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Latinx adolescents' school-related science conversations with family members: Associations with adolescents' science expectancy-value beliefs in high school

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ABSTRACT

Integrating situated expectancy-value and family systems theories, the current study tested the extent to which Latinx adolescents' 9th-grade school-related science conversations with parents and older siblings/cousins positively predicted their 10th-grade science ability self-concepts and task values. We also tested whether these links were moderated by who primarily initiated the conversations (i.e., adolescents, family members, or both). We used two-wave, multi-reporter survey data from 104 Latinx families, consisting of triads of parents, older siblings/cousins, and adolescents (89% Mexican-descent, 40% female; $M_{age} = 14.53$ years). Partially supporting our hypotheses, parent-adolescent school-related science conversations predicted adolescents' 10th-grade science ability self-concepts. Moreover, the links between parent-adolescent conversations and science ability self-concepts and task values were positive and significant when parents more frequently initiated conversations than adolescents. Similar but weaker associations were found for sibling/cousin-adolescent school-related science conversations. These findings underscore the motivational benefits of family members initiating school-related science conversations with Latinx adolescents.

Despite accounting for 27% of school-aged youth and being the largest ethnic minority group in the U.S., Latinx individuals account for only 7–10% of bachelor's degree recipients in scientific fields (National Science Foundation, 2019). Students' pursuit of science careers often becomes central in high school when adolescents choose whether to enroll in more rigorous science courses and plan their future education (Hulleman & Harackiewicz, 2009). Two direct determinants of these choices and aspirations are whether adolescents believe they can succeed in science (i.e., ability self-concepts) and perceive science as valuable (i.e., task values; Eccles & Wigfield, 2020). However, Latinx adolescents often face significant barriers in schools that contribute to academic demotivation and underachievement (e.g., stereotypes about under-achievement; Andersen & Ward, 2014; Valenzuela, 1999). Though several studies describe the barriers Latinx adolescents face, very little research provides insight into what supports Latinx adolescents' science motivational beliefs.

Eccles' situated expectancy-value theory posits that adolescent development is situated within their immediate contexts (Eccles & Wigfield, 2020). Apart from schools, the theory hypothesizes that youth's motivational development is primarily situated within families, and family socializers' domain-specific support strategies (e.g., encouragement, provision of materials) promote the positive development of adolescents' ability self-concepts and task values (Eccles, 1993; Eccles & Wigfield, 2020). Qualitative studies find that high-achieving Latinx adolescents and STEM professionals attribute their STEM motivation and success more so to their families rather than peers or teachers (Azmitia et al., 2009; Navarro et al., 2007; Taningco, 2008). Thus, examining how families support Latinx adolescents' science motivational beliefs is needed to provide insights on supporting Latinx adolescents' positive development. Given the barriers many Latinx adolescents face at school and that school is one central context in which adolescents learn about science, we examined the extent to which school-related

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science conversations (i.e., conversations about science classes and grades and the importance of science) with family members predicted Latinx adolescents' science ability self-concepts and task values.

School-related science conversations within Latinx families

Research on parent involvement in children's education suggests that parent-adolescent conversations about school and education are stronger, more consistent predictors of adolescents' overall academic functioning among racially/ethnically diverse adolescents compared to home-based (e.g., homework help) and school-based (e.g., school volunteering) involvement (Hill & Tyson, 2009; Suizzo et al., 2016; Wang & Sheikh-Khalil, 2014). These differential relations for educational conversations may be explained by stage-environment fit theory, which posits that socializers' support behaviors must be responsive to students' growing developmental needs for autonomy and competence in adolescence (Eccles et al., 1993). The beginning of high school can introduce new challenges for students (e.g., more advanced, departmentalized curricula) that lead to mismatches with students' developmental needs for autonomy, competence, and relatedness (Benner & Graham, 2009; Benner, 2011; Eccles et al., 1993). This need for socializers to be developmentally responsive may explain why educational conversations are more strongly predictive of adolescents' academic achievement than other types of academic support (e.g., Hill & Tyson, 2009). Educational conversations are theorized to leverage and promote adolescents' growing autonomy and decision-making skills in regard to students' education (Hill & Tyson, 2009; Tenenbaum et al., 2007). Educational conversations are also easily implementable at home and do not typically necessitate help from teachers or other school personnel. Hence, educational conversations are likely to be more accessible to parents and responsive to adolescents' need for autonomy than other types of supports. It is no surprise, then, that intervention work has found that parent-adolescent science-specific conversations are positively associated with adolescents' science utility value in high school (Harackiewicz et al., 2012).

However, the extent to which school-related science conversations are associated with adolescents' academic functioning is understudied among Latinx families. Quantitative research suggests that overall indicators of family support, which include educational conversations among a variety of indicators (e.g., monitoring, help with schoolwork), are positively related to Latinx adolescents' overall academic functioning though it is unclear how much conversations account for these associations (Alfaro et al., 2006; Carranza et al., 2009; Ceballo et al., 2014; Sands & Plunkett, 2005). More research is needed to examine the potential of these conversations in promoting Latinx adolescents' educational success in order to inform the development of effective programs to help Latinx adolescents' science motivation at home while simultaneously considering the role of family cultural values.

The existing research suggests that school-related science conversations may matter for Latinx adolescents, though it has yet to be tested. Qualitative studies find that adolescents' school-related science conversations with parents and older siblings and cousins are one primary strategy families use to support Latinx adolescents (Ramos Carranza & Simpkins, 2021; Soto-Lara & Simpkins, 2020). Additionally, school-related science conversations with adolescents may be especially useful for Latinx parents, who often face linguistic and cultural barriers when interacting with teachers and school personnel (Soto-Lara & Simpkins, 2020). Nevertheless, prior studies have not formally tested the potential effectiveness of school-specific science conversations on Latinx adolescents' science motivational beliefs. To address this gap in the literature, we examined the associations between Latinx family school-related science conversations and adolescents' science ability self-concepts and task values in the current study.

Understanding the role of science support from multiple family members

Complementing situated expectancy-value theory (e.g., Eccles & Wigfield, 2020), a family systems perspective suggests that multiple sources of support within the family contribute to adolescents' positive development (Cox & Paley, 1997). This perspective conceptualizes that family processes transpire within multiple subsystems, including parent-adolescent and sibling-adolescent subsystems, which shape children's development individually and synergistically (Cox & Paley, 1997). Understanding multiple family subsystems for Latinx adolescents' development is important considering the cultural values within Latinx families. For example, familism values, family cohesion, and respect are cultural assets that underscore the importance of family in adolescents' development (Knight et al., 2010; Updegraff et al., 2005). As a result, Latinx familism

values predict higher levels of science support provided by Latinx family members (Puente & Simpkins, 2020; Simpkins et al., 2018). Hence, families are culturally salient sources of strength for the academic development of Latinx adolescents.

