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Rebecca Lazarides
Universität Potsdam

Charlott Rubach
Universität Potsdam

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Adolescents' Perceptions of Socializers' Beliefs, Career-Related Conversations, and Motivation in Mathematics

Rebecca Lazarides[1], Charlott Rubach[1] & Angela Ittel[2]

[1]Universität Potsdam, Germany

[2]Technische Universität Berlin, Germany

Author Note

Please direct correspondence to: Rebecca Lazarides, Department of Education, Universität Potsdam, Karl-Liebknecht Straße 24-25, 14476 Potsdam, Germany, telephone: +49 (0) 331 977 2132; fax: +49 (0) 331 977 2067, rebecca.lazarides@uni-potsdam.de.

Abstract

Research based on the Eccles model of parent socialization demonstrated that parents are an important source of value and ability information for their children. Little is known, however, about the bidirectional effects between students' perceptions of their parents' beliefs and behaviors and the students' own domain-specific values. This study analyzed how students' perceptions of parents' beliefs and behaviors and students' mathematics values and mathematics-related career plans affect each other bidirectionally, and analyzed the role of students' gender as a moderator of these relations. Data from 475 students in 11^{th} and 12^{th} grade (girls: 50.3%; 31 classrooms; 12 schools), who participated in two waves of the study, were analyzed. Results of longitudinal structural equation models demonstrated that students' perceptions of their parents' mathematics value beliefs at Time 1 affected the students' own mathematics utility value at Time 2. Bidirectional effects were not shown in the full sample but were identified for boys. The paths within the tested model varied for boys and girls. For example, boys', not girls', mathematics intrinsic value predicted their reported conversations with their fathers about future occupational plans. Boys', not girls', perceived parents' mathematics value predicted the mathematics utility value. Findings are discussed in relation to their implications for parents and teachers, as well as in relation to gendered motivational processes.

Keywords: parents' beliefs, parent–child conversations, task value, mathematics, gender, bidirectional effects

Adolescents' Perceptions of Socializers' Beliefs, Career-Related Conversations, and Motivation in Mathematics

Research based on the Eccles model of parent socialization (Eccles, 1993; Eccles et al., 1983) has shown, that parents are an important source of information for their children regarding value and ability. Parents communicate their beliefs to their children through conversations, activities, and/or the provision of materials and tasks (Jacobs & Bleeker, 2004; Simpkins, Fredricks, & Eccles, 2012; Tenenbaum & Leaper, 2003), thus influencing their children's motivation, which, in turn, affects their career plans (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Simpkins et al., 2012; Simpkins, Fredricks, & Eccles, 2015). Research has shown that parents are a central source of academic support for their children during the early high school years (Demaray & Malecki, 2002; Ferry, Fouad, & Smith, 2000; Frome & Eccles, 1998; Gniewosz, Eccles, & Noack, 2012; Simpkins et al., 2015; Wilkins & Ma, 2003) and that this support continues into late adolescence, when students face the transition from high school to university or the workplace (Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Perez-Felkner, McDonald, & Schneider, 2014).

Given that socialization can be seen as a dynamic process, in which both parents and children participate actively, scholars have emphasized the need to consider the bidirectionality of parent–child interaction (Bell, 1968; Lerner & Spanier, 1978). However, only a few longitudinal studies have examined the bidirectional effects of parents' beliefs/behaviors and students' motivation (Dumont, Trautwein, Nagy, & Nagengast, 2014; Simpkins et al., 2015). This longitudinal study addresses the gap in the existing research and contributes to the field by examining the bidirectional relations between students' perceptions of parents' beliefs regarding the value of mathematics, student-reported frequency of parent–child conversations, and students' mathematics task values and mathematics-related career plans during late adolescence. As it has been emphasized that socialization processes operate through individuals' perceptions of others' beliefs and behaviors (Bandura, 1977; Eccles et al., 1983; Gniewosz & Noack, 2012), this study focuses on students' perceptions of their parents. Given that socialization processes are shaped by cultural and social gender norms (Eccles, Jacobs, & Harold, 1990; Schoon & Eccles, 2014; Watt & Eccles, 2008), this study can be seen as broadening existing research by analyzing the role of students' gender as a moderator within these relationships.

Student Perceptions of Parents' Beliefs, Parent–Child Conversations, Task Values, and Choice Behaviors

A large number of studies have shown that parents' beliefs regarding the abilities of their children affect their children's own expectations of success (Bleeker & Jacobs, 2004; Jacobs & Bleeker, 2004; Jacobs & Eccles, 1992; Neuenschwander, Vida, Garrett, & Eccles, 2007), as well as the value that they attach to tasks (Viljaranta, Lazarides, Aunola, Räikkönen, & Nurmi, 2015). Recent research has also demonstrated that parents' beliefs regarding academic value affect their children's task values directly (Gniewosz & Noack, 2012; Jodl et al., 2001; Lazarides, Harackiewicz, Pesu, & Viljaranta, 2015; Simpkins et al., 2015). According to Eccles et al.'s (1983) expectancy-value model, both students' task values and student's expectations of success in a task are good predictors of their academic-choice behaviors (Eccles, 2005b; Lazarides & Watt, 2015; Nagy, Trautwein, Baumert, Köller, & Garrett, 2006; Watt et al., 2012). Longitudinal studies have outlined the direct effects of parents' actual beliefs regarding mathematics-related value on their children's interest in mathematics (Frenzel, Goetz, Pekrun, & Watt, 2010). This kind of interest-based value is labeled *intrinsic value* in Eccles et al.'s expectancy-value model (Eccles, 2005b). It has been found that mothers' valuing of mathematics and science disciplines as useful can have an effect on their children's beliefs about the importance of mathematics in terms of reaching their own goals (Harackiewicz et al., 2012); this kind of value is conceptualized in Eccles et al.'s model as *utility value* (Eccles, 2005b). Adolescents who perceive their parents as valuing mathematics have been shown to display greater interest in mathematics (Ahmed, Minnaert, van der Werf, & Kuyper, 2010; Lazarides & Ittel, 2013) and maintain more positive feelings about the usefulness of mathematics throughout high school (Wilkins & Ma, 2003). Parents' beliefs influence students' task values through support behaviors such as encouragement, conversations, coactivity, and the provision of material (Simpkins et al., 2012, 2015). Indeed, students' perceptions of parents' support behaviors have been shown to be positively related to students' performance (Bowen, Hopson, Rose, & Glennie, 2012), self-conception (Demaray, Malecki, Rueger, Brown, & Summers, 2009), academic attitudes (Malecki & Demaray, 2003; Rice, Barth, Guadagno, Smith, & McCallum, 2013; Rueger, Malecki, & Demaray, 2010), and career plans (Wang & Staver, 2001). Although conversations with parents about future occupations provide an important source of information and support in terms of students' career exploration (Dietrich & Kracke, 2009; Dietrich, Kracke, & Nurmi, 2011), only a few studies have focused on parent–child conversations (Crowley, Callanan, Tenenbaum, & Allen, 2001; Tenenbaum, 2009). The findings of these studies demonstrate that perceived (Daniels, 2008) and actual conversations between parents and their children (Crowley et al., 2001) have an important influence on adolescents' interest in particular subjects, as well as their perceptions of the subjects' utility value (Harackiewicz et al., 2012). While existing papers have often focused on domain-specific conversations, this study addresses a gap in the research by focusing on adolescents' reports of the frequency of conversations with mothers and fathers about their occupational plans in the context of achievement motivation.

Directions of Influence

A large amount of longitudinal research has investigated the effects of students' perceptions of parents' beliefs and support behaviors on students' own beliefs and behaviors (e.g., Bowen et al., 2012; Gniewosz & Noack, 2012; Rueger et al., 2010; Wilkins & Ma, 2003). Only a few longitudinal studies, however, have taken into account bidirectional effects between parents and their children (e.g., Aunola, Viljaranta, Lehtinen, & Nurmi, 2013; Keijsers, Branje, VanderValk, & Meeus, 2010; Simpkins et al., 2015). Developmental theorists (Bell, 1968; Bronfenbrenner, 1979; Lerner & Spanier, 1978; Pardini, 2008; Sameroff, 1975) have emphasized that parent–child interactions are bidirectional, proposing that children play an active role in eliciting their parents' reactions through their behaviors. Following the reciprocal effects model (Bell, 1968; Lerner & Spanier, 1978; Sameroff, 1975), interactions between parents and their children can be understood as dynamic processes that are *parent- and youth-driven* (Kerr, Stattin, & Burk, 2010). Regarding *parent-driven processes,* it can be assumed that parents' beliefs and behaviors can influence or inhibit their children's beliefs and behaviors. Where *youth-driven processes* are concerned, adolescents' own beliefs and behaviors are assumed to affect their parents' beliefs and behaviors.

