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Task Value Profiles Across Subjects and Aspirations to Physical and IT-Related Sciences in the United States and Finland

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Two independent studies were conducted to extend previous research by examining the associations between task value priority patterns across school subjects and aspirations toward the physical and information technology- (IT-) related sciences. Study 1 measured task values of a sample of 10th graders in the United States (N = 249) across (a) physics and chemistry, (b) math, and (c) English. Study 2 measured task values of a sample of students in the second year of high school in Finland (N = 351) across (a) math and science, (b) Finnish, and (c) the arts and physical education. In both studies, students were classified into groups according to how they ranked math and science in relation to the other subjects. Regression analyses indicated that task value group membership significantly predicted subsequent aspirations toward physical and IT-related sciences measured 1–2 years later. The task value groups who placed the highest priority on math and science were significantly more likely to aspire to physical and IT-related sciences than were the other groups. These findings provide support for the theoretical assumption regarding the predictive role of intraindividual hierarchical patterns of task values for subsequent preferences and choices suggested by the Eccles [Parsons] (1983) expectancy-value model.

Keywords: task values, educational aspirations, occupational aspirations, physical and IT-related sciences

Why are some individuals more likely than others to take advanced courses in the hard sciences and to aspire to careers in these fields? According to the expectancy-value model of achievement-related choice (Eccles [Parsons], 1983), individuals' perceived values of various school subjects or activities, *subjective task values* (*STVs* or simply *task values*), play a key role in the choices individuals make regarding education and occupation. More specifically, this model suggests that individuals are more likely to select the option that they value most when choosing among several alternatives. From a developmental perspective, how adolescents rank STVs across school subjects is conceptualized as a key factor in shaping their subsequent educational and occupational aspirations in different disciplines (Eccles, 1994, 2011). However, studies examining the associations between STV patterns across school subjects and subsequent aspirations are rare (Chow & Salmela-Aro, 2011). To fill this gap, in this article, we focus on the role of STV patterns exhibited by adolescents across several school subjects in predicting their subsequent aspirations for college majors or careers in math, physical science, or information technology (hereafter we refer to these disciplines as *physical and IT-related sciences*).

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Task Values and Subsequent Outcomes

The STV of an activity is composed of four key components: intrinsic value, attainment value, utility value, and perceived cost (Eccles [Parsons], 1983). Intrinsic value is defined as the expected enjoyment of engaging in a specific activity or task. Attainment value refers to the perceived importance that individuals attach to performing well in or being competent at a task, which is closely associated with their perception of how relevant the task is to their personal and social identities. Utility value is the perceived usefulness of a task in obtaining any rewards or facilitating the achievement of other immediate or long-term goals. Last, the perceived cost refers to what individuals believe they must give up to do a task, such as time, effort or psychological well-being. Supported by empirical evidence, the first three components of task values are taken as attracting characteristics that are related to the positive valence of a task, while perceived costs are related to its negative valence (Eccles [Parsons], 1983; Wigfield & Eccles, 1992; Wigfield et al., 1990). It is common for researchers to employ a combination of intrinsic, attainment, and utility values to indicate STVs, but to not include cost in these measures (e.g., Bong, 2001; Cole, Bergin, & Whittaker, 2008; Durik, Vida, & Eccles, 2006; Liem, Lau, & Nie, 2008; Wolters & Rosenthal, 2000).

The associations between STVs of students and their subsequent choices or behaviors have been the focus of many investigations (e.g., Atwater, Wiggins, & Gardner, 1995; Crombie et al., 2005; Durik et al., 2006; Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Guthrie, 1997). Most of these studies have followed a variable-centered approach, in which the interrelationships between variables, or more specifically, between STVs of specific school subjects and subsequent outcomes related to the corresponding subject domains, are examined. For example, Simpkins et al. (2006) and Watt (2005a) revealed that STVs attached to math by 10th graders significantly predicted the total number of high school math courses and the level of the math courses that the students subsequently took. Similarly, Durik et al. (2006) found that the STVs attached to reading by fourth graders predicted the number of English courses that they took in high school, as well as their aspirations for jobs that involved high literacy skills. These studies can be contrasted with those of person-centered studies on STVs (e.g., Chow & Salmela-Aro, 2011), which consider how choices and outcomes are affected by how students prioritize or rank the STVs of various subjects (i.e., *intraindividual hierarchical patterns* of STVs; Eccles, 2005, 2011). As pointed out by Eccles (Eccles, 2011; Eccles [Parsons], 1983), choices and preferences are made within a context of complex social realities, in which selecting one option means forfeiting another (see also Schwartz, 2004). For example, undergraduates who choose to major in physics are deciding to spend their next few years specializing in this field and having very little time available for taking courses in other fields such as literature, history, or biology. Thus, knowing how students prioritize the STVs of various subjects is probably a more psychologically direct way of assessing the relevance of STVs for understanding why individuals pick one particular educational or occupational option rather than another. However, compared with variable-centered approaches, person-centered approaches have to date been less applied in the task value literature to explain achievement-related choices (see Chow & Salmela-Aro, 2011; Viljaranta, Nurmi, Aunola, & Salmela-Aro, 2009; Watt, 2005b, for exceptions). The extent to which within-person choices are influenced by within-person hierarchies of values across subject areas has been understudied. More person-centered research on STVs is needed to advance researchers' understanding of the role of STVs in choices and other outcomes (Eccles, 2011; Eccles [Parsons], 1983).

Values and Gender Imbalance in Physical and IT-Related Sciences

Despite the fact that there are no gender differences in academic achievement scores of adolescents in science (Organisation for Economic Cooperation and Development [OECD], 2007) and math (National Center for Education Statistics, 2008), women continue to be underrepresented in the scientific careers associated with math, physical science, engineering, and IT (Jacobs, 2005; Xie & Shauman, 2003; Zarrett & Malanchuk, 2005). Developmental scientists have noted that the gender imbalance in career choices among adults can be traced back to the differences between the evaluative beliefs of boys and girls about the characteristics and rewards of jobs, or *occupational values*, during adolescence (Eccles, 1994). For instance, Eccles, Barber, and Jozefowicz (1999) documented the link between adolescents' occupational values for their future work and their career aspirations: valuing a job that allows one to help others was predictive of their aspirations to human service or health-related professions and was also predictive of *not aspiring* to physical-science-related professions. In addition, from an intraindividual perspective, previous research has shown gender differences in hierarchical patterns of occupational values among individuals. Compared with girls, boys are more interested in money-making jobs and work related to the manipulation of physical objects than in people-oriented jobs (Eccles, 1994; Jozefowicz, Barber, & Eccles, 1993). Such differences in the relative occupational values of boys and girls partly explain gender differences in career aspirations toward the physical and IT-related science fields (Eccles, 1994, 2005, 2011; Jozefowicz et al., 1993).

Given that quite a number of previous studies (e.g., Eccles, 1994, 2005, 2011; Jozefowicz et al., 1993) have shown that career aspirations are related to priority patterns for various job characteristics and job rewards (i.e., intraindividual hierarchical patterns of *occupational values*), it would be meaningful to further examine whether these aspirations are associated with how students prioritize the values of different school subjects (i.e., intraindividual hierarchical patterns of *STVs*). However, to date, only a handful of studies have employed a person-centered perspective to examine intraindividual hierarchical patterns of STVs and corresponding gender differences (Chow & Salmela-Aro, 2011; Viljaranta et al., 2009; Watt, 2005b). In a study by Chow and Salmela-Aro (2011), a sample of ninth graders in Finland was classified into groups according to their STVs for four subject areas (math and science, languages, the arts and PE, and social sciences). Boys were more likely than girls to fall into an STV group that valued math and science the most. This STV group also showed a greater tendency to continue their studies after finishing compulsory education. Another study on STV patterns by Viljaranta, Nurmi, Aunola, and Salmela-Aro (2009) revealed that boys were overrepresented in an STV group that accorded the highest priority to math and science over Finnish, foreign languages, social sciences, and the nonacademic subjects such as music. The same study also found that students who attached particularly high values to math and science exhibited stronger aspirations toward jobs with higher prestige than did students who did not value any subjects or valued only nonacademic subjects. In line with these two studies, in an interview study among 60 ninth graders in Australia, Watt (2005b) reported that twice as many boys as girls planned to pursue math-related careers. Placing a very high value on math over other subjects was a key determinant for aspiring to math-related jobs; in contrast, placing a higher value on areas other than math predicted *not aspiring* to such jobs (Watt, 2005b). Taken together, these studies have provided initial evidence on the possible linkage between STV patterns pertaining to school subjects and aspirations for math and science jobs. Building on and extending these studies, our work was designed to assess the relationships among gender, STV patterns, and aspirations to physical and IT-related sciences. We examined the relations among these variables in two studies, one using data collected in the United States (Study 1) and the other using data collected in Finland (Study 2).

