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Gender Differences in Fields of Study: The Role of Significant Others and Rational Choice Motivations

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Abstract

Although gender inequalities in education have greatly changed in recent decades with young women outpacing young men, girls and boys continue to study in gender-typical fields of study. Recognizing that boys and girls might have different educational preferences, we conceptualized gender differentiation as an outcome of both socialization processes and rational choice factors. Using a data set from an original survey of curricular choices of high school students in Tel Aviv-Jaffa in Israel, we employed nested logit regression models using the KHB method to examine the determinants of the gender differentiation in advanced course-taking. We found that socialization mechanisms (significant other influences) and rational choice motivations (utility considerations and failure expectations) explain up to 40 percent of the gender-typical curricular choice in our data. The implications of these results for future research are discussed.

Introduction

In recent decades, young women outperform men academically at all levels of school and are more likely to obtain college degrees and enroll in graduate school (DiPrete and Buchmann, 2013). However, while women have achieved parity in fields such as medicine, law, biology, and chemistry, they lag far behind men in science, technology, engineering, and mathematics (henceforth STEM-fields). Women's low participation in STEM-fields is true for the United States (DiPrete and Buchmann, 2013) and for many Western educational systems (Charles and Bradley, 2009; Barone, 2011). Research suggests that high school is the key to understanding the field-major segregation in higher education. During high school years, students develop a realistic understanding of their future work lives, including gendered expectations about appropriate jobs, considerations about work–family balance, and self-assessment of career-relevant abilities (Legewie and DiPrete, 2012). Correspondently, by 12th grade, girls are more likely to abandon a science career aspiration even if they expressed interest in 8th grade, while boys are more likely to persist in STEM orientation and to enter a STEM path. This gender gap in STEM orientation during high school is decisive for the gender gap in STEM bachelor degrees (Legewie and DiPrete, 2012).

The parallel literature on the Israeli case, the focus of this article, is consistent with the patterns discussed so far. In 2009, the majority of college degrees were earned by women; yet, within the STEM-fields men had a clear majority (Israel Central Bureau of Statistics, 2012). Looking at earlier stages of the schooling process, Friedler and Tamir (1990) reported that in elementary school boys and girls had similar attitudes towards STEM-fields, whereas data on junior high school students reveal this changed. By 10th grade, boys were more oriented towards physics and engineering, while girls were more likely to prefer biology, with chemistry occupying a place in the middle. A similar pattern of gender differentiation was documented by Ayalon (1995), and recently by Feniger (2011).

The gender differentiation in fields of study is manifested in the labour market; Beede *et al.* (2011) show that in the US economy, although women fill close to half of all jobs, they hold less than 25 per cent of STEM jobs. In Israel, more than 70 per cent of working women are employed in non-STEM occupations such as clerical and personal service occupations, teaching, and nursing, while men concentrate in professional, technical, and managerial occupations (Kraus, 2002). The consequences of curricular gender differentiation for gender economic inequality are fairly straightforward: STEM jobs in which women are under-represented are usually economically rewarding, whereas non-STEM jobs, where women dominate, though producing lower returns (Charles and Grusky, 2004), are said to provide a work environment that enables women to fulfil their familial roles (Stier *et al.*, 2001).

Understanding the determinants of the gender differentiation in field majors—the aim of this article—will help shed light on both educational and occupational stratification processes as decisions made early in life producing irreversible effects. Unfortunately, decades of research on gender segregation in education left us with only limited knowledge about how curricular preferences are formed and educational decisions are made. Focusing on advanced course taking in high school, we assume that boys and girls may have different educational preferences, which are reflected in gender-typical educational choices. Seeking to clarify this tendency for gender-typical course taking, we recruit both gender roles socialization theory and cost-benefit calculus perspectives to provide a more general explanation of gender differentiation in field majors. We examine whether high school students' curricular choices are affected by future-oriented incentives embedded in gender role socialization. Applying multinomial logit regression technique to data collected in Tel Aviv-Jaffa in Israel specifically for this study, we examine the effect of significant other influences (henceforth, SOI) and cost-benefit calculus on gender differentiation in advanced course taking. By conducting a purposive survey, we were able to collect information about students' preferences and incentives, which are not often measured in nationally representative off-the-shelf data sets. Although the sample is small ($N = 539$) and local, it suits our purposes and follows a long tradition of research on education based on local samples. We believe that our results could have implications for other settings with similar gender disparities in fields of study and in which students choose school majors. The main contribution of this study lies in its attempt to open the 'black box' of how gender-typical curricular preferences are formed.

