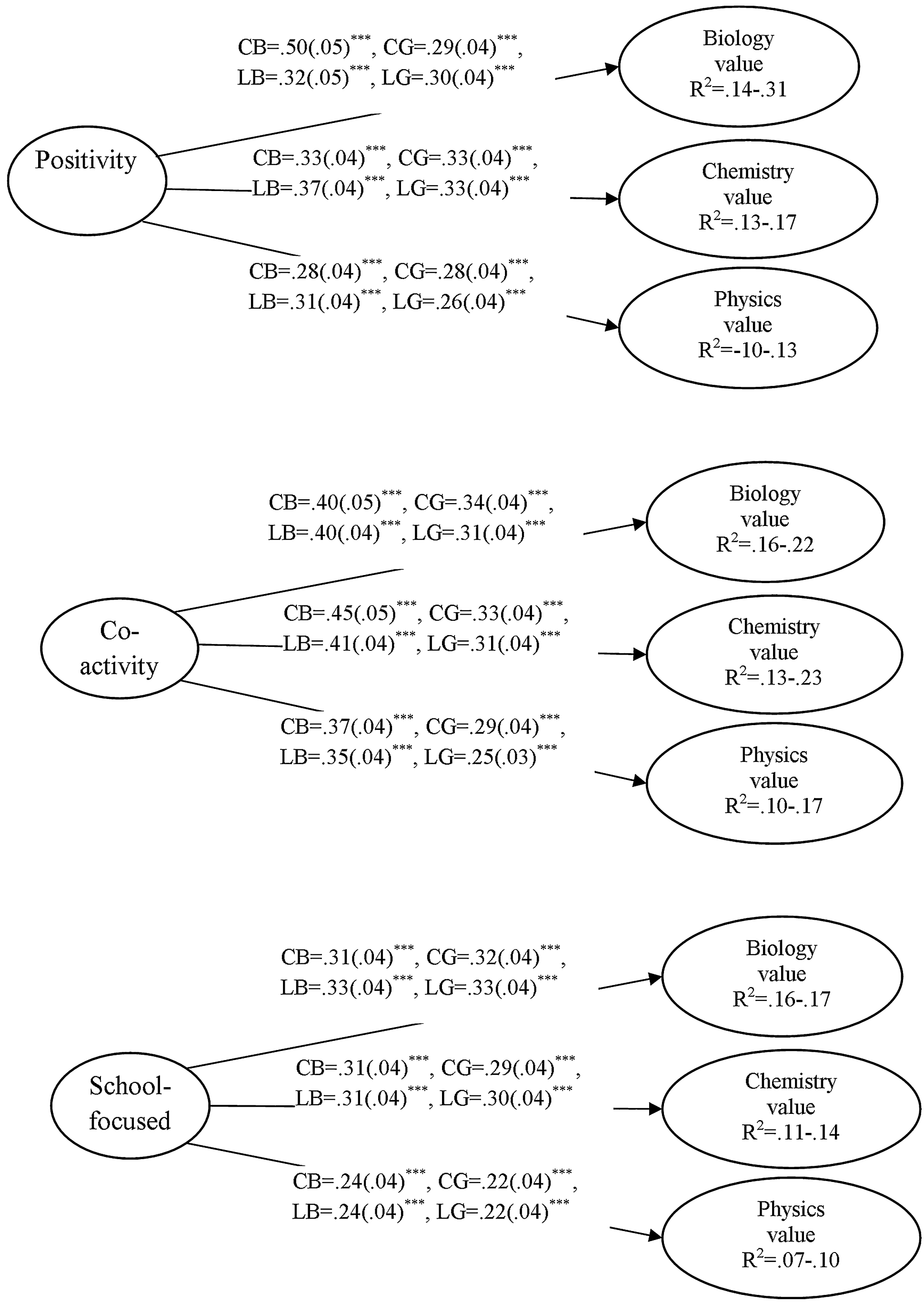

Figure 2. Results showing whether parents' behaviors predict adolescents' importance values. The standardized path estimates and (standard errors) are presented for each group: CB, Caucasian boys; CG, Caucasian girls, LB, Latino boys, LG, Latina girls. ***$p < .001$.

enabled us to examine differences within science. For example, the gender and ethnic differences in adolescents' ability self-concepts fluctuated across biology, chemistry, and physics, and mirror differences found in the STEM choices of adults (National Science Board, 2014). Examining youths' science motivational beliefs, achievement, and choices in multiple science subdisciplines will help the field pinpoint at what age these differences by science subdiscipline emerge, how they change with age, and possible strategies to help reverse these trends.