From a variable-centered perspective, studies conducted in the 1980s and early 1990s consistently found that boys tend to attach greater personal importance to math and science than did girls (Meece, Wigfield, & Eccles, 1990; Updegraff, Eccles, Barber, & O'Brien, 1996). By and large, such differences in task values of boys and girls have been taken by researchers as a factor accounting for gender imbalance in various occupations (Eccles, 2011). Nevertheless, quite a number of more recent studies comparing means on STVs for math and science have found no significant differences between boys and girls (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Simpkins et al., 2006), suggesting a possible narrowing of the gender gap. Although at the mean level gender differences in math and science valuation seem to have become smaller or insignificant, gender differences in how boys and girls prioritize math and science in relation to other school subjects still exist (Chow & Salmela-Aro, 2011). Thus, it is timely and important to examine the associations between STV priority patterns across school subjects and aspirations toward the physical and IT-related sciences.

Overview of the Two Studies

We deliberately situated the two studies in the United States and Finland because they are different in at least four important ways that may relate to both individual and gender differences in STVs and educational or occupational choices. First, according to the *Global Gender Gap Report 2009* (Hausmann, Tyson, & Zahidi, 2009), Finland is the second best country in equality for men and women, while the United States placed 31st among 134 countries. Second, as evidenced by the OECD Programme for International Student Assessment (PISA), Finnish students have demonstrated better and more balanced academic performance across reading, math, and science than U.S. students (OECD, 2010). PISA indicates that Finnish students performed better in math than in reading, while U.S students scored higher in reading than in math (OECD, 2010). Third, Finland has a well-established social welfare system (Castells & Himanen, 2002; World Bank, 2009), in which tertiary education is free, and university students are entitled to receive substantial financial support for their living costs. In contrast, the cost of attending college and university in the United States is relatively high, and student debt burden has been an enduring social problem (Kamenetz, 2006). Finally, these two countries also differ in the time at which subject matter specialization is likely to occur. In Finland, students must select their potential college majors before entering university. This constraint forces students to specialize and maintain a very high grade point average (GPA) in those courses most directly linked to their anticipated college majors. As Finnish students have to take highly demanding entrance exams organized by individual university departments, in deciding on college majors they may consider their academic performance more but their interest or values less. In contrast, in the United States, most students do not have to declare their college major until they are in college. They apply to enter general undergraduate programs and then pick their majors after getting into college. Admission to college is based on obtaining a high GPA across subject areas and on taking a demanding set of college-preparatory courses during their high school years. Thus, most students planning to attend college in the United States take courses in both the math/sciences and English/literature subject areas. The U.S. educational model is therefore likely to lead to less differentiated STV profiles among high school students than is the Finnish model.

To sum up, because gender stereotypes and financial issues are of less concern, Finnish students are more likely than U.S. students to make educational and career choices based on their genuine interests and values. Being academically more competent in math than in reading, Finnish students on average are probably more likely to aspire to math or science than their U.S. counterparts, who show the reverse pattern in academic achievement. However, the U.S. university system is more favorable in allowing students to pursue the college major that they value without overly worrying about their academic performance. Considering these differences, researching how students' task value profiles are related to their aspirations to physical and IT-related sciences in the United States and Finland can help investigators to understand the generalizability of the findings across cultures that differ in gender equality, the cost of attending higher education, the academic characteristics of students, and educational models. Nevertheless, it is important to note that the two studies were not designed for direct comparison. Instead, we reported the two studies together in this article to explore if, by and large, similar patterns would be found between STVs patterns and aspirations, despite the heterogeneous nature of the two samples and the heterogeneity in the specific measures and cohorts in the two studies.

Both studies were designed to answer three research questions. First, are there meaningful groups of adolescents who differ in their STV patterns across various school subjects? If so, what groups can be identified? Wigfield and Eccles (1992) pointed out that by the time children reach late elementary school, they begin to evaluate what activities are more useful and important to them. As students proceed through junior and senior high school, the perceived importance and usefulness of activities to future goals become prominent in differentiating the students' STVs. Mathematical and scientific knowledge may not be relevant to some educational or career fields, but language skills are essential to all fields (Durik et al., 2006). For example, mathematical skills may not be relevant to the career of a historian, but a physicist still needs language skills for reading and writing reports. Therefore, we expected that the participants would tend to place a relatively high value on languages, regardless of their educational or career goals. In contrast, it would be primarily the students who planned to pursue math and science disciplines to place high values on these subjects. In line with this prediction, a recent study found that math and science were particularly critical in distinguishing STV patterns of a sample of ninth graders in Finland (Chow & Salmela-Aro, 2011). Taken together, we predicted that math and science would emerge as the subject domains playing a key role in differentiating STV patterns across subjects.

Second, do boys and girls differ in their STV profiles across subject areas? In a recent study, Jerrim (in press) reported that PISA 2006 data indicated that in both the United States and

Finland, 15-year-old boys were more likely than girls to place higher attainment values on math and science than on reading, while girls were more likely than boys to place higher values on reading than on math and science. Drawing on a sample of ninth graders in Finland, Chow, and Salmela-Aro (2011) also found gender differences in STV patterns across school subjects: on average, boys placed higher value on math and science than on language, and vice versa for girls. Based on these studies, we predicted that boys, on average, would have a stronger tendency to fall into an STV pattern with math and science rated higher than the other subject areas, and girls would have a stronger tendency to fall into an STV pattern with math and science rated lower than the other subject areas.

Third, do STV profiles of students relate to their subsequent occupational or educational aspirations in the physical and IT-related sciences? Also, do STV profiles mediate the effects of gender on these aspirations? Watt (2005b) found that students who attached higher values to math over other subjects were more likely to aspire to math-related jobs. We expected to find similar results in our work. In addition, according to Eccles [Parsons] (1983) expectancy-value model, STV profiles were expected to mediate the relationships between gender and these aspirations.

Study 1

Method

Participants. The U.S. data are from the Childhood and Beyond Study (CAB; see Durik et al., 2006, and Eccles, Wigfield, Harold, & Blumenfeld, 1993, for details about CAB). CAB is a longitudinal study tracking three cohorts of children from elementary through high school. The first wave of data was collected in 1986, when the participants were in kindergarten, Grade 1, and Grade 3. The CAB sample included mainly children from middle- and working-class households in southeastern Michigan, 95% of whom were European American. In this study, we focused on those participants who were followed through Grade 12 ($N = 303$; 195 from the oldest cohort, and 117 from the middle cohort). If students had data on at least one of their STV ratings for each subject area at Grade 10 and also on their occupational aspirations at Grade 12, they were included in the final sample, which comprised 249 students (163 from the oldest cohort and 86 from the middle cohort). The mean age at Grade 10 was 15.5 years ($SD = 0.34$), with girls composing 58.2% of the sample. Regarding their families, 82.2% of mothers and 90.7% of fathers had at least some college education. The median family income between 1986 and 1989 ranged from $50,000 to $59,999 annually. Thus, these families are largely white and middle class. The sample is from four school districts in southeast Michigan outside the city of Detroit.

In the United States, high school students are required to take a set of prerequisite courses to earn the high school diploma, but beyond that they have a high degree of freedom regarding the courses that they want to take. Nevertheless, the high school courses taken is one of the important admission criteria for university. It is possible to determine whether students are on a "college preparatory track" by their high school courses. In addition, students are strongly advised to take advanced mathematics and both chemistry and physics in high school if they are planning to pursue a STEM (science, technology, engineering and math) major at university.

Procedure. CAB data were collected during school time in the spring of each data collection year. Questionnaires were administered to the participants in their classroom by project staff. This study used the self-reported GPA and STV data from students when they were in Grade 10 (spring of 1994 for the oldest cohort and spring of 1996 for the middle cohort) and their occupational aspirations data at Grade 12 (spring of 1996 for the oldest cohort and spring of 1998 for the middle cohort). Although the data at Grades 10 and 12 for the oldest and middle cohorts were collected at different time points, the data for the two cohorts were measured by the same items. We conducted a series of *t* tests to compare the students of each cohort in terms of their GPA and their responses on each STV item. Since none of these 10 comparisons yielded significant results, we combined the two cohorts into a single group.

Measures.

Subjective task values. STVs were collected for three school subject domains: (a) physics and chemistry, (b) math, and (c) English. Based on the Eccles [Parsons] (1983) expectancy-value model, the STVs for each subject domain were assessed by three items representing the attainment value, intrinsic value, and utility value. For example, for physics and chemistry, the item measuring attainment value was "For me, being good at physics and chemistry is . . . ," and the responses were given on a 7-point scale that ranged from 1 (*not at all important*) to 7 (*very important*). The item on intrinsic value was "How much do you like doing physics and chemistry?" The responses were based on a 7-point scale, ranging from 1 (*a little*) to 7 (*a lot*). Last, the item on utility value was "How useful is what you learn in physics and chemistry?" Responses were given on a 7-point scale that ranged from 1 (*not useful*) to 7 (*very useful*). For each respondent, the means of these three items were calculated for each subject area. The Cronbach's alpha reliabilities of the STVs for physics and chemistry, math, and English were .86, .76, and .80, respectively.