When analyzing the bidirectional effects that occur between parents and their children, many studies have focused on multiple informants by using parent and student reports (e.g., Aunola et al., 2013; Combs-Ronto, Olson, Lunkenheimer, & Sameroff, 2009; Keijsers et al., 2010; Simpkins et al., 2015; Steinberg, 1988). However, it is important to consider students' perceptions of their parents' beliefs and behaviors when analyzing the reciprocal effects on parents and their children. According to the assumptions of Eccles et al.'s expectancy-value theory (Eccles, 2007; Eccles et al., 1983), parents' values and behaviors affect students' values through the students’ perceptions and interpretation of these behaviors. Accordingly, longitudinal studies in developmental psychology have recently begun to examine the bidirectional effects of adolescents’ perceptions of their parents’ behaviors and the adolescents’ own behaviors (e.g., Kerr et al., 2010; Willoughby & Hamza, 2011). However, these studies have focused on adolescents’ problem behaviors, and less is known about the context of achievement-related motivation.

Given that previous research (Gniewosz & Noack, 2012) has demonstrated that parents’ beliefs can have an effect on adolescents’ domain-specific perceptions of value only if those beliefs are perceived consciously, this longitudinal study concentrates on adolescents’ perceptions of their parents as supportive (specifically, student-perceived mathematics-related value beliefs; student-reported career conversations). Based on the reciprocal effects model (Bell, 1968; Lerner & Spanier, 1978; Sameroff, 1975), it has been assumed here that students who perceive their parents to value mathematics and to provide time for conversations about future occupations (parent-driven processes) may report higher mathematics values and mathematics-related career plans. Regarding youth-driven processes, it was assumed that students who perceive mathematics as useful and interesting may report that more mathematics-related conversations take place with their parents and may perceive their parents to value mathematics highly. The few existing studies that have investigated bidirectional relations in terms of students’ perceptions of parents’ behaviors and students’ motivation have indicated that reciprocal effects exist between students’ reading effort and students’ perceptions of parental involvement in homework during Grades 5 and 7 (Dumont et al., 2014). Other findings have focused on parents’ self-reported beliefs and behaviors, indicating that parents’ beliefs and behaviors affect middle school students’ motivation more strongly than the students themselves affect the parents’ beliefs (Simpkins et al., 2015).

Gendered Socialization Processes

The Eccles et al. expectancy-value theory (Eccles, 2007; Eccles et al., 1983) indicates that parents' beliefs regarding their children's abilities and the value of domains for their children's future are influenced by social gender-role stereotypes. These beliefs, in turn, are transmitted to their children through communication and behaviors (Eccles, Freedman-Doan, Frome, Jacobs, & Yoon, 2000; Eccles & Jacobs, 1986). For example, parents encourage boys more strongly than girls to be involved in mathematics- and science-related activities (Crowley et al., 2001; Tenenbaum, 2009); in turn, girls perceive their parents to offer lower levels support to them in mathematics than boys do (Rice et al., 2013). On the other hand, girls report more often than boys that their parents solicit school-related information from them (Stattin & Kerr, 2000). Additionally, girls report lower intrinsic value (Eccles & Harold, 1992; Watt, 2004; Watt et al., 2012)and utility in mathematics than boys (Steinmayr & Spinath, 2010), and are less likely to report mathematics-related career plans (Eccles, 2005a; Watt, 2006).

Only a limited number of studies have investigated how the relationship between student-perceived parents' beliefs/behaviors and students' motivation in mathematics differs for girls and boys (for an overview see Simpkins et al., 2015; Watt, 2016). Some studies have demonstrated that perceptions of parents' support behaviors are equally important for adolescent girls' and boys' general academic adjustment (e.g., Dunn, Putallaz, Sheppard, & Lindstrom, 1987; Rueger et al., 2010; Wall, Covell, & MacIntyre, 1999). When focusing on mathematics and science, other studies have not found evidence of a gendered relationship between parents' beliefs/behaviors and students' motivation/participation in elementary school (Simpkins et al., 2015). However, when concentrating on adolescent students, it has been found that, compared to girls, boys' motivation in science is more strongly related to their parents' self-reported ability expectations

(Taskinen, Dietrich, & Kracke, 2015). A possible explanation for the heterogeneity in the findings may be the age of the students and the domain specificity of the studies. Gender mean level differences in mathematics and science exist already in early adolescence and persist throughout high school, with girls being less interested in mathematics than boys (Fredricks & Eccles, 2002; Frenzel et al., 2010; Watt, 2004) and reporting lower mathematics utility values than boys (Eccles, 1994; Steinmayr & Spinath, 2010). Given that these gender differences in gender-stereotyped domains are already well established by late adolescence, and taking into account the idea that that gender-role acquisition is an important developmental task in adolescence (Eccles, 2009; Havighurst, 1948), it may be assumed that perceptions of parents' values and beliefs in late adolescence have more potential to affect the value that boys attach to mathematics and mathematics-related career plans than girls. This may differ, however, for more direct sources of perceived parent support – for example, joint activities or conversations (Harackiewicz et al., 2012). Thus, it can be expected that value-transmission processes in late adolescence will affect boys more than girls in gender-stereotyped domains such as mathematics (Brandell & Staberg, 2008), but more direct forms of parental support such as perceived conversations may be particularly important for girls' motivation in mathematics. Given that other research has indicated that same gender socialization processes, showing that girls may be more strongly influenced by their mothers' support behaviors than by their fathers' in relation to mathematics (Leaper, Farkas, & Brown, 2012a), it can be assumed that girls in particular will benefit from perceiving their mothers to be available for conversations about occupational plans. Furthermore, given societal norms and parental expectations, boys' choices are more limited than girls', and thus their personal values may play a smaller role in terms of occupational intentions

(Watt et al., 2012). It can be assumed, therefore, that task values are more important for girls than boys, when it comes to career plans.

The Present Study

In accordance with the Eccles et al. expectancy-value model (Eccles, 2007; Eccles et al., 1983), it has been assumed here that students' perceptions of parents' values and behaviors play a central role in academic-value transmission processes. This study investigated the research question of whether and how students' perceptions of their parents' mathematics value beliefs and conversations with their parents (Time 1 and 2) affect their own mathematics value beliefs and career plans (Time 1 and 2). Previous longitudinal research has investigated the unidirectional effects of students' perceptions of their parents' beliefs (e.g., Ahmed et al., 2010; Lazarides & Ittel, 2013; Wilkins & Ma, 2003) and behaviors (e.g., Bowen et al., 2012; Frenzel et al., 2010; Rueger et al., 2010) on students' own beliefs and behaviors. The present study takes a novel approach, analyzing the bidirectional effects among student-perceived parents' beliefs and behaviors and their own beliefs and behaviors. The longitudinal data analysis conducted in this study has allowed the bidirectionality of the hypothesized effects to be tested via the modeling of cross-lagged paths (Jöreskog, 1979; McArdle & Nesselroade, 2014). Existing empirical studies in this area have offered evidence for bidirectionality in students' perceptions of their parents' behaviors and their own academic behaviors in the domain of reading (Dumont et al., 2014). This study extends previous research by addressing the research question of bidirectional effects among students' perceptions of their parents' value beliefs/behaviors and their own value beliefs/career plans in the domain of mathematics. The domain of mathematics is seen as a critical filter for careers in mathematics- and science-related fields (Ma & Johnson, 2008), but often stereotyped as typically male (Brandell & Staberg, 2008). A strict test of the bidirectional effects of parents' beliefs/behaviors and students' beliefs/behaviors was not possible, however, as this would require parent data to be gathered. Nevertheless, this study provides a better understanding of the mechanisms that underlie students' perceptions of parental support in relation to the field of mathematics learning and career orientation. To help expand the knowledge base in this area, the present study has investigated the research question of whether students' gender would moderate the relationship between students' perceptions of their parents' beliefs/behaviors and their own beliefs/career plans in the domain of mathematics.

Regarding our first research question, we hypothesized that students' perceptions of parents' beliefs about the value of mathematics and students' reported frequency of parent–child career conversations at Time 1 would positively predict students' mathematics intrinsic and utility values and mathematics-related career plans at Time 2 (Simpkins et al., 2012, 2015; Taskinen et al., 2015). Regarding our second research question, we expected that the effects of student-perceived parental value beliefs and the frequency of parent–child career conversations upon students' own valuing of mathematics and mathematics-related career plans would be stronger than the effects of students' mathematics values and career plans upon student-perceived parental value beliefs and the frequency of parent–child career conversations (Simpkins et al., 2015). Regarding our third research question, we anticipated that the tested relationships would be different for boys than for girls. We expected that students' perceptions of their parents' beliefs and the reported frequency of parent–child career conversations would have stronger effects on boys' than on girls' mathematics task values, while mathematics values were expected to have a stronger effect on girls' than on boys' mathematics-related career plans (Watt et al., 2012).