Although most studies on Latinx family socialization processes focus on parents' support, some studies focus on the supports of older siblings and cousins. Older siblings and cousins have more symmetrical relationships with adolescents than other adult family members and are often conceptualized together as peer-like family members in prior studies (Johnson et al., 2016; Simpkins et al., 2020). Studies also highlight that older siblings and cousins engage in similar socializing roles with both providing advice and serving as role models for Latinx adolescents' academic development (Aschbacher et al., 2009; Martinez & Castellanos, 2018; Patrón, 2020; Ramos Carranza & Simpkins, 2021). Moreover, the supports older siblings and cousins provide in science and school more broadly predict adolescents' academic and science motivational beliefs (Alfaro & Umana-Taylor, 2010; Puente & Simpkins, 2020; Simpkins et al., 2020).

Prior research suggests that parents and older siblings/cousins may provide complementary support of Latinx adolescents' academic development. Latinx siblings, for example, can take a more prominent role in supporting adolescents' academic development if parents experience barriers to family involvement including linguistic differences, occupational demands, and limited education (Flores et al., 2017; Updegraff et al., 2010). Despite the importance of siblings/cousins, very few studies examine sibling/cousin processes, particularly alongside parent processes. Only focusing on Latinx parents could overlook a critical source of support for Latinx adolescents and underestimate the strengths of Latinx families. Examining the individual contributions of multiple family members on Latinx adolescents' science motivational beliefs can provide a more ecologically valid understanding of adolescent motivational processes within Latinx families. Thus, the present study tested the extent to which adolescents' school-related science conversations with parents and with older siblings/cousins predicted adolescents' science ability self-concepts and task values.

Who initiates school-related science conversations in adolescence?

Another understudied yet potentially informative empirical question is whether the links between school-related science conversations and adolescents' motivational beliefs depend on who primarily initiates these conversations. Studies on shared agency explore the ways in which adolescents and parents variably share the responsibility in attaining adolescents' academic goals (Chang et al., 2010; Kriegbaum et al., 2016). In one case, adolescents and families may share agency in adolescents' academic development, jointly engaging in strategies to achieve academic goals. In other cases, family members can either be less involved, with adolescents having more responsibility for their own education, or more involved, with families directing adolescent's education more than the adolescents' input. Prior studies find that adolescents benefit more academically when they and their families share academic agency than when families are either uninvolved or over-involved (Chang et al., 2010; Kriegbaum et al., 2016). These findings align with stage-environment fit theory positing the benefits of families scaffolding opportunities for adolescents to exercise adolescents' growing academic autonomy (Eccles et al., 1993). Hence, it may be that Latinx adolescents benefit most from school-related science conversations when these conversations are primarily initiated by both adolescents and family members.

In contrast, when adolescents primarily initiate school-related science conversations, it may indicate adolescents' higher familiarity, interest, or engagement with formal science-related topics and classwork compared to their families, or adolescents' desire to steer school-related science conversations with their families (Kriegbaum et al., 2016). As such, this may result in family members' comparatively lower initiation of these school-based science conversations than adolescents. According to the shared agency literature and stage-environment fit theory, however, this scenario may lead to weak or negative associations between family school-related science conversations and motivational beliefs given that students still need to be guided by family socializers in their academic development in adolescence (Chang et al., 2010; Eccles et al., 1993; Kriegbaum et al., 2016).

Predicting the relations between family-initiated school-related science conversations and adolescents' motivational beliefs is less straightforward. On one hand, school-related science conversations that are primarily initiated by family members may be due to adolescents' relatively lower baseline motivation, engagement, and knowledge with science compared to their family members (Kriegbaum et al., 2016). Shared agency literature suggests that adolescents may perceive their family to be too directing or overly involved in this scenario, resulting in lower adolescent

motivational beliefs (Chang et al., 2010; Kriegbaum et al., 2016). On the other hand, scholars argue that educational conversations inherently afford socializers the opportunities to scaffold adolescents' growing academic autonomy (Hill & Tyson, 2009). Hence, family-initiated conversations may signal that families are invested in adolescents' education and are being responsive to adolescents' developmental needs. Couple this with the emphasis on familism, family cohesion, and respect within Latinx families (Knight et al., 2010), adolescents may be more open to and hence benefit from school-related science conversations when initiated by family members and not perceive them as over-controlling at all.

In sum, the shared agency literature provides nuances to the relations between family support and adolescents' academic outcomes. However, extant studies largely focus on White and Asian samples and on general parenting practices, potentially leading scholars to make tenuous assumptions as to whether prior findings apply to culturally different populations like Latinx families and to specific supports like school-related science conversations. The current study fills this gap by examining whether the links between Latinx families' school-related science conversations and adolescents' motivational beliefs are moderated by who primarily initiate these conversations—adolescents or family socializers (i.e., parents and older siblings/cousins).

The current study

The current study examined two research questions. First, to what extent do Latinx adolescents' 9th-grade school-related science conversations with their parents and older siblings/cousins predict their 10th-grade science ability self-concepts and task values? We predicted that parent-adolescent and sibling/cousin-adolescent school-related science conversations would positively predict adolescents' science ability self-concepts and task values. Second, to what extent are these links moderated by who primarily initiated conversations between adolescents and their family members? We predicted stronger associations when both adolescents and family socializers initiate school-related science conversations equally than when these conversations are adolescent-initiated. However, we examined two competing hypotheses for conditions when family members primarily initiate conversations. On one hand, there may be weaker associations for family member-initiated conversations than when conversations are initiated both by family members and adolescents. On the other hand, an alternative hypothesis is that when school-related science conversations are family member-initiated, these associations may be stronger than when conversations are adolescent-initiated and just as strong as when conversations are initiated both by family members and adolescents.

Method

Participants

The current study examined 9th- and 10th-grade data from Latinx families with adolescents attending one of three public high schools in a large metropolitan city in the Southwestern United States. There were 104 families who participated in 9th grade, consisting of triads with adolescents, parents, and older siblings or cousins. About 89% ($n = 93$) of families also participated in 10th grade. Adolescents (~89% Mexican-descent) were 40% female and had a mean age of 14.53 years ($SD = .52$, range = 14–16 years) in 9th grade. Parents had a median education level of a high school diploma and a median annual income between $30,000-$39,999. About 63% of parents were married and 5% had a science-related job requiring a college degree.