Occupational aspirations for physical and IT-related sciences. Occupational aspirations concerning physical and IT-related sciences were assessed by two items. One requested respondents to report their perceived likelihood of pursuing physical and IT-related science professions that would require a bachelor's or master's degree, such as computer engineering. The other item asked respondents to report their perceived likelihood of pursuing physical and IT-related science jobs that would require a doctoral degree, such as doing research in chemistry. Responses were given on a 7-point scale ranging from 1 (*very unlikely*) to 7 (*highly likely*).

Grade point average. Participants were asked to report their GPA in the first semester in 10th grade. This was included as the indicator of overall academic performance and was used as a control for endogeneity. The mean value for GPA was 3.35 ($SD = 0.56$; minimum = 1.4, maximum = 4.0).

Socioeconomic status (SES). Parents of the participants were asked to report their occupations between 1986 and 1989. Responses were coded according to the socioeconomic index (SEI), with ratings ranging from 0 to 100 (Entwisle & Astone, 1994; Nakao & Treas, 1992). The average SEI between 1986 and 1989 for each parent was calculated. If both parents were working, the higher SEI of either parent was used as the indicator of family SES.

Analyses. The analyses proceeded in two key stages. First, we applied latent profile analysis (LPA) to classify students into groups based on their STVs for the three subject domains, using M*plus* statistical package, Version 5.1 (Muthén & Muthén, 2007b). LPA is a statistical procedure that estimates the number of latent homogeneous classes in a heterogeneous sample according to the patterns of observed responses (Vermunt & Magidson, 2002). LPA is exploratory in nature, which means there are no specific a priori assumptions regarding the number or distribution of groups (Nylund, Bellmore, Nishina, & Graham, 2007). Typically, performing LPA results in a series of models being specified. The best fitting model is then selected based on the goodness-of-fit indices and conceptual considerations such as the interpretability of the latent groups in the solutions (Aldridge & Roesch, 2008; Herman, Ostrander, Silva, March, & Walkup, 2007; Tuominen-Soini, Salmela-Aro, & Niemivirta, 2008).

Among the goodness-of-fit indices, Bayesian information criterion (BIC) and Akaike's information criterion (AIC) have been widely used (e.g., Marsh, Lüdtke, Trautwein, & Morin, 2009; Smith & Shevlin, 2008). We employed BIC as the key referencing indicator because recent simulation research revealed that it provides the most reliable indicator of model fit (Nylund, Asparouhov, & Muthén, 2007). A model with a lower BIC value was considered to provide a better fit to the data. In addition, the results of the bootstrap likelihood ratio test (BLRT), which indicated whether an additional class led to a significant increase in fit (Nylund, Asparouhov, et al., 2007), were also considered. The latent class probabilities indicated how parsimoniously individuals were assigned to their respective classes. Last, in reference to Marsh et al. (2009) and Bowen, Lee, and Weller (2007), the size of the smallest group of an acceptable solution should at least exceed 5% of the sample.

Upon completion of the LPA, we saved the group membership information on each student. Subsequent statistical procedures, including analyses of variance (ANOVAs), cross-tabulations, regression analyses, and bootstrap tests, were employed to investigate the associations between STV profile membership, gender, and aspirations for physical and IT-related science professions, controlling for GPA and SES. We followed Baron and Kenny's (1986) procedures for testing the mediation effects of STV group membership on the associations between gender and occupational aspirations: gender, GPA, and SES were entered in Step 1 of the regression model, and STV group membership was added as an additional independent variable in Step 2. If the coefficient for gender (or GPA or SES) decreased from Step 1 to Step 2, a follow-up bootstrap test was conducted to further determine the significance of the mediation effects of STV group membership between gender (or GPA/SES) and occupational aspirations. The bootstrap procedures were conducted using M*plus* statistical package Version 5.1 (Muthén & Muthén, 2007b).

Results

Table 1 shows the means and standard deviations of the measures and their intercorrelations. At the mean level, STVs for English appeared to be the highest ($M = 4.99$; $SD = 1.31$). STVs for physics and chemistry were positively correlated with that for math ($r = .53$, $p < .001$). No significant correlation was found between the STVs for English and the other two subjects. Absolute values of skewness and kurtosis for the three STV measures ranged from –.37 to –.61 and from –.61 to .22, respectively (not shown in the table), indicating no major deviations from normal distributions. Gender (girls coded 0 and boys coded 1) was positively correlated with STVs for physics and chemistry ($r = .17$, $p < .01$) and negatively correlated with STVs for English ($r = -.23$, $p < .001$). In addition, gender was positively correlated with aspirations for physical and IT-related science jobs requiring a bachelor's or master's degree ($r = .29$, $p < .001$) and requiring a doctorate ($r = .16$, $p < .01$). In contrast, gender was not correlated with either the STVs for math or 10th grade GPA. Socioeconomic status did not correlate with any measure, except GPA ($r = .20$, $p < .01$).

Identification of STV groups. To answer the first research question, we conducted a series of LPA procedures using the STV scores for the three subject domains. Referring to Table 2, the BIC index of the two-class solution was lowest (BIC = 2612.98), but it did not differ substantively from that of the three-class solution

Table 1
Study 1: Correlations Among Measures for the U.S. Sample (N = 249)

Variable	*M*	*SD*	Correlations 1	2	3	4	5	6	7	8
Subjective task values										
1. Physics & chemistry	4.49	1.59	—	.53***	.07	.17**	.28***	.02	.31***	.37***
2. Math	4.54	1.40		—	.03	.08	.30***	.06	.32***	.27***
3. English	4.99	1.31			—	−.23***	.04	−.02	−.22***	−.04
Other measures										
4. Gender	0.42	0.49				—	−.04	.07	.29***	.16**
5. Grade point average	3.35	0.56					—	.20**	.30***	.22***
6. Socioeconomic status	62.74	9.70						—	.12	.09
7. Aspirations to physical and IT-related science jobs with bachelor's or master's degree	3.64	2.37							—	.54***
8. Aspirations to physical and IT-related science jobs with doctoral degree	2.66	2.12								—

Note. Gender coded: girl = 0 and boy = 1.
** $p < .01$. *** $p < .001$.

Table 2
Study 1: Fit Indices for Latent Profile Analysis Models in the U.S. Sample (N = 249)

No. of							Latent class probabilities				
Classes	Parameters	Log likelihood	AIC	BIC	*p*BLRT	Class size ≤ 5%	1st	2nd	3rd	4th	5th
1	6	−1323.87	2659.73	2680.84		0					
2	10	−1278.90	2577.81	2612.98	.00	0	.90	.92			
3	14	−1268.14	2564.29	2613.53	.00	0	.90	.91	.87		
4	18	−1263.31	2562.61	2625.93	.18	0	.96	.85	.86	.89	
5	22	−1256.89	2557.77	2635.16	.20	1	.99	.90	.83	.78	.90

Note. AIC = Akaike's information criterion; BIC = Bayesian information criterion; *p*BLRT = *p* values for the bootstrap likelihood ratio test for *K* versus *K* − 1 classes; class size ≤ 5% = the number of groups with equal to or less than 5% of the sample.

(BIC = 2613.53). Since the *p* value of BLRT indicated that increasing the number of classes from two to three significantly improved the model fit, but not increasing the classes from three to four, we decided that the three-class solution was optimal. The average probabilities of individuals being parsimoniously assigned into their respective classes were .90 (Class 1), .91 (Class 2), and .87 (Class 3), which further indicated the robustness of the three-class model.

The three STV groups were labeled according to how math, physics, and chemistry were ranked in relation to English (see Figure 1). Accordingly, the three groups were labeled (a) high math and physical science, (b) moderately low math and physical science, and (c) low math and physical science. These three groups represented 41.8%, 43.8% and 14.5% of the sample, respectively. To examine differences among the three STV groups on GPA, SES, and each of the STVs, we performed a series of one-way ANOVAs. Referring to Table 3, the three groups were significantly different in terms of their GPA and STVs for math as well as physics and chemistry, but no significant differences were found for SES and the STV for English. Post hoc comparisons using Fisher's least significant difference tests revealed that the high math and physical science group was highest in STVs for both math and physics/chemistry.