In Berlin, Germany, where the present study was conducted, two main types of secondary schools remained in place after the 2010–2011 school reforms took place. An “integrated” secondary school provides courses for different ability levels (Maaz, Baumert, Neumann, Becker, & Dumont, 2013), while a “gymnasium” offers a college-bound track. At both types of school, students can graduate after Grade 9 or 10 and enter the dual system, or they can graduate after the final examination in Grade 13 and enter university. Research has shown that students at gymnasiums reported higher levels of mathematics self-concept and interest in mathematics (Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006). In this study, the relationships were therefore controlled not only for students’ achievements and gender, but also for school type.

Method

Sample

The sample for this study consisted of 475 adolescents (girls: 50.3%) from 31 classrooms in 12 secondary schools in Berlin, Germany, who participated in the Berlin Career Exploration and Guidance Study (Ohlemann et al., 2014). The longitudinal sample for this study began in 11th grade. Participating schools were randomly selected, and data were assessed in fall 2014 and spring 2015. The participation rate of the schools involved in the study was high as all of the selected 12 public co-educational secondary schools participated. Students were informed about the voluntary nature of their participation. Parental consent was not needed as the students were older than 14 years (Berlin Senate for Education Youth and Research, 2013). Surveys were administered at the end of a compulsory class by trained research assistants and took approximately 25 minutes to complete. Students were informed that the research project aimed to examine adolescents’ motivation in school and that students from several secondary schools were participating in the survey. Data were included from integrated secondary schools (24.4%) and gymnasiums (75.6%). Students' mean age was 16.77 years (*SD* = 0.972). Most students (60.4%) reported that they were native German speakers, that they had been born in Germany (89.7%), and that they had German citizenship (76.8%; other: 8.8%; German and other: 9.9%). In accordance with the local authority guidelines (Berlin Senate for Education Youth and Research, 2013), no variables related to family background, such as highest level of parental education or occupation, were assessed. Referring to the Programme for International Student Assessment (PISA) studies, students were asked to report the number of books that they had at home. In the PISA studies (OECD, 2014), together with the highest level of parental education and occupation, the number of home possessions—including the number of books at home—is an indicator of parents' economic, social, and cultural status. In this study, almost half of the students (41.1%) reported that their family had more than 200 books, 13.5% of the students reported that their family had 25 or fewer books at home, 9.9% of the students reported they had approximately 11–25 books at home, and 3.6% reported that they had no books or only a few books at home. The percentage of students eligible for free learning materials is furthermore a measure of the socioeconomic background of schools in Germany (Berlin Senate for Education, Youth and Research, 2016). At the participating schools, the average percentage of students eligible for free learning materials was 21.77% (average at secondary schools in Berlin: 34%; Berlin Senate for Education Youth and Research, 2015).

Measures

Individual variables. Gender was coded 0 for boys, 1 for girls. Prior mathematics achievement was assessed by students' self-reported mathematics school grades at the end of the last semester in the school year. In Germany, school grades range from 1 (*very good*) to 6 (*unsatisfactory*), with lower values indicating better performance. To facilitate the interpretation of the findings, we reverse-coded the grades so that higher values reflect better mathematics achievement. School type was coded 0 for integrated secondary school and 1 for gymnasium.

Students' intrinsic value. Students' intrinsic value of mathematics was assessed at Time 1 and Time 2 with a scale developed by Steinmayr and Spinath (2010). The three-item, 5-point Likert scales ranged from 1 (*does not apply at all*) to 5 (*fully applies*). Example items are "I have fun doing mathematics" and "I like doing mathematics." Latent factor reliability was ξ_j = .938 (Time 1) and ξ_j = .932 (Time 2).

Students' utility value. Students' mathematics utility value was assessed at Time 1 and Time 2 with a scale from Steinmayr and Spinath (2010). The three-item, 5-point Likert scales ranged from 1 (*does not apply at all*) to 5 (*fully applies*). Example items are "What I learn for mathematics is generally important for my future" and "What I learn for mathematics will help me in my future life." Latent factor reliability was ξ_j = .894 (Time 1) and ξ_j = .885 (Time 2).

Students' perceptions of parents' mathematics value beliefs. Students' perceptions of parents' mathematics value beliefs were assessed at Time 1 and Time 2 with a five-item scale based on Wendland and Rheinberg (2004). The 4-point Likert scale ranged from 1 (*strongly disagree*) to 4 (*strongly agree*). Example items are "My parents think that I will not be able to find a good job after school without good grades in mathematics" and "My parents think that learning for mathematics is more important than learning for other school subjects." Latent factor reliability was ξ_j = .809 (Time 1) and ξ_j = .848 (Time 2).

Reported frequency of parent–child career conversations. Student-reported conversations with their mothers and fathers about future occupations were assessed at Time 1 and Time 2 with single items ranging from 1 (*never*) to 4 (*very often*). An example answer option is "I have talked with my mother [father] about my occupational future."

Career plans. Students' mathematics-related career plans were assessed at Time 1 and Time 2 with "What job would you like to have in the future?" Answers were coded per nominated career using O*NET (National Center for O*NET Development, 2014) to quantify career plans in relation to "knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications" on a scale ranging from 0 (*not mathematics-related*) to 100 (*completely mathematics-related*). Examples of careers highly rated ("high") were science, accounting, and engineering.

Analytic Strategy

This longitudinal study used a cross-lagged panel design (Jöreskog, 1979; Kenny, 2014) in which the same variables are measured across time points. This design enabled us to test assumptions about the stability of constructs and the (bi)directionality of effects between constructs. However, it does not overcome the limitation of potential overestimation of effects that could be explained by third variables (see Laursen, Little, & Card, 2012). This study aimed to test for bidirectional effects among students' beliefs and plans and student-perceived parents' beliefs and behaviors. The hypothesized theoretical model is displayed in Figure 1. To test for bidirectional effects, students' perceptions of parents' mathematics value beliefs, the perceived frequency of parent–child career conversations, students' intrinsic and utility values of mathematics, and students' mathematics-related career plans at Time 1 were specified as predictors of students' perceptions of parents' mathematics value beliefs, the perceived frequency of parent–child career conversations, students' intrinsic and utility values of mathematics, and students' mathematics-related career plans at Time 2. All analyses were controlled for gender, books at home, self-reported mathematics achievement, and school type. The empirical model is displayed in Figure 2.

Scalar measurement invariance was tested for the latent variables in the full sample, as well as in the gender subgroups (Little, 1997). Although measurement invariance restrictions were kept, the measurement model was also tested for invariance across gender groups. While measurement constraints were kept in the model, the hypothesized effects were tested with longitudinal structural equation modeling. With invariance constraints from the measurement and gender group invariance testing, the hypothesized structural paths were included in a multiple-group model. Paths were first allowed to vary across groups. The structural paths for girls and boys from this model are displayed in Figure 3. Group differences in the relations between dependent and independent variables were tested by constraining those paths sequentially to be equal across groups that were significant in at least one group. Nonsignificant coefficients were kept in all models. For reasons of clarity, the nonsignificant coefficients and the regression coefficients of gender, books at home, self-reported mathematics achievement, and school type on the other variables in the model are not displayed in Figure 2 or Figure 3 (although they are reported in the text).

The Mplus program, version 6.0, was used for all analyses (Muthén & Muthén, 1998-2010). Chi-square difference tests incorporated the scaling correction factor indicated by Satorra and Bentler (2001). For all analyses, maximum likelihood estimation with robust standard errors and chi-square (MLR) was used. Standard errors and chi-square values were corrected using the TYPE = COMPLEX function of Mplus that takes into account the nested structure of the data (Muthén & Muthén, 1998-2010). Missing data were handled by using full-information maximum likelihood (FIML) estimation. Based on Tanaka (1993), the following criteria were employed to evaluate the goodness of fit of the models: Yuan-Bentler scaled χ^2 (YB χ^2, mean-adjusted test-statistic robust to nonnormality), Tucker and Lewis index (TLI), comparative fit index (CFI), and root mean square of approximation (RMSEA) with associated confidence intervals. Additionally, standardized root mean residual values (SRMR) were reported. TLI and CFI values greater than .95 (Hu & Bentler, 1999), RMSEA values lower than .06, and SRMR ≤ .08 (Hu & Bentler, 1999) were accepted as indicators of a good model fit.

--Figure 1--

Results

Preliminary Analyses

Table 1 presents descriptive statistics for each variable included in the analyses separated for gender and school type. To assess mean-level differences for the latent variables in multiple-group analyses that included scalar invariance across groups we used chi-square difference tests that incorporated the scaling correction factor indicated by Satorra and Bentler (2001). In a next step, latent means for boys were constrained to zero in order to estimate z-values for the latent mean-level differences. To assess mean-level differences for the manifest variables one-way analyses of variance (ANOVA) were computed.