About 85% ($n = 88$) of the sibling/cousin sample were siblings and 15% ($n = 16$) were cousins. We recruited older cousins if adolescents were the eldest sibling or did not have any siblings. Participating cousins lived close to, frequently interacted with, and shared a sibling-like relationship with adolescents. Older siblings/cousins had to be at least one grade level above the target adolescents to participate. Siblings/cousins were 50% female and had a mean age of 18.12 years ($SD = 2.44$, range = 15–26 years). About 58% of siblings/cousins were minors in high school, 23% were adults with a high school diploma or below, and 18% were adults who had at least some college education.

The three schools that adolescents attended covered the range of schools in the area. School A (39% Latinx, 30% eligible for free/reduced lunch; $n = 63$) was a higher performing school with 68% of students passing the 9th-grade statewide science exam. By contrast, School B (36% Latinx, 63% eligible for free/reduced lunch; $n = 14$) was a lower-performing, Title I school with 29% of students passing the statewide science exam. Finally, School C (23% Latinx, 17% eligible for free/reduced lunch; $n = 27$) was also a higher performing school with a 63% pass rate on the statewide science exam. The schools had a sizable Latinx student body, required students to pass three years of science courses to graduate, and were not specifically STEM-oriented.

Procedures

In 9th (2012–2013) and 10th grades (2013–2014), adolescents, parents, and older siblings/cousins separately completed surveys with a team of trained interviewers. Most participants completed the surveys at home, with about 20% of families visiting the university or a local library to complete the surveys. One adolescent, three siblings/cousins, and 59 parents completed surveys in Spanish; everyone else completed surveys in English. Researchers used forward-translation and panel method approaches to translate the questionnaires from English to Spanish (Knight et al., 2009). Each participant received $50 for each year of participation due to the extensive procedures of the larger research project (i.e., surveys, interviews, and videotaped activities over several visits). All procedures performed were IRB-approved, and researchers obtained informed consent or assent from each participant.

Measures

We list all survey items for each scale in Table S1 of the appendix.

Parents' and siblings'/cousins' school-related science conversations with adolescent

In 9th grade, parents and siblings/cousins each answered four items about how often within the past year each engaged in school-related science conversations with the focal adolescents (e.g., 'Talked with [Adolescent] about [his/her] science schoolwork', 'Talked with [Adolescent] about the importance of science'; 1 = *Never*, 5 = *Always*). We adapted this scale from the National Educational Longitudinal Study of 1988 (NELS:88; Prindle & Rasinski, 1989) by making the items science-specific. The original scale has shown predictive validity on academic achievement among the Mexican-American adolescent sample of NELS:88 (Keith & Lichtman, 1992). The four items in the current study showed high internal consistency and loaded into one factor in confirmatory factor analyses (CFAs) for parents ($\alpha = .79$, CFA loadings = .57–.85, χ^2 (26) = 27.42, $p = .387$, RMSEA = .02 [.00; .08], CFI/TLI = .995/.993) and for siblings/cousins ($\alpha = .77$, CFA loadings = .50–.78, χ^2 (25) = 40.45, $p = .026$, RMSEA = .077 [.03; .12], CFI/TLI = .947/.923). To accommodate the data's modest sample size, we created two mean-composite variables indicating adolescents' school-related science conversations with parents (which was the average of the four parent items) and, separately, school-related science conversations with siblings/cousins (which was the average of the four sibling/cousin items).

In the survey, each conversation item noted above was followed by a question about who primarily initiated conversations with adolescents (e.g., 'Who usually starts a conversation about [his/her] science schoolwork?' and 'Who usually starts a conversation about the importance of science?'). The scales for these conversation items ranged from 1 = *Teen*, 3 = *Both*, to 5 = *You* (i.e., parent or sibling/cousin). We created two mean-composite variables of conversation initiators by averaging across the four items for parents ($\alpha = .67$) and, separately, averaging across the four items for siblings/cousins ($\alpha = .70$). Higher scores indicated that family members initiated conversations more frequently than adolescents, whereas lower scores indicated that adolescents initiated conversations more than family members.

Adolescent's science motivational beliefs

In 9th and 10th grades, adolescents reported their science ability self-concepts and task values (Eccles et al., 1993; Jacobs et al., 2002). Adolescents' science ability self-concepts included four items for each of the three central science subjects in high school: biology, chemistry, and physics (12 total items; 9th grade: $\alpha = .93$, 10th grade: $\alpha = .92$; e.g., 'How good at [biology/chemistry/physics] are you?'; 1 = *Not at all*, 7 = *Very*). Adolescents' science task values included five items for each of these subjects (15 total items; 9th grade: $\alpha = .94$, 10th grade: $\alpha = .96$; e.g., 'How much do you like [biology/chemistry/physics]?'; 1 = *A little*, 7 = *A lot*). CFAs supported two factors for adolescents' 9th-grade science ability self-concepts and task values across the three science domains based on excellent model fit, χ^2 (5) = 1.88, $p = .857$, RMSEA = .00 [.00; .07], CFI/TLI = 1.00/1.03, and significant factor loadings (ability self-concepts: .58–.82; task values: .76–.89). Results for 10th-grade science self-concepts and task values were similar in terms of model fit, χ^2 (5) = 5.24, $p = .388$, RMSEA = .02 [.00; .15], CFI/TLI = .999/.998, and significant factor loadings (ability self-concepts: .56–.93; task values: .82–.91). In prior studies, these scales have demonstrated convergent, face, and discriminant validity (Jacobs et al. 2002; Simpkins et al., 2015a) and strong measurement invariance among 9th-grade Latinx- and European-American girls and boys (Simpkins et al., 2015b). We created four separate mean-composite variables for adolescents' science ability self-concepts and task values at 9th and 10th grades.