Gender differences in STV group membership. To answer the second research question, we examined the relationship between gender and STV group membership. The cross-tabulation with chi-square test indicated a significant relationship between gender and STV group membership, $\chi^2(2, N = 249) = 8.21$, $p < .001$. The high, moderately low, and low math and physical science groups constituted 35.2%, 46.2%, and 18.6% of girls and 51%, 40.4%, and 8.7% of boys, respectively (see Table 4). Follow-up regression analyses using gender to predict group membership further revealed that boys were more likely to fall into the high math and physical science group, Exp(*B*) = 1.92 (girls as reference group), $p < .05$. In contrast, boys were significantly less likely than girls to fall into the low math and physical science group, Exp(*B*) = 0.41 (girls as reference group), $p < .05$.

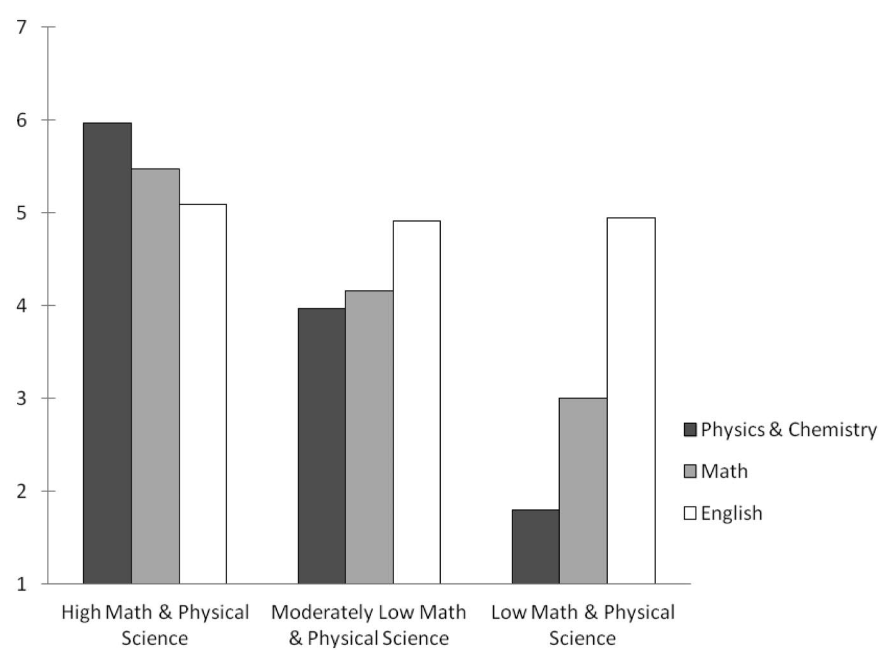

Figure 1. Study 1: Subjective task value scores of the three groups across the subject domains (U.S. sample; $N = 249$).

Table 3
Study 1: Mean Differences in Subjective Task Values and Grade Point Average Across the Three Groups in the U.S. Sample (N = 249)

Variable	Subjective task value groups: High math and physical science (N = 104) *M*	*SD*	Moderately low math and physical science (N = 109) *M*	*SD*	Low math and physical science (N = 36) *M*	*SD*	$F(2, 246)$	η^2
Subjective task value								
Physics & chemistry	5.97	0.67	3.97	0.69	1.80	0.62	570.05**	.82
Math	5.48	0.92	4.16	1.18	3.00	1.23	81.19**	.40
English	5.09_a	1.25	4.91_a	1.39	4.94_a	1.22	0.53	.00
Grade point average	3.53	0.48	3.26_a	0.59	3.10_a	0.56	11.04***	.82
Socioeconomic status	62.05_a	10.09	63.81_a	9.68	61.47_a	8.26	1.54	.01

Note. Means within a row sharing the same subscripts are not significantly different at the $p < .05$ level.
** $p < .01$. *** $p < .001$.

The *t* tests on GPA indicated that among girls, the students in the high math and physical science group had a significantly higher GPA than the girls in the other two STV groups. In contrast, boys' GPA did not differ across the three STV groups. No significant findings emerged for family SES.

Linking STV group membership to occupational aspirations. Last, we examined the associations between STV patterns and occupational aspirations for physical and IT-related science professions, with a particular interest in testing the mediation effects of STV patterns between gender and aspirations toward these professions. Table 5 lists the results with aspirations toward physical and IT-related science professions that require a bachelor's or master's degree as the dependent variable. In Step 1, gender, GPA, and SES were entered. The results of this model were significant, $F(3, 245) = 17.86$, $p < .001$. Only gender and GPA were significant predictors, β of gender = .29, $p < .001$, and β of GPA = .30, $p < .001$. In Step 2, STV group membership was entered. More specifically, the STV group membership was indicated by two dummy variables, with high math and physical science as the reference group in each contrast. The model was significant, $F(5, 243) = 14.25$, $p < .001$. The change in R^2 indicated that STV group membership significantly improved the prediction, accounting for an extra 5% of the variance. Compared with the high math and physical science group, the moderately low math and physical science group had significantly lower occupational aspirations for physical and IT-related science jobs requiring a bachelor's or master's degree, $\beta = -.17$, $p < .01$. That of the low math and physical science was also significant, $\beta = -.23$, $p < .001$. The effects of gender and GPA on the outcome variable both decreased, β of gender = .25, $p < .001$, and β of GPA = .23, $p < .001$. Finally, the interaction terms among gender, GPA, SES, and STV group membership were entered (e.g., Gender × GPA and Gender × First Dummy Variable of STV Group Membership), none of which were significant predictors.

Given that the regression coefficients for gender and GPA both decreased from Step 1 to Step 2, we conducted a bootstrap procedure to determine whether STV group membership significantly mediated the associations of either gender or GPA with aspirations for physical and IT-related science professions requiring a bachelor's or master's degree, controlling for SES. Because the occupational aspiration variable was a continuous measure, the maximum likelihood estimator was used in the bootstrap procedure, as suggested by Preacher and Hayes (2008). The indirect effects of gender on occupational aspirations through the mediation of STV group membership ($B = 0.22$, $SE = 0.09$, $p < .01$) and of GPA on occupational aspirations through the mediation of STV group

Table 4
Study 1: Gender Distribution and Grade Point Average Means Across the Three Subjective Task Value Groups in the U.S. Sample (N = 249)

Variable	High math and physical science	Moderately low math and physical science	Low math and physical science
Girls			
N	51	67	27
Percentage within girls	35.2	46.2	18.6
Grade point average mean (*SD*)	3.62 (0.35)	3.28_a (0.59)	3.11_a (0.60)
Socioeconomic status mean (*SD*)	60.93_a (9.16)	63.32_a (10.03)	61.80_a (8.03)
Boys			
N	53	42	9
Percentage within boys	51.0	40.4	8.7
Grade point average mean (*SD*)	3.44_a (0.56)	3.24_a (0.59)	3.07_a (0.46)
Socioeconomic status mean (*SD*)	63.14 (10.76)	64.59 (9.11)	60.45 (9.08)

Note. Means within a row sharing the same subscripts are not significantly different at the $p < .05$ level.

Table 5
*Study 1: Regression Analysis Predicting Occupational Aspirations for Physical and IT-Related Science Professions Requiring a Bachelor's or Master's Degree in the U.S. Sample (*N = 249*)*

Step and predictor	Step 1 *B*	Step 1 *SE*	Step 1 95% CI	Step 1 β	Step 2 *B*	Step 2 *SE*	Step 2 95% CI	Step 2 β	R^2	ΔR^2
Step 1									.18***	—
Gender	1.40***	0.28	[0.85, 1.95]	.29***	1.17***	0.28	[0.62, 1.73]	.25***		
Grade point average	1.27***	0.25	[0.77, 1.77]	.30***	0.96***	0.27	[0.44, 1.48]	.23***		
Socioeconomic status	0.011	0.02	[−0.03, 0.05]	.04	0.02	0.02	[−0.02, 0.06]	.07		
Step 2										
Subjective task value groups									.23***	.05***
Moderate vs. **high**					−0.83**	0.31	[−.1.43, −0.23]	−.17**		
Low vs. **high**					−1.55***	0.43	[−.2.40, −0.70]	−.23***		

Note. IT = information technology; *B* = unstandardized regression coefficients; β = standardized regression coefficients; CI = confidence interval; ΔR^2 = change in R^2; low = low math and physical science group; moderate = moderately low math and physical science group; high = high math and physical science (reference group). Group in bold is reference group.
** $p < .01$. *** $p < .001$.

membership ($B = 0.30$, $SE = 0.11$, $p < .001$) were both significant. Considering that the direct effects of both gender and GPA on occupational aspirations were still significant (*B* of gender = 1.18, $SE = 0.29$, $p < .001$; *B* of GPA = 0.97, $SE = 0.27$, $p < .001$), these results indicated that STV group membership partially mediated the effects of both gender and GPA on aspiration toward physical and IT-related science professions requiring a bachelor's or master's degree. On the other hand, no significant direct or indirect effects from SES on occupational aspirations were found.

