Vol. 12, No. 4, August 2006, pp. 323–345

Taylor & Francis Group

Gender and Course Selection in Upper Secondary Education: Effects of academic self-concept and intrinsic value

Gabriel Nagy[a]*, Ulrich Trautwein[a], Jürgen Baumert[a], Olaf Köller[b], and Jessica Garrett[c]

[a]*Max Planck Institute for Human Development, Berlin, Germany,* [b]*Humboldt University, Berlin, Germany, and* [c]*University of Michigan, Ann Arbor, USA*

Predictions about processes linking gender to students' choices of advanced courses were derived from the internal/external frame of reference (I/E) model and expectancy value (EV) theory. The predictions were tested for the domains of mathematics and biology using data from 1,148 students attending academically oriented secondary schools in Germany. Results revealed substantial gender differences on measures gathered in Grade 10. Males outperformed females on the mathematics and biology achievement tests, and reported higher math self-concepts and intrinsic values. Females scored higher on the biology self-concept and intrinsic value scales. Consistent with our expectations, gender differences in Grade 10 mediated the effect of gender on course enrollment in Grade 12. In line with the EV model, self-concepts and intrinsic values had substantial effects on subsequent course choices. As predicted by the I/E model, domain-specific self-concepts and intrinsic values were positively related to course choices in the same domain, but negatively related to choices in the other domain. In addition, results of multigroup structural equation models revealed that the processes underlying course choices were different for males and females. Finally, students' choices of specialized courses were related to their aspired field of college education.

Introduction

The impact of college course selection on students' later career choices, job security, and income is well known. Expectancy – Value Theory (Eccles (Parsons) et al., 1983) has been applied to predict course selection at the college level, as well as career choices (e.g., Watt, this issue), and has highlighted the role of gender in these

*Corresponding author. Center for Educational Research, Max Planck Institute for Human Development, Lentzeallee 94, 14195 Berlin, Germany. E-mail: nagy@mpib-berlin.mpg.de

ISSN 1380-3611 (print)/ISSN 1744-4187 (online)/06/040323–23
© 2006 Taylor & Francis
DOI: 10.1080/13803610600765687

processes. Yet, gendered choices are also apparent prior to college entrance. Influenced by cultural norms surrounding gender and gender-specific parenting (e.g., Eccles, 1987; Jacobs, Chhin, & Bleeker, this issue), specific patterns of self-concepts and values are developed early in students' school careers, leading to gendered *high school* course selection. The choice of high school courses, in turn, often determines students' field of study at college and, consequently, their future occupations (e.g., Schnabel & Gruehn, 2000). Thus, it is important to understand the mechanisms that underlie students' choices of specialized high school courses because these early decisions can be seen as the first steps in the long process of establishing an occupational career. In particular, gender-differentiated enrollment rates in specialized courses may be interpreted as an early sign for the emergence of gender-differentiated segments within the labor market.

In the present study, we focus on the role of domain-specific academic self-concepts and intrinsic values, which are assumed to mediate the effects of gender. We integrate two important theoretical models—Marsh's (1986) Internal/External Frame of Reference Model (I/E model) and Eccles (Parsons) et al.'s (1983) Expectancy–Value Theory (EV theory)—and apply the combined model to a large sample of students at the Gymnasium, the most academically competitive, college-bound track of the German three-tiered school system. Two aspects of the German system are of critical importance here. First, all Gymnasium students are required to take two (and only two) advanced courses at upper secondary level; this prompts them to engage in ipsative-like decision processes. Second, science education in Germany is split into the three subjects of physics, chemistry, and biology; this makes it possible to explore gendered choices within the sciences.

Internal/External Frame of Reference Model and Expectancy–Value Theory

The Internal/External Frame of Reference Model (Marsh, 1986) describes and explains the pattern of relationships that is usually found when academic achievement and domain-specific self-concepts in mathematics and verbal domains are studied. First, academic self-concepts are closely connected to achievement in the same domain. In their review of 34 independent studies on the I/E model, Möller and Köller (2004) found a median correlation of $r = .47$ between math achievement and math self-concept and a median correlation of $r = .39$ between achievement in the first language and verbal self-concept. Second, math and verbal achievement are highly correlated. This was the case in 33 of the 34 studies reviewed by Möller and Köller (between $r = .31$ and $r = .94$, $Md = .63$). Third, math and verbal self-concepts tend to be only weakly related; Möller and Köller found a median correlation of $r = .10$.

The I/E model (Marsh, 1986) explains this seemingly paradoxical pattern as the joint effect of two processes. First, students compare their own achievement with the perceived achievement of other students. Thus, their classmates provide a frame of reference for a social comparison process, which results in higher self-concepts among higher achieving students. Second, students compare their perceived achievement in one domain (e.g., verbal achievement) with that in another domain (e.g., mathematics). This internal frame of reference results in a negative path from achievement in one domain to self-concept in the other (e.g., the better my achievement in math, the lower my verbal self-concept, controlling for verbal achievement). Although individuals with high math achievement also tend to have high verbal achievement, "people think of themselves as either 'math' persons or 'verbal' persons—but not both" (Marsh & Hau, 2004, p. 57).

Strong empirical support for the I/E model has been provided by both experimental (e.g., Möller & Köller, 2001) and longitudinal studies (e.g., Marsh & Yeung, 1997), and its cross-cultural generalizability has been demonstrated by Marsh and Hau (2004). The particular strengths of the I/E model include the internal, ipsative-like process of internal comparison. Clearly, the I/E model has important implications for studies on behavioral outcomes, such as effort and persistence, on scholastic work or high school course selection. However, only recently have studies begun to explore this potential (see Marsh & Yeung, 1997).

Unlike the I/E model, Eccles' Expectancy–Value (EV) model (Eccles & Wigfield, 2002) has always focused on explaining behavior and academic choices. It provides a useful theoretical framework for combining the influences of academic intrinsic values and expectancies of success as predictors of academic decision-making. In the EV model, expectancy and task value are related, but clearly separable components (Eccles & Wigfield, 1995), which have been demonstrated "to directly influence performance, persistence and task choice" (Eccles & Wigfield, 2002, p. 118). Depending on the investigated domain, the relative strengths of the predictive power of the two constructs differ (e.g., Feather, 1988). In general, there is some empirical support for the assumption that the expectancy component is a better predictor for achievement, whereas the value component is more closely associated with academic choices (e.g., Eccles, 1987; Eccles & Wigfield, 2002). More generally, Eccles' EV theory considers the social and psychological factors that affect an individual's expectancies of success and task value.

Expectancies of success are defined as individuals' beliefs about how well they will perform on a future task (Eccles & Wigfield, 2002). Early writings on the EV model differentiated between self-concept and expectancy of success. However, based on empirical studies in which the two components showed very high intercorrelations, self-concept and expectancy have sometimes been collapsed into a single construct. In this study, we do not differentiate between the two constructs, but use the terms synonymously. *Task value* is broken down into four components: intrinsic value, attainment value, utility value, and cost (Eccles & Wigfield, 2002). Intrinsic value is defined as the enjoyment a person gets from performing the activity or an individual's subjective interest in the subject. The key role of interest in learning is embedded in several motivational theories and has been highlighted in a large number of studies. Attainment value is defined as the personal importance of succeeding at a task; utility value indicates how well a task relates to goals; and, finally, cost is defined as the perceived negative consequences of engaging in the task, including performance anxiety, fear of failure, the effort necessary for success, and the opportunity cost of choosing that option. In empirical studies, the value component has been operationalized in several different ways (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Watt, 2004). Whereas some researchers have focused on one specific component or treated all four components separately, it is also quite common to use a combined measure that integrates, for instance, the attainment and utility values.