Results of latent mean-level difference testing showed that girls reported significantly lower mathematics intrinsic and utility value than boys at both time points. Furthermore, girls compared to boys perceived significantly lower parents' mathematics value beliefs at both time points (see Table 1). Results of one-way analyses of variance showed that girls reported lower mathematics-related career plans than boys at both time points (Time 1: F (1, 238) = 19.12, $p < .001$; Time 2: F (1, 138) = 8.29, $p < .01$). Girls furthermore reported more often conversations with their mothers about their future careers than boys (Time 1: F (1, 443) = 22.23, $p < .001$; Time 2: F (1, 283) = 15.38, $p < .001$).

Students at the Gymnasium reported significantly higher mathematics intrinsic value at both time points and higher utility value at Time 2 than students who attended an integrated secondary school. Results of one-way analyses of variance showed that students at the Gymnasium reported significantly more often mathematics-related occupational plans at Time 1 (F (1, 245) = 4.31, $p < .05$) and conversations with their fathers about occupational plans at Time 2 (F (1, 289) = 12.31, $p = .001$) than students who attended an integrated secondary school.

Table 2 presents bivariate Spearman's correlations between the study variables. Students' intrinsic and utility values of mathematics at both time points were positively associated with the students' mathematics-related career plans at both time points. Students' perceptions of parents' mathematics value beliefs at both time points were positively associated with the students' mathematics-related career plans at Time 2. The weak and non-significant correlations between the variables "student-reported of conversations with mothers [fathers]" and "student-perceived parents' mathematics beliefs" (Time 1: Mothers: $r = .014$, $p = .803$; Fathers: $r = .085$, $p = .171$; Time 2: Mothers: $r = .108$, $p = .094$; Fathers: $r = .083$, $p = .173$) can be seen as an indicator for the discriminant validity of the one-item measure "student-reported of conversations with mothers [fathers]" as this measure assessed students' perceptions of the general availability of their mothers and fathers for conversations about future careers in contrast to the domain-specific measure of students' perceived parents' mathematics value beliefs.

--Table 1--

--Table 2--

Time and Gender Measurement Invariance Tests and Measurement Models

Measurement invariance was tested for the latent variables in the full sample, as well as in the gender subgroups. Model fit indices for the measurement models are displayed in Table 3. First, a measurement model with no equality constraints but with configural invariance for the latent constructs was established in all samples (full sample; girls; boys; Table 3, step 1). Item intercepts of the same items were allowed to correlate across time. Factor loadings were set invariant across time (Table 3, step 2). In a subsequent step, loadings and intercepts were set invariant across time (Table 3, step 3; Byrne, 1989). Partial scalar measurement invariance was established in the full sample, as well as in the samples of girls and boys.[1] The data showed a good fit to the measurement model, with six latent factors (including partial scalar measurement invariance restrictions) showing good fit to the measurement model (see Table 3, step 3a) in all samples (full sample; girls; boys). Latent factors in the model were as follows: intrinsic value (Time 1: $\lambda = .813$ to $\lambda = .966$; Time 2: $\lambda = .813$ to $\lambda = .966$); utility value (Time 1: $\lambda = .810$ to $\lambda = .901$; Time 2: $\lambda = .781$ to $\lambda = .913$) and students' perceptions of parents' mathematics value beliefs (Time 1: $\lambda = .595$ to $\lambda = .711$; Time 2: $\lambda = .667$ to $\lambda = .760$), each at Time 1 and Time 2.

--Table 3--

Multiple-group measurement invariance tests across gender groups revealed scalar measurement invariance across groups. Results of multiple-group invariance tests are presented in Table 4.

--Table 4--

Student Perceptions of Parents' Beliefs, Parent–Child Conversations, Task Values, and Choice Behaviors and Direction of Influence

The data showed good fit to the hypothesized model, $\chi^2 = 532.776$, $df = 359$, CFI = .97, TLI = 0.96, RMSEA = .032, SRMR = .041. The significant standardized regression coefficients of this model are displayed in Figure 2.

--Figure 2--

Students' gender, number of books at home, self-reported mathematics achievement, and school type. Compared to boys' results, girls reported lower intrinsic value of mathematics at Time 1 ($\beta = -.152$, $SE = .05$, $p < .01$), lower utility value of mathematics at Time 1 ($\beta = -.151$, $SE = .07$, $p < .05$), and lower perceptions of parents' mathematics value beliefs at Time 1 ($\beta = -.154$, $SE = .05$, $p < .01$) and Time 2 ($\beta = -.120$, $SE = .05$, $p < .05$) and less often reported mathematics-related career plans at Time 1 than boys ($\beta = -.221$, $SE = .07$, $p = .001$). However, girls reported more frequent conversations with their mothers about occupational plans than boys did at Time 1 ($\beta = .225$, $SE = .05$, $p < .001$) and at Time 2 ($\beta = .123$, $SE = .06$, $p < .05$). The student-reported number of books at home was statistically significantly and negatively related to students' perceptions of parents' mathematics value beliefs at Time 1 ($\beta = -.159$, $SE = .06$, $p < .01$) and positively related to the student-reported frequency of conversations with mothers about occupational plans at Time 2 ($\beta = .130$, $SE = .05$, $p < .01$). Students' self-reported mathematics achievement was positively related to their intrinsic value of mathematics at Time 1 ($\beta = .512$, $SE = .03$, $p < .001$) and Time 2 ($\beta = .140$, $SE = .05$, $p < .05$), to their mathematics utility value at Time 1 ($\beta = .343$, $SE = .05$, $p < .001$), to their mathematics-related career plans at Time 1 ($\beta = .295$, $SE = .06$, $p < .001$), and to students' perceptions of parents' mathematics value beliefs at Time 1 ($\beta = .238$, $SE = .06$, $p < .001$). Students who attended a gymnasium reported higher intrinsic value at Time 1 ($\beta = .128$, $SE = .05$, $p < .01$) and more frequent conversations with fathers ($\beta = .113$, $SE = .04$, $p < .05$) and mothers at Time 2 ($\beta = .069$, $SE = .03$, $p < .05$) than did students who attended an integrated secondary school.

Stability of latent constructs. Results revealed high stability of the latent constructs. Students' perceptions of parents' mathematics value beliefs at Time 1 positively predicted the students' perceptions of parents' mathematics value beliefs at Time 2 ($\beta = .681$, $SE = .07$, $p <$

.001). Students' perceptions of the frequency of conversations with mothers about occupational plans at Time 1 positively predicted the students' perceptions of the frequency of conversations with mothers about occupational plans at Time 2 ($\beta = .562$, $SE = .04$, $p < .001$). Students' perceptions of the frequency of conversations with fathers about occupational plans at Time 1 positively predicted the students' perceptions of the frequency of conversations with fathers about occupational plans at Time 2 ($\beta = .686$, $SE = .03$, $p < .001$). Students' mathematics intrinsic value at Time 1 positively predicted their mathematics intrinsic value at Time 2 ($\beta = .659$, $SE = .04$, $p < .001$). Students' mathematics utility value at Time 1 positively predicted their mathematics utility value at Time 2 ($\beta = .433$, $SE = .06$, $p < .001$). Students' mathematics-related career plans at Time 1 positively predicted students' mathematics-related career plans at Time 2 ($\beta = .642$, $SE = .08$, $p < .001$). The stability of the constructs did not vary by gender.

Interrelations among students' perceptions of parent variables, students' mathematics intrinsic and utility values, and career plans. Students' perceptions of parents' mathematics value beliefs at Time 1 ($\beta = .140$, $SE = .06$, $p < .05$) and their mathematics-related career plans at Time 1 ($\beta = .173$, $SE = .07$, $p < .01$) positively predicted students' mathematics utility value at Time 2. The perceived frequency of conversations with mothers about occupational plans at Time 1 positively predicted students' mathematics-related career plans at Time 2 ($\beta = .119$, $SE = .06$, $p < .05$). The perceived frequency of conversations with mothers about occupational plans at Time 1 positively predicted students' intrinsic value of mathematics at Time 2 ($\beta = .109$, $SE = .05$, $p < .05$). The model explained significant amounts of variance in students' mathematics-related career plans (Time 1: $R^2 = .16$, Time 2: $R^2 = .63$), as well as in their mathematics intrinsic value (Time 1: $R^2 = .32$; Time 2: $R^2 = .64$), utility value (Time 1: $R^2 = .15$; Time 2: $R^2 = .52$), their perceptions of their parents' mathematics value beliefs (Time 1: $R^2 = .09$;

Time 2: $R^2 = .57$), and the perceived frequency of parent–child career conversations with mothers (Time 1: $R^2 = .06$; Time 2: $R^2 = .41$) and fathers (not significant for Time 1: $R^2 = .01^{n.s.}$; significant for Time 2: $R^2 = .52$).