The Complexity of Group Differences

One goal of many scholars is to test if the gender and ethnic differences evident in adults' STEM occupational choices can be traced back to differential youth motivation and support. Our findings suggest that there were several differences among the four groups included in this study. But, parent education and Spanish language use partially explained some of the differences that emerged across Latinos and Caucasians within the same gender. For instance, Caucasian boys reported higher parental behaviors and ability self-concepts in all three science areas than Latino boys, but these differences weakened and many changed from statistically significant to non-significant once we accounted for parents' demographic information. Further, the size of nearly all of these differences was reduced at least by half once parents' demographic information was included. The differences between Caucasian and Latina girls also lessened after controlling for parents' demographic information though two differences persisted to be small in size. These reductions suggest that ethnic differences are partly the result of differences in parental resources—and not ethnicity specifically.

The distinction between ethnic-based processes or processes in something related to ethnicity is an important one. Ethnic-based processes include discrimination, stereotypes, or differential treatment based on one's ethnicity. For example, teachers who hold lower expectations of Latino students simply due to their ethnicity is an example of an ethnic-based process as it is a function of the students' ethnicity (Archer et al., 2014; Carlone et al., 2014). There are other processes that are not ethnically-based, such as those related to social class or immigration, that account for ethnic differences. Parent education and resources more broadly are examples of processes that are related to ethnicity, but which are not inherently ethnic-based processes. Our findings suggest that ethnic differences in these constructs are actually partly the result of differences in social class and parental resources, which aligns with previous work (Archer et al., 2014; Carlone et al., 2014; Chang et al., 2014; Weiland, 2015). Put another way, adolescents whose parents have a lower level of education and/or parents who primarily use Spanish may be a group who could benefit from additional supports.

Latina girls continued to be at a disadvantage compared to other groups even after accounting for parents' demographic information. Specifically, Latina girls had lower ability self-concepts in all three science disciplines and value of physics than Caucasian boys, Caucasian girls, and Latino boys. These differences were most pronounced in Latina girls' ability self-concepts where the differences were small to moderate in size even after accounting for parents' demographic information. It is important to note that these indicators are adolescents' beliefs about their abilities and not their actual abilities. The differences found in ability self-concepts may not reflect actual differences in ability or achievement. For example, girls often score similar to or higher than boys on math achievement tests, but boys rate their math ability self-concept higher than girls (e.g., Wigfield et al., 2015). Though our data do not provide insight on why these differences might exist, they align with previous qualitative work suggesting ethnic/racial minority females face many challenges and structural barriers as well as receive messages that they are not "science material" (Johnson et al., 2011, p. 354; Aschbacher et al., 2010). Such experiences may lead Latina females to doubt their abilities and question whether they are good enough.

Our findings on measurement invariance suggest that these differences are not simply the result of bias in the measurement tools. The scales were reliable for all youth in this study. These scales also evidenced strong discriminate validity by distinguishing between the three science disciplines and concurrent validity as evidenced by the expected relations with the control variables (e.g., students' science grade). Researchers should have confidence that the scales in this study capture similar constructs across groups.

In addition, we examined if the strength of parents' behaviors predicting adolescents' beliefs varied across the four groups. Scholars have posited that support outside of school may be particularly critical for female and ethnic/racial minority youth (e.g., Andersen & Ward, 2014; Johnson et al., 2011; Mutegi, 2013; Stake & Mares, 2001). In our data, parents' behaviors were consistent predictors of adolescents' motivational beliefs for all groups, with one exception. Parents' positivity was a significant predictor of adolescents' biology importance values for all groups, but this relation was stronger for Caucasian boys compared to the other three groups (who were similar to each other). We are cautious about this finding because the one path represented only 5.5% of the paths tested. That percent is similar to the Type I error rate (5%), suggesting that this finding may be due to chance. Further, several studies have noted that despite having mean-level group differences, the relations among indicators in math are not different based on gender (Lazarides & Ittel, 2012; Simpkins et al., in press; Watt et al., 2012). Why might there be mean-level differences, but no process differences? This pattern suggests that there are existing differences among the groups—in that one group is higher than another on parent support or motivation. But the lack of process differences means that parents' behaviors have the potential to support adolescents' science motivation for adolescents from all groups included in this study.

When taken from a more applied perspective, the mean-level differences suggest which groups and what phenomena may need extra support. For example, Latina girls had less confidence in their science ability than everyone else. This is a potential topic for an intervention among Latinas. When designing the intervention, one needs to know what supports adolescents' ability self-concepts and whether different supports matter for Latina girls compared to other groups. The lack of process differences suggests that similar interventions focused on parents' behaviors should be beneficial for all adolescents in this study.

The Nature of Parents' Behaviors and Their Relations With Adolescents' Motivation

Adolescents reported their parents engaged in three general parental behaviors: positivity, co-activity, and school-focused. The current findings complement previous research focused on parents' support broadly (Ing, 2014) as they provide specific strategies parents can use to help support their high school students. Parents can help their adolescent by praising them and helping them feel better when things do not go well. Parents can also engage in many school-related tasks that do not require them to help complete the homework or go to their adolescents' high school, such as making sure adolescents have time and space to do their home and that it is complete, or talking to them about how their science class is going. Parent-adolescent science activities, like watching science shows, talking about current events or the importance of doing well in science, can also be helpful. Our work suggests that how often parents use these strategies is related to adolescents' motivation. The work on parents' explanations in museums and goal-orientation provide tips on how to maximize the impact of parents' behaviors and interactions with their adolescent children (e.g., Crowley et al., 2001; Vedder-Weiss & Fortus, 2013). Our data also underscore the myriad of ways parents can effectively support their adolescents' academic success at home (Zarate, 2007). These findings are important for teachers in at least two regards.

