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Differential Effects of Adolescents' Expectancy and Value Beliefs about Math and English on Math/Science-Related and Human-Services-Related Career Plans

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ABSTRACT
Informed by Eccles's expectancy–value theory and Möller and Marsh's dimensional comparison theory, we examined the predictive effects of adolescents' motivational beliefs across two academic domains, English and math, on adolescents' math/science-related and human-services-related career plans at the end of high school (N = 425). Consistent with earlier evidence, male adolescents were more likely to aspire to math/science-related careers, whereas female adolescents favored human services occupations. The effects of gender on these career plans were mediated by adolescents' valuing of English. Compared to males, females were less likely to consider math/science-related careers and more likely to consider human services occupations partially because they valued English more than males did. In addition, a negative interaction effect suggested that adolescents' math-related self-concept of ability was a weaker predictor of math/science-related career plans at higher levels of perceived ability in English. Accordingly, the combination of high perceived ability in both math and English implied a somewhat lower probability of pursuing math/science-related careers, relative to individuals with a high math but lower English self-concept of ability. These findings underscore the importance of considering cross-domain influences in the career choice process, and especially with regard to gendered choices in the domains of math and science.

KEYWORDS
Expectancy–Value Theory; Adolescent Development; Career Choice; Gender and STEM

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INTRODUCTION

In the United States and most industrialized countries, persistent disparities exist in the participation of women in math-intensive fields such as the physical sciences, technology, engineering, and math (U.S. Census Bureau, 2012). In contrast, women are over-represented in human services occupations such as education and social work. Differences in math ability cannot adequately explain these disparities. Recent meta-analyses of national datasets in the U.S. indicated that there are either no mean differences in math achievement between boys and girls (Lindberg, Hyde, Petersen & Linn, 2010), or that boys outscore girls by a small margin (Reilly, Neumann & Andrews, 2014). When achievement differences do exist, their effects on gendered educational and occupational choices related to science, technology, engineering and mathematics (STEM) are typically small (Ceci & Williams, 2010; Riegle-Crumb, King, Grodsky & Muller, 2012; Riegle-Crumb, Moore & Ramos-Wada, 2011). Differences in math-related motivations between boys and girls can occur, however, even in the absence of performance differences. Relative to boys, girls tend to underrate their math abilities, to feel more anxious about math, and to report lower interest in math (Frenzel, Goetz, Pekrun & Watt, 2010; OECD 2013; Watt, 2004). Such motivational factors as adolescents' self-evaluated abilities and valuing of math have been identified as key influences on adolescents' participation in STEM, and as antecedents of gendered occupational choices (e.g., Eccles, 2005; 2009).

Most studies examining the role of self-evaluated abilities and values in predicting gendered choices related to math-intensive fields have focused on beliefs about single domains such as math and science (see review in Wang & Degol, 2013). Accumulating evidence suggests, however, that a consideration of multiple academic domains is necessary for understanding gendered educational and occupational choices in the math domain. For instance, analyses by Wang, Eccles, and Kenny (2013) suggested that the combination of high math and high verbal abilities – which is more typical for females than males – may lower the likelihood of ending up in a STEM-related career. In addition, Nagy, Trautwein, Baumert, Koeller, and Garrett (2006) documented gender-specific cross-domain effects in math and biology in a German sample of adolescents. For males, higher math achievement and perceived math abilities were related to lower interest in and lower likelihood of taking advanced biology courses in high school, whereas females' interest and participation in biology were less affected by their math abilities and beliefs. Analogous cross-domain effects were found for math and English (as a foreign language for German adolescents), but the potential moderating role of gender was not examined (Nagy et al., 2008). Collectively, these studies indicate that boys' and girls' engagement in math-related activities and fields is influenced not only by their beliefs about math, but also by their beliefs about and interests in other academic domains.

The present study was designed to contribute to this growing body of research by focusing on adolescents' motivational beliefs and gendered career plans across different academic and career domains. Eccles' expectancy–value theory (EEVT, Eccles et al., 1983) and Möller and Marsh's dimensional comparison theory (DCT, Möller & Marsh, 2013) provided the theoretical foundation for this study.[1] According to EEVT, achievement-related choices such as careers are predicted by two sets of beliefs: the relative expectations of success and the relative value one attaches to success in the various options being considered (Eccles et al., 1983). This implies that the pursuit of a math-related career should be more likely for individuals who perceive that they are more able in math than in other subject areas like English, and who place more value on being good at math than on being good at something else, like English. Möller and Marsh (2013) have made a similar prediction based on the DCT; namely that ability comparisons across different academic domains are critical for motivated behavioral choices.

However, whereas the usefulness of EEVT for understanding gendered career choices is well established (Eccles, 2009; Wang, 2012; Wang & Degol, 2013), the role of cross-domain comparisons in explaining individual differences in career choices has received much less empirical investigation. Only a handful of studies have integrated the DCT and EEVT (Eccles, 2007; Nagy et al., 2008; Nagy et al., 2006). Accordingly, drawing on both theoretical frameworks, we examined potential negative cross-domain effects not only of adolescents' self-concept of ability in math and English on their career preferences, but also of adolescents' valuing of math and English. Furthermore, we examined possible multiplicative associations between adolescents' cross-domain motivational beliefs in math and English, as well as potential gender-specific differences in motivations and career preferences. In the following sections, we review EEVT and the DCT, and present our research questions.

The Role of Expectancies and Values in the Career Choice Process

According to EEVT, individuals are most likely to engage in activities in which they have relatively high expectations of succeeding and to which they attach relatively high subjective task value compared to possible alternatives (Eccles et al., 1983). Whether a task or an activity has relatively high subjective task value depends on its perceived utility for future goals, personal importance, intrinsic interest, and the perceived personal cost. There is substantial empirical support for the usefulness of this theoretical framework in predicting adolescents' career plans and engagement in such areas as math (Watt, 2004; Watt, Eccles & Durik, 2006; Watt et al., 2012), science (Simpkins & Davis-Kean, 2005; Simpkins, Davis-Kean & Eccles, 2006), and literacy (Durik, Vida & Eccles, 2006). In general, higher levels of perceived ability in and valuing of a given subject area are associated with a higher likelihood of pursuing an occupation related to that area.