A parallel set of regression analyses was conducted for occupational aspirations for physical and IT-related professions requiring a doctoral degree (see Table 6). In Step 1, gender, GPA, and SES were entered. The model was significant, $F(3, 245) = 6.78$, $p < .001$. Only gender and GPA were significant predictors, β of gender = .71, $p < .01$, and β of GPA = .81, $p < .001$. STV group membership was entered in Step 2, and this model was also significant, $F(5, 243) = 10.97$, $p < .001$. The inclusion of STV membership significantly improved the prediction, explaining an additional 10% of the variance. Compared with the high math and physical science group, both moderately low and low math and physical science groups had significantly lower occupational aspirations for physical and IT science jobs requiring a doctoral degree (moderately low vs. high math and physical science: β = –.34, $p < .001$; low vs. high math and physical science: β = –.27, $p < .001$). Similar to the procedure in previous regression analysis, we entered the interaction terms for gender, STV group membership, and GPA into the model and found no significant effects.

Finally, a follow-up bootstrap procedure was conducted to test whether STV group membership significantly mediated the effects of either gender or GPA on aspirations toward physical and IT-related science professions requiring a doctoral degree. The indirect effects of gender on these occupational aspirations through the mediation of STV group membership ($B = 0.27$, $SE = 0.10$, $p < .01$) and on GPA through the mediation of STV group membership ($B = 0.37$, $SE = 0.11$, $p < .001$) were both significant. As the direct effects of gender and GPA were both eliminated, we concluded that STV group membership fully mediated the relationship between gender/GPA and aspirations toward physical and IT-related science professions requiring a doctoral degree. On the other hand, SES had no significant direct or indirect effects on occupational aspirations.

Table 6
*Study 1: Regression Analysis Predicting Occupational Aspirations for Physical and IT-Related Science Professions Requiring a Doctoral Degree in the U.S. Sample (*N = 249*)*

Step and predictor	Step 1 *B*	Step 1 *SE*	Step 1 95% CI	Step 1 β	Step 2 *B*	Step 2 *SE*	Step 2 95% CI	Step 2 β	R^2	ΔR^2
Step 1									.08***	—
Gender	0.71**	0.26	[0.19, 1.23]	.16**	0.43	0.26	[−0.08, 0.94]	.10		
Grade point average	0.81***	0.24	[0.34, 1.28]	.21***	0.40	0.24	[−0.07, 0.88]	.11		
Socioeconomic status	0.01	0.01	[−0.02, 0.04]	.04	0.02	0.02	[−0.02, 0.05]	.08		
Step 2										
Subjective task value groups									.18***	.10***
Moderate vs. **high**					−1.45***	0.28	[−2.00, −0.90]	−.34***		
Low vs. **high**					−1.64***	0.40	[−2.42, −0.86]	−.27***		

Note. IT = information technology; *B* = unstandardized regression coefficients; β = standardized regression coefficients; CI = confidence interval; ΔR^2 = change in R^2; low = low math and physical science group; moderate = moderately low math and physical science group; high = high math and physical science (reference group). Group in bold is reference group.
** $p < .01$. *** $p < .001$.

Summary

As expected, the students could be reliably classified into STV groups with distinct characteristics. Across physical science, math, and English, the groups differed only in STVs for physical science and math. Second, a significant relationship was found between gender and STV group membership. Boys were more likely to fall into the high math and physical science group, and they were less likely to fall into the low math and physical science group than girls, despite the fact that the two genders did not differ in their GPA. The girls in the high math and physical science group outperformed the other two groups of girls, while there were no significant differences among the boys in the three groups. Third, again as expected, we found that STV group membership predicted these students' 12th grade aspirations for physical and IT-related science occupations requiring either a bachelor's or master's degree or a doctoral degree, even after controlling for gender, GPA, and SES. Furthermore, STV group membership fully mediated the association between gender and aspirations for physical and IT-related science careers requiring a doctoral degree and partially mediated the association between gender and aspirations for physical and IT-related science careers requiring a bachelor's or master's degree.

Study 2

Given that the results of Study 1 were consistent with our hypotheses, we conducted a similar set of analyses (Study 2) based on a sample of high school students in Finland to explore the generalizability of these findings. The three research questions of Study 1 were asked again in Study 2.

Method

Participants. Finnish data were from the Finnish Educational Transition Studies (FinEdu; see Salmela-Aro, Kiuru, & Nurmi, 2008, and Salmela-Aro & Tynkkynen, 2010, for details about FinEdu), which is an ongoing longitudinal study of the transition to adulthood. FinEdu commenced in 2004, and its sample consisted of all the second year students from all six high schools in a city in central Finland. Four of the six are regular high schools, and the remaining two are specialized schools that put strong emphasis on the performing arts. A total of 560 participants from these six high schools reported their STVs and their educational aspirations, respectively, in the second and third year of high school (equivalent to Grade 11 and Grade 12 in the United States, hereafter referred to as Grade 11 and Grade 12, respectively). The Study 2 sample included participants from the four regular high schools ($N = 351$). The cases from the two specialized high schools were not included because their school curriculum deviated greatly from that of the regular high schools. As for the 351 students in the final sample, the mean age at Grade 11 was 17 years ($SD = 0.21$), and 65.5% of the sample were girls. The majority of participants (99%) reported Finnish as their mother tongue. This percentage aligns well with the ethnic composition of Finland at the national level.

In Finland, upon the completion of compulsory education at Grade 9 in comprehensive school, students can choose to further their education by following an academic track (which prepares them for tertiary education at university) or a vocational track. Students following the academic track continue their education at high school for 3 or 4 years. The academic score requirements for admission to high schools are minimal, allowing most students to meet these requirements. For instance, in a typical Finnish city, 90.7% of the students who selected the academic track were successfully admitted to a high school in 2009 (City of Kuopio, Finland, 2009). The percentage of comprehensive school graduates admitted to high school was 54.8% in 2002 and 50.6% in 2008 (Statistics Finland, 2009). Finnish high school students are required to take a set of basic courses and optional advanced courses in the subjects that they would like to pursue further. Because Finnish high school graduates have to select their anticipated college majors and take the respective admission examinations when they apply for university programs, these students usually select the advanced courses that are relevant to the university majors to which they aspire. Thus, compared with students in the United States, Finnish students are likely to take a narrower range of advanced courses and are forced to select their college majors much earlier.

Procedure. This study used self-reported questionnaire data collected from the participants at two time points with a 1-year interval. The participants were in Grade 11 at the first measurement point (January 2004). They were surveyed again a year later (January 2005) when they were in Grade 12. The questionnaires were administered to students at school during regular class sessions, under the supervision of school contact people.

Measures.

Subjective task values. STVs for three school subject domains, including (a) math and science, (b) Finnish, and (c) the arts and PE, were assessed with the STV scale developed from the Eccles et al. expectancy-value theory (Eccles [Parsons], 1983; Niemivirta, 2002). As in Study 1, in Study 2 we measured the STVs for each subject using three items that measured attainment value, intrinsic value, and utility value. However, the exact wording of the items was different from the wording used in Study 1. The STV items in Study 2 were structured by a common question stem: "How important, useful, and interesting do you think each of the following subjects is?" The participants were then guided to rate the (a) importance, (b) usefulness, and (c) level of interest for each subject. The responses were based on a 7-point scale ranging from 1 (*not at all*) to 7 (*very much*). The means of these three items were calculated for each subject domain. The Cronbach's alpha reliabilities for the STVs for math and science, Finnish, and the arts and PE were .82, .82, and .84, respectively.

Educational aspirations for physical and IT-related sciences. The participants were asked to report the field they would like to major in at the postsecondary school level, a question designed as an open-ended item. The open-ended responses on educational aspirations were coded according to the *Classification of Educational/Occupational Field* issued by the Ministry of Education and Culture of Finland (2004). The responses were coded into nine categories: (a) humanities and education (include teaching science and math in high school), (b) culture, (c) social sciences, business, and administration, (d) math and physical science, (e) computer, engineering, and IT, (f) natural resources and the environment, (g) life science, medicine, and nursing, (h) tourism, catering, and domestic services, and (i) military, police, and fire fighting. A dichotomous variable was created to indicate whether the students planned to major in physical or IT-related sciences in the future: physical or IT-related science (combining the fourth and fifth categories; coded 1) versus all other fields (the other seven categories; coded 0).

Grade point average (GPA). The participants were asked to report their GPA at Grade 10. The mean value for GPA was 8.68 (SD = 0.55; minimum = 7.0 and maximum = 10.0).

Family socioeconomic status (SES). Parents' occupations at Grade 11 were used as the indicator of family SES. Each parent's occupation was first coded according to the *Classification of Educational/Occupational Field* issued by the Ministry of Education and Culture of Finland (2004). We then recoded this measure further according to a four-category scheme: 0 (unsalaried position), 1 (blue collar), 2 (lower white collar), and 3 (upper white collar). If both parents were working, the higher SES of either parent would be taken as the indicator of the family SES.