Gendered Socialization Processes

The multiple-group longitudinal structural equation model included time and gender partial measurement invariance and all structural paths of the hypothesized model. Almost all paths that were significant in the full sample were significant in at least one gender group. Only the path from the reported frequency of mother–child conversations (T1) to the students' intrinsic value of mathematics (T2) was not significant in both gender groups (although the path was marginally statistically significant in the group of girls with $p = .069$). The multiple-group model differed from the model in the full sample. Three paths were not in the full sample but were statistically significant for boys (not for girls). These three paths were the path between students' intrinsic value (T1) and reported frequency of father–child conversations (T2), the path between students' career plans (T1) and reported frequency of mother–child conversations (T2), and the path between student-perceived parents' mathematics value (T1) and frequency of father–child and of mother–child conversations (T2). Two paths were not in the full sample but were statistically significant for girls (not for boys). These two paths were the path between students' mathematics intrinsic value (T1) and mathematics-related career plans (T2), and the path between students' utility value (T1) and frequency of mother–child conversations (T2). The coefficients of the paths are reported in the following section.

Six structural regression paths were moderated by students' gender. Only for boys, perceptions of parents' mathematics value beliefs at Time 1 positively predicted the utility value of mathematics at Time 2 (boys: $\beta = .261$, $SE = .09$, $p < .01$; girls: $\beta = .013$, $SE = .08$, $p = .872$;

$\Delta\chi^2$ (1) = 13.82). Only for boys, perceptions of parents' mathematics value beliefs at Time 1 positively predicted perceptions of the frequency of conversations with fathers (boys: $\beta = .150$, $SE = .08$, $p < .05$; girls: $\beta = -.154$, $SE = .09$, $p = .084$; $\Delta\chi^2$ (1) = 7.50) and with mothers about occupational plans at Time 2 (boys: $\beta = .273$, $SE = .10$, $p < .01$; girls: $\beta = -.100$, $SE = .08$, $p = .186$; $\Delta\chi^2$ (1) = 29.28). Only for boys, intrinsic value of mathematics at Time 1 positively predicted perceptions of the frequency of conversations with their fathers at Time 2 (boys: $\beta = .177$, $SE = .06$, $p < .01$; girls: $\beta = -.031$, $SE = .07$, $p = .667$; $\Delta\chi^2$ (1) = 10.20). Only for boys, mathematics-related career plans at Time 1 were negatively related to the student-reported frequency of conversations with mothers about occupational plans at Time 2 (boys: $\beta = -.179$, $SE = .08$, $p < .05$; girls: $\beta = .131$, $SE = .09$, $p = .128$; $\Delta\chi^2$ (1) = 5.14). Only for girls, intrinsic value of mathematics interest at Time 1 predicted mathematics-related career plans at Time 2 (boys: $\beta = -.125$, $SE = .12$, $p = .280$; girls: $\beta = .289$, $SE = .09$, $p < .01$; $\Delta\chi^2$ (1) = 3.88).

Three paths were significant only in one gender group, but were not significantly moderated by students' gender. The path between student-reported frequency of conversations with mothers about occupational plans at Time 1 and students' career plans at Time 2 was statistically significant only for girls (boys: $\beta = .051$, $SE = .08$, $p = .537$; girls: $\beta = .199$, $SE = .09$, $p < .05$; $\Delta\chi^2$ (1) = 0.94). The path between students' utility value of mathematics at Time 1 and the student-reported frequency of conversations with mothers about occupational plans at Time 2 was statistically significant only for girls (boys: $\beta = .051$, $SE = .12$, $p = .677$; girls: $\beta = .228$, $SE = .10$, $p < .05$; $\Delta\chi^2$ (1) = 2.12). Those coefficients that were at least significant in one gender group are displayed in Figure 3.

--Figure 3--

Discussion

This longitudinal study contributes to current research by examining parental value transmission processes and thus, by investigating the research question of whether and how students' perceptions of their parents' beliefs/behaviors affect their own value beliefs and occupational plans. The second research question of this study was whether the effects among students' perceptions of their parents' beliefs/behaviors affect their own value beliefs and occupational plans are bidirectional. As existing longitudinal research into the bidirectional effects of students' motivations and their perceptions of their parents' beliefs/behaviors in the context of achievement motivation is limited (Dumont et al., 2014). The findings further expand previous knowledge by examining the third research question of whether students' gender is a moderator of the relationships between student-perceived parental mathematics values, students' perceptions of the frequency of parent–child career conversations, and students' mathematics values/mathematics-related career plans. The study helps to demonstrate the reliability of Eccles et al.'s (1983) expectancy-value model by testing its assumptions in the context of the German educational system. In Germany, the highest level of mathematics in school is not a prerequisite when entering university courses. Given the high degree of freedom that students have when choosing their university courses, it is important to consider the role that student's perceived parents' mathematics-related beliefs and behaviors play as predictors of their mathematics-related career plans. Furthermore, gaining knowledge about how perceived socializers' beliefs and behaviors may contribute to students' occupational choices in late adolescence may help to prepare students for the impending transition from school to work life or university. The findings of this study thus are of great relevance for researchers interested in predicting academic outcomes.

Student Perceptions of Parents' Beliefs, Parent–Child Conversations, Task Values, and Choice Behaviors

Our first research question was whether students' perceptions of parents' beliefs about the value of mathematics and students' reported frequency of parent–child career conversations at Time 1 would positively predict students' mathematics intrinsic and utility values and mathematics-related career plans at Time 2 (Simpkins et al., 2012, 2015; Taskinen et al., 2015). The findings showed that students' perceptions of their parents' value beliefs at Time 1 affected students' mathematics utility value at Time 2. However, student-perceived parental mathematics value beliefs at Time 1 did not significantly affect their mathematics intrinsic values or mathematics-related career plans at Time 2. A possible explanation for these findings is the extrinsic character of utility value. Utility value is similar to extrinsic motivation (Eccles, 2005b) and, therefore, may be more easily influenced by socializers. According to previous research (Harackiewicz et al., 2012), these results point to the usefulness of interventions involving socializers that aim to provide students in late adolescence with information about the relevance of mathematics to their lives (Gaspard, Dicke, Flunger, Brisson, et al., 2015; Harackiewicz et al., 2012; Hulleman, Godes, Hendricks, & Harackiewicz, 2010). Students' mathematics utility value at Time 2 was also affected by students' mathematics-related career plans at Time 1. Thus, when aiming to motivate students to value mathematics in late adolescence, it may also be worthwhile focusing on career exploration and providing information about future careers in mathematics-related fields (Jansen & Derksen, 2016).

Direction of Influence

Based on the theoretical tenets of the reciprocal effects model of parent–child socialization (Bell, 1968; Bronfenbrenner, 1979; Lerner & Spanier, 1978; Pardini, 2008; Sameroff, 1975), the second research question of this study was whether student-perceived parental value beliefs/behaviors and students' value beliefs/behaviors would affect each other reciprocally. Findings in the full sample showed that parent-driven processes shaped the relationship between perceptions of parents' beliefs/behaviors and students' motivation more strongly than youth-driven processes. These results are in line with previous research by Simpkins et al. (2015) on students in late-elementary and early-middle school, which does not give empirical evidence of the bidirectional effects of parents' self-reported beliefs and students' own task values and competence beliefs. The authors explain their findings by noting the high degree of stability in parents' self-reported beliefs, which are not likely to be influenced by students' own mathematics-related values (Simpkins et al., 2015). Although these results might indicate that socialization processes are more strongly shaped by parent-driven processes than by youth-driven processes, some research has emphasized that there is a decrease in parental influence upon adolescents' motivations after the transition into secondary education (Gniewosz et al., 2012). Thus, there may be benefits to investigating the bidirectionality of such effects within different age groups and across educational transitions. Furthermore, it must be acknowledged that the relatively small sample size can be considered a method-based explanation for the non-significant bidirectionality of the effects being investigated in the full sample. The parameters are likely to be insignificant in small samples and models based on large samples might also reflect population processes more accurately (Tanaka, 1987). Thus, future studies with larger samples will provide more detailed information about the bidirectional influences that exist between children and their parents. Nonetheless, the results of this study correspond with its theoretical underpinnings (Eccles, 1993; Simpkins et al., 2015) and the analyses given are based on a sample that was representative of the student population in terms of gender ratio, socio-economic status, and the ratio of native German speakers (Berlin Senate for Education, 2015). Therefore, the conclusion to the finding of parent-driven effects in adolescence might be that perceptions of parents' beliefs are important in late adolescence, in terms of an intergenerational transmission of domain-specific values. This is particularly interesting as students have already developed stable domain-specific value beliefs in late adolescence (Frenzel et al., 2010; Watt, 2004). Although in the full sample the study was only partially successful in demonstrating that bidirectional influences exist, it must also be noted here that the directionality of these effects differed between girls and boys.