First, high school adolescents report their parents are doing something. Previous studies have emphasized the declines in parental involvement in the school (e.g., Hill & Tyson, 2009). While parents may be pulling back from being on the school campus, many are still doing things at home. Such informal parent-youth opportunities can impact youths' science motivation and achievement, as well as general problem solving skills (Harackiewicz et al., 2012; LeFevre et al., 2009; Zimmerman, 2012). These findings confirm the continued supportive role parents play in high school students' science motivation.

Second, many of the parental behaviors included in this study do not require parents to be science experts. Some parents feel lost trying to help with science homework (Zarate, 2007). Parents' hesitation may be heightened in regard to high school science compared to science at earlier ages and other subjects in high school, because parents often feel the subject matter is too complicated or surpasses their level of education (Zarate, 2007). However, our study suggests that parents can engage in other meaningful ways that do not require mastery of science facts in textbooks and still predict their adolescent's motivation.

Limitations and Future Directions

One central focus of this paper was the differences across four broad demographic groups. This work needs to be complemented by research on differences within each group. The four groups considered in this study—Latino boys, Latina girls, Caucasian boys, and Caucasian girls —are each quite diverse. Although on average Latina girls rated their ability self-concepts lower than all other groups, there are Latina girls who believe they are highly skilled at science and achieve successful science careers (e.g., Johnson et al., 2011). At the same time, there are also some Caucasian boys who have little confidence in their science abilities. It is important to understand what has helped or hindered these adolescents.

We have largely assumed that parental behavior is a precursor to adolescents' motivational beliefs and not the reverse. Researchers have found more parent to child effects for Caucasian children in a variety of domains in elementary school (Simpkins et al., in press). This may change with development and for particular populations. Youths' interest and skills may be more likely to affect parental supports in high school compared to elementary school due to youths' increased autonomy and decision making. Parents may also increase support to help thwart a downward turn or to address a perceived deficit. For example, Zimmerman (2012) found that the mother of a middle school-aged girl actively tried to convince her daughter of the utility of a science career when she started to lose interest. Youth may also play a pivotal role in parental support throughout development for particular populations. Youth in families with foreign-born parents who were not educated in the U.S. may have more power in these relationships if parents know little about the U.S. school system and if youth broker the relations between the schools and parents (Suarez-Orozco, Suarez-Orozco, & Todorova, 2008). Examination of the variability within Latinos might provide insight into what family circumstances might lead to youth having a stronger influence on family processes than is typical among mainstream, US-born families.

Another potential limitation to the study is that all of the data were reported by adolescents. Inclusion of data reported by parents would help strengthen future studies on this topic. Not only are parents better reporters of some family-level indicators like parent income and occupation (Ensminger et al., 2000); parents can also provide their perception of their behaviors and the reasons why they engage in those behavior. Observational data is a good complement to the survey reported data to better understand the quality of the parent-adolescent interactions as seen in the work on interactions in museums (e.g., Crowley et al., 2001). Observational and other methods (e.g., time diaries) can also help address some of the limitations of our measures. For example, the anchors of our parent behavior scale addressed the general frequency at which these behaviors occurred, such as "a little," "a lot," or "always." We used these more general anchors because the frequency at which parents engage in these behaviors varies (e.g., visit a museum versus make sure you completed your homework) and we wanted to know if adolescents thought these things happened a lot or a little. Our tests of measurement invariance suggest that the items have similar meaning and function in a similar way across groups. But, it is possible that the groups still vary on what they consider is a little or a lot. Having anchors more closely tied to specific frequencies (e.g., times per week) would help ensure that an anchor has a similar meaning across groups; however, researchers will need to consider the statistical implications as the relatively low frequency of some behaviors will result in highly skewed data depending on the specific anchors.

Conclusions

High school is a turning point in the STEM pipeline (Maltese & Tai, 2011). In 2012, only three states required four years of science in order to graduate with most states requiring two or three years (Snyder & Dillow, 2013), suggesting ample opportunities for students to choose to enroll or not enroll in science courses. High school students who do not enroll in science courses or who are not adequately motivated might inadvertently close the door to future educational and occupational STEM possibilities. Many of the gender and ethnic disparities prevalent in occupational pursuits are present at the beginning of high school. What can be done to address this early, substantial leak in the pipeline? In line with the call to look beyond the classroom (Rennie et al., 2003), our findings suggest that parents are a resource. Teachers can suggest a variety of relatively simple things parents can do to support their adolescents. Because many of these behaviors do not require parents to be science experts, they may be appealing and attainable for parents from diverse educational backgrounds.

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Supporting Information

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