Analyses. Similar analysis procedures were conducted here as in Study 1. That is, LPA was first applied to classify students into groups according to their STVs across the three subject domains. Next, we used subsequent statistical procedures such as cross-tabulations, regression analyses, and bootstrap tests to investigate the relationship among STV patterns, gender, and educational aspirations, controlling for GPA and SES. As the educational aspiration variable was a binary measure (1 = physical or IT-related science; 0 = all other fields), logistic regression was applied in Study 2.

Results

Table 7 shows the means and standard deviations of the measures and their intercorrelations. At the mean level, the STVs for Finnish appeared to be the highest (M = 5.13; SD = 1.18). STVs for math and science did not correlate with those of the other two subject domains. A significant positive correlation was found between STVs for Finnish and for the arts and PE (r = .24, $p <$ .001). Absolute skewness and kurtosis values for the three STV measures ranged from –.51 to –.58 and from –.10 to .33, respectively (not shown in the table), indicating no major deviations from normality. Gender (girls coded 0 and boys coded 1) was negatively correlated with STVs for Finnish (r = –.37, $p <$ .001) and STVs for the arts and PE (r = –.18, $p <$ .001), indicating that girls placed a higher value on these domains than did boys. In contrast, gender was positively correlated with STVs for math and science (r = .16, $p <$ .001), indicating that boys had higher STVs for math and science. Gender was positively correlated with educational aspirations for physical and IT sciences (r = .29, $p <$ .001) but did not correlate with GPA. Last, SES only correlated significantly with GPA (r = .12, $p <$ .05).

Identification of STV groups. Based on the students' STV scores for the three subject domains, a series of LPA models was specified. Table 8 lists the fit information for the models with one through five classes. We evaluated these models employing the same set of evaluation criteria used in Study 1. All the p values of the BLRTs were significant, indicating that the stepwise increment from one to five classes significantly improved the model fit. The BIC index of the two-class solution was lowest (BIC = 3618.24), but it did not differ much from that of the three-, four- and five-class solutions (BICs = 3623.31, 3624.19, and 3628.18, respectively). The average probabilities of individuals being parsimoniously assigned into the corresponding classes of the two- to five-class solutions were all satisfactory (all > .80). Compared with the above indices, the sizes of the smallest groups across the solutions provided a stronger distinction between the qualities of the models. Both the four- and five-class solutions comprised group(s) with less than 5% of the cases. The three-class solution was subsequently identified as the optimal solution, a decision further confirmed by the unique characteristics across the groups of the three-class model.

As with Study 1, the three groups were labeled according to how math and science were ranked in relation to other subjects (see Figure 2). The three groups were labeled (a) high math and science, (b) no preference, and (c) low math and science, which accounted for 20.5%, 53.6%, and 25.9%, respectively, of the sample. Referring to Table 9, the three STV groups were significantly different in their STVs for all the three subject areas. The STVs for math and science were significantly highest in the high math and science group and lowest in the low math and science group. No significant differences in GPA and SES were found among the three groups.

Gender differences in STV group membership. Table 10 lists the distribution of boys and girls among the three STV groups. The high math and science, no preference, and low math and science groups accounted for 11.3%, 57.8%, and 30.9% of girls and 38%, 45.5%, and 16.5% of boys, respectively. The cross-

Table 7
*Study 2: Correlations Among Measures in the Finnish Sample (*N *= 351)*

Variable	M	SD	Correlations 1	2	3	4	5	6	7
Subjective task values									
1. Math and science	4.92	1.45	—	−.02	−.10	.16***	.15**	.02	.27***
2. Finnish	5.13	1.18		—	.24***	−.37***	.13*	.02	−.20***
3. The arts and physical education	4.97	1.42			—	−.18***	.07	.04	−.22***
Other measures						—			
4. Gender	0.34	0.48					−.10	−.02	.29***
5. Grade point average	8.68	0.55					—	.12*	.09
6. Socioeconomic status	3.36	0.76						—	−.03
7. Educational aspirations to physical and IT-related sciences	0.14	0.34							—

Note. Gender coded: girl = 0 and boy = 1. IT = information technology.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 8
Study 2: Fit Indices for the Latent Profile Analysis Models in the Finnish Sample (N = 351)

No. of							Latent class probabilities				
Classes	Parameters	Log likelihood	AIC	BIC	*p*BLRT	Class size ≤ 5%	1st	2nd	3rd	4th	5th
1	6	−1805.24	3622.47	3645.64	—	0	—	—	—	—	—
2	10	−1779.81	3579.63	3618.24	.00	0	.92	.82	—	—	—
3	14	−1770.58	3569.16	3623.31	.00	0	.81	.81	.82	—	—
4	18	−1759.35	3554.70	3624.19	.00	1	.84	.81	.85	.87	—
5	22	−1749.62	3543.24	3628.18	.00	2	.82	.91	.81	.85	.86

Note. AIC = Akaike's information criterion; BIC = Bayesian information criterion; *p*BLRT = *p* values for the bootstrap likelihood ratio test for *K* versus *K* − 1 classes; class size ≤ 5% = the number of groups with equal to or less than 5% of the sample.

tabulation with chi-square test indicated a significant relationship between gender and STV group membership, $\chi^2(2, N = 351) = 36.12$, $p < .001$. Regression analyses in which gender was used to predict group memberships revealed that boys were more likely to fall into the high math and science group, Exp(*B*) = 4.81 (girls as the reference group), $p < .001$. In contrast, boys were significantly less likely than girls to fall into the no preference and low math and science groups, Exp(*B*) = 0.61, $p < .05$ and Exp(*B*) = 0.44, $p < .01$. For both boys and girls, there were no significant differences in GPA and SES across the three STV groups.

Linking STV group membership to educational aspiration. Last, we examined the relationships among STV patterns, gender, and educational aspirations to physical and IT sciences, controlling for GPA and SES. Table 11 lists the results for each step of the regression analysis. The chi-square generated by omnibus tests indicated the significance of the overall model. Nagelkerke R^2 gives an estimate of the variance that can be predicted by the combination of predictors at each step.

Similar to the procedures adopted in Study 1, gender, GPA, and SES were first entered in Step 1. The model was significant, $\chi^2(3, N = 351) = 33.90$, $p < .001$. Only gender and GPA were significant predictors, Exp(*B*) of gender = 6.16, $p < .001$, and Exp(*B*) of GPA = 2.21, $p < .01$. Next, STV group membership was entered, yielding a significantly improved model, $\chi^2(5, N = 351) = 47.72$, $p < .001$. The odds for the no preference group reporting educational aspirations for physical and IT-related science were significantly lower than those of the high math and science group, Exp(*B*) = 0.43, $p < .05$. Similarly, compared with the high math and science students, the low math and science students were also significantly less likely to report such aspirations, Exp(*B*) = 0.13, $p < .01$. These results indicated that when gender, GPA, and SES were controlled, STV group membership still predicted educational aspirations. The effects of gender and GPA on the outcome variable both decreased in Step 2, Exp(*B*) of gender = 4.29, $p < .001$, and Exp(*B*) of GPA = 2.03, $p < .05$. As in Study 1, we next entered the interaction terms between gender,

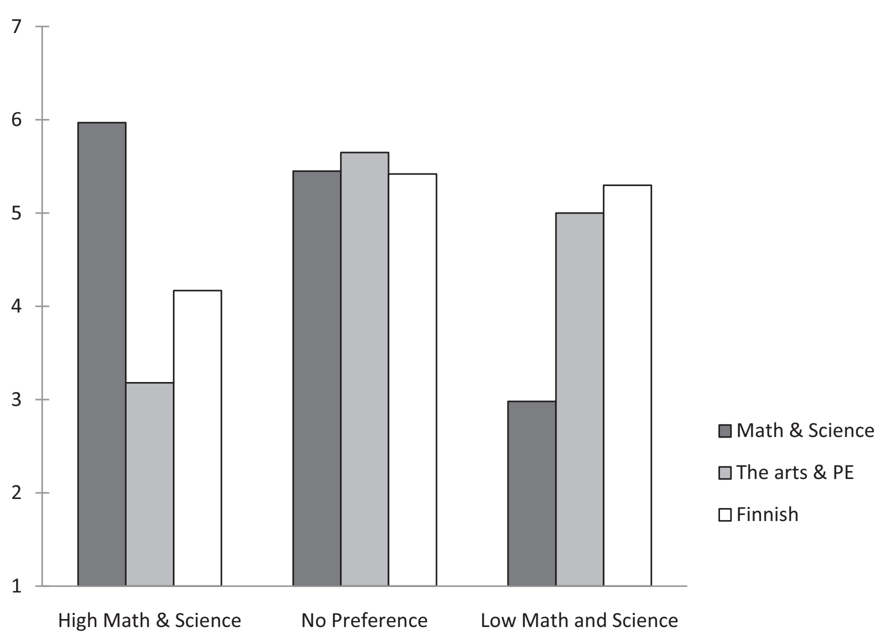

Figure 2. Study 2: Subjective task value scores of the three groups across the subject domains (Finnish sample; *N* = 351). PE = physical education.