The Educational Attainment Process and Gender-Typical Preferences.

Taking a sociological approach, we largely rely on the importance of gender role socialization mechanisms and forward-looking motivations. We conjoin the status socialization theory, first proposed by Sewell and his colleagues in the Wisconsin model (Sewell *et al.*, 1969), with cost-benefit calculus typically associated with choice-related explanations of educational stratification (Breen and Goldthorpe, 1997; Goldthorpe, 1998; Morgan, 2005). We hypothesize that adolescent educational preferences are shaped simultaneously by students' rational cost-benefit calculations and SOI, and both are not gender neutral. We discuss each of these two sets of effects on educational preferences, starting with the effects of SOI.

SOI, Gender Norms, and Educational Preferences

During childhood and adolescence, gender roles are conveyed through socialization processes shaped by significant others, mainly parents, teachers, and peers. According to the Wisconsin model, student educational aspirations are affected by significant others' expectations either through direct encouragement to attain a certain education level or indirectly by serving as role models (Sewell *et al.*, 1969). Research found it true for parental influence (Sewell and Hauser, 1975; Morgan, 1998, 2005; van de Werfhorst De Graaf and Kraaykampet, 2001) and also identified teachers' guidance and advice as major influences over students' educational incentives and attitudes. Apart from adult influences, adolescents may also respond to peers while shaping their educational preferences (Riegle-Crumb *et al.*, 2006), as they tend to conform to their peers' expectations and demands to make or keep friends and to avoid risk of social isolation (Haynie, 2001). The Wisconsin model has undergone a number of revisions over the years; yet, the importance of SOI in educational expectation formation remains (Cheng and Starks, 2002). Recently, Morgan (1998, 2005) recast the model as a theory of educational intentions and preferences; accordingly high school students adapt educational expectations based on new and pertinent, direct and indirect information from their significant others.

SOI is responsive to a student's personality, ability, and behaviour, and importantly, to a student's gender. Recent research argues that girls now perform as well as boys at all grade levels on standardized mathematics tests, which play a crucial role in success in STEM careers (Hyde *et al.*, 2008; Hyde and Mertz, 2009; DiPrete and Buchmann, 2013). In fact, prior achievements explain very little of the gender gap in STEM majors in the United States (Mann and DiPrete, 2013; Riegle-Crumb *et al.*, 2012). Nevertheless, stereotypes, that girls and women lack mathematical ability, persist and are widely held by parents and teachers (Li, 1999; Furnham, Reeves and Budhani, 2002). Research shows that girls are more encouraged than boys to choose fields of study that are related to emotional and nurturing tasks (i.e., 'feminine fields') and in which reading skills are required (van de Werfhorst, Sullivan and Cheung, 2003). Some argue that depending on the class subject, teachers treat male and female students differently: they hold higher expectations from boys in sciences and from girls in languages (Worrall and Tsarna, 1987); downplay boys' failures while downplaying girls' successes in mathematic classes (Jungwirth, 1991); and comment (accepting/criticizing) on the academic responses of boys more than of girls in both mathematics and literature-language classes (Duffy, Warren and Walsh, 2001). Gender is also relevant to peer effect, as students look to their same-sex friends for clues about 'appropriate' behaviour (Correll, 2001). Thus, influenced by their same-sex friends, girls are more likely to favour humanities and social sciences, whereas boys are more likely to prefer STEM-fields.