There is some commonality between the I/E and the EV models. In both models, the outcomes (self-concept, educational choices) are postulated to be influenced by ipsative-like processes. These processes are clearly apparent in the internal comparison processes postulated by the I/E model. However, they are also inherent in the EV model, in which choices are assumed to be influenced by positive and negative task characteristics, and to have associated opportunity costs in that one choice necessarily eliminates other options (Eccles & Wigfield, 2002). Moreover, academic interests play an important role in both models. This is clearly apparent in the EV model, where interest is an important part of the value component (intrinsic value). Less obviously, interest is also relevant to work on the I/E model, in that the self-concept component of the I/E model is often measured with Marsh's Self-Description Questionnaire, which also contains items that tap interest (e.g., "I find many mathematical problems interesting and challenging") as well as items focusing on ability (e.g., "I am quite good at mathematics"). Recent studies (e.g., Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) have called for self-concept and interest to be separated, because confirmatory factor analyses show two clearly distinguishable factors.

What is the relationship between intrinsic value and self-concept? Is there a causal predominance of either construct? Despite the lack of intensive research, there is some indication that—at least in mathematics—the effect of self-concept on interest or intrinsic value is stronger than *vice versa* (e.g., Marsh et al., 2005). This is also in line with the original EV model proposed by Eccles (Parsons) et al. (1983), in which the value component was assumed to be influenced by self-concept. However, there is still a need for research on how, and under what conditions, self-concept and intrinsic value impact on each other. In Figure 1, we present the combined I/E and EV model. Because our own study contrasts math and biology, these two subjects are used as domains. Even stronger effects are to be expected when contrasting, for instance, math and languages.

According to the research model, achievement is posited to have a positive influence on the self-concept in the same domain and a negative effect on the self-concept in the other domain. Self-concept is hypothesized to impact intrinsic value, which, in turn, is believed to affect high school course choice. Moreover, we expect the paths relating neighboring constructs to be strongest, but do not think that significant paths will be restricted to these relations.

In the present study, we combine the I/E model and the EV model by using two academic areas (as in the I/E model) as well as self-concept and intrinsic value (as in the EV model) to predict high school course choice. Furthermore, we believe that the effects of achievement and self-concept on academic choices are partially or wholly mediated by intrinsic values.

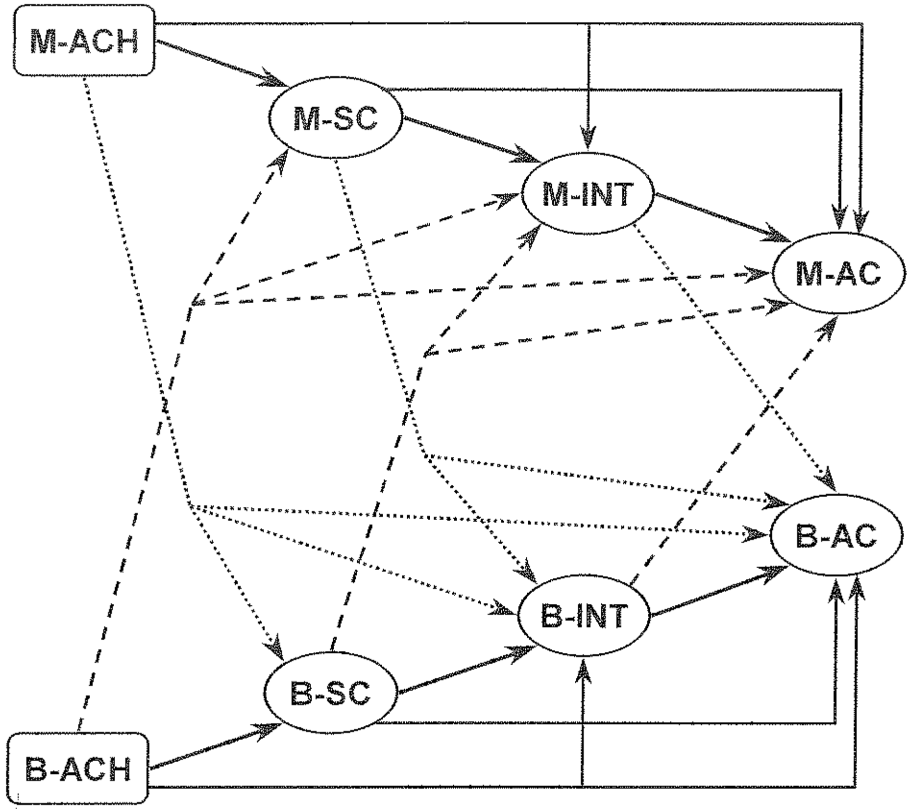

Figure 1. Research model combining I/E model and EV theory.
Note: The first letter indicates the school subject (M: Mathematics; B: Biology). ACH: achievement; SC: self-concept; INT: intrinsic value; AC: advanced course

The Effects of Gender

The I/E model and EV theory are both useful frameworks for conceptualizing the relationship between achievement, academic self-concepts, intrinsic values, and high school course choice. Theoretically, two different sorts of gender effects might be observed within our combined model. First, gender might impact on domain-specific self-concepts and intrinsic value, which, in turn, influence academic choices. Indeed, gender effects consistent with gender stereotypes (higher math self-concepts and values in males, higher language self-concepts and values in females) have been found in cross-sectional and longitudinal studies (e.g., Jacobs et al., 2002; Marsh et al., 2006; Trautwein, 2003; Watt, 2004; Wigfield, Eccles, & Pintrich, 1996).

The second way in which gender might impact on our model is via moderator effects. The predictive power of, say, math self-concept for students' choice of mathematics course at upper secondary level might be higher in males than in females (or vice versa). Such moderator effects would reflect different decision-making processes in males and females (see Larose, Ratelle, Guay, Senécal, & Harvey, this issue; Watt, this issue). Studies of the original I/E model testing for a moderator effect of gender have typically found no evidence for such effects (Möller & Köller, 2004). However, no previous studies have investigated the moderator effect of gender using the present model, which combines I/E and EV effects and the juxtaposition of math and biology.

Important Features of the German Upper Secondary School System

Decision-making processes can also be influenced by contextual variables (see Wigfield et al., 1996). In fact, educational systems with their specific affordances and constraints are of particular interest when it comes to explaining differential decision-making processes (Schnabel, Alfeld, Eccles, Köller, & Baumert, 2002). Clearly, important academic decisions are not made in isolation from an individual's personal and cultural context. The participants in our study are students at the Gymnasium, the most academically competitive, college-bound track in Germany—only about one third of all students enter this track. Course selection is an integral part of the last two years at the Gymnasium (Grades 12 and 13), with students selecting two advanced courses in addition to their core classes. Thus, in contrast to the United States, for example, even students who perform well across the board are forced to specialize. Although certain restrictions apply, students can choose from a wide range of academic subjects. Prior studies have shown that course selection at the Gymnasium is clearly based on academic interests and self-concepts and closely related to the choice of future academic fields (Watermann & Maaz, 2004).