Table 9
Study 2: Mean Differences in Subjective Task Values and Grade Point Averages Across the Three Groups in the Finnish Sample (N = 351)

	Subjective task value groups							
	High math and science (N = 72)		No preference (N = 188)		Low math and science (N = 91)			
Variable	M	SD	M	SD	M	SD	F(2, 348)	η^2
Subjective task values								
Math & science	5.97	0.85	5.45	0.88	2.98	0.83	319.71***	.65
Finnish	4.17	1.19	5.42_a	1.01	5.30_a	1.13	36.71***	.17
The arts and physical education	3.18	0.95	5.65	0.96	5.00	1.30	142.21***	.45
Grade point average	8.68_a	0.52	8.70_a	0.56	8.63_a	0.54	0.51	.00
Socioeconomic status	3.36_a	0.84	3.34_a	0.74	3.42_a	0.75	0.36	.00

Note. Means within a row sharing the same subscripts are not significantly different at the $p < .05$ level.
*** $p < .001$.

GPA, SES, and STV group membership into the model. None of these interaction terms were significant predictors.

We conducted a follow-up bootstrap test to evaluate the mediation effects of STV patterns between gender/GPA and aspirations to major in the physical and IT-related sciences, controlling for SES. Because the educational aspiration variable was a binary measure, the weighted least square estimator was used in the bootstrap procedure (Muthén & Muthén, 2007a). The indirect effect of gender on educational aspirations through the mediation of STV group membership was significant (B = 0.46, SE = 0.21, $p < .05$). As the direct effect of gender was still significant (B = 0.52, SE = 0.23, $p < .05$), we concluded that STV group membership partially mediated the relationship between gender and aspirations to major in the physical and IT-related science fields. On the other hand, the indirect effect of GPA on educational aspirations through STV group membership was insignificant, indicating STV patterns did not mediate the effect of GPA on aspirations to major in the physical and IT-related sciences. Last, no significant direct or indirect effects from SES on educational aspirations were found.

Summary

As was true in Study 1, the LPA procedures in Study 2 showed that the Finnish students could be classified into distinct groups according to their STVs across subjects. Second, similar to Study 1, STVs for math and science stood out in distinguishing the characteristics of the STV groups, particularly between the low and high math and science groups. A significant association between gender and STV group membership was also found in the Finnish sample, with boys more likely to fall into the high math and science group and less likely to fall into the no preference and low math and science groups. Consistent with Study 1, the regression analyses in Study 2 demonstrated a strong association between STV group membership at Grade 11 and subsequent educational aspirations to major in the physical and IT-related science fields. Study 2 also showed that STV patterns had a significant mediation effect on the relationship between gender and these educational aspirations.

General Discussion

This article used a person-centered approach to directly test the associations between the STV profiles of students and their aspirations toward physical and IT-related sciences. The analyses drew on two student samples collected in two distinct settings: the United States and Finland. The two countries differ in terms of their gender inequity, financial support provided for university students, and relative academic performance of students across different subject domains. They also differ in terms of when strong

Table 10
Study 2: Gender Distribution and Grade Point Average Means Across the Three Subjective Task Value Groups in the Finnish Sample (N = 351)

Variable	High math and science	No preference	Low math and science
Girls			
N	26	133	71
Percentage within girls	11.3	57.8	30.9
Grade point average mean (SD)	8.65_a (0.60)	8.76_a (0.55)	8.66_a (0.57)
Socioeconomic status mean (SD)	3.50_a (0.71)	3.33_a (0.76)	3.41_a (0.75)
Boys			
N	46	55	20
Percentage within boys	38.0	45.5	16.5
Grade point average mean (SD)	8.70_a (0.48)	8.55_a (0.57)	8.52_a (0.42)
Socioeconomic status mean (SD)	3.45_a (0.76)	3.35_a (0.70)	3.45_a (0.76)

Note. Means within a row sharing the same subscripts are not significantly different at the $p < .05$ level.

Table 11
*Study 2: Regression Analysis Predicting Educational Aspirations for Physical and IT-Related Science Fields in the Finnish Sample (*N *= 351)*

Step and predictor	Step 1				Step 2						
	B	*SE*	Exp(*B*)	95% CI for Exp(*B*)	*B*	*SE*	Exp(*B*)	95% CI for Exp(*B*)	χ^2	$\Delta\chi^2$	Nagelkerke R^2
Step 1	1.82***	0.35	6.16***	[3.12, 12.18]	1.46***	0.37	4.29***	[2.09, 8.80]	33.90***		.17
Gender											
Grade point average	0.79**	0.32	2.21**	[1.18, 4.13]	0.71*	0.33	2.03*	[1.07, 3.83]			
Socioeconomic status	−0.16	0.21	0.85	[0.57, 1.29]	−0.12	0.22	0.89	[0.58, 1.36]			
Step 2									47.72***	13.82***	.23
Subjective task value groups											
No preference vs. **high**					−0.85*	0.37	0.43*	[0.21, 0.88]			
Low vs. **high**					−2.07**	0.66	0.13**	[0.04, 0.46]			

Note. IT = information technology; Exp(*B*) = exponential odds ratio; CI = confidence interval; $\Delta\chi^2$ = change in chi-square; low = low math and science group; no preference = no preference group; high = high math and science group. Group in bold is reference group.
* $p < .05$. ** $p < .01$. *** $p < .001$.

subject matter specialization is most likely to occur: during the early high school years in Finland but during the late high school and college years in the United States. Although the measures of STVs and aspirations were somewhat different across the two studies, at a general level, both were designed to test how students' priorities on math and science in relation to other subjects were linked to their aspirations toward physical and IT-related sciences. The two studies thus allowed us to evaluate the generalizability of the findings across cultures and educational settings.

Considering the differences between the U.S. and Finnish settings and the measures employed in both studies, the similarities in patterns of results are noteworthy. First, the students in both samples were reliably classified into groups according to their hierarchies of STVs for different subject areas. These groups could be defined in terms of the STVs attached to math and physical science in each country. Second, the predicted stereotypical gender patterns were evident in both countries. Third, STV group membership at the first measurement point predicted subsequent educational (Study 2) and occupational (Study 1) aspirations related to physical and IT related sciences, even after gender, GPA, and family SES were included as controls. Moreover, consistent with the Eccles et al. expectancy-value model (Eccles [Parsons], 1983), STV group membership either fully or partially mediated the relationships between gender and subsequent educational and occupational aspirations to physical and IT-related sciences. Furthermore, in Study 1, STV group membership partially mediated the relationships between GPA and occupational aspirations toward these fields. Unlike most published studies on STVs that focus on individual differences in the values attached to only one specific school subject, the focus of our study was person-centered STV patterns across different subject areas, which lends initial empirical support to the theoretical predictions regarding the linkages between intraindividual hierarchical patterns of STVs and outcomes made by the Eccles et al. expectancy-value model (Eccles [Parsons], 1983).

There were also some very interesting differences between the two studies that may reflect the differences in the educational systems of the United States and Finland. First, the nature of the profiles differed in interesting ways between the two samples. In Study 1 (United States), the three groups did not differ in the values they attached to English; they differed only in the values they attached to math and physical science. In contrast, in Study 2 (Finland), the three groups differed on all three sets of school subjects, yielding two quite distinct patterns: the high math and science group reported the lowest scores for the arts and PE and for Finnish, while the low math and science group reported quite high scores for the arts and PE and for Finnish. This greater differentiation for the STVs for the arts and PE and for Finnish might reflect the need for students to start specializing in their course taking during high school in order to be prepared for their anticipated college major prior to applying for admission.

Second, GPA did not differ across the three groups in Finland for either boys or girls but did differ for girls in the United States, with girls in the high math and physical science group having higher GPAs than girls in the other two groups. Again this difference may reflect national differences in when students need to specialize in their choice of course. Because Finnish students apply for specific college majors, they begin specializing in their courses in high school, and they need to obtain high GPAs in their chosen set of courses in order to be admitted to the college major of their choice. This is less true in the United States unless one is planning to go into the traditional STEM fields. These fields are seen as more difficult, and admission into colleges that specialize in these disciplines, such as schools of engineering or institutes of technology, is more competitive than getting into liberal arts colleges. Thus students, particularly girls, with a high interest in math and science may also be motivated to work for a higher GPA than students without such interests.

Third, STV group membership mediated the relationships between GPA and aspirations toward physical and IT-related sciences in the U.S. sample. However, such a result was not found in the Finnish sample, probably because of the university admission system in Finland. Finnish students have to take demanding entrance examinations organized by the specific university departments to which they apply. Successful admission is very much dependent on applicants' GPA and their entrance examination results. Since the competition for the STEM majors is usually intense, GPA and one's own academic ability are important considerations for Finnish high school students in deciding on college majors. Some students may decide not to apply for STEM majors merely because of their GPA, regardless of their interest or task values. Thus, in Study 2, GPA had a unique effect on educational aspirations which was not mediated by STV group membership.