Research grounded in this framework has identified students' expectancies and task values as key mediators of the effects of gender on educational and occupational choices (Eccles, 2005, 2009). With regard to self-evaluated abilities in math, the preponderance of evidence indicates a gender gap favoring males (National Science Foundation, 2013; OECD, 2013), although some studies suggest that this gap tends to close during adolescence (Jacobs, Lanza, Osgood, Eccles & Wigfield, 2002). Evidence regarding the valuing of math further suggests that males sometimes report greater interest in math than females, but there are no gender differences in the overall perceived value of math, including its subjective utility and personal importance (Frenzel et al., 2010; Jacobs et al., 2002; Watt, 2004; Watt et al., 2012). A gender gap in self-evaluated abilities in and the perceived value of English and language arts favoring girls has been consistently documented (Durik et al., 2006; Jacobs et al., 2002; OECD, 2013), although not universally (Stipek & Gralinski, 1991). Such gender differences in math- and English-related motivations contribute to differences in educational and occupational choices, especially related to STEM (e.g., Eccles, 2005, 2009; Watt et al., 2012).

Although most studies have focused on single academic domains, research in EEVT is increasingly focusing on the implications of adolescents' expectancy and value beliefs across multiple domains for their educational and career choices. For instance, a recent study by Chow, Eccles and Salmela-Aro (2012) identified three types of adolescent profiles in terms of their valuing of math, the physical sciences, and English. Adolescents who valued math and the physical sciences over English were more likely to aspire to physical science and IT-related occupations. Boys were more likely than girls to value math and the physical sciences over English, and to pursue these types of occupations. These findings are consistent with qualitative evidence suggesting that placing higher value on math over non-math subjects played a key role in guiding adolescents towards math-related jobs, whereas placing higher value on subject areas other than math deterred adolescents from pursuing math-related careers (Watt, 2005). Accordingly, a decision against math-related careers could potentially be driven by higher preferences for another domain, rather than by a low preference for math. This notion of comparative evaluations constitutes a key component of EEVT (Eccles et al., 1983).

The Role of Cross-Domain Effects in the Career Choice Process

The importance of the relative hierarchies of expectations for success and subjective value in the EEVT framework for predicting achievement-related choices is consistent with the idea of negative cross-domain effects articulated in the DCT (Möller & Marsh, 2013), although the DCT has generally focused on beliefs about ability rather than on both expectations for success and subjective task values. According to the DCT, individuals' ability self-assessments in a given subject area are influenced by intrapersonal comparisons of their own abilities across different subject areas or domains. For domains that are not closely related (e.g., math and English), high ability in one domain sets a high standard against which other abilities are evaluated; accordingly, high ability in one subject area generally has a negative impact on the individual's self-evaluated abilities in the other subject (Marsh et al., 2014; Möller & Marsh, 2013; Möller, Pohlmann, Köller & Marsh, 2009). Such negative cross-domain effects have been confirmed for both genders (Möller et al., 2009), but gender-specific effects have also been documented. For instance, Nagy et al. (2006) found that achievement and self-concept of ability in math had a stronger negative effect on self-concept of ability, interest, and participation in biology for males than for females. In fact, females' math achievement was unrelated to their interest in biology.

Although the evidence is still relatively scarce, researchers have begun to examine the implications of such negative cross-domain effects for individual educational and career paths. Parker et al. (2012) demonstrated that achievement and self-concept of ability in English functioned as negative predictors of choosing math-intensive college majors relative to verbal-intensive majors, whereas achievement and self-concept of ability in math negatively predicted preferences for verbal-intensive majors relative to math-intensive majors. Males expressed significantly stronger preferences for math-intensive college majors than females, which was partially attributable to differences in achievement and self-concept of ability. Nagy and colleagues demonstrated analogous negative cross-domain effects of achievement and self-concept of ability on enrollment in advanced high-school courses in math versus biology (Nagy et al., 2006), and in math versus English (Nagy et al., 2008), although – as discussed subsequently – these effects were found only in German samples, and not in a U.S. sample.

Only a few studies to date have examined possible cross-domain effects for both beliefs about ability and subjective task values, thus integrating EEVT and the DCT (Nagy et al., 2008; Nagy et al., 2006). For instance, across two samples from the U.S. and Germany, Nagy and colleagues (2008) examined the effects of math- and English-related self-concept of ability and intrinsic value on the selection of math- and English-related high-school courses. In the German sample, the authors confirmed negative cross-domain effects of achievement on both self-concept of ability and intrinsic interest, suggesting that intra-individual cross-domain comparisons of abilities negatively predict not only one's self-evaluated abilities in another domain, but also the perceived intrinsic value of that domain. Furthermore, the perceived intrinsic value of English (as a foreign language) negatively predicted enrollment in advanced math courses, although the perceived intrinsic value of math was not a significant predictor of course enrollment in English. These findings suggest that cross-domain effects should be examined not only with respect to beliefs about ability, but also for subjective values.

The findings in the U.S. sample in Nagy et al.'s (2008) research were not consistent with the German sample; the expected negative cross-domain effects of adolescents' achievement, self-concept of ability, and intrinsic interest on adolescents' enrollment in advanced high-school courses in math and English were not confirmed. Multiple factors could contribute to this discrepancy. For instance, the authors proposed that the lack of (negative) cross-domain effects in the U.S. sample may be due to the fact that enrollment in advanced courses in both math and English is necessary for pursuing a college degree, regardless of one's area of specialization. The utility of these courses for future educational goals such as college enrollment may thus override the negative cross-domain effects of self-concept of ability and intrinsic interest. Possibly, outcomes that allow greater specialization (e.g., career preferences) may be more strongly influenced by cross-domain effects in this context.

In summary, our review of available evidence delineates several avenues for future research. First, even though substantial evidence supports the critical importance of achievement, ability beliefs, and values for educational and occupational choices, negative cross-domain influences between these constructs and their implications for career-related choices represent an understudied area of research. Second, analyses of negative cross-domain effects have focused primarily on beliefs about ability; less is known about the cross-domain effects of academic values. This gap in the literature warrants further attention, because subjective task values are important antecedents of adolescents' educational and occupational decisions. Third, analyses of cross-domain effects reviewed thus far have focused only on the additive effects of beliefs about math and English, but have not examined their potential multiplicative effects. It is possible that the combination of high math and high verbal (perceived) abilities leads to a lower likelihood of pursuing a STEM-related career, because high abilities across domains imply greater choice and access to a broader range of educational and career opportunities (Wang et al., 2013). Accordingly, significant interaction effects may exist in addition to the additive cross-domain effects discussed in the DCT. The present study was designed to address these questions.