Covariates

We included several covariates given their links to the focal variables (Funk & Parker, 2018; Hazari et al., 2013; Simpkins et al., 2015a). We created binary variables for adolescent-reported gender (1 = *Girl*, 0 = *Boy*) and for Schools B and C with School A as the reference group. We included parents' education ($M = 2.82$, SD = 1.48, range: 1 = *Less than high school*, 6 = *Graduate degree or beyond*) and marital status (1 = *Married*, 0 = *Not married)* as covariates in the parent models. We included a binary variable indicating whether siblings/cousins were still in high school as a covariate in the sibling/cousin models. To examine the unique links between school-related science conversations and adolescents' science motivational beliefs, we also controlled for general academic conversations between adolescents and family members. Five items assessed conversations about general academic topics (parents: $\alpha = .76$; siblings/cousins: $\alpha = .77$; e.g., 'Talked with [Adolescent] about college or other schools after high school'; 1 = *Never*, 5 = *Always*; Keith & Lichtman, 1992; Prindle & Rasinski, 1989). CFAs indicated these items significantly loaded into one factor for parents (CFA loadings = .53–.68, χ^2 (26) = 27.42, $p = .387$, RMSEA = .02 [.00; .08], CFI/TLI = .995/.993) and sibling/cousins (CFA loadings = .48–.71, χ^2 (25) = 40.45, $p = .026$, RMSEA = .077 [.03; .12], CFI/TLI = .947/.923). We created two mean-composite variables indicating adolescents' academic conversations with parents and with siblings/cousins.

Plan of analysis

Given the modest sample size of the current study, we addressed issues of power in several ways. First, a priori power analysis conducted by the third author confirmed that a sample of 104 cases provided sufficient power of .80 to detect moderate effects at $p < .05$ with 10 predictors and moderation in two-way interactions (Cohen et al., 2003). Second, along with statistical significance, we also focused on the effect sizes of the associations to examine the practical significance of effects.

Our first research aim examined the extent to which 9th-grade school-related science conversations positively predicted adolescents' 10th-grade science ability self-concepts and task values. We estimated, in total, four path models in Stata 14.2 in order to avoid issues of multicollinearity; there were two models for each of the two motivational belief outcomes (i.e., science ability self-concepts and task values) – two path models included parent predictors and two path models included sibling/cousin predictors (Cohen et al., 2003; Keith, 2015). The parent models included parent-reported school-related science conversations and conversation initiator as the two main predictors, as well as parent-adolescent general academic conversations and parent-specific demographic characteristics (i.e., parent education and marital status). The sibling/cousin models included sibling-reported school-related science conversations and science conversation initiator as the two main predictors, along with sibling-adolescent general academic conversations and a dummy code indicating whether siblings/cousins were still in high school as covariates. We also added adolescents' 9th-grade science ability self-concepts and task values in their respective path models to account for the continuity of motivational beliefs across time. In addition, every model included binary indicators for adolescents' gender, as well as for Schools B and C (reference: School A) in order to estimate within-school variation and parse out between-school variation in our models (O'Dwyer & Parker, 2014).

Our second research aim was to examine the extent to which the links between school-related science conversations and adolescents' science motivational beliefs depended on who primarily initiated the school-related science conversations. We added the interaction between school-related science conversations and the conversation initiator to each model from our first hypothesis. We mean-centered all continuous predictors prior to creating the interaction terms to avoid multicollinearity issues and to ease the interpretability of results (Cohen et al., 2003). Then, we conducted simple slopes analyses to further test if the relations between school-related science conversations and motivational beliefs were significant for different levels of conversation initiators. Following Preacher et al. (2006), we estimated simple slopes at −1.0 standard deviations (SDs) *below* the mean, indicating adolescents primarily initiated conversations; at the mean, indicating both adolescents and socializers equally initiated conversations; and at +1.0 SDs *above* the mean, indicating socializers primarily initiated conversations (see http://quantpsy.org/interact/mlr2.htm).

We conducted a robustness check in order to parse out the specific role of older siblings' school-related science conversations with adolescents from those of older cousins. We first examined group mean differences in the study variables between the sibling ($n = 88$) and cousin ($n = 16$) participants and then reanalyzed the path models using only the sibling sample.

Table 1. Descriptive and correlational statistics of study variables.

	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1.	P-A science conversations	3.16	.86	—										
2.	P-A conversation initiator[a]	3.32	1.17	-.08	—									
3.	S/C-A science conversations	2.74	.83	.24*	-.18†	—								
4.	S/C-A conversation initiator[a]	3.14	1.16	.08	.01	.27**	—							
5.	10th-grade science self-concept	4.40	.82	.19†	-.15	.09	-.04	—						
6.	10th-grade science task value	4.62	1.11	.02	-.13	.13	-.11	.62***	—					
7.	9th-grade science self-concept	4.29	.92	.12	-.22*	.01	-.19*	.61***	.32**	—				
8.	9th-grade science task value	4.72	.98	-.01	-.14	.09	-.04	.41***	.67***	.58***	—			
9.	P-A academic conversations	3.17	.81	.57***	-.05	.21*	.08	.08	-.04	.08	.02	—		
10.	S/C-A academic conversations	3.04	.82	.25**	-.12	.59***	.07	.05	.17	-.09	-.03	.20*	—	
11.	Parent education	2.82	1.48	-.03	.21*	-.09	-.05	.19†	-.10	.09	-.12	.17†	-.04	—

Note. P-A = parent-adolescent. S/C-Y = older sibling/cousin-adolescent.
[a]Range is 1 = adolescent initiates, 3 = Both adolescent and socializer initiate equally, 5 = socializer initiates.
†$p < 0.10$. *$p < 0.05$.**$p < 0.01$. ***$p < 0.001$.

Results

Missing data analysis

We conducted missing data analyses to examine whether study variables explained missingness. About 89% of families participated in both waves. Adolescents with missing data at 10th grade ($n = 11$) had siblings/cousins who were more likely to have some college education or above (χ^2 [1] = 16.73, $p < .001$, Cramér's $V = .40$) and had siblings/cousins who were less likely to initiate school-related science conversations with adolescents (t[102] = −2.02, $p = .046$, Cohen's $d = -.64$) compared to those with complete data. However, adolescents with and without missing data did not differ on several indicators, including adolescent gender (χ^2 [1] = .13, $p = .717$, Cramér's $V = .04$), adolescents' 9th-grade science motivation (t's[101] = −.17–.84, $p = .398$–.863, Cohen's d's = −.05–.28), conversations with parents or siblings/cousins (t's[102] = −1.31– −.20, $p = .194$–.845, Cohen's d's = −.41– −.06), parents' reports of science conversation initiator (t[102] = −.67, $p = .505$, Cohen's $d = -.21$), parents' education (t[102] = .01, $p = .993$, Cohen's $d = .003$), parents' marital status (χ^2 [1] = 1.52, $p = .217$, Cramér's $V = -.12$), and schools (χ^2 [2] = .20, $p = .904$, Cramér's $V = .04$). To account for the few sample differences, we estimated the path models using full information maximum likelihood (Enders, 2010).