Two specific features of the German school system are of particular relevance in the present context. First, the need to choose two (and only two) advanced courses forces students to engage in ipsative-like decision-making processes—which are typical at college entrance— while still at high school (see Köller, Baumert, & Schnabel, 2001). Second, there is no combined science education in Germany; rather, the sciences are split into three domains of physics, chemistry, and biology, and are typically taught by different teachers. Students at upper secondary level are not permitted to take advanced courses in more than one of the sciences. This differentiation within the domain of 'hard' sciences makes it possible to explore gendered attitudes and choices concerning these subjects. Data on ninth-grade Gymnasium students from the national German extension (Baumert et al., 2002) to the OECD's Programme for International Student Assessment (PISA) indicated that males outperform females in all three domains, but that these differences are much smaller in biology than in physics or chemistry. When students from all school types are included in the analysis, gender differences in biology (but not physics or chemistry) achievement disappear. This pattern may contribute to the perception of biology as being a rather "female science", which would, in turn, have implications for course enrollment.

Aims of the Present Study

The focus of this study is to investigate relations between domain-specific achievement, self-concept, intrinsic value, and academic choices in upper secondary school; these choices can open or close career paths in college and beyond (Eccles, Vida, & Barber, 2004). In the present investigation, we examine advanced course selection in mathematics and biology and test four sets of hypotheses. First, we expect to find several gender differences on the bivariate level. More specifically, we expect males to report higher math self-concept and intrinsic value than females, and to be more likely to opt for an advanced mathematics course, while we expect the opposite pattern to emerge for biology. Second, we believe that applying our combined I/E and EV model to the prediction of biology and math courses will advance research on gendered outcomes. This is conditional on the following three findings emerging:

a. The explicit addition of an intrinsic value component to the I/E model must predict academic decision-making outcomes above and beyond self-concept.
b. As in the mathematics and verbal domains, social comparison processes (the "E" component of the I/E model) must be accompanied by internal, ipsative-like comparison processes (the "I" component), resulting in negative cross-domain path coefficients between math and biology. For instance, achievement in one domain must negatively influence self-concept and intrinsic value in the other; likewise, self-concept in one domain must negatively predict intrinsic value and course choice in the other. The I/E model is usually applied to verbal versus mathematical self-concept because these two domains are perceived to be very different—a prerequisite for negative cross-domain paths. It will be interesting to see whether these negative cross-domain paths also emerge in the present study, which examines biology and math.
c. Effects of gender must be partially or completely mediated by self-concept and/or intrinsic value.

The third question concerns possible moderator effects. Is the prediction model emphasizing the role of self-concept and achievement equally valid for male and female students? Do the same processes take place? As a rule, research on the I/E model has not found support for moderation effects (Möller & Köller, 2004). However, the new combination of domains (math vs. biology), the extension of the model (to include a separate intrinsic value construct), and the particular situation of the students (imminent choice of advanced courses) certainly make it worth investigating possible moderator effects of gender.

Our final aim is to investigate students' aspired university majors. We aim to examine whether gender differences in relative course enrollment are mirrored by gender differences in college aspirations. Furthermore, the association between choices of specialized courses in mathematics or biology and long-term educational plans will be examined. Because we expect students' choices of advanced courses to be linked to their career aspirations, we also expect these choices to be associated with their aspired fields of study. For the same reason, we predict gender differences in study plans.

Method

Sample and Procedures

The empirical basis for the present investigation is the longitudinal study "Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and

Young Adulthood" (BIJU), conducted by the Max Planck Institute for Human Development in Berlin, Germany (Baumert, Gruehn, Heyn, Köller, & Schnabel, 1997). For the purposes of the present investigation, only students attending academic-track schools (Gymnasium) were included. Students attending the vocational track typically leave school after Grade 10 and do not have the opportunity to choose between core and advanced courses at school. The schools were located in four different federal states; two in East Germany and two in West Germany. Schools were randomly sampled in each participating state. The sample used in the present investigation is restricted to schools offering an advanced biology course in Grade 12.

The first data collection took place at the end of Grade 10, the second in the middle of Grade 12. At each occasion of measurement, students completed standardized achievement tests for several subjects and also completed questionnaires covering a wide range of psychological constructs and sociodemographic variables. Our final sample of $N = 1{,}148$ participants (60% female) from 46 schools consists of those students who completed the mathematics and biology achievement tests. This group constitutes about half of the BIJU sample, because students were randomly assigned either to complete a math and a biology test *or* a math and an English test.

Instruments

Mathematics achievement scores. The items of the mathematics achievement test were taken from previous studies conducted by the International Association for the Evaluation of Educational Achievement (IEA)—the First and Second International Mathematics Study and the Third International Mathematics and Science Study—and from an investigation carried out at the Max Planck Institute for Human Development (see Baumert et al., 1997). Thirty items were administered in Grade 10. Analyses based on Item Response Theory (IRT) demonstrated that a unidimensional Rasch model was appropriate for summarizing the test data. IRT-scaled test scores were used in the analyses.

Biology achievement scores. The items constituting the biology achievement test were taken from several sources: the Second International Science Study and the Six Subjects Survey conducted by the IEA, the National Assessment of Educational Progress study, and an item pool constructed at the Max Planck Institute (see Baumert et al., 1997). The biology test encompassed 21 items. Again, IRT-scaled test scores were produced by applying the unidimensional Rasch model.

Domain-specific self-concepts of ability. Self-concepts of ability for math and biology were measured at the end of Grade 10 using an established German self-concept instrument (item sample: "Nobody's perfect, but I'm just not good at math"). Each domain-specific scale contained five items. Students responded to each item on a four-point response scale. The wording of the items for the two subjects was strictly parallel except for the name of the subject itself (i.e., math or biology). We used the self-concept items as indicators of latent self-concept factors specific to the domains of mathematics and biology. Effects of parallel wording were controlled by introducing residual correlations between school subjects.

Intrinsic value of mathematics and biology. Intrinsic value at the end of Grade 10 was measured by means of a four-item scale with five-point ratings, one example being, "How much do you look forward to mathematics [biology] class?" The scale primarily measures interest in the specific subject, but also touches on the attainment value component (one item was, "How important is it to you to gain a deeper understanding in mathematics [biology]?"). Again, the wording of the items for the two subjects was strictly parallel except for the subject name. Math and biology intrinsic value items were used to create two latent factors, and residual correlations were introduced to account for the effects of parallel wording. Because items 1 and 4 had identical stems, these residuals were additionally allowed to correlate within each intrinsic value construct.

Course level in mathematics and biology. Course selection at upper secondary level was measured in Grade 12. Students reported whether they had chosen an advanced mathematics or biology course. Although there are no entrance tests to restrict course admission, some restrictions apply to the overall pattern of course selection. Most importantly, students are required to attend classes in the three domains of humanities, sciences, and social sciences, and they are not allowed to completely drop math from their curriculum.

Statistical Analyses

Structural equation modeling (SEM) analyses were performed using the Mplus 3.0 software (Muthén, & Muthén, 1998–2004), since Mplus uses algorithms capable of dealing with dichotomous variables such as the course selection variables. All SEM analyses that included categorical variables were estimated using weighted least squares with robust standard errors (WLSM).

Longitudinal studies almost always face the problem of missing data. Popular approaches to missing data such as listwise and pairwise deletion may bias the results (Allison, 2001). We used multiple imputation (MI) methodology, which—in contrast to single imputation strategies—accounts for uncertainty with respect to the missing values so that derived test statistics are unbiased. Five imputed data sets (see Allison, 2001) were created using the NORM 2.03 program (Schafer, 1999).