THE PRESENT STUDY

The objectives of this study were threefold, focusing on (a) potential gender differences in adolescents' motivations and career preferences, and on (b) additive and (c) multiplicative cross-domain effects of academic motivations on career preferences. First, we examined potential gender differences with regard to preferences for math- and science- related careers (e.g., engineering, architecture) and human services occupations (e.g., social work, counseling, and teaching). Consistent with prior evidence, we expected that female adolescents would be more likely to pursue human services occupations, whereas male adolescents would have greater interest in math- and science-related occupations (e.g., National Science Foundation, 2013). Such differences have been attributed, for instance, to the greater value placed by girls on working with and helping people (e.g., Jozefowicz, Barber & Eccles, 1993). We expected that gender differences in career plans may also be at least partially attributable to differential self-evaluated abilities in and valuing of math and English. If gender differences occurred, we expected such differences to favor male adolescents for math-related motivations, and female adolescents for English-related motivations.

Following EEVT (e.g., Eccles, 2005; Watt et al., 2012), we expected positive paths from math-related motivations to math-related career plans. We also expected positive paths from English-related motivations to human services occupations, even though such occupations may appeal to individuals with diverse academic abilities and interests. Parker et al. (2012) found that, controlling for the effects of gender and achievement in math and English, adolescents' self-concept of ability in English positively predicted their choice of college majors that could qualify them for human services occupations (majors in the humanities and biological and medical fields) over math-intensive college majors. Thus there is some indirect evidence for a positive link between English-related motivations and preferences for human services occupations.

Second, consistent with both EEVT and the DCT, we expected that adolescents' perceived math ability would predict math/science-related career plans positively, whereas their perceived English ability would predict math/science-related career plans negatively. We examined analogous effects on human services occupations (expecting a positive association with English-related motivations), but we did not state specific hypotheses about negative cross-domain effects. It is possible that human services occupations appeal to individuals with diverse abilities and values, or that, on average, they are more likely to attract individuals with high verbal abilities and values.[2] Cross-domain effects were examined for both perceived abilities and subjective values related to math and English.

Third, in addition to additive cross-domain effects, we examined possible interaction effects between adolescents' perceived abilities in math and English, as well as between their subjective valuing of math and English. Analogous to Wang et al. (2013), we examined whether the links between adolescents' math-related expectancies and career plans are weaker at higher levels of perceived abilities in English. Analogous interactive effects were also examined for career plans related to human services occupations. All analyses were conducted for both self-concept of ability and the perceived value of math and English.

METHOD

Participants and Procedure

Data for this research were part of the Childhood and Beyond Study (CAB), which is a longitudinal research program examining the educational and occupational pathways of three cohorts of students (for a detailed description, see www.rcgd.isr.umich.edu/cab or www.rcgd.isr.umich.edu/garp). Owing to funding constraints, CAB data from all three cohorts in the high-school years (when adolescents' career plans were examined) were available only for grade 12. The present study thus focused on variables assessed in grade 12, namely adolescents' math- and English-related expectancies and values, and their plans to pursue careers related to math and science or to human services. In addition, all analyses included parental education, the child's general cognitive ability, teacher-rated aptitude in math and reading, and age cohort as covariates. These covariates were assessed when the participants initially joined the CAB study in elementary school (see Measures).

The sample consisted of 425 participants with available data at the end of high school. Table 1 shows the number of participants with available data, as well as descriptive information for each variable. Incomplete data were handled with the full information maximum likelihood (FIML) algorithm (Schafer & Graham, 2002).

Table 1

Zero-Order Correlations and Descriptive Statistics for All Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Variables assessed in elementary school														
1. Female	--													
2. Parent education	-.001	--												
3. Cognitive ability	-.155**	.182**	--											
4. Teacher-rated math aptitude	-.127**	.215**	.426**	--										
5. Teacher-rated reading aptitude	.037	.220**	.387**	.819**	--									
6. Cohort 1 vs. 2	.034	.049	.132**	-.015	.009	--								
7. Cohort 1 vs. 3	-.018	.033	-.224**	-.004	-.004	-.563**	--							
Variables assessed in high school (Grade 12)														
8. Self-reported grade point average	.135**	.368**	.320**	.371**	.384**	.094	.022	--						
9. Math self-concept	-.109*	.197**	.278**	.375**	.238**	.039	.031	.468**	--					
10. Reading self-concept	.136**	.169**	.134**	.084	.279**	.018	.011	.174**	-.196**	--				
11. Math value	-.048	.067	.083	.158**	.059	-.002	.051	.249**	.709**	-.282**	--			
12. English value	.216**	.023	-.004	.009	.144**	.068	-.012	.039	-.273**	.736**	-.267**	--		
13. Math/Science-related career plans	-.302**	.141*	.243**	.260**	.157**	-.013	.060	.284**	.517**	-.199**	.469**	-.315**	--	
14. Human-services-related career plans	.300**	-.001	-.034	-.020	.027	-.005	-.015	-.027	-.128*	.199**	-.134**	.269**	-.172**	--
M	0.57	4.93	117.56	5.33	5.39	0.27	0.46	3.32	4.72	5.04	3.98	4.73	3.44	3.50
SD	0.49	1.72	15.42	1.02	1.06	0.45	0.50	0.57	1.38	1.19	1.39	1.20	2.34	2.18
N	425	336	422	424	424	425	425	406	424	424	425	424	398	398
Cronbach's alpha				.89	.90				.87	.93	.92	.91		

* $p < .05$, ** $p < .01$

Measures

Demographics. The participants' parents provided demographic information at the start of the CAB study, including their children's gender (0 = male, 1 = female) and their own level of education (1 = grade school through 9 = Ph.D. or advanced professional degree). The educational level of the parent with the highest education was used as an indicator of the child's family background (cf. Durik et al., 2006). Slightly more than half of the participants were female (57%). The average level of parental education was M = 5.96, SD = 1.735 (*Median* = 6.00), corresponding to a college graduate.