Gendered Socialization Processes

The third research question of this study was whether students' gender moderated the bidirectional effects of students' mathematics motivation and student-perceived parental beliefs/behaviors. We investigated this research question in line with the theoretical tenets of Eccles et al.'s expectancy-value theory (Eccles, 2007; Eccles et al., 1983) that describes that socialization processes may differ for girls and boys. In this study, different parent-driven processes could be identified for boys and girls. Where girls were concerned, the perceived frequency of conversations with their mothers about future occupational plans enhanced their mathematics-related career plans. For boys, student-perceived parental mathematics-related values were a predictor of students' mathematics utility value. These findings might be explained by existing work on gender socialization processes in families (Eccles, 1993; Watt, 2016). Boys are more strongly encouraged by their parents to be involved in mathematics- and science-related activities than girls (Crowley et al., 2001; Tenenbaum & Leaper, 2003). In turn, girls and boys develop gender-specific mathematics-related task values in childhood, which persist until late adolescence (Fredricks & Eccles, 2002; Watt, 2004). In this study, the low mean levels of perceived parents' mathematics values among girls and their own low mathematics task values might reflect such gender-related socialization processes and could explain why the intergenerational value-transmission process was not evident for girls in our results. Given that studies show that girls perceive low mathematics encouragement from their parents already in elementary school (Rice et al., 2013), the continuous gender-specific parental encouragement may be an explanation for the low importance of perceived parents' mathematics value beliefs for girls' mathematics-related values and career plans in this study. However, it is positive that this study showed that girls' mathematics career plans were affected by their reported frequency of conversations about occupational plans with their mothers. Although this path was not significantly moderated by students' gender, it may indicate that direct forms of support behaviors may help to better understand how to enhance girls' mathematics-related career plans.

Extending the findings of the full sample, youth-driven processes were identified as relevant for boys but not for girls. For boys, mathematics intrinsic value was a positive predictor of the reported frequency of conversations with their fathers, while mathematics-related career plans were a negative predictor the reported frequency of conversations with mothers about occupational plans. This result may be related to the same gender socialization processes discussed above (Leaper, Farkas, & Brown, 2012b), as well as to the domain-specificity of this study. It could be assumed that boys who attach a high level of intrinsic value to mathematics would be more likely to speak with their fathers than their mothers about their occupational plans in mathematics because it is a domain stereotyped typically as male (Brandell & Staberg, 2008).

Interestingly, in this study, it was the level of intrinsic value ascribed to mathematics by the girls, rather than the boys, that served to predict mathematics-related career plans. This is in line with previous research (Watt et al., 2012), which has suggested that task values are more important to girls than boys, in terms of their academic choice behaviors. Watt et al. (2012)

demonstrate that importance value influences girls' mathematics-related career plans more strongly than boys'. This study focused on utility value and did not include students' personal views on the importance of mathematics, which is a component of importance value. As girls often underestimate their own mathematical abilities (Marsh & Yeung, 1998; Nagy et al., 2010), the findings of this study might indicate that girls' mathematics intrinsic values prevent them from deciding against mathematics-related careers. Previous research (Trautwein et al., 2012) has stated that high task-value beliefs in combination with low-competence beliefs do not prevent low achievement. Future studies should examine the role of interaction effects in girls' and boys' mathematics-related career plans (Lauermann, Chow, & Eccles, 2015).

Taken together, the findings of this study emphasize the importance of interest as a motivational predisposition (Renninger & Hidi, 2016) and, furthermore, indicate the importance of enhancing the intrinsic value placed on mathematics education by girls (Lazarides & Watt, 2015). Moreover, this study provides new information about how different aspects of perceived parental support, such as the perceived parents' value of mathematics and the frequency of conversations with mothers and fathers about future occupational plans, can affect late-adolescent girls' and boys' plans to pursue mathematics-related careers.

Limitations and Conclusions

The first limitation of this study lies in the measurement of student-perceived parental beliefs and behaviors. This study did not consider students' perceptions of the mathematics-related value beliefs of their mothers and fathers separately. Furthermore, the measurement of students' perceptions of their parents' mathematics-related value beliefs included students' perceptions of parents' general and child-specific mathematics-related value beliefs. Theoretically speaking, parents' general and child-specific beliefs are modeled separately in the Eccles model of parent socialization (Eccles, 1993; Eccles et al., 1983) and, thus, it would be fruitful to test their differential effects on students' task values and future plans. This study also included measures assessing the quantity of student-perceived conversations with their parents. However, the interactions can vary substantially in terms of levels of parental support and/or interference (Dietrich & Kracke, 2009). The qualitative variance of such interactions may, in turn, have influenced the effects that the student-reported conversations had on students' value beliefs and career plans. Therefore, it is also important to consider the qualitative aspects of students' conversations with their parents, such as the concrete topic of the conversation and the amount of encouraging or discouraging comments, in future studies.

The second major limitation lies in the utilization of students' self-reporting of their parents' beliefs and behaviors. Previous research (Gniewosz & Noack, 2012) has demonstrated that parental beliefs affect adolescents' value beliefs if those beliefs are consciously perceived by the adolescent. However, further work is needed that includes self-reported parent data, as this would allow a strict examination of the bidirectional effects of students' own value beliefs and parents' actual value beliefs to be undertaken. By using student self-reporting only, the relationship between students' perceptions of their parents' beliefs and their own task values and career plans may be biased due to the shared variance that is attributable to the same method effect described above. When analyzing bidirectional relations in particular, the use of self-reported student data only may be problematic because disentangling method variance from the relationships between the constructs is difficult. In order to validate the findings of this study, future research should include an examination of parents' self-reported beliefs and behaviors.

The third limitation here is that this study assessed individual student data only and did not include, for example, school records of students' achievement. Past empirical findings have suggested that there are high correlations between students' self-reported achievements and their actual grade point averages (Holopainen & Savolainen, 2005). However, self-reported grades should be used with caution as they are unlikely to represent the actual scores of students with low levels of achievement (Kuncel, Credé, & Thomas, 2005).

The fourth limitation of this study is that the analyses did not consider students' cost. Research on task values often excludes cost (Bong, 2001; Chow, Eccles, & Salmela-Aro, 2012; Jacobs & Eccles, 2000). However, as previous studies have highlighted, students' perceived cost is an important facet of students' task-value beliefs (Eccles et al., 1983; Gaspard, Dicke, Flunger, Schreier, et al., 2015; Perez, Cromley, & Kaplan, 2014) and should be considered, therefore, in future studies.

The findings of this study inform educational policy and practices with regard to how adolescents' mathematics-related motivations and career plans may be enhanced. This study shows that students who perceive that their parents value mathematics highly place a greater utility value on the subject, which, in turn, is related positively to students' plans to pursue a mathematics-related career. As such, parents need to be involved in interventions that aim to motivate adolescents to consider careers in mathematics-related disciplines (Harackiewicz et al., 2012). The results of this study suggest further that the intrinsic value that girls place upon mathematics affects their mathematics-related career plans, which indicates that it is important to provide interest-enhancing learning environments when aiming to support girls in planning a mathematics-related career. Overall, this research highlights the great importance of perceptions of socializers' value beliefs in terms of adolescents' career-planning processes in late adolescence, when students face the transition from school to the workplace or university.

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Footnote

[1] Two intercepts varied across time. Latent factor student-perceived parents' value – item (wording "My parents think that people with high mathematics competencies will be sought out over the next several years."): Full sample Time 1: M = 0.46 (0.15), Time 2: M = 0.64 (0.14); Girls Time 1: M = 0.53 (0.23), Time 2: M = 0.61 (0.18); Boys Time 1: 0.33 (0.26), Time 2: M = 0.63 (0.28); Latent factor intrinsic value – item 3 (wording: "Mathematics is interesting."): Full sample Time 1: M = 0.76 (0.09), Time 2: M = 0.59 (0.09); Girls Time 1: M = 0.65 (0.12), Time 2: M = 0.39 (0.12).

Tables.