Although girls do as well as boys in mathematics and science courses, STEM-fields are still believed to be masculine territory. Fields of study are associated with particular gender stereotypes. The computer science prototype, for example, is perceived as incongruent with the female gender role (Cheryan *et al.*, 2009). As STEM-fields are still believed to be men's land, we argue that a student's significant others' influence is affected by these gendered stereotypes, and thus we hypothesize the following:

H1. *Girls are less likely than boys to be encouraged by their significant others to choose STEM-fields rather than humanities and social sciences.*

H2. *Gender-typical educational preferences are partially explained by SOI, net of academic ability.*

Rational Choice and Gender-Typical Preferences

Rational choice models of educational inequality hypothesize that individuals are forward-looking decision-makers who engage in a cost-benefit calculus when faced with educational options (Breen and Goldthorpe, 1997; Morgan, 2005). Research shows that educational choice is affected by the relative utility that individuals attribute to the various options, and by their expectations of failure in the alternative educational routes (Jonsson, 1999; Stocké, 2007; van de Werfhorst and Hofstede, 2007; Gabay-Egozi, Shavit and Yaish, 2010).[1] These rational incentives are not gender-free, as perceptions of young boys and girls are primarily shaped by gender-role socialization. Although most women today provide for their families by working outside the home (Boushey, 2009), young women are still subjected to the expectation that they should devote more time than men to family matters and responsibilities (DiPrete and Buchmann, 2013). Thus, women are expected to pay special attention to career 'utilities' that will elevate their performance in the labour market as well as at home (Becker, 1991). When defining their ideal job, young women emphasize the importance of intrinsic, altruistic, and social reward opportunities within an occupation, whereas young men are more interested in a job involving physical objects and abstract concepts, and place a higher value on its extrinsic rewards (Eccles, 2007).

Research shows that from early childhood to adolescence, boys, compared with girls, are more likely to expect to work in science or engineering (Jacobs *et al.*, 2002; Legewie and DiPrete, 2012). Girls perceive STEM-fields as less instrumental for their dual role (Eccles, Adler and Meece, 1984) and prefer courses that require emotional and nurturing skills, namely, the humanities and social sciences (Jacobs *et al.*, 1998). As gender differences in career utility perception at young ages shape choices about the types of skills they seek in the course of education, we hypothesize the following:

H3. *Compared with boys, girls perceive relative lower utility from STEM-fields than from humanities and social sciences.*

H4. *Gender-typical educational preferences are partially explained by these gender differences in relative expected utility, net of academic ability.*

Further, educational choice is also influenced by individuals' subjective prospects of successfully completing the considered educational path (Jonsson, 1999; Stocké, 2007; Gabay-Egozi, Shavit and Yaish, 2010). Students' success and failure expectations in specific courses are based to some extent on previous performance in the subject, as students are expected to choose subjects that they are comparatively good in (Jonsson, 1999). Recent research demonstrates that girls have long gotten better grades in school than boys (Perkins *et al.*, 2004) and even reached parity with boys in mathematics performance (Hyde and Mertz, 2009). However, the variability of mathematics skills is greater among males than among females, which in turn produces a preponderance of males at the highest levels of performance (Hyde *et al.*, 2008). Further, comparing mathematics and reading skills reveals comparative male advantage in mathematics and comparative female advantage in reading (Marks, 2008). We suggest that these gender differences can forecast women's underrepresentation in STEM-careers as girls, compared with boys, expect to perform less well in STEM than in other fields (Ehrlinger and Dunning, 2003). Hence, our last two hypotheses read:

H5. Compared with boys, girls hold relative higher failure expectations in STEM-fields than in humanities and social sciences.

H6. Gender-typical educational preferences are partially explained by these gender differences in relative failure expectations, net of academic ability.