Cognitive ability. General cognitive ability was assessed with the Slosson Intelligence Test – Revised (SIT-R), which was given to all children when they joined the CAB study (Slosson, Nicholson & Hibpshman, 1991). Using the CAB data, Jacobs et al. (2002) found positive associations between the SIT-R scores and children's self-evaluated competence beliefs in both math and language arts.

Teacher-evaluated math and reading aptitude in elementary school. Elementary-school teachers of participating students evaluated their students' math and reading aptitude in the first four waves of data collection (kindergarten through grade 4) using two items: "Compared to other children, how much innate ability or talent does this child have in math [reading]?", ranging from 1 = very little to 7 = a lot, and "How well do you expect this child to do next year in math [reading]?," ranging from 1 = very poorly to 7 = exceptionally well. The students' teacher-rated math and reading aptitude was assessed as the average of all available teacher ratings per student (α=.89 and .90, respectively).

Grade point average (GPA). At the end of high school, the participants were asked to report their grade point average as a measure of school performance, on a scale from 1 (low) to 5 (high), M = 3.32, SD = 0.571.

Expectancy and value beliefs in math and English. The participants' self-concept of ability and expectancy of success in each academic subject was assessed with five items at the end of high school (e.g., "How good at math [English] are you?", ranging from 1 = not very good to 7 = very good, and "How well do you expect to do in math [English] next year?", ranging from 1 = not well to 7 = very well). Similar to prior research in EEVT, we do not distinguish between self-concept of ability and expected future success. The subjective task value of math and English was assessed with seven items capturing the perceived utility (e.g., "How useful is what you learn in math [English]?", ranging from 1 = not useful to 7 = very useful), importance ("For me, being good at math [English] is:" from 1 = not at all important to 7 = very important), and intrinsic interest in each subject (e.g., "How much do you like math [English]?", ranging from 1 = a little to 7 = a lot). These measures are widely used and have been validated across several academic domains (e.g., Wigfield & Eccles, 2000). The internal consistencies of all constructs were very good, ranging from α=.87 to α=.93 (see Table 1).

Career plans for math- or science-related and human services occupations. In grade 12, the participants were asked to assess the likelihood of pursuing types of occupations under the category "Professional with a college bachelor's or master's degree". This clarification was important to highlight that the listed occupations required the same level of education. The participants rated the likelihood of pursuing the following occupational fields: "Science- or math-related field (like engineer, architect)" and "Human services (like social worker, counselor, teacher)" on a scale from 1 = very unlikely to 7 = very likely. We profiled these occupations using the occupational information network (ONet, http://www.onetonline.org), a database of all occupations recognized by the U.S. Department of Labor. This database provides information about the required level of knowledge of mathematics and English for each occupation (e.g., architect), on a scale from 0 (*low*) to 100 (*high*). The average of all applicable occupations given as examples for the two occupational fields in this study was used as an indicator of the degree to which these fields require knowledge of mathematics (arithmetic, algebra, geometry, calculus, statistics, and their applications) and English (the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar). On average, math- and science-related occupations (engineer or architect) required relatively high levels of both English and math knowledge (60 and 66 respectively), whereas human services occupations (social worker, counselor, teacher) required higher levels of English than math (66 and 39 respectively). These profiles lend support to the relevance of math- and English-related abilities and motivations for these two occupational fields.

RESULTS

A series of six sequential path analyses was conducted to examine the stated research questions. The analyses used bootstrapping with 5000 iterations. Unlike normal theory, bootstrapping does not require assumptions about the shape of the sampling distribution, and is particularly suitable for mediation and moderation analyses (Rucker, Preacher, Tormala & Petty, 2011). As shown in Figure 1, the models included variables assessed in elementary school (gender, parental education, the child's general cognitive ability, teacher-rated aptitude in math and reading, and age cohort) as predictors of grade 12 variables (self-reported GPA, math- and English-related motivations, and career plans), as well as grade 12 GPA and motivations as predictors of grade 12 career plans.

Path coefficients for predictors of career plans in each model are shown in Table 2, and the significant paths for two full models (M03 and M04) are presented and discussed subsequently in Figures 2 and 4. Specifically, as shown in Table 2, M01 focused on demographic characteristics, the elementary school variables and grade 12 GPA as predictors of career plans. M02 expanded upon M01 by including the main effects of math- and English-related self-concept of ability. M03 tested the interaction of math- and English-related self-concept of ability. M04 and M05 were analogous to M02 and M03, but tested the effects of subjective task value instead of self-concept of ability. Finally, M06 combined previous models, and included demographic characteristics, the elementary school variables, grade 12 GPA, grade

12 math- and English-related motivations, and the interaction between math- and English-related self-concept of ability as predictors of adolescents' career plans.