Descriptive statistics

We present descriptive statistics for the study variables in Table 1. On average, parents and siblings/cousins 'sometimes' engaged in school-related science conversations with adolescents (parents: $M = 3.16$, $SD = .86$, siblings/cousins: $M = 2.74$, $SD = .83$). Parents and sibling/cousins also reported that they and adolescents equally initiated school-related science conversations on average (parents: $M = 3.32$, $SD = 1.17$, siblings/cousins: $M = 3.14$, $SD = 1.16$). In 9th grade, adolescents reported moderate levels of science ability self-concepts ($M = 4.29$, $SD = .92$) and task values ($M = 4.72$, $SD = .98$). In 10th grade, adolescents reported similar levels of science ability self-concepts ($M = 4.40$, $SD = .82$) and task values ($M = 4.62$, $SD = 1.11$). Compared to cousins, siblings engaged in more conversations with adolescents (siblings: $M = 2.83$, $SD = .09$, cousins: $M = 2.25$, $SD = .19$; Cohen's $d = .72$). Due to this difference, we added a binary variable indicating the relationship of the siblings/cousins to adolescents (1 = sibling, 0 = cousin) in our sibling/cousin models. Lastly, adolescents' science ability self-concepts and task values were positively correlated with each other across grades (r's = .32–.67, p's < .001).

Associations between school-related science conversations and motivational beliefs

All path models tested were just-identified and perfectly fit the data, χ^2 (0) = 0.00, RMSEA [90% CI] = 0.00 [0.00–0.00], CFI/TLI = 1.00/1.00. Table 2 shows the results for parent-adolescent school-related science conversations. The predictors in these models explained 44% and 51% of the variances in adolescents' 10th-grade science ability self-concepts and task values, respectively. In line with our hypothesis, the relation between parent-adolescent school-related science conversations and ability self-concepts was small and significant (ß = .20, $SE = .09$, $p = .040$). Adolescents who engaged in more parent-adolescent school-related science conversations in 9th grade had higher science ability self-concepts in 10th grade than their peers who engaged in fewer parent-adolescent school-related science conversations. Contrary to our hypothesis, however, we found a nonsignificant association between parent-adolescent school-related science conversations and adolescents' 10th-grade science task values (ß = .14, $SE = .12$, $p = .121$).

Results for sibling/cousin-adolescent school-related science conversations are shown in Table 3.

Table 2. Associations between 9th-grade parent-adolescent school-related science conversations and adolescents' 10th-grade science motivational beliefs.

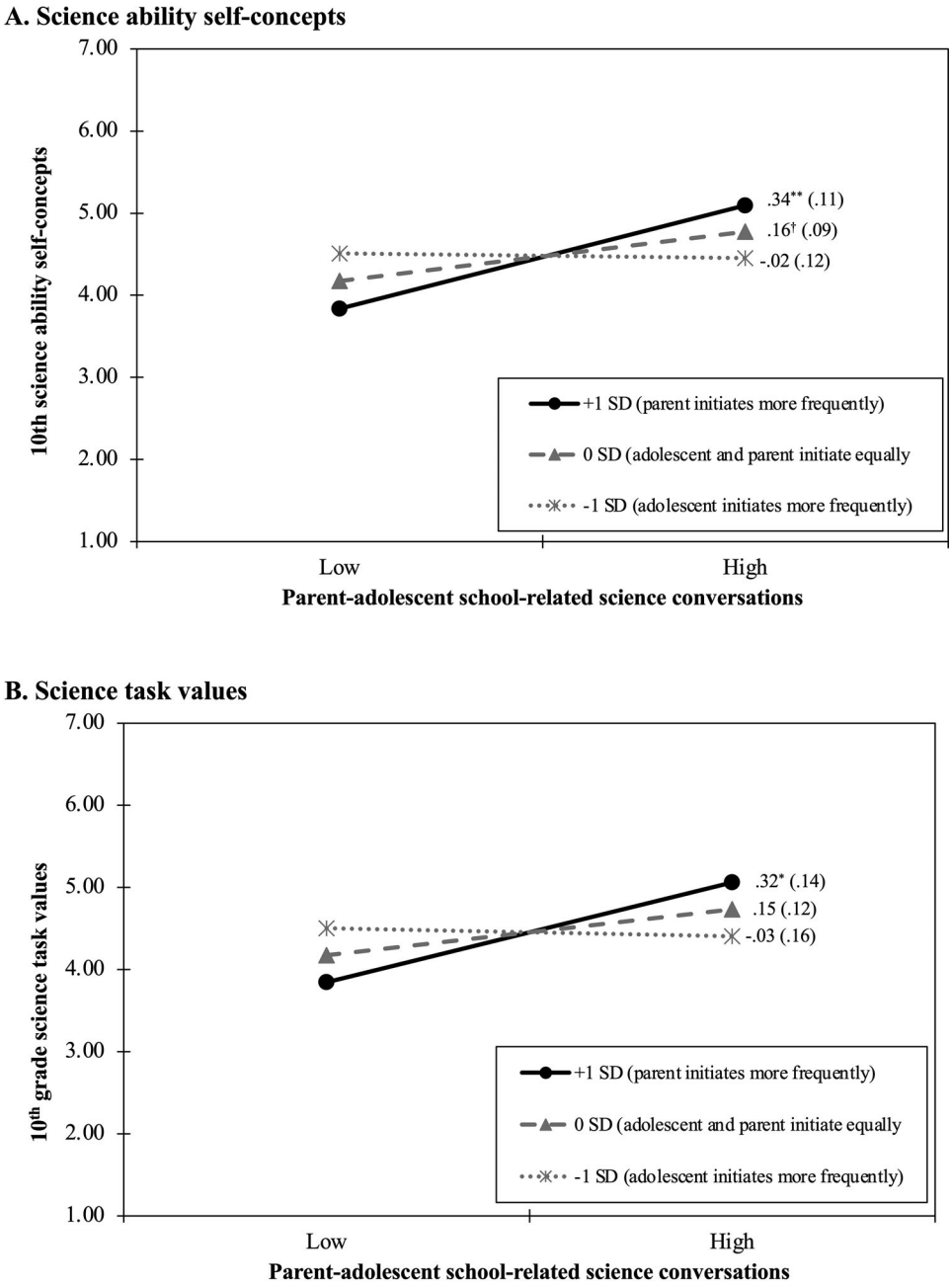
	10th-grade science ability self-concept		10th-grade science task value	
Predictors	Main ß (SE)	Interaction ß (SE)	Main ß (SE)	Interaction ß (SE)
P-A science conversations	0.20*	0.17†	0.14	0.11
	(0.09)	(0.09)	(0.12)	(0.12)
P-A conversation initiator	−0.04	−0.00	−0.02	0.00
	(0.06)	(0.06)	(0.07)	(0.07)
Science conversations × conversation initiator		0.20**		0.15*
		(0.06)		(0.07)
9th-grade science self-concept	0.59***	0.58***		
	(0.08)	(0.08)		
9th-grade science task value			0.67***	0.64***
			(0.09)	(0.09)
P-A academic conversations	−0.12	−0.11	−0.17†	−0.16†
	(0.10)	(0.10)	(0.13)	(0.13)
Adolescent is a girl	−0.10	−0.07	−0.08	−0.06
	(0.14)	(0.14)	(0.18)	(0.18)
Parent education	0.12	0.13	−0.01	−0.01
	(0.05)	(0.05)	(0.06)	(0.06)
Parent is married	0.00	0.02	0.11	0.12†
	(0.14)	(0.13)	(0.17)	(0.17)
School B	−0.05	−0.06	0.02	0.02
	(0.20)	(0.19)	(0.26)	(0.25)
School C	−0.03	−0.03	0.02	0.02
	(0.17)	(0.16)	(0.21)	(0.21)
Observations	104	104	104	104
r^2	0.44	0.48	0.51	0.53