Given the current critical shortage of people entering physical and IT-related science careers in the United States and Finland (Herzig, 2004; Jacobs, 2005), examining the factors that shape adolescents' aspirations and choices in physical and IT-related sciences is an important policy concern. While previous research (Eccles, 1994; Jozefowicz et al., 1993) has found that students' intraindividual hierarchical patterns of occupational values (e.g., work that allows one to help other people and work that allows one to earn a lot of money) are influential to their aspirations, this study further extended previous research by revealing the empirical associations between adolescents' STVs across school subjects and their aspirations. From a developmental perspective, this finding is particularly important because the high school years are critical for students in making crucial educational and occupational plans. The preferences and choices that they form during this period can affect and channel the future educational and career options available to them. For instance, in the United States, the completion of advanced math courses such as calculus is usually a prerequisite for entry into physical and IT-related science majors at university. Indeed, in our additional analyses, we found that students in STV groups prioritizing math and physical science were significantly more likely to complete these advanced math courses by Grade 12 (unfortunately, such data are not available for the Finnish sample). All in all, this study illustrates that the tendencies of individuals to enter the physical and IT-related science fields can be traced back to their intraindividual hierarchical patterns of STVs across school subjects in adolescence, which provides a new and empirically grounded perspective for researchers, policy makers, and educational practitioners in understanding the developmental factors that shape the educational and career pathways of young people.

The gender differences in the STV profiles were consistent across both studies. Boys were more likely to fall into the high math and (physical) science groups and girls were more likely to fall into the low math and (physical) science groups, despite the GPAs of girls being just as high as the GPAs of the boys, and in general girls in both countries receive achievement scores in math and science just as high as their male peers (Jacobs, 2002; Lavonen, 2008). Some recent studies following the variable-centered tradition found no significant gender difference in STVs for math and science at the mean level, indicating a possible closing of the gender gap (Jacobs et al., 2002; Simpkins et al., 2006). In line with these recent studies, we found no significant correlation between gender and math valuation in Study 1. Nevertheless, from an intraindividual perspective, we found that boys and girls in Study 1 held different patterns in how they prioritized math and science in relation to other subjects, which indeed exhibited the power of person-centered approaches. These results suggest that even if boys and girls have started to place more similar values on math and science, the two gender groups still vary in how they rank math and science in relation to other school subjects.

Consistent with previous research (Watt, 2005a; Zarrett & Malanchuk, 2005), both gender and GPA were significant predictors of subsequent occupational and educational aspirations to physical and IT-related sciences, and no significant relationship was found between SES and aspirations to these fields. The bootstrap tests further revealed that STV group membership was a significant mediator of the relationships between gender and subsequent educational and occupational aspirations to physical and IT-related sciences. It should be noted that, in Study 1, STV group membership fully mediated the gender effect on aspirations to more advanced hard science jobs. This finding revealed that STV patterns across school subjects played a particularly important role in individuals' aspirations to advanced science jobs, and the gender differences in these outcomes were indeed manifested through STV group membership. These results suggest that more attention should be paid to girls' STV ranking for math and science relative to their ranking of other subjects if the problem of the gender imbalance in the physical and IT-related science fields is to be remedied. Several ways to increase the values female students attach to math and science relative to other subject areas are possible. For example, teaching math, chemistry, and physics using more biologically based metaphors and a more real-world problem-oriented approach have been shown to increase female students' interest in physics (see Klein et al., 2007). Vocational education programs designed to provide a much fuller image of the nature of work in STEM-related fields might also make the associations between careers in these fields with the work values of young women more salient. As such, these programs might help to boost the utility and attainment values of math and science for girls and increase the number of high school girls considering such careers. Nevertheless, further studies are highly recommended to assess the effectiveness of these possible measures and to identify effective intervention strategies for encouraging more girls to enter the physical and IT-related science fields from a motivational perspective.

Because we were interested in examining how STV patterns were related to aspirations toward the physical and IT-related science disciplines, the STV groups were labeled according to how math and (physical) science were ranked. Nevertheless, given that the STV groups of Study 2 also differed in their ratings for Finnish and for the arts and PE, it is possible to interpret the STV groups of Study 2 based on their relative ratings for these subjects. For example, the high math and science group in Study 2 can alternatively be interpreted as the low Finnish group or the low arts and PE group. Having found that STV group membership in both studies was associated with subsequent aspirations to physical and IT-related sciences measured 1 or 2 years later, it will be important to examine the relationships between the STV group membership and aspirations toward other fields in the future, such as literacy and reading. Last, it would also be interesting to further assess STV patterns across a wider range of subjects and explore the relationships between STV patterns and other achievement-related choices further, for example, the choice of extracurricular activities.

In interpreting our results, some limitations should be noted. First, due to our use of secondary data, the two studies employed different measures for STVs and aspirations. While Study 1 examined STVs across physical science, math, and English (the mother tongue of the U.S. participants), Study 2 covered the STVs of math and science, Finnish (the mother tongue of the Finnish participants), and the arts and PE. Also, rather than measuring occupational aspirations for physical and IT-related sciences, Study 2 measured educational aspirations for these fields. Nonetheless, by and large, the analyses yielded quite similar patterns across the two studies for each of our theoretical questions, strengthening the generalizability of our conclusions.

Second, the construct of expectancies for success, another important variable in the expectancy-value model (Eccles [Parsons], 1983) was not included in the studies reported in this article. Although it is not uncommon for studies on task values and interests, including those particularly drawing on the expectancy-value model, to focus only on perceived task values and not include expectancies for success in the investigations (e.g., Chow & Salmela-Aro, 2011; Viljaranta et al., 2009; Yli-Piipari, Kiuru, Jaakkola, Liukkonen, & Watt, 2011), further studies are recommended to extend researchers' understanding of the effects of these two factors on outcomes when they are considered simultaneously. Also, because we wanted to focus on the motivational attractor values of different school subjects, individuals' STVs for each school subject in both studies were indicated by a combination of the intrinsic, attainment, and utility values. Even though it is common to exclude cost in measuring STVs in research on task values (e.g., Bong, 2001; Cole et al., 2008; Durik et al., 2006; Liem et al., 2008; Wolters & Rosenthal, 2000), this should be noted as a limitation of our studies.

Third, the periods of observations for the two studies also differed. The data in Study 1 were collected from 1994 to 1998, while the data in Study 2 were collected from 2004 to 2005. Nevertheless, the comparability of the results again strengthen our conclusions—these results hold over different cohorts, different Western countries, and with slightly different measures. Fourth, limited by available data, we used students' self-reported GPA instead of institution-reported GPA in both studies. Moreover, due to the high levels of ethnic homogeneity of the two samples (92.8% of the U.S. sample were White, and 99.7% of the Finnish sample were Finns), we did not control for ethnicity in either study. This is probably less problematic in generalizing the findings of this article to a larger population in Finland than in the United States as over 90% of the population in Finland are Finns (Statistics Finland, 2011). However, one must be cautious about generalizing the results to the broader contexts of both countries, especially for the United States. Indeed, the sample of Study 1 was collected from a local area in the United States from 1994 to 1998. The high homogeneity of the sample may be a reason for the lack of a relationship between SES and aspirations in Study 1. Further studies on a more recent and broader sampling of ethnic groups in both countries are recommended. Finally, in Study 1, the number of boys in the low math and physical science group was particularly small. Although this reflected gender differences in STV patterns across subjects, caution should be exercised in interpreting the analysis results for this group of boys.

The two studies showed that adolescents who prioritized math and physical science exhibited stronger aspirations toward the hard sciences. Nevertheless, previous research has indicated that such aspirations are not always realized. For example, in previous studies conducted within the U.S. contexts, almost half of the students entering university with the intention of majoring in the physical and IT-related science fields did not complete calculus in high school, which was a prerequisite for entering these programs (Cole & Korkmaz, 2011; Tyson, Lee, Borman, & Hanson, 2007). Similar results were found in our additional analyses of the U.S. data. Although the additional regression analyses found that the high math and physical science group was significantly more likely than the other two groups to complete calculus by Grade 12, only 44% of students in this group (i.e., 46 out of 104 students) had completed calculus by Grade 12. This misalignment between ambitions and actions taken to fulfill these ambitions (Schneider & Stevenson, 1999) is a problem that likely hinders the opportunities of adolescents to enter the hard sciences even if they aspire to do so. To make sure calculus is both available and expected for all college-bound youth in American high schools is a possible solution. Further studies for identifying strategies for remedying this problem, particularly in the U.S. contexts, are needed.

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