Our data, as is typical for educational research, contains students nested within schools. Such clustered data violate the assumption of independence of observations (Bryk & Raudenbush, 1992). Disregarding this is likely to result in negatively biased SEM goodness of fit indices, and positively biased significance tests. The Mplus software is able to account for the clustering effect, so that our fit statistics and standard errors are not affected by the hierarchical sampling strategy implemented in the BIJU study.

Results

Gender Differences

Descriptive statistics for the variables investigated are given in Table 1. All multi-item measures exhibited good internal consistencies. Table 1 also presents gender differences. For continuous variables, gender differences are given in standard deviation units. The metric is similar to Cohen's *d*, with the exception that measurement error is controlled for self-report scales by using latent variables. Positive numbers indicate higher values in males. Gender differences in course enrollment are given as odds ratios. The coefficients represent the relative chance of males enrolling in an advanced mathematics or biology course.

Males outperformed females in both math and biology. The relatively good overall performance of males compared with females in the German Gymnasium is largely attributable to the fact that more females than males attend the academic track. In other words, there is a higher selectivity for males than for females in the Gymnasium (e.g., Hosenfeld, Köller, & Baumert, 1999). Males reported higher math self-concepts ($d = .52, p < .01$) and higher math intrinsic value ($d = .21, p < .05$) than females, whereas females reported higher biology self-concepts ($d = -.15, p < .05$) and higher biology intrinsic value ($d = -.51, p < .01$)—despite being outperformed by the males in the biology achievement test. This suggests that self-concept and intrinsic value in a domain are not merely reflections of achievement in that domain.

Thirty-four percent of the students in the sample selected an advanced math course in Grade 12, and 45% opted for a specialized biology course. As indicated by the significant odds ratios, course selection in both domains was highly gendered. Males were about twice as likely as females to choose an advanced math course ($OR = 2.16$, $p < .01$), and the reverse pattern was found for biology ($OR = .37$, $p < .01$). Taken together, males outperformed females on all measures related to mathematics, and were

Table 1. Gender differences for continuous measures given in standard deviation units, and gender differences for course enrollment given as odds ratios

	M	*SD*	Reliability	Gender diff.
Math achievement	1.20	.85	.80[b]	.49**
Biology achievement	1.63	.84	.74[b]	.35**
Math self-concept	2.88	.75	.87[a]	.52**[c]
Biology self-concept	3.20	.58	.88[a]	−.15*[c]
Math intrinsic value	3.15	.80	.83[a]	.21*[c]
Biology intrinsic value	3.26	.87	.90[a]	−.51**[c]
Advanced math course	.34	–	–	2.16**
Advanced biology course	.45	–	–	.37**

[a]Cronbach's α. [b]KR-20. [c]Differences based on latent variables.
$p < .10$. *$p < .05$. **$p < .01$.

more likely to choose an advanced math course. Females, on the other hand, scored higher on the biology self-concept and intrinsic value scales, and were more likely to opt for an advanced biology course. Thus, the results support our first hypothesis.

Gender, Achievement, Self-concept, Intrinsic Values, and Course Enrollment

We now turn to our second hypothesis and examine the impact of school achievement, self-concepts, and intrinsic values on course selection. These variables were expected to mediate the effect of gender on course selection. In a first step, a confirmatory factor model (CFA) was specified to estimate latent correlations between the variables in the model, with polychoric correlations estimated for the dichotomous variables (gender and course enrollment). The data showed a good fit to the model, $\chi^2(df = 188) = 868.3$, $RMSEA = .056$, $CFI = .963$; all factor loadings were substantial and highly significant. Construct correlations based on the CFA model are presented in Table 2. Mathematics and biology achievement were positively correlated ($r = .31$, $p < .01$). Math achievement showed substantial positive correlations with the mathematical self-concept, math intrinsic value, and choice of mathematics course. Lower correlations were found for biology. As predicted by our extended I/E model, subject-specific self-concepts and intrinsic values were positively correlated with course enrollment in the same domain, but negatively related to course enrollment in the other domain.

Table 2. Construct correlations based on CFA model (WLSM estimates)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Gender (0: fem., 1: male) [1]	–							
Math achievement [2]	.30**	–						
Biology achievement [3]	.22**	.31**	–					
Math self-concept [4]	.34**	.31**	.18**	–				
Biology self-concept [5]	−.09†	.02	.19**	.10**	–			
Math intrinsic value [6]	.18**	.21**	.10**	.68**	−.03	–		
Biology intrinsic value [7]	−.34**	−.11**	.13**	−.11**	.47**	.07†	–	
Advanced math course [8]	.28**	.26**	.09*	.65**	−.12*	.61**	−.24**	–
Advanced biology course [9]	−.35**	−.16**	.09†	−.37**	.24**	−.26**	.55**	−.46**

Note: $\chi^2(df = 188) = 868.3$, $RMSEA = .056$.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$.

In the second step, regression parameters were included to represent the theoretical assumptions shown in Figure 1. It was assumed that the causal order of the variables in a school subject leads from achievement to self-concept to intrinsic value to course choice, and that negative cross-domain paths would be found. Parallel constructs across domains were allowed to correlate. Finally, gender effects on all other variables were freely estimated. Based on the mediation assumption, we expected gender effects on course selection to be partly or fully mediated by the other variables in the model.

The mediation model yielded a good fit:[1] $\chi^2(df = 188) = 845.4$, $RMSEA = .056$, $CFI = .964$. As shown in Figure 2, the findings provide strong support for our second hypothesis. First, intrinsic value had a solid impact on course enrollment, above and beyond the impact of self-concept. Second, cross-domain effects were found. Interestingly, these cross-domain paths emerged for the relationship between self-concept, intrinsic value, and course enrollment, but not for the effects of achievement on self-concept (see, however, the analyses reported below). Third, the effects of gender were completely mediated by the achievement, self-concept, and intrinsic value components of the model. Of particular interest is the comparably strong