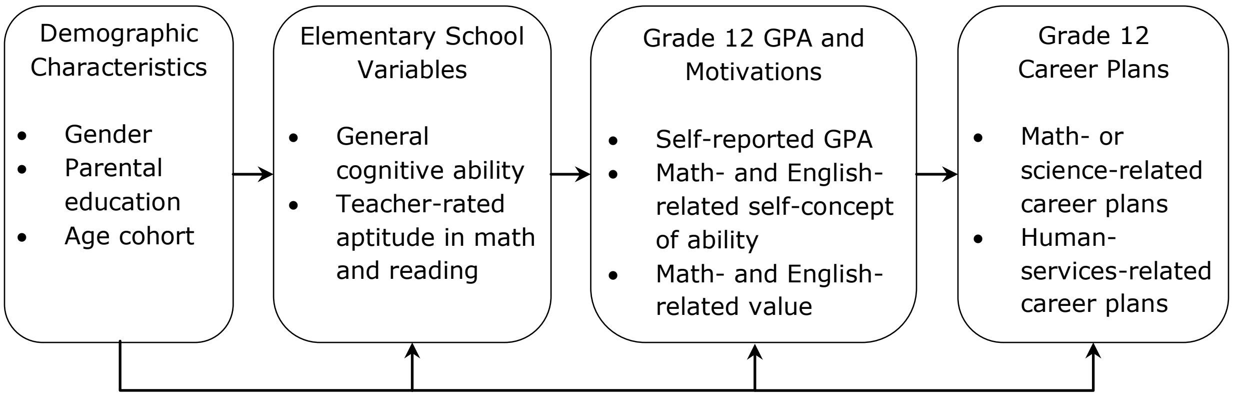

Figure 1. *A schematic representation of tested models*

First, M01 confirmed the expected gender differences in career plans, with female participants being less likely than male participants to favor math- and science-related careers (β=-.29, p<.001, see Table 2), and more likely to favor human-services-related careers (β= .32, p<.001). Cognitive ability and teacher-rated aptitude in math and reading were positively correlated with career plans in math and science (see Table 1), but these ability and aptitude ratings were not significant predictors of career plans in M01 (see Table 2). Only gender and end-of-high-school GPA emerged as significant predictors of math/science-related career plans in this model. Mediation analyses revealed the following indirect effects of gender on career plans. Girls' somewhat higher GPA relative to boys' GPA positively predicted their subjective likelihood of pursuing math- or science-related careers at the end of high school (β_{ind}=.05, p=.002). None of the remaining aptitude assessments alone significantly mediated the effects of gender on career aspirations (p's>.117). However, girls' slightly lower scores for general cognitive ability assessed in elementary school negatively predicted their grade 12 GPA, and thus indirectly negatively affected their math/science-related career aspirations (β_{ind}= -.01, p=.030). No systematic associations emerged between achievement indicators (GPA, cognitive ability, and teacher-rated aptitude) and human-services-related career plans. These types of occupations appear more likely to accommodate individuals with diverse ability profiles than are occupations related to math and science.

Table 2

Path Coefficients for Predictors of Math/Science-related and Human-Services-related Career Plans

	M01		***M02***		***M03***		***M04***		***M05***		***M06***	
Predictors	*Math/ Science*	*Human service*	*Math/ Science*	*Human service*	*Math/ Science*	*Human service*	*Math/ Science*	*Human service*	*Math/ Science*	*Human service*	*Math/ Science*	*Human service*
Female	-.29***	.32***	-.25***	.30***	-.25***	.30***	-.24***	.28***	-.24***	.28***	-.23***	.28***
Parent education	.00	.02	.02	.00	.01	.01	.03	.01	.03	.01	.01	.02
Cohort 1 vs. 2	.01	-.02	-.01	-.02	.00	-.02	.02	-.04	.03	-.04	.02	-.04
Cohort 1 vs. 3	.08	-.02	.07	-.02	.06	-.02	.08†	-.03	.08†	-.03	.07	-.02
Cognitive ability	.10†	.02	.09	.00	.09†	.00	.11*	.01	.11*	.01	.09†	.01
Teacher-rated math aptitude	.16†	.05	-.05	.14	-.05	.14	.03	.11	.03	.11	.00	.11
Teacher-rated reading aptitude	-.10	.00	.07	-.10	.07	-.10	.04	-.08	.04	-.08	.04	-.08
Grade Point Average (GPA)	.28***	-.08	.10†	-.05	.11†	-.06	.16**	-.05	.16**	-.05	.11†	-.05
Math self-concept			.38***	-.05	.40***	-.07					.19**	.01
English self-concept			-.12*	.17**	-.11*	.16**					.06	.01
Math x Reading self-concept					-.08*	.07					-.06	.05
Math value							.35***	-.07	.35***	-.06	.26***	-.08
English value							-.17***	.20***	-.17***	.21***	-.18*	.19**
Math x English value									-.02	-.03		
R^2	.22	.10	.35	.13	.36	.13	.38	.14	.38	.15	.40	.15

†$p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

M02 examined the hypothesized negative cross-domain effects of math- and English-related self-concept of ability on career plans. Such effects were confirmed only for math- and science-related occupations, but not for human services occupations. In addition to the negative effect of female gender (β=-.25, p<.001, see Table 2), math/science-related career plans were positively predicted by math self-concept of ability (β=.38, p<.001), but negatively by English self-concept of ability (β= -.12, p=.016). Human-services-related career plans were positively predicted by being female (β= .30, p<.001) and by English self-concept of ability (β=.17, p=.001), but were not significantly predicted by math self-concept of ability (β=-.05, p=.424). M03 further indicated a significant negative interaction effect between math and English self-concept of ability in predicting math/science-related career plans (β= -.08, p=.041, Table 2), but not human-services-related career plans (β= .07, p=.168). As expected, the association between math self-concept of ability and math/science-related career plans was weaker for participants with higher levels of English self-concept of ability. Significant paths for the full model M03 are illustrated in Figure 2, and the interaction effect is illustrated in Figure 3.

M03

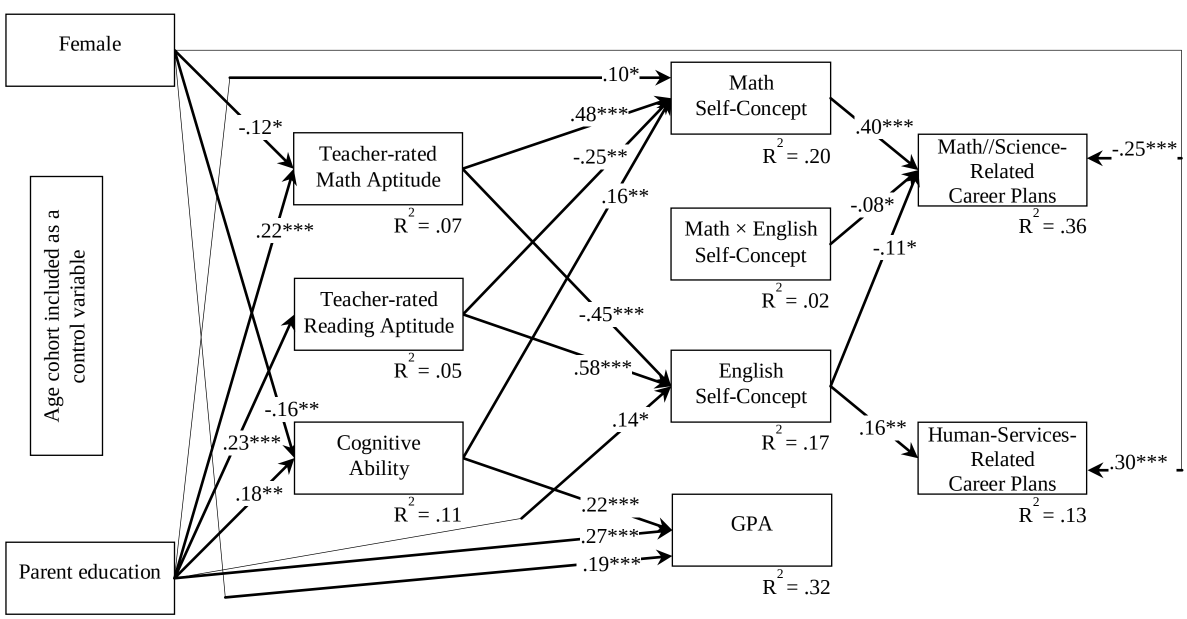

Figure 2. *Model testing the main and interactive effects of math- and English-related self-concept of ability (M03). The effects of age cohort and correlations between endogenous variables were estimated, but are not shown for simplicity. Only significant paths are shown. *** p < .001, ** p < .01, * p < .05*