Note. Standardized coefficients presented. P-A = Parent-adolescent. Conversation initiator is a mean-centered, continuous variable indicating the extent to which P-A science conversations were primarily started by the adolescent (−2 to −1), both the adolescent and parent (0), or the parent (+1 to +2).
†$p < 0.10$. *$p < 0.05$.**$p < 0.01$. ***$p < 0.001$.

Table 3. Associations between 9th-grade sibling/cousin-adolescent school-related science conversations and adolescents' 10th-grade science motivational beliefs.

	10th-grade science ability self-concept		*10th-grade science task value*	
Predictors	*Main* ß (SE)	*Interaction* ß (SE)	*Main* ß (SE)	*Interaction* ß (SE)
S/C-A science conversations	0.05	0.05	−0.03	−0.03
	(0.10)	(0.10)	(0.13)	(0.13)
S/C-A conversation initiator	0.06	0.08	−0.13†	−0.12
	(0.06)	(0.06)	(0.07)	(0.07)
Science conversations × conversation initiator		0.15*		0.10
		(0.08)		(0.10)
9th-grade science self-concept	0.67***	0.66***		
	(0.08)	(0.08)		
9th-grade science task value			0.68***	0.68***
			(0.09)	(0.08)
S/C-A academic conversations	0.08	0.08	0.22*	0.22*
	(0.10)	(0.10)	(0.13)	(0.13)
Adolescent is a girl	−0.16†	−0.16*	−0.08	−0.08
	(0.14)	(0.14)	(0.18)	(0.18)
Sibling is in high school	−0.14	−0.14	−0.04	−0.04
	(0.15)	(0.15)	(0.18)	(0.18)
Reporter is a sibling	−0.01	0.00	0.07	0.07
	(0.19)	(0.18)	(0.23)	(0.23)
School B	−0.06	−0.07	−0.01	−0.01
	(0.20)	(0.20)	(0.25)	(0.25)
School C	0.01	0.05	−0.04	−0.01
	(0.17)	(0.17)	(0.21)	(0.21)
Observations	104	104	104	104
r^2	0.47	0.50	0.55	0.56

Note. Standardized coefficients presented. S/C-A = sibling/cousin-adolescent. DV = dependent variable. Conversation initiator (mean-centered) is the extent to which S/C-A science conversations were primarily started by the adolescent (-2 to -1), both the adolescent and sibling/cousin (0), or the sibling/cousin (+1 to +2).
†$p < 0.10$. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.



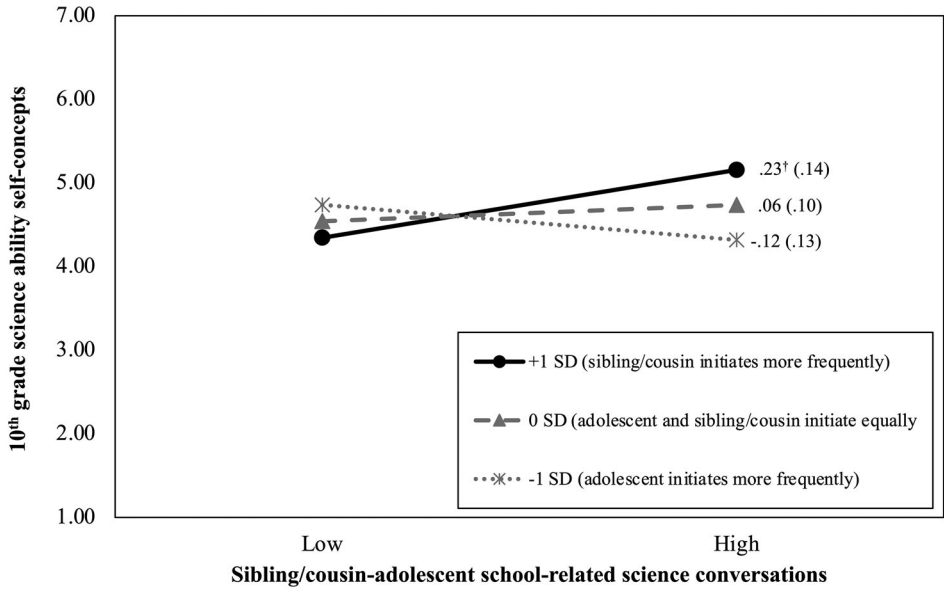
†$p < .10$. * $p < .05$. ** $p < .01$.

Figure 1. Results of simple slopes analyses for the interaction between parent-adolescent school-related science conversations and conversation initiator on adolescents' 10th-grade motivational beliefs.

Predictors in these models explained 47% and 55% of the variation in 10th-grade science ability self-concepts and task values, respectively. Overall, we did not find support for the hypothesis that 9th-grade sibling/cousin-adolescent school-related science conversations would predict adolescents' 10th-grade science ability self-concepts (ß = .05, $SE = .10$, $p = .642$) or task values (ß = −.03, $SE = .13$, $p = .717$; Table 3).

Moderating role of the initiator of school-related science conversations

Our second hypothesis posed that the relations between school-related science conversations and adolescents' science motivational beliefs would be stronger if both adolescents and family members equally initiated conversations than if adolescents primarily initiated conversations or if family members initiated



†$p < 0.10$.