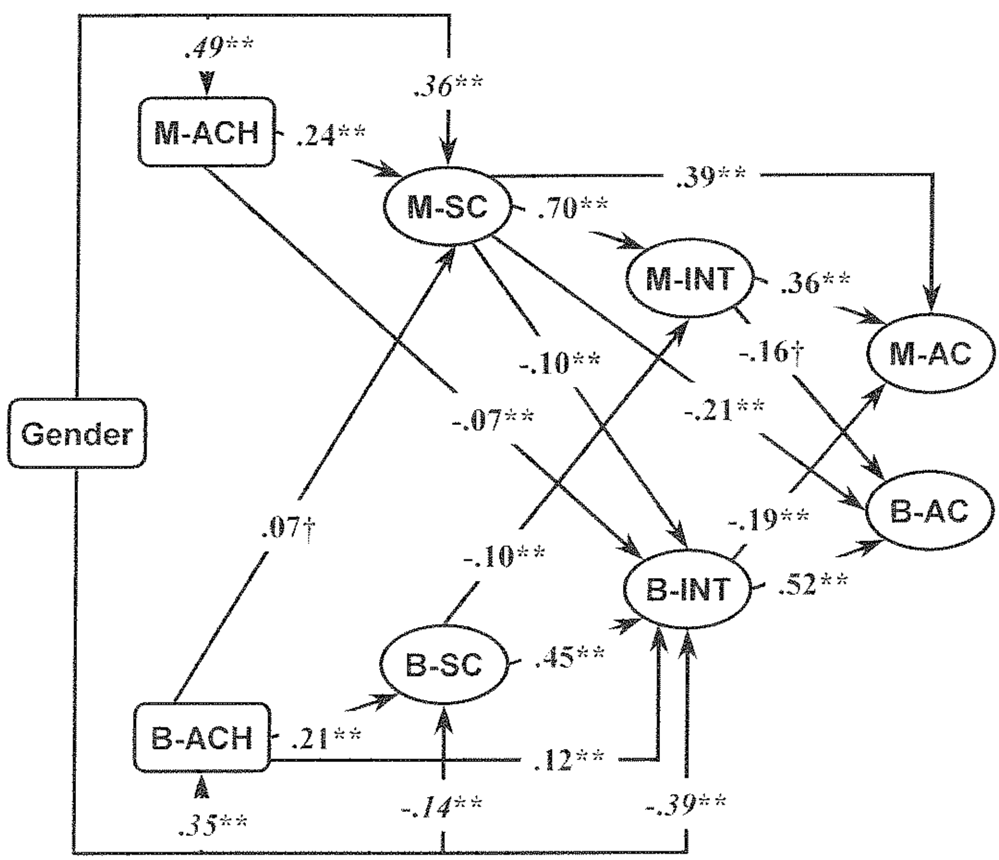

Figure 2. Path diagram of the structural model. *Note*: Nonsignificant paths and correlations are not depicted. Parameters printed in italics are y-standardized, all other coefficients are fully standardized. The first letter indicates the school subject (M: Mathematics; B: Biology). ACH: achievement; SC: self-concept; INT: intrinsic value; AC: advanced course. †$p < .10$. *$p < .05$. **$p < .01$

negative path from gender to biology intrinsic value, which implies that males reported lower intrinsic value in biology when achievement and self-concept in math and biology were controlled.

Overall, then, empirical support was found for our model integrating the I/E and EV approaches and for the mediation hypothesis. Interestingly, although cross-domain paths reflecting internal comparison processes were found for the effects of self-concept on intrinsic value and course enrollment and for the effects of intrinsic value on course enrollment, no such effects were found for the relation between achievement and self-concept. That is, in contrast to more common applications of the I/E model, in which the mathematical and verbal domain are contrasted, no negative cross-domain effects on the formation of self-perceptions were found. However, our data do provide evidence for the existence of contrast effects of self-perceptions (self-concepts and intrinsic values) on course enrollment. We consider this finding in more detail below.

Gender-Differentiated Patterns in the Prediction of Course Enrollment

Our third research question concerned possible moderator effects of gender for course enrollment. Do males and females weight their achievement, ability perceptions, and subject-specific intrinsic values differently when choosing advanced courses? In order to investigate this question, we specified three two-group models in which we regressed course selection in math and biology on school achievement (model M1), self-concepts (M2), and intrinsic values (M3). Models that incorporate latent predictors (M2 and M3) were specified to have the same measurement properties across groups. Factor loadings and measurement intercepts were constrained to be equal across groups, and all structural parameters were allowed to vary. Because the chi-square difference test typically used cannot be applied with the WLSM estimator, a different strategy for group comparisons was employed. Group-specific regression parameters were freely estimated and a z test (Cohen & Cohen, 1983) used to determine whether the parameters differed significantly across groups.

In M1 (see Figure 3), course selection was regressed on achievement. Fit statistics cannot be derived for this model because it is saturated. The comparison of effects leading from school achievement to course selection revealed a significant gender difference ($z = 2.35$, $p < .05$). The effect of math achievement on the choice of an advanced biology course was not significant for females, but was substantial for males ($OR = .63$, $p < .01$). Good math achievement in Grade 10 thus discourages males from choosing an advanced biology course in Grade 12.

A good fit was determined for model M2 (see Figure 3): $\chi^2(df = 106) = 286.6$, $RMSEA = .054$, $CFI = .972$. The comparison of structural parameters revealed that the effect of math self-concept on the choice of an advanced biology course differed for the sexes ($z = 2.14$, $p < .05$). A high math self-concept discouraged both males and females from opting for an advanced biology course, but the effect was stronger for males. A sex difference approaching statistical significance was also found for the effect of biology self-concept on the choice of biology course ($z = 1.81$, $p < .10$),

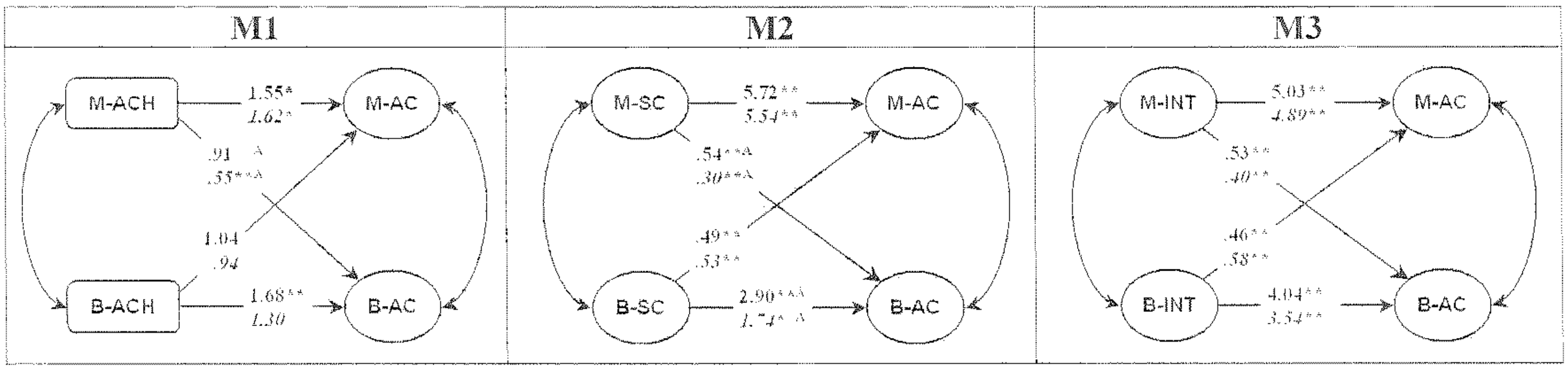

Figure 3. Odds ratios from probit regression models predicting course enrollment in math and biology. *Note:* Separate regressions for females and males (coefficients in italics). Superscripts (A) indicate coefficients that differ significantly across groups ($p < .05$). M1: Math (M-ACH) and biology achievement (B-ACH) predicting enrollment in advanced math course (M-AC) and advanced biology course (B-AC). M2: Math (M-SC) and biology self-concept (B-SC) predicting advanced course selection. M3: Math (M-INT) and biology intrinsic value (B-INT) predicting advanced course selection. $^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$

with biology self-concept having a stronger impact on the choice of an advanced biology course for females than for males.

The third model (M3) achieved a good fit: $\chi^2(df = 62) = 163.9$, $RMSEA = .053$, $CFI = .979$. However, no differential effects of subject-specific intrinsic values on course enrollment were found: the relation between intrinsic values and selection of advanced courses in biology was invariant across gender groups.