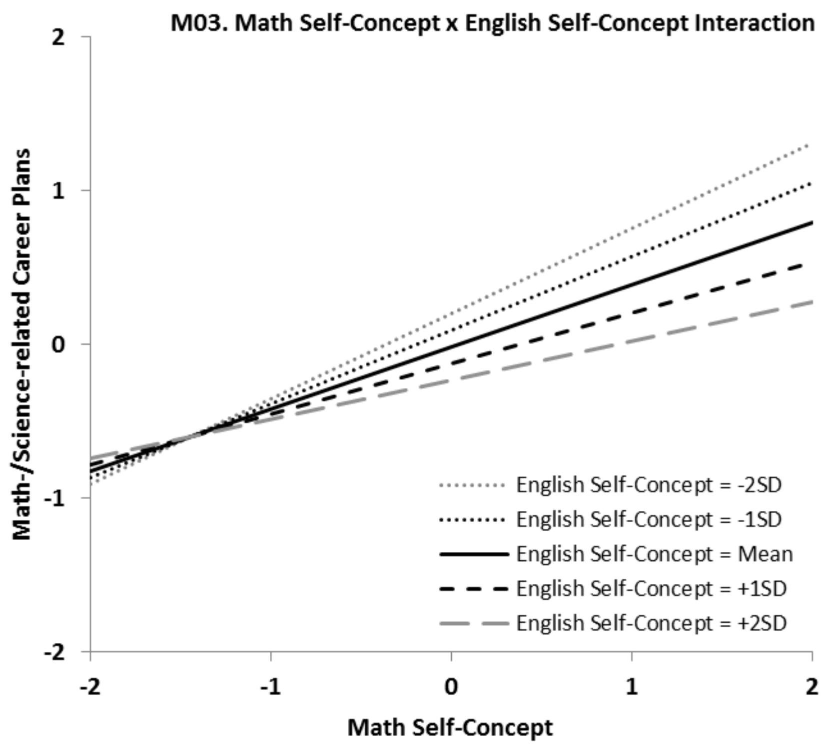

Figure 3. *Associations between math self-concept of ability and math/science-related career plans at high levels (one and two SD above the mean), average level, and low levels (one and two SD below the mean) of self-concept of ability in English. All variables are standardized.*

An additional set of analyses based on M03 was conducted to examine potential gender differences. First, even though being female was weakly negatively related to math self-concept of ability (r=-.11, p=.025, Table 1), and positively with English self-concept of ability (r=.14, p=.005), gender was not a significant predictor of self-concept of ability after controlling for ability indicators in any of our models (e.g., M03 in Figure 2). However, being female negatively predicted teacher-rated math aptitude and general cognitive ability in elementary school, and thus indirectly negatively predicted adolescents' math self-concept of ability, which in turn predicted their math/science-related career plans (indirect effect of being female on career plans via teacher-rated math ability and self-concept of ability: β_{ind}=-.02, p=.028; indirect effect of being female on career plans via general cognitive ability and self-concept of ability: β_{ind}=-.01, p=.037, see Figure 2). A multi-group analysis for M03 confirmed that the estimated path coefficients and covariances were not significantly different across gender (χ^2=73.20, χ^2_{female}=31.41, χ^2_{male}=41.79, df=66, p=.254, RMSEA=.023, CFI=.994, SRMR=.045).[3] Collectively, the predictors in M03 explained about 36% of the variance in math/science-related career plans and 13% of the variance in human-services-related career plans. Self-concept of ability in math and English explained about 13% of the variance in math/science-related career plans, and about 3% of the variance in human-services-related career plans. The interaction term explained about 1% additional variance.

M04 and M05 were analogous to M02 and M03, but tested the main and interactive effects of subjective task value instead of self-concept of ability (see Table 2). Our findings generally mirrored M02 and M03, with two notable exceptions that we discuss below. Similar to M02 and M03, math/science-related career plans in M04 and M05 were positively predicted by math value (M04: β=.35, p<.001, Table 2), but negatively by English value (M04: β= -.17, p<.001). Also analogous to M02 and M03, human-services-related career plans were positively predicted by being female (M04: β= .28, p<.001, Table 2) and by valuing English (M04: β=.20, p<.001), but were unrelated to valuing math (M04: β= -.07, p=.241). However, unlike M03, M05 revealed no significant interaction effect between the subjective value of math and English on math/science-related career plans (β= -.02, p=.709, Table 2). Accordingly, M05 supported an additive association such that the positive effect of math value and the negative effect of English value on math/science-related career plans were relatively independent of each other. Separate analyses by gender further revealed that the interaction effect of the perceived values of math and English on career plans was not significant in either group. We therefore focus our discussion on the more parsimonious M04 (see Figure 4).