As we take a sociological approach to study gender-typical educational preferences, we largely rely on the importance of gender role socialization mechanisms and forward-looking motivations. Thus, we conjoin in this study the status socialization theory, first proposed by Sewell and his colleagues in the Wisconsin model (Sewell *et al.*, 1969), with the cost-benefit calculus, typically associated with rational choice theory (Breen and Goldthorpe, 1997; Goldthorpe, 1998; Morgan, 2005). Our theoretical framing might seem at odds as status socialization theory is widely regarded as a model of behaviour devoid of rational calculation. Drawing from Morgan's 'theory of educational expectations' (1998, 2005), however, we view significant others' expectations as rational construction:

> (...) although it is not generally recognized, there have always been some 'rational' expectations within the theory of status socialization. Under the causal assumptions of the Wisconsin Model, it is assumed that expectations exist in the minds of significant others and that some of these expectations are based on rational appraisals of student potential. Students then adopt the expectations that others have of them and add these to their own expectations formed independently through their own rational self-reflection. (Morgan, 1998: p. 136)

Morgan further suggests shifting the focus from the cognitive evaluation of significant others to the student's own rational evaluation. Educational intentions should be grounded simultaneously on students' cost-benefit calculations and on significant others' influence (Morgan, 1998). In view of that, we hypothesize that adolescents' educational preferences are shaped, simultaneously, by both students' cost-benefit calculations and significant others, yet these preferences are not gender neutral.

Israel's Educational System

At age 12 years, after a year in pre-school and 6 years in primary school, Israeli children enter middle schools (Grades 7–9), and after upper secondary schools (Grades 10–12), students take courses leading to the matriculation certificate (*bagrut*), which is prerequisite for higher education. Upper secondary education consists of academic and vocational schools. While most vocational-track students have been able to take matriculation examinations, their success rates are lower than those of their academic counterparts (Ayalon and Shavit, 2004). Important to the issue on hand, vocational schools offer an abundance of technical curricula but a limited curriculum of academic subjects. Aiming for schools with similar core curricula we sampled academic schools.

Within upper secondary academic schools, Israeli 10th graders are faced with a curricular choice. The school curriculum consists of both compulsory and elective subjects, all offered on different levels, ranging from 1 to 5 units, reflecting the time devoted to the subject and its degree of difficulty. Seven subjects are compulsory (English, math, civic studies, Bible studies, history, literature, and Hebrew language) and must be taken at either a basic level (1–3 units) or an advanced level (4 or 5 units). Students are also offered a variety of elective subjects to choose from in the sciences, humanities and social sciences. To be eligible for *bagrut*, students must accrue at least 20 units, including at least one elective subject at an advanced level, and must pass exams in all compulsory subjects. The basic 20-unit diploma is not in itself sufficient for university admission, as more prestigious departments and institutions of higher education set several additional requirements: (i) advanced English (at least four units); (ii) a high matriculation grade point average; (iii) higher grades in advanced math and/or sciences—specifically required by some technical and prestigious departments (engineering and the sciences) and institutions (Israel Institute of Technology).

In recent years, about two-thirds of 12th-grade students who took matriculation examinations passed the necessary requirements for obtaining a matriculation diploma, with female students surpassing male students in eligibility (Israel Central Bureau of Statistics, 2012). Mathematics and English are generally deemed difficult examinations and, unlike other difficult subjects (e.g., physics and computer science), are compulsory. In an effort to raise students' success rates in English and math, schools evaluate their performance early on and set their unit levels as early as ninth grade. Once a student has been placed on a unit level, he or she usually has little further choice in the matter, as they cannot opt for a higher level. For this reason, English and math were omitted from this study as an elective subject.