Taken together, good math achievement and high self-perceptions of mathematical ability were more likely to discourage males than females from choosing an advanced biology course. Given a high biology self-concept, females were more strongly attracted to biology than males are. To investigate whether the interactions identified were mediated by other variables, a multivariate two-group SEM including all of the variables was fitted to the data. The measurement properties of the latent factors were again constrained to be equal. The specification of the structural model was similar to that of the mediation model. In the first run, all structural parameters were allowed to vary across groups. This model yielded a good fit to the data: $\chi^2(df = 376) = 1056.7$, $RMSEA = .056$, $CFI = .960$. However, *post hoc* comparisons of group differences in regression slopes revealed five statistically different coefficients. In the next step, regression coefficients that did not differ significantly between groups were set to be equal ($\chi^2(df = 395) = 998.9$, $RMSEA = .052$, $CFI = .964$). The results of this model are presented in Figure 4.

Gender-specific effects are represented as solid lines, with the coefficient for the females above that for the males. Dashed lines indicate gender-invariant paths. The overall pattern of results clearly indicates that negative cross-domain effects leading from mathematics to biology were stronger for males than for females. This was true for the effect of math achievement on biology self-concept ($z = 3.18$, $p < .01$), the effect of math self-concept on biology intrinsic value ($z = 3.48$, $p < .01$), and the effect of math achievement on course enrollment in biology ($z = 2.14$, $p < .05$). Moreover, the regression of math intrinsic value on biology self-concept was significant in the male group only ($z = 3.08$, $p < .01$). The fifth gender interaction was found for the effect of biology achievement on biology intrinsic value ($z = 2.13$, $p < .05$), which was significant for the female group only.

Taken together, the analyses show that the pattern of negative cross-domain relations between self-concepts and intrinsic values hypothesized in Figure 2 was apparent in the male group only. Furthermore, the interaction of math self-concept and the choice of biology course reported in Figure 3 was mediated by its effect on biology intrinsic value.

Patterns of Advanced Course Selection and Aspired University Majors

Up to this point, we have investigated the processes that underlie students' choices of advanced courses in math or biology. It is important to understand these mechanisms because early specializations can be seen as individuals' first steps in the long process of establishing an occupational career. We have argued that gender-differentiated enrollment rates in specialized math and biology courses are early signs for the

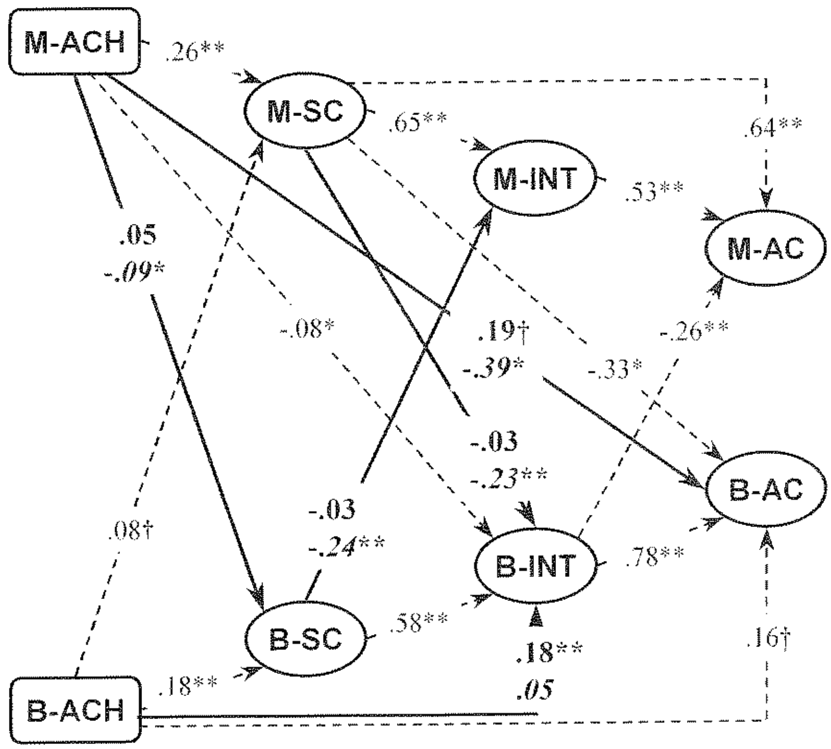

Figure 4. Path diagram of the structural model (nonstandardized solution). *Note*: Nonsignificant paths and correlations are not depicted. Dashed arrows represent gender-invariant coefficients. Solid lines represent gender-specific effects. Parameters printed in italics are specific to the male group, parameters printed in bold are specific to the female group. The first letter indicates the school subject (M: mathematics; B: biology). ACH: achievement; SC: self-concept; INT: intrinsic value; AC: advanced course. $^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$

emergence of gender-differentiated segments within the work force (e.g., Schnabel & Gruehn, 2000). It is reasonable to expect choices of advanced courses to be directly related to students' aspired university majors.

An extended sample of 12th graders was used to investigate the relation between students' advanced course combinations and their aspired university majors. The sample comprised the students in the longitudinal BIJU sample as well as all of their classmates in Grade 12. The analyses were thus based on data from 4,130 12th graders (59% females). Students' combinations of specialized courses were coded into four categories. We distinguished between students who opted for math but not biology (MA-H group, $N = 1{,}115$), students who took biology but not math (BI-H group, $N = 1{,}390$), and students who chose a combination of math and biology (MB-H group, $N = 247$). The final group consisted of students who did not enroll either in an advanced math course or in an advanced biology course (OT-H group, $N = 1{,}378$). Gender differences in enrollment rates in mathematics and biology courses were similar to the findings for the original sample (math: $OR = 2.64$, $p < .01$; biology: $OR = .44$, $p < .01$).

Students' university aspirations were assessed by asking them what field of study they would like to pursue after leaving high school. Their aspirations were then coded into four categories. $N = 90$ students aspired to major in mathematics (MA-S group), $N = 206$ responded that they would like to study biology (BI-S group). Fields of study that require good math skills (e.g., engineering, computer science, physics) were summarized into a third category (HM-S, $N = 520$). Fields of study within the natural sciences that do not require such advanced math skills (e.g., chemistry, pharmacy, environmental studies) constituted the fourth category (LM-S, $N = 201$). Students with study aspirations outside these four groups made up the last group (OT-S, $N = 3{,}113$). Gendered compositions were found for the MA-S ($OR = 2.06$, $p < .01$) and BI-S group ($OR = .72$, $p < .05$) and, to a much more pronounced extent, for the HM-S group ($OR = 10.16$, $p < .01$). Study aspirations in the LM-S category were not related to gender ($OR = 1.07$, *ns*). The gender differences observed with respect to the aspired field of study are consistent with the pattern of gender differences discerned for course enrollment.

In accordance with our expectations, students' study aspirations were associated with their choices of advanced courses. We determined a contingency coefficient of $CC = .38$ ($p < .01$). Table 3 summarizes the standardized (Pearson) residuals based on a cross-tabulation between students' advanced courses and their categorized aspirations. The sign of the cell entries indicates whether the observed cell frequencies were larger or smaller than frequencies expected by chance. Positive entries indicate higher frequencies than expected, whereas negative entries indicate that lower frequencies were observed than expected by chance.