Figure 2. Results of simple slopes analyses for the interaction between sibling/cousin-adolescent school-related science conversations and conversation initiator on adolescents' 10th-grade motivational beliefs.

conversations. However, we also examined the alternative hypothesis that relations between school-related science conversations and adolescents' science motivational beliefs would be stronger if family members primarily initiated conversations as well. Predictors in the parent models explained 48% and 53% of the variance in adolescents' 10th-grade science ability self-concepts and task values, respectively. Likewise, predictors in the sibling/cousin models accounted for 50% and 56% of the variation in science ability self-concepts and task values, respectively.

We found significant interactions between parent-adolescent school-related science conversations and conversation initiator in predicting adolescents' 10th-grade science ability self-concepts (ß = .20, *SE* = .06, *p* = .008) and task values (ß = .15, *SE* = .07, *p* = .046; Table 2). In line with our alternative hypothesis, there was a significant relation between parent-adolescent school-related science conversations and science ability self-concepts (B = .34, *SE* = .11, *p* = .002) and task values (B = .32, *SE* = .14, *p* = .020) at levels of the conversation initiator where parents primarily initiated conversations (see Figure 1A). The relation between parent-adolescent conversations and science ability self-concepts was also positive at the trend level at levels where both adolescents and parents initiated conversations (B = .16, *SE* = .09, *p* = .084). The relations between parent-youth school-related science conversations and science motivational beliefs were not statistically significant at levels where adolescents initiated conversations.

We also found partial but weaker support for our alternative hypothesis in the sibling/cousin models. We found a small, significant interaction between sibling/cousin-adolescent school-related science conversations and conversation initiator in predicting adolescents' 10th-grade science ability self-concepts (ß = .15, *SE* = .08, *p* = .045; Table 3). At levels where siblings/cousins initiated school-related science conversations, the relation between school-related science conversations and science ability self-concepts was positive at the trend level (B = .23, *SE* = .14, *p* = .093; see Figure 2). These relations were not statistically significant, however, at levels where both siblings/cousins and adolescents equally initiated or where only adolescents initiated conversations. Further, we did not find a significant interaction between sibling/cousin-adolescent school-related science conversations and science conversation initiator in predicting adolescents' 10th-grade science task values (ß = .10, *SE* = .10, *p* = .153).

Robustness checks utilizing only data from the older siblings largely replicated results in the main sibling/cousin models (see Table S2 and Figure S1 of the Appendix). Notably, there was a significant interaction between sibling-youth school-related science conversations and conversation initiator (ß = .18, *SE* = .09, *p* = .025) in predicting 10th-grade ability self-concepts. In line with our alternative hypothesis, at levels where siblings initiated school-related science conversations, the association between sibling-adolescent school-related science conversations and science ability self-concepts was positive at the trend level

(B = .29, *SE* = .16, *p* = .070; see Figure S1). These links were not statistically significant at levels where both siblings and adolescents equally initiated or where adolescents initiated school-related science conversations.

Discussion

Families are key sources of support in the academic development of Latinx adolescents (Carranza et al., 2009; Ceballo et al., 2014; Simpkins et al., 2015b, 2018), a population that is significantly underrepresented in science (NSF, 2019). One of the most salient forms of Latinx family support is school-related science conversations that communicate the importance of science classes for Latinx adolescents (Soto-Lara & Simpkins, 2020). In the current study, we hypothesized that 9th-grade adolescents' school-related science conversations with their parents and older siblings/cousins would positively predict their 10th-grade science ability self-concepts and task values. We also tested the extent to which these links were moderated by who primarily initiated school-related science conversations.

School-related science conversations and Latinx adolescents' science motivation

One key contribution of the current study is testing the relations between the frequency of family school-related science conversations and Latinx adolescents' science motivational beliefs. Extant studies on situated expectancy-value theory typically examine family supports holistically using overall measures of multiple support behaviors in a domain instead of specific behaviors, like family conversations (e.g., Eccles, 1993; Simpkins et al., 2015a). Likewise, studies specifically focused on family educational conversations typically examine adolescents' general academic achievement and not domain-specific motivational beliefs (e.g., Hill & Tyson, 2009). The current study integrated these literatures in order to test the specific utility of family school-related science conversations to promote adolescents' science motivational beliefs in high school. Examining these links is especially important given prior studies have found that educational conversations are a primary supportive behavior that Latinx families implement in adolescence (e.g., Soto-Lara & Simpkins, 2020; Ramos Carranza & Simpkins, 2021).

Our findings indicated that more 9th-grade school-related science conversations between Latinx adolescents and parents significantly predicted higher 10th-grade science self-concepts, but not task values. Though these effects were small in size (ß = .20 and ß = .15 for ability self-concepts and task values, respectively), they are comparable to similar studies with larger sample sizes (e.g., Harackiewicz et al., 2012; Simpkins et al., 2015b, 2018). Moreover, the current models were conservative as we controlled for adolescents' prior motivational beliefs. Hence, although the relation between parent-adolescent school-related science conversations and adolescents' science task values was not statistically significant, its effect size were comparable to the effects in other studies, indicating their practical significance.

One strength of the current study is our examination of multiple sources of school-related science conversations within Latinx families. Family systems theory suggests multiple family members socialize adolescents' development (Cox & Paley, 1997). As such, one theoretical implication of the current study is for scholars to delineate the roles of multiple family subsystems (i.e., parent-adolescent, sibling/cousin-adolescent) more explicitly within models of family socialization and adolescent motivation like the situated expectancy-value theory, which largely focus on parent influences (Eccles, 1993). Integrating these perspectives into one conceptual model may explain in clearer terms the ways in which the supports of multiple family members individually and jointly contribute to adolescents' domain-specific motivational beliefs.

Contrary to our hypotheses, we did not find significant main effects for the relations between adolescents' school-related science conversations with their older siblings/cousins and their science ability self-concept or task value. The relatively weak effect sizes compared to prior studies (e.g., Alfaro et al., 2007; Simpkins et al., 2020) also indicate that these relations were not practically significant. One likely explanation for these nonsignificant main effects is that sibling/cousin effects may depend on the presence of other factors salient to family interactions and processes. For example, Puente and Simpkins (2020) found significant relations between older sibling/cousin science supports and science task values specifically when siblings held higher familism values. Hence, unlike Latinx parents, school-related science conversations between Latinx adolescents and siblings/cousins may only benefit adolescents' science motivational beliefs under certain conditions. Beyond familism values, the current study found that relations with adolescents' motivational beliefs depended on who initiated these conversations, which we discuss next.