M04

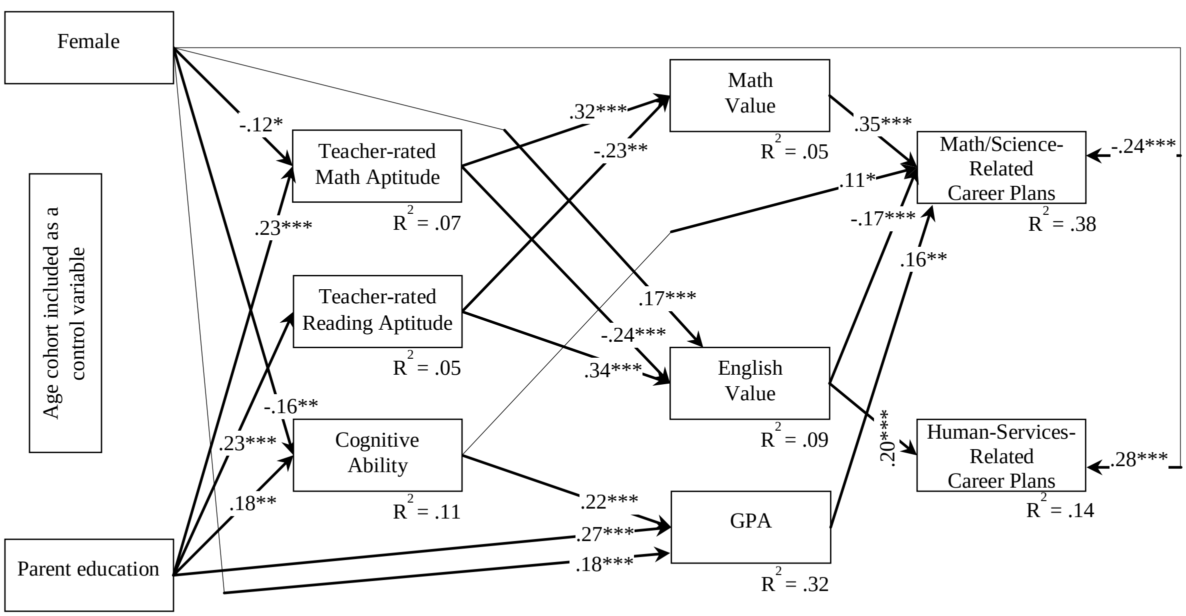

Figure 4. *Model testing the main effects of math- and English-related subjective task value (M04). The effects of age cohort and correlations between endogenous variables were estimated, but are not shown for simplicity. Only significant paths are shown.*
**** p < .001, ** p < .01, * p < .05*

Controlling for ability and aptitude indicators, M04 (and M05) revealed systematic gender differences favoring females in the subjective value of English (β= .17, p<.001, see Figure 4), but not math (β= .01, p=.874). In addition to the direct effects of gender on career plans, mediation analyses in M04 supported significant indirect effects via the perceived value of English. Being female had a negative (and being male a positive) indirect effect on math/science-related career plans via its positive (and for males negative) association with the perceived value of English,

β_{ind}= -.03, *p*=.018 (see Figure 4). Analogously, being female had a positive (and being male a negative) indirect effect on human-services-related career plans via its positive (and for males negative) association with the perceived value of English, β_{ind}= .03, *p*=.010 (Figure 4). A multi-group analysis for M04 indicated that the path coefficients and covariances in this model did not differ significantly by gender (χ^2=59.59, χ^2_{female}=23.11, χ^2_{male}=36.48, *df*=49, *p*=.143, RMSEA=.032, CFI=.989, SRMR=.043). Collectively, the predictors in M04 explained about 38% of the variance in math/science-related career plans, and 14% of the variance in human-services-related career plans. Math- and English-related values explained about 16% of the variance in math/science-related careers, and about 5% of the variance in preferences for human services occupations, beyond the effects of gender and ability indicators such as cognitive ability, teacher-rated aptitude, and GPA.

A final model combined M03 and M04. This model, M06 in Table 2, indicated that including self-concept of ability as a predictor did not change the associations between task values and career plans (see M04 vs. M06 in Table 2). However, the relations between self-concept of ability and career plans became somewhat weaker when task values were included as a predictor (see M03 vs. M06 in Table 2). The main effect of math self-concept of ability on math/science-related career plans remained significant (β=.19, *p*=.006, Table 2), but the main effect of English self-concept of ability and the interaction between these two constructs became non-significant (β=.06, *p*=.468 and β=-.06, *p*=.136). The path coefficients and covariances between constructs in M06 did not differ significantly by gender (χ^2=104.41, χ^2_{female}=42.34, χ^2_{male}=62.07, *df*=91, *p*=.159, RMSEA=.026, CFI=.993, SRMR=.047). Predictors in M06 explained about 40% of the variance in math/science-related career plans and 15% of the variance in preferences for human services occupations.

DISCUSSION

The present study examined cross-domain additive and interaction effects of math- and English-related self-concept of ability and task values on math/science-related and human services-related career plans. Our analyses confirmed gendered career preferences such that male adolescents were more likely to plan pursuing math/science-related careers, whereas female adolescents were more likely to favor careers in human services occupations. These gender-stereotypical career preferences were only weakly related to ability indicators. Relative to females, males' slightly higher teacher-rated math aptitude and general cognitive ability in elementary school contributed positively to their self-concept of ability in math as assessed at the end of high school, which in turn positively predicted math/science-related career aspirations.

On the one hand, these findings suggest that it is important to address gender disparities relating to math early on, because such disparities can have long-term implications for adolescents' self-beliefs. On the other hand, it is essential to note that the observed gender differences in math aptitude and their effects on career aspirations were very small (these effects were only marginally significant in M01, and the indirect effects of gender via math aptitude in other models did not exceed .02 standard deviations). These small effects could be partially attributable to the relatively large time lag between the teacher-rated assessments of aptitude and adolescents' self-reported career plans. However, our findings are consistent with the preponderance of available evidence, which suggests that even when ability differences between boys and girls exist, their effects on gendered educational and career choices in STEM are typically small (e.g., Ceci & Williams, 2010; Riegle-Crumb et al., 2011, 2012).

The perceived value of English emerged as a mediator of the effects of gender on adolescents' career plans, even after controlling for differences in ability indicators such as general cognitive ability, teacher-rated aptitude in math and reading, and end-of-high-school GPA. The fact that females valued English more than males did contributed negatively to females' math/science-related career aspirations, and positively to females' pursuit of human services occupations (and vice versa for males). These effects underscore the importance of considering cross-domain influences in analyses of gendered career preferences (Eccles, 2005, 2009; Nagy et al., 2008; Nagy et al., 2006; Parker et al., 2012). In some cases, a choice "against" a math-related field may reflect a stronger preference "for" another field as much as a decision against going into the math-related field (Eccles et al., 1983; Eccles, 2007). Thus, a focus solely on abilities and motivations related to math may paint an incomplete picture of adolescents' career choices related to STEM.