Attending an advanced mathematics course was associated with a higher likelihood of choosing a university major in mathematics or a field of study that requires a high level of mathematical ability. In turn, belonging to the MA-H group was associated with a decreased likelihood of choosing a major in biology or outside the natural sciences. The opposite relation was observed for the students in the BI-H group. These students were less likely to choose a field of study related to mathematics. At the same time, membership of the BI-H group was associated with an increased likelihood of choosing to major in biology. Only 247 students opted for a combination of math

Table 3. Cross-tabulation between advanced mathematics and advanced biology courses and aspired fields of study: deviations from expected cell sizes (standardized residuals)

Aspired university	Advanced course			
Major	*MA-H*	*BI-H*	*MB-H*	*OT-H*
MA-S	8.3	−4.1	2.0	−4.2
HM-S	14.8	−8.5	−.4	−4.6
BI-S	−6.1	10.3	4.8	−6.8
LM-S	−.9	1.9	1.7	−1.8
OT-S	−13.4	2.6	−3.8	11.9

Note: H: high school advanced courses; S: aspired university majors; MA: mathematics; BI: biology; MB: mathematics and biology; OT: other; HM-S: math-intensive fields of study; BI-S: biology; LM-S: non-math-intensive natural sciences.

and biology advanced classes. These students were likely to choose to major in either mathematics or biology. In line with our expectations, students from the OT-H group were more likely to aspire to a field of study outside the domain of the natural sciences.

Taken together, the analyses support our assumption that students' choices of advanced courses are related to their aspired field of study in tertiary education. Students' choices of advanced courses were not perfect predictors of their aspired fields of study, but knowledge of the aspired domain enables a good prediction of the advanced courses chosen. For example, 83% of students who aspired to a university major in mathematics were enrolled in an advanced math course. A similar association was determined for biology; 89% of the students who aspired to a university major in biology attended an in-depth biology course. The tight coupling between advanced course selection and study aspirations indicates continuity in gendered educational and occupational outcomes. Both outcome measures—choice of advanced courses and aspired fields of study—were highly gendered, suggesting that the foundations of gendered occupational outcomes are already laid during high school.

Discussion

Gendered patterns of course selection were investigated by integrating two important theoretical models—the Internal/External Frame of Reference Model and Expectancy–Value theory—and applying the combined model to high school course selection in Germany. Overall, results supported the prediction that gendered high school course choices are mediated by achievement, self-concept, and intrinsic value. We also found that gender moderated the prediction of course selection. This pattern of results has important implications for research on gendered educational and occupational outcomes, as well as for theorizing on internal comparison processes in the academic domain.

Gender Differences

In line with our expectations, substantial gender differences emerged. Males reported higher math self-concepts and intrinsic value, and were more than twice as likely to choose an advanced math course in Grade 12. The opposite pattern was found for females. Females scored higher than males on biology self-concept and intrinsic value, and were significantly more likely to opt for an advanced biology course. It is important to remember that the high biology self-concepts and intrinsic values of females are not attributable to higher biology achievement; indeed, because more females than males attend the German Gymnasium (see Hosenfeld et al., 1999), the males in the sample performed better on the biology test than their female counterparts. After controlling for achievement, self-concept, and intrinsic value, no direct effect of gender on course selection remained. This illustrates the pervasive power of self-related cognitions such as self-concepts and intrinsic values.

The higher proportion of males electing advanced mathematics courses hardly comes as a surprise. However, the clear gender imbalance in favor of females where advanced biology classes are concerned needs some interpretation given the greater popularity of sciences among males. We would like to stress that academic decision-making is always situated in a specific context. In this study, we have argued that, in order to fully understand males' and females' high school choices, considerable attention must be paid to the specific affordances and constraints of the educational context (Schnabel et al., 2002). In Germany, the sciences are split into three separate subjects typically taught by different teachers from the beginning of secondary education (about age 10 or 5th grade) onward. Thus, students might acquire gender stereotypes about biology and math over the course of several years. Second, the guidelines for choosing advanced courses in Germany prescribe that math and/or one of the three sciences be selected as advanced courses or as courses with a high examination load. This might make advanced biology courses more attractive to students who are not entirely at ease with math and chemistry/physics—apparently, this is less often the case for males.

Internal Frame of Reference Effects

Generally, extensive empirical support for Marsh's (1986) I/E model is found when mathematical and verbal domains are juxtaposed, but no (or rather small) negative cross-paths emerge when the domains are more similar—for instance, mother tongue vs. foreign language (e.g., Sparfeldt, Schilling, & Rost, 2004). However, to our knowledge, no previous studies based on the I/E framework have explicitly contrasted math with biology. Moreover, studies on gender moderation of internal and external comparison processes have never before been tested in a combined framework such as the one proposed in the present paper.

Overall, although cross-domain paths were found, they were not totally clear cut. For instance, they tended to be much stronger for effects on course selection than for effects on intrinsic value or self-concept. Most importantly, gender moderated the relationship between math and biology achievement, self-concept, intrinsic value, and course enrollment. Our analyses based on separate samples of males and females reveal strong support for the presence of gender-differentiated processes in students' selection of advanced courses in the domains in question. One important finding is that the cross-domain effects leading from mathematics to biology are more heavily accentuated in males. Good math achievement and a strong math self-concept discourage males from choosing a biology course at Grade 12. These effects influence their choices directly, and also have the indirect effect of lowering their biology self-concept and intrinsic value. An additional finding based on the two-group models is that the negative cross-domain effects linking self-concepts to intrinsic values were found in the male group only. Male students attach more value to biology given a low math self-concept, and vice versa. These results imply that, compared with females, males' perceptions of biology, as well their academic choices in that domain are more strongly determined by their perceptions of ability and intrinsic value in the math domain. In contrast, females' perceptions of ability and intrinsic value are not as closely linked between domains. For males, math and biology intrinsic values tend to develop in relation to their self-concepts in the contrasted domain; for females, in contrast, the intrinsic values attached to these subjects tend to develop independent of their self-concepts in the contrasted domain.

The gender-differentiated processes complicate the interpretation of the proposed mediation model. However, it is important to note that the presence of gender interactions does not necessarily contradict the assumption of mediator effects. Additional two-group SEM models (not reported in the results section) showed that, when controlling for gender differences in construct means and allowing the processes to be different for both groups, corrected enrollment rates emerge for both subjects that do not differ across groups. This finding both provides support for mediator effects, and emphasizes the importance of detecting gender differences in the underlying processes.

Implications for Subsequent Educational and Occupational Outcomes

High school course choice can be seen as a precursor of college course selection. There is evidence that course selection in high school is closely connected to the field of study at college in Germany (Schnabel & Gruehn, 2000; Watermann & Maaz, 2004). Mathematics and most sciences are typically "male" subjects at both high school and college; biology is the exception. High school course choice and choice of college major appear to be contingent on similar decision processes.

The present study highlights the associations between the advanced courses students elect and their aspired fields of study. Students who elect an advanced math course are attracted to fields of study that require a good deal of mathematical ability, and less drawn to most other fields of university education. A different pattern of association was discerned for students enrolled in an advanced biology course. These students are more likely to aspire to a college major in biology and less likely to want to major in a math-intensive subject.