Adolescent- and family member-initiated school related science conversations

Another contribution of the study is examining the extent to which the links between school-related science conversations and adolescents' science motivational beliefs were moderated by who primarily initiated these conversations. Extant studies on family socialization and parental involvement typically only focus on how often socializers engage in supportive behaviors (e.g., Jacobs & Eccles, 2000; Hill & Tyson, 2009; Puente & Simpkins, 2020; Simpkins et al., 2015b, 2020). However, the literature on shared agency suggests that the primary facilitator of academic supports between adolescents and their socializers makes a difference for youths' academic achievement (Chang et al., 2010). In the current study, we found the positive associations between school-related science conversations and adolescents' science motivational beliefs were strongest when parents and siblings/cousins initiated conversations.

Contrary to our hypothesis, however, we found largely trend-level or nonsignificant associations between school-related science conversations and adolescents' science motivational beliefs when adolescents and family members equally initiated conversations. These results may be surprising based on a shared agency perspective, which posits that students benefit more academically when parents and adolescents share responsibility over adolescents' educational goals than when the onus is on parents or adolescents alone (Chang et al., 2010; Kriegbaum et al., 2016). These discrepant findings may be caused by lower power attributed to the study's relatively modest sample size, as some of the effect sizes are also sizeable enough to be significant in larger studies (e.g., Simpkins et al., 2015b, 2018). However, these weaker findings may also be due to the operational differences between the current study and prior research. Shared agency studies examine family supports broadly as the extent to which students' academic development is shared between the student and their parents (Chang et al., 2010; Kriegbaum et al., 2016). In contrast, the current study specifically measured the frequency of family school-related science conversations and who primarily initiates these conversations.

The latter distinction is important, as school-related science conversations are theorized as an autonomy-supporting behavior that leverages adolescents' developing decision-making skills (Hill & Tyson, 2009). The school-related science conversations measure in the current study was focused on family members keeping abreast of adolescents' science schoolwork, discussing science grades, and the importance of science domains. Hence, one interpretation of the results is that school-related science conversations may not be perceived as overly controlling by Latinx adolescents, as adolescents benefited motivationally when parents and, to a lesser extent, siblings/cousins initiated these conversations. From a stage-environment fit perspective, then, this form of family science support may provide adolescents the opportunities to fulfill their growing needs for autonomy, thereby helping sustain their academic motivation (Eccles et al., 1993). As such, family-initiated school-related science conversations may exemplify Latinx families' desire to support adolescents' academic development and the recognition of adolescents' burgeoning autonomy.

The current results also illustrate that family school-related science conversations may not be sufficient to promote motivational beliefs if adolescents are the ones primarily initiating these conversations. Adolescents may initiate school-related science conversations for a variety of possible reasons, such as if their families are less familiar with science topics, if they have a higher science interest or engagement than their families, or if they want to be in control of school-related conversations with their families (Kriegbaum et al., 2016). Whatever these reasons may be, stage-environment fit theory and shared agency literature suggest that adolescent-initiated science conversation may not be optimal, as adolescents still need support from socializers and need to feel that family members are invested in and actively supporting their education (Chang et al., 2010; Eccles et al., 1993). Hence, although adolescence is a period when individuals increasingly seek opportunities to exercise their growing autonomy and competence, it is still important for families to be involved by regularly facilitating autonomy-supportive behaviors like educational conversations (Eccles et al., 1993; Hill & Tyson, 2009).

One practical implication of these findings is the importance of parents and siblings/cousins to proactively initiate educational conversations with adolescents in order to help sustain their academic motivation over time. That is, it may not be beneficial for family members to wait for adolescents to seek support. However, such an assertion may likely be specific only to autonomy-supporting behaviors like school-related science conversations. Our study findings may not replicate for other behaviors like homework help or direct instruction, as they are conceptualized as more facilitative and can risk impeding on adolescents' growing need for academic autonomy (see Hill et al., 2018 for discussion).

Nevertheless, a key theoretical and empirical implication is for researchers to develop hypotheses on which specific family supports warrant the family members' initiation, adolescents' invitation, or a mix of both.

Limitations and future directions

Although the current study sheds light on the utility of Latinx families' school-related science conversations, there are caveats and limitations that future research should address. First, most of the science conversation items used in the current study focused on adolescents' science classes. In the current study, we focused on school-related science conversations within families given that school is a primary context for adolescents' learning and motivational development in science and families likely play a role in supporting this development. Hence, family science conversations beyond adolescents' experiences in classes, such as conversations about science current events or about potential future science pursuits, are beyond the scope of the results (Hill & Tyson, 2009). It should be noted, however, that the one item that did not explicitly focus on science classes (i.e., "Talked with [Adolescent] about the importance of science") loaded well with other science conversation items and jointly contributed to the relations found. Still, future work should capture a more comprehensive array of family science conversations. Beyond the frequency of science conversations, future work should also test the extent to which the quality of conversations predicts adolescents' science motivational beliefs.

Second, the relatively modest sample size of the present study may have led to issues of power and precluded the detection of otherwise significant effects in some of the focal processes under investigation. We addressed this limitation in several ways. We conducted a priori power analyses and confirmed that our analyses had sufficient power to detect effects, as well as interpreted our findings in terms of relative effect sizes to evaluate the practical significance of our results. Still, our findings would benefit from conceptual replication using a larger sample of Latinx families in order to avoid power issues and to utilize more complex statistical techniques.

Finally, the current study examined socialization processes for parents and siblings/cousins separately. However, family socialization and family systems perspectives posit that multiple family subsystems influence adolescent development individually and synergistically (Cox & Paley, 1997; Simpkins et al., 2020). As such, one empirical question is to examine how Latinx adolescents differentially engage in school-related science conversations with multiple family members. Using a typological approach that uncovers multiple patterns of family school-related science conversations would complement the current study's findings by providing a more holistic picture of school-related science conversations within the entire family system. Beyond the family, however, prior studies have also highlighted the role of peers and teachers in the motivational development of Latinx adolescents (e.g., Simpkins et al., 2020). Hence, future work should examine the associations between adolescents' school-related science conversations with these non-family socializers and Latinx adolescents' motivational beliefs.

Conclusion

The current study highlighted the potentially important role of family-based school-related science conversations for Latinx adolescent science motivational beliefs. By examining these processes, the current study sheds light into one way Latinx families are a source of strength and can promote adolescents' science motivation despite barriers youth and their families face within science. In sum, these findings point to the need for educators to focus on empowering Latinx families to more frequently initiate school-related science conversations at home in order to foster adolescents' motivational beliefs in science.

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Data availability statement

Data available upon reasonable request from the authors.

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