Table 1

Means, Standard Deviations, and Effect Size for Mean Differences in the Full Sample (N = 475)

Measure	Boys *M* (*SE*)	Girls *M* (*SE*)	*Δχ(df)*	*d*	Sc.School *M* (*SE*)	Gym *M* (*SE*)	*Δχ(df)*	*d*
IntT1	3.02 (0.15)	2.60 (0.09)	11.00 (1)		2.43 (0.11)	2.94 (0.11)	26.73 (1)	
IntT2	3.07 (0.16)	2.71 (0.10)	6.25 (1)		2.47 (0.13)	3.04 (0.11)	26.84 (1)	
UtiT1	2.80 (0.12)	2.47 (0.06)	10.61 (1)		2.61 (0.12)	2.65 (0.09)	0.17 (1)	
UtiT2	2.79 (0.14)	2.43 (0.08)	9.46 (1)		2.34 (0.11)	2.72 (0.09)	18.88 (1)	
PVT1	2.57 (0.08)	2.30 (0.08)	16.11 (1)		2.48 (0.10)	2.39 (0.09)	0.18 (1)	
PVT2	2.49 (0.08)	2.07 (0.10)	16.41 (1)		2.22 (0.11)	2.33 (0.10)	0.63 (1)	
MCT1	2.88 (0.78)	3.22 (0.72)		0.454	3.11 (0.81)	3.04 (0.75)		–0.091
MCT2	2.95 (0.76)	3.30 (0.75)		0.464	3.02 (0.86)	3.18 (0.72)		0.209
FCT1	2.67 (0.92)	2.69 (0.97)		0.021	2.59 (1.03)	2.71 (0.93)		0.126
FCT2	2.78 (0.88)	2.70 (0.95)		–0.087	2.44 (1.02)	2.84 (0.85)		0.443
CaPT1	64.02 (21.13)	52.72 (18.74)		–0.567	52.98 (20.09)	59.49 (21.11)		0.312
CaPT2	61.85 (19.95)	51.96 (19.41)		–0.504	55.49 (21.61)	57.63 (19.67)		0.106

Note. Sc.School = Integrated secondary school; Gym = gymnasium; Intr = intrinisc value; Uti = utility value; PV = student-perceived parents' mathematics value; MC = student-reported mother–child conversations; FC = student-perceived father–child conversations; CaP = Student-reported mathematics-related career plans.

Table 2

Intercorrelations between Latent Factors and Manifest Variables (N = 475)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1) Girls															
2) Book	.01														
3) Ach	–.06	.25***													
4) Schl	.11	.23**	.12												
5) InT1	–.17***	.14*	.53***	.17***											
6) InT2	–.16**	.18***	.53***	.17*	.78***										
7) UtT1	–.17*	.10	.36***	.02	.57***	.47***									
8) UtT2	–.20*	.17*	.38***	.17**	.53***	.60***	.65***								
9) PT1	–.17***	–.10	.21***	–.01	.38***	.32***	.40***	.39***							
10) PT2	–.24***	.01	.26***	.06	.38***	.33***	.37***	.49***	.74***						
11) MT1	.22***	.03	–.05	–.04	–.09	–.04	–.05	–.04	.01	–.02					
12) MT2	.23***	.15**	–.01	.09*	.04	.08	.10	.06	.11	–.01	.56***				
13) FT1	.01	.07	.09**	.06	.05	.03	.05	.06	.09	.05	.39***	.23***			
14) FT2	.01	.09	.17***	.18***	.15***	.13*	.12*	.12*	.08	.08	.17**	.36***	.69***		
15) CT1	–.23**	.07	.32***	.13*	.31***	.33***	.34***	.42***	.16	.18*	–.10*	–.06	.01	.12*	

16) CT2	–.28***	.09	.37***	.08	.38***	.37***	.36***	.53***	.22**	–.32***	–.03	.01	–.01	.10	.76***

Note. *p < .05; ** p < .01; *** p < .001. Ach = students' self-reported achievement; Schl = school type; In = intrinisc value; Ut = utility value; P = student-perceived parents' mathematics value; M = student-reported mother–child conversations; F = student-perceived father–child conversations; C = Student-reported mathematics-related career plans.

Table 3

Model Fit Indices for Measurement Invariance Testing (Full Sample/Girls/Boys)

	χ^2	*df*	$\Delta\chi^2$	Δ*df*	CFI	TLI	RMSEA
1	290.53/315.60/227.74	184	–	–	.98/.95/.98	0.97/ 0.94/0.98	0.035/0.055/0.033
2	295.66/323.47/236.63	192	3.4/ 7.6/8.6	8	.98/.95/.98	0.97/0.94/0.98	0.034/0.054/0.033
3	320.15/340.01/250.81	199	27.3*/ 20.7*/15.6*	7	.98/.95 /.98	0.97/0.94/0.97	0.036/0.053/0.035
3a	303.90/329.33/239.44	197/197/198	8.4/5.9/6.9	5/5/6	.98/.95/.98	0.97/0.94/0.98	0.034/0.053/0.031

Note. 1 = no equality constraints but configural invariance; 2 = loadings invariant across time; 3 = loadings and intercepts invariant across time; 3a = loadings and intercepts partially invariant across time.

Table 4

Multiple-Group Analyses with Gender as the Grouping Variable

Step	χ^2	*df*	$\Delta\chi^2$	Δdf	CFI	TLI	RMSEA	SRMR
1	568.999	597	–	–	.966	0.960	0.044	0.064
2	577.816	405	8.37	8	.966	0.961	0.043	0.064
3	581.800	412	3.98	7	.966	0.962	0.043	0.065
4	1052.058	704	–	–	.944	0.926	0.046	0.060
5	1057.174	705	13.82*	1	.943	0.926	0.047	0.061
6	1056.113	705	10.20*	1	.943	0.926	0.047	0.060
7	1059.566	705	7.50*	1	.943	0.925	0.047	0.061
8	1061.719	705	29.28*	1	.943	0.925	0.047	0.062
9	1058.308	705	5.14*	1	.943	0.925	0.047	0.060
10	1057.627	705	3.88*	1	.943	0.926	0.047	0.061

Note. 1 = measurement model variant; 2 = loadings invariant; 3 = loadings and intercepts invariant; 4 = structural paths included; 5 = path between student-perceived parents' mathematics value beliefs (T1) and utility value (T2) restricted; 6 = path between intrinsic value (T1) and frequency of conversations with fathers (T2) restricted; 7 = path between student-perceived parents' mathematics value beliefs (T1) and frequency of conversations with fathers (T2) restricted; 8 = path between student-perceived parents' mathematics value beliefs (T1) and frequency of conversations with mothers (T2) restricted; 9 = path between mathematics mathematics-related career plans (T1) and frequency of conversations with mothers (T2) restricted; 11 = path between students' intrinsic value (T1) and mathematics-related career plans (T2) restricted.

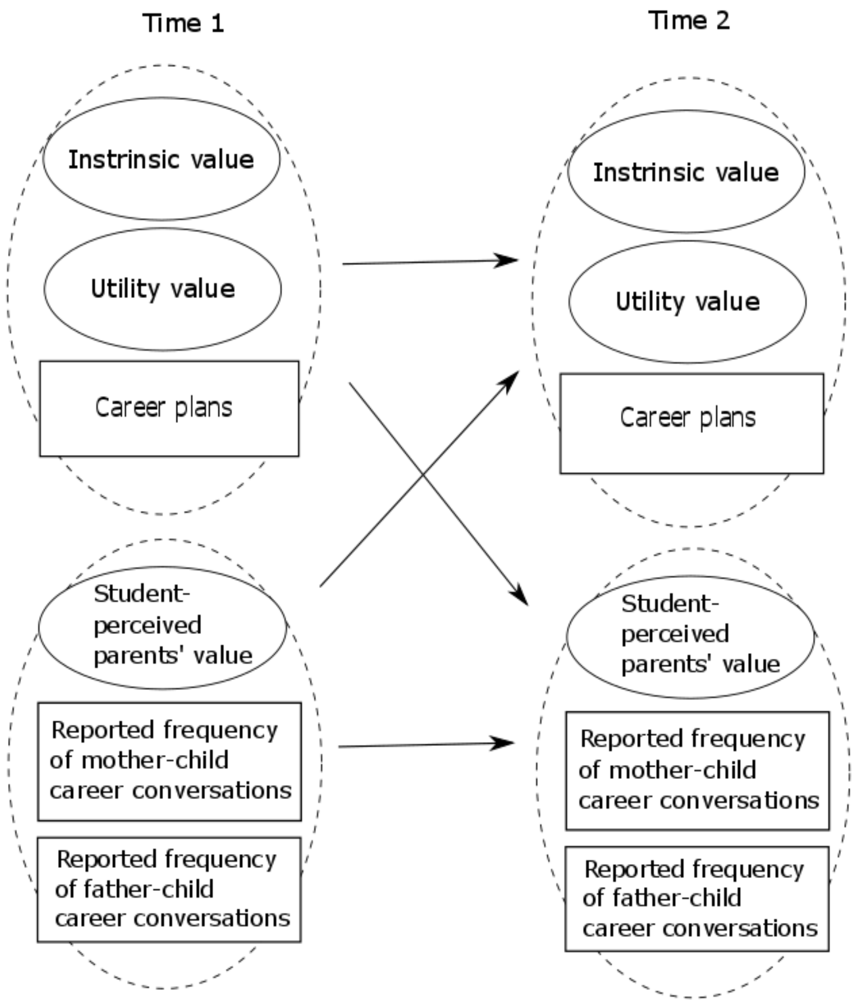

Figure 1. Hypothesized theoretical model.