Conclusion and Outlook

Academic and occupational decisions depend on individual and contextual factors. The predictor variables for course selection examined in the present paper (academic achievement, self-concept, and intrinsic values) are strongly influenced by contextual factors, making it impossible to understand the processes that account for students' course choices without taking the educational context into account. Educational systems differ in the ways they regulate individuals' academic and occupational careers. They can have a direct influence on students' career paths by imposing restrictions on subsequent choices of tertiary education. Alternatively, they can have an indirect effect by impacting the development of psychological variables that are central to individuals' educational and occupational decisions. Therefore, comparative longitudinal studies are needed to study the consequences of the peculiarities of educational systems on the development of individual educational and occupational careers. Comparisons between highly differentiated systems, such as those implemented in Germany, Austria, and Switzerland, and the less differentiated systems of the United States, Canada, and Australia, for example, would be of particular interest. The German educational system compels high school students to make decisions about specializations that, in the United States, Canada, and Australia, can be delayed until college entrance. On the other hand, students in the latter countries have more opportunity to individualize their school curriculum by choosing from a variety of courses of varying complexity in each school subject. In the German Gymnasium, the individual's choice of advanced subjects is strongly associated with her or his later choices in tertiary education. Gender-differentiated enrollment rates in advanced high school courses thus constitute a mechanism that tracks females and males into different types of occupations at an early stage (Watermann & Maaz, 2004). Furthermore, gender differences in school course enrollment are also likely to enhance gender differences in abilities, self-concepts, and intrinsic values at the end of high school. This is not necessarily the case in the United States, for example, where students are, in principle, allowed to select their courses on a year-to-year basis.

The hypothesized impact of school contexts on individual decisions thus warrants comparative, longitudinal studies to gain a deeper insight into students' educational decisions. We believe that our model, which encompasses key elements of two prominent and well-validated theoretical propositions, is a fruitful vehicle in this endeavor. We are currently exploring the role of different educational contexts by investigating the applicability of the proposed combined EV and I/E model in predicting course choices in the United States and Germany (Nagy et al., in press).

Note

1. The CFA model and the mediation model exhibit slightly different fit statistics because gender was used as a dichotomous indicator in the CFA model, but treated as an ordinal variable in the structural regression model.

References

Allison, P. D. (2001). *Missing Data. Sage university papers series on quantitative applications in the social sciences, 07-136.* Thousand Oaks, CA: Sage.

Baumert, J., Artelt, C., Klieme, E., Neubrand, M., Prenzel, M., Schiefele, U., et al. (Eds.). (2002). *PISA 2000: Die Länder der Bundesrepublik Deutschland im Vergleich* [PISA 2000: Comparing the German States]. Opladen, Germany: Leske + Budrich.

Baumert, J., Gruehn, S., Heyn, S., Köller, O., & Schnabel, K.-U. (1997). *Bildungsverläufe und psychosoziale Entwicklung im Jugendalter (BIJU). Dokumentation – Band 1* [Learning Processes, educational careers, and psychosocial development in adolescence. Documentation – Volume 1]. Berlin, Germany: Max Planck Institute for Human Development.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Applications and data analysis methods.* Newbury Park, CA: Sage.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.

Eccles, J. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly, 11,* 135 – 172.

Eccles (Parsons), J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectations, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75 – 146). San Francisco: W. H. Freeman.

Eccles, J. S., Vida, M. N., & Barber, B. L. (2004). The relation of early adolescents' college plans, and both academic ability and task value beliefs to subsequent college enrollment. *Journal of Early Adolescence, 24,* 63 – 77.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin, 21,* 215 – 225.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53,* 109 – 132.

Feather, N. T. (1988). Values, valences, and course enrollment: Testing the role of personal values within an expectancy-value framework. *Journal of Educational Psychology, 80,* 381 – 391.

Hosenfeld, I., Köller, O., & Baumert, J. (1999). Why sex differences in mathematics achievement disappear in German secondary schools: A reanalysis of the German TIMSS data. *Studies in Educational Evaluation, 25,* 143 – 161.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73,* 509 – 527.

Köller, O., Baumert, J., & Schnabel, K. U. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education, 32,* 448 – 470.

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal, 23,* 129 – 149.

Marsh, H. W., & Hau, K.-T. (2004). Explaining paradoxical relations between academic self-concepts and achievements: Cross-cultural generalizability of the internal/external frame of reference predictions across 26 countries. *Journal of Educational Psychology, 96,* 56 – 67.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2006). Integration of multidimensional self-concept and core personality constructs: Construct validation and relations to well-being and achievement. *Journal of Personality, 74,* 403 – 456.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effect models of causal ordering. *Child Development, 76,* 397 – 416.

Marsh, H. W., & Yeung, A. S. (1997). Coursework selection: Relations to academic self-concept and achievement. *American Educational Research Journal, 34,* 691 – 720.

Möller, J., & Köller, O. (2001). Dimensional comparisons: An experimental approach to the internal/external frame of reference model. *Journal of Educational Psychology, 93,* 826 – 835.

Möller, J., & Köller, O. (2004). Die Genese akademischer Selbstkonzepte: Effekte dimensionaler und sozialer Vergleiche [On the development of academic self-concepts: The impact of social and dimensional comparisons]. *Psychologische Rundschau, 55,* 19 – 27.

Muthén, L. K., & Muthén, B. O. (1998 – 2004). *Mplus User's Guide. Third Edition.* Los Angeles: Muthén & Muthén.

Nagy, G., Garrett, J., Trautwein, U., Cortina, K. S., Baumert, J., & Eccles, J. S. (in press). Gendered high school course selection as a precursor of gendered occupational careers: The mediating role of self-concept and intrinsic value. In H. M. G. Watt & J. S. Eccles (Eds.), *Explaining gendered occupational outcomes: Examining individual and social explanations through school and beyond.* Washington, DC: APA Books.

Schafer, J. L. (1999). NORM: Multiple imputation of incomplete multivariate data under a normal model, version 2 [Computer Software]. Retrieved, September 17, 2003, from http://www.stat.psu.edu/~jls/misoftwa.html

Schnabel, K., Alfeld, C., Eccles, J. S., Köller, O., & Baumert, J. (2002). Parental influence on students' educational choices in the U.S.A. and Germany: Different ramifications – same effect? *Journal of Vocational Behavior*, *60*, 178 – 198.

Schnabel, K. U., & Gruehn, S. (2000). Studienwünsche und Berufsorientierungen in der gymnasialen Oberstufe [Study aspirations and occupational orientation in upper secondary education]. In J. Baumert, W. Bos, & R. Lehmann (Eds.), TIMSS/III. *Dritte internationale Mathematik- und Naturwissenschaftsstudie – Mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn: Bd. 2. Mathematische und physikalische Kompetenzen am End der gymnasialen Oberstufe* (pp. 405 – 453). Opladen, Germany: Leske + Budrich.

Sparfeldt, J. R., Schilling, S. R., & Rost, D. H. (2004, July). *How general is the model? The internal/external frame of reference model with more than two school subjects.* Paper presented at the 3rd International Biennial SELF Research Conference, Berlin, Germany.

Trautwein, U. (2003). *Schule und Selbstwert* [School and self-esteem]. Münster, Germany: Waxmann.

Watermann, R., & Maaz, K. (2004). Studierneigung bei Absolventen allgemein bildender und beruflicher Gymnasien [Study intentions at the end of upper secondary education in traditional and vocational gymnasium students]. In O. Köller, R. Watermann, U. Trautwein, & O. Lüdtke (Eds.), *Wege zur Hochschulreife in Baden-Württemberg: TOSCA – eine Untersuchung an allgemein bildenden und beruflichen Gymnasien* (pp. 403 – 450). Opladen, Germany: Leske + Budrich.

Watt, H. M. G. (2004). Development of adolescents' self-perceptions, values, and task perceptions according to gender and domain in 7th- through 11th-grade Australian students. *Child Development*, *75*, 1556 – 1574.

Wigfield, A., Eccles, J. S., & Pintrich, P. R. (1996). Development between the ages of 11 and 25. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 148 – 185). New York: Macmillan Library.