For both genders, our analyses supported negative cross-domain effects of adolescents' motivations in math and English on their preferences for math/science-related careers and thus provide support for predictions made within both EEVT and the DCT. Adolescents' perceived ability in and valuing of English negatively predicted the pursuit of math/science-related careers, even after controlling for the effects of ability indicators and math-related motivations. These findings are consistent with prior evidence examining the effects of self-concept of ability across math and English on preferences for math-intensive college majors (Parker et al., 2012), and high-school course enrollment (Nagy et al., 2008). Analogous to Nagy and colleagues' research (Nagy et al., 2008; Nagy et al., 2006), our data suggest that negative cross-domain comparisons may apply not only to beliefs about ability, but also to the perceived value of different academic domains. However, whereas Nagy and colleagues focused only on intrinsic interest, our analyses were based on a broader assessment of value that included judgments of intrinsic interest, subjective utility and the perceived importance of math and English, respectively. In addition, whereas Nagy et al. (2008) focused on implications for high-school course enrollment, we examined analogous effects on adolescents' career plans.

In addition to analyses of additive cross-domain effects, our analyses expanded upon earlier research by focusing on the multiplicative associations between self-concept of ability in math and English, as well as between the perceived value of math and English in predicting adolescents' career plans. We found a negative interaction between math and English self-concept of ability in predicting math/science-related career plans, but not between adolescents' value beliefs about these two academic domains. The significant interaction between math- and

English-related self-concept of ability implies that the combination of high perceived ability in both math and English had a negative effect on pursuing math/science-related careers. This finding is consistent with Wang et al.'s (2013) research, which suggested that the combined effects of high math and high verbal ability negatively predicted participation in STEM-related careers. It is noteworthy, however, that the interaction between self-concept of ability in math and English was no longer significant when the subjective valuing of math and English was also included as a predictor of adolescents' career plans. This finding further underscores the importance of considering not only beliefs about ability, but also cross-domain academic valuing in the career choice process.

Why did we fail to identify analogous interactive associations for values? Wang et al. (2013) proposed that the combination of high verbal and high math abilities may lower the likelihood of choosing a STEM-related career, because high abilities across multiple domains imply access to a broader range of career options. This may not be true for task values, since subjective values are less relevant for the accessibility of different occupations than for the subjective desirability of these occupations. Thus, individuals with high verbal and high math abilities would be equally as qualified for occupations that require only math abilities as for occupations that require both high math and high verbal abilities. However, individuals who value both domains may not find occupations that would satisfy only one of these values as equally desirable as occupations that would satisfy their values across both domains. Accordingly, if math/science-related occupations are perceived as a poor fit for individuals who value English, then such occupations would also be a poor fit for individuals who desire occupations that accommodate their values for both English and math. This could partially explain why we did not find a significant interaction effect between English and math values on preferences for math/science-related careers, beyond the positive main effect of math values and the negative main effect of English values. Analyses of intra-individual value profiles may be necessary to examine this issue further (cf. Chow et al., 2012).

Notably, none of these negative cross-domain and interactive effects emerged for human services occupations. Even though preferences for such occupations were positively predicted by the perceived ability in and valuing of English, math-related motivations had no significant effects on preferences for this occupational field. Compared to math- and science-related careers, human services occupations seem to appeal to individuals with more diverse academic abilities and values, at least with regard to math and English. Non-academic values such as the desire to work with people or to serve and help others may play a more important role in the pursuit of these types of occupations (see Jozefowicz et al., 1993).

The identified links between math- and English-related motivations and human-services-related and math/science-related career plans raise a question about the extent to which adolescents are aware of the importance of different academic domains for these two occupational fields. Specifically, there is a discrepancy between the negative effect of English-related motivations on adolescents' preference for math-intensive fields and the actual importance of English for these fields. Indeed, the occupational information network (ONet, www.onetonline.org) suggests that such math-intensive occupations as engineering or architecture require relatively high levels of knowledge not only in math, but also in English. Furthermore, literacy skills are critical for a variety of desirable outcomes across disciplines, including school success, future socio-economic status, and employment rates (Madden, Slavin, Karweit, Dolan & Wasik, 1993; Raudenbush & Kasim, 1998; Smith, 1990). Yet, adolescents' valuing of English emerged as a potential factor that steers them away from math-intensive fields such as engineering and architecture.

These findings have implications not only for theory development but also for intervention research. Thus far, intervention research informed by EEVT has focused only on the relevance of math and science for students' lives (Harackiewicz, Rozek, Hulleman & Hyde, 2012; Hulleman & Harackiewicz, 2009) and for various occupations in STEM (Harackiewicz et al., 2012) as a means of increasing adolescents' involvement in math and science and thus of expanding their educational and occupational opportunities. The present study suggests that broadening the scope of such interventions to focus also on the utility of English-related abilities and values for STEM-related occupations may be a worthwhile avenue for future intervention research. Highlighting the utility of both math and English for professional success in STEM (cf. ONet database) could potentially increase the attractiveness of STEM-related occupations among individuals who value not only math but also English.

In sum, expanding upon prior evidence in EEVT and the DCT, we examined the cross-domain effects of adolescents' self-evaluated abilities in and valuing of math and English on their math/science-related and human-services-related career plans. Our analyses documented negative additive and multiplicative cross-domain effects across math and English on math/science-related career plans, but we found no such effects on adolescents' preferences for human services occupations. These findings have two implications. First, our findings suggest that a focus solely on math-related abilities and motivations may be insufficient for understanding adolescents' preferences and involvement in the STEM domain. Second, the potential of math-intensive occupations to accommodate diverse abilities and values for both math and English, especially for females, constitutes an important avenue for future research.

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ENDNOTES

[1] Note that the DCT is a generalization of Marsh's internal/external frame of reference model (Marsh, 1986). Thus, both frameworks are relevant for the present study.

[2] In the Methods section, we report profiles of both math/science-related and human-services-related occupations in terms of required knowledge of math and English. On average, human services occupations do seem to require higher levels of English knowledge than of math.
[3] Since the full model is saturated, it has perfect fit to the data. Thus, our model constraining the path and covariance coefficients across gender is being compared against a model with perfect fit.

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