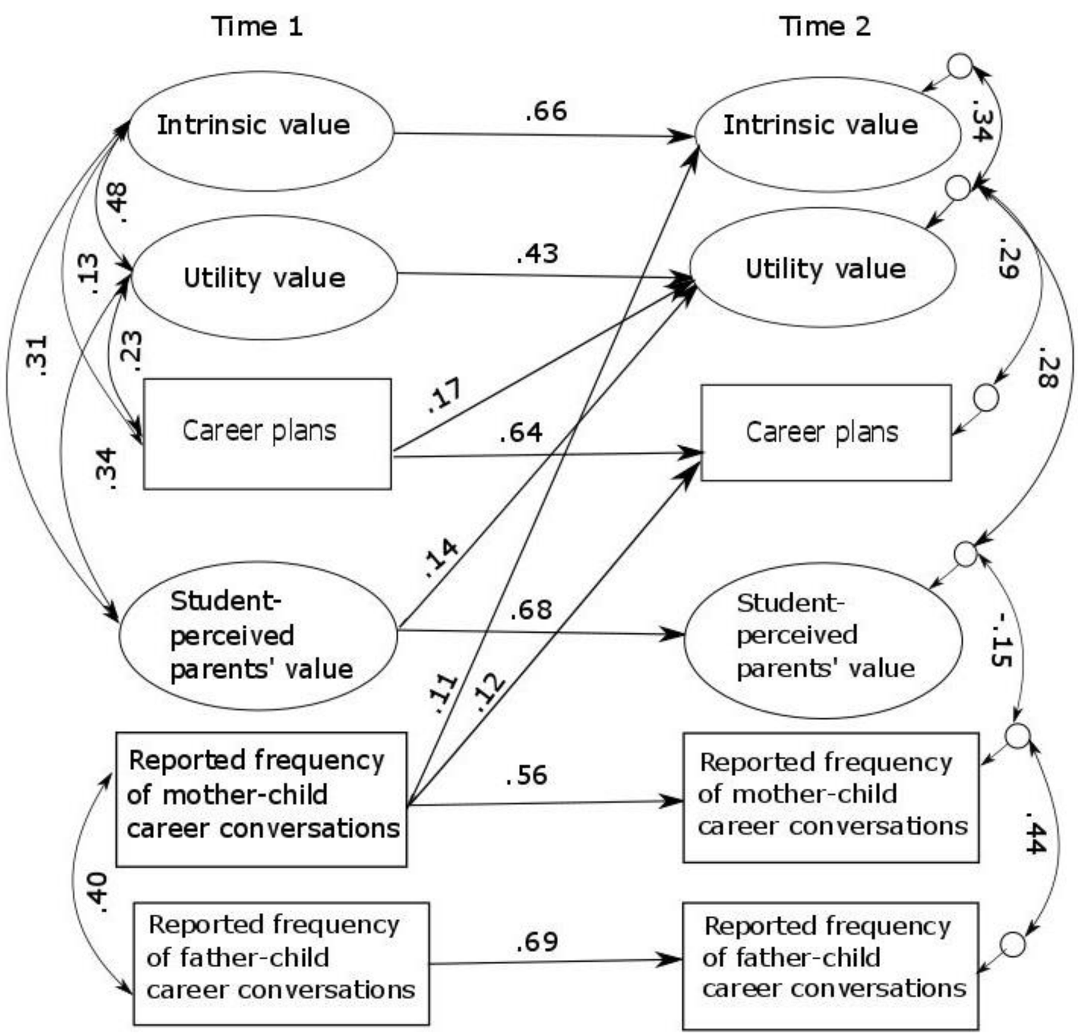

Figure 2. Relationships between student-perceived parents' mathematics value beliefs, student-reported frequency of parent–child career conversations, students' mathematics intrinsic and utility value, and mathematics-related career plans. Gender, self-reported mathematics achievement, number of books at home, and school type are included as control variables, but coefficients are reported only in the main text. Displayed paths are standardized. All paths were statistically significant at $p < .05$.

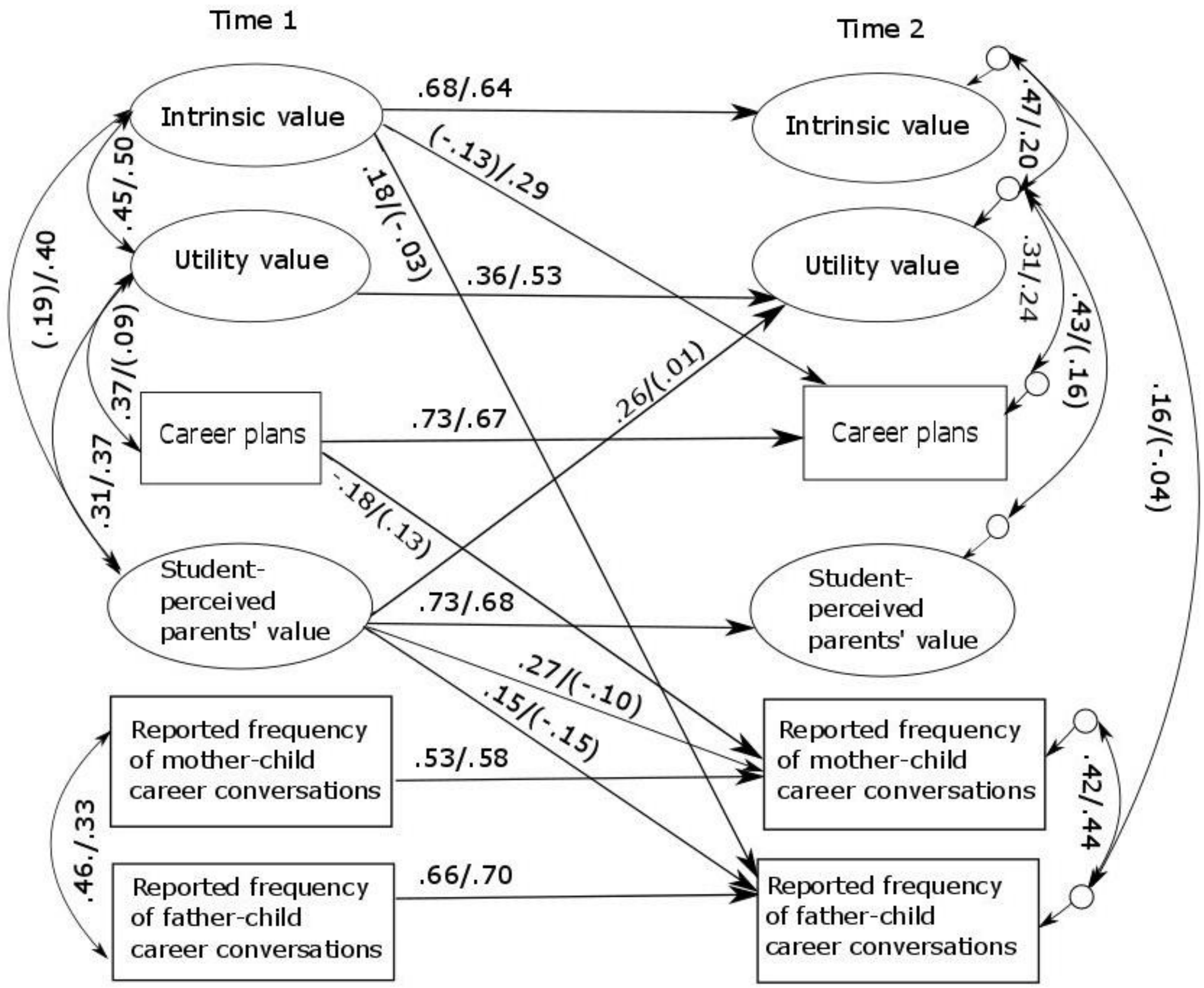

Figure 3. Results for boys and girls (boys/girls)—relationships between student-perceived parents' mathematics value beliefs, student-reported frequency of career conversations with mothers and fathers, students' mathematics intrinsic and utility value, and mathematics-related career plans. Self-reported mathematics achievement, number of books at home, and school type are included as control variables. For reasons of clarity, only stability paths and those paths that are statistically significantly moderated by students' gender are displayed in the Figure. All other coefficients are reported in text. Paths are standardized. Nonsignificant coefficients are parenthesized. All other paths were statistically significant at $p < .05$.