Gender and STEM-fields in Israel's Educational System

Informal stratification of the elective majors exists, as boys and students from an advantaged social background tend to specialize in sciences, mainly physics and computer science, while girls and students from a lower social background tend to specialize in humanities and social sciences (Ayalon and Yogev, 1997). Friedler and Tamir (1990), who reviewed studies carried out in Israel in the 70's and 80's, report large gender differences in STEM in high school. On average, girls take fewer advanced science courses than boys, and only 34 per cent of students who choose to specialize in sciences are girls. The most pronounced gender segregation was found in physics, which is dominated by male students, and in biology in which girls are over-represented. A similar pattern was documented by Ayalon (1995), who studied a sample of Israeli academic-track 12th graders in 1989, and also by Feniger (2011), who studied a representative sample of Israeli Jewish high school students who graduated in the mid 90s. Recently, based on longitudinal data from 1988 to 2000 from approximately 400 high schools, Zohar and Sela (2003) showed that the ratio of girls to boys (1:3) who took advanced physics has hardly changed. Similarly, the gender ratio in advanced computer science subjects hardly changed (Eidelman and Hazzan, 2007). These studies, which are based on secondary analyses of data, could not explore the determinants of these course selection processes. By contrast, this study relies on data purposely collected to test the extent to which gender-typical course taking can be explained by students' own expectations and incentives.

Methodology

Data

In the spring term of 2006, we collected data in four public secondary schools in Tel Aviv-Jaffa. Tel Aviv-Jaffa, one of Israel's largest cities, has nine administrative districts, which are socio-economically fairly homogeneous (Tel Aviv-Jaffa Municipality, 2007). The city has 33 secondary schools, 23 of which—vocational, religious, Arabic, and magnet schools—were not part of our target population because they differ in their curriculum and emphasis. The remaining 10 schools are secular Hebrew academic high schools. Of these, we sampled two in working-class districts and two in middle-class districts. Fortunately, all four school principals allowed us access. The four schools offer students similar core curricula with the same elective fields (see Table 1). In unreported analyses, we controlled for sampling districts and obtained substantively identical results. Dropping this variable from the analysis did not alter the substance of our results in any way.

We distributed self-administered questionnaires among 10th graders,[2] collected data in 28 classes, and obtained 683 answered questionnaires. Allowing for list-wise deletion, our statistical analysis covered 539 cases, 267 girls, and 272 boys. Our sample is local rather than nationally representative. Research focusing on local samples has a long tradition in sociology in general (Anderson, 1999; Lareau, 2002) and in the field of education, in particular. Thus, for example, van de Werfhorst and Hofstede (2007) tested whether, and to what extent, family cultural capital and status maintenance motivation explained educational performances of secondary school students in Amsterdam, based on survey data collected from secondary school pupils in

Table 1. Percent distribution of elected fields of study by gender

Advanced subjects	Girls	Boys
Social science***	0.52	0.31
Communications**	0.24	0.14
Literature	0.14	0.12
Biology	0.20	0.18
History	0.15	0.15
Economics	0.25	0.19
Chemistry	0.17	0.21
Computer science***	0.12	0.28
Physics***	0.12	0.33
N	267	272

Notes: Asterisks indicate statistically significant (**$P < 0.01$, ***$P < 0.001$) differences between the genders.

Amsterdam ($N = 573$). Similarly, Stocké (2007) tested whether subjective costs, success probabilities, and the status maintenance motivation affect parents' school choice in Germany, based on survey data collected from parents of fourth graders in Rhineland-Palatinate in Germany ($N = 762$ families). In a recent Israeli study using data on high school students' curricular choices ($N = 563$ students) from a big metropolis, the authors tested whether choice is affected by students' utility considerations, their expectations regarding the odds of success or failure in alternative educational options, and their motivation to avoid downward social mobility (Gabay-Egozi, Shavit and Yaish, 2010). While acknowledging the limited generalizability of our findings, we have the benefit of purposively collected data that include rich information relevant to the present purposes. We thus believe that the results of this study can shed light on gender-typical field of study choice also in other settings, where similar gender disparity exists across majors.

Variables and Measurements

The dependent variable: curricular choices

To acquire students' educational intentions, we presented our respondents with a list of elective fields of study available in their school and asked them to indicate whether they intended to take each subject at an advanced level. Table 1 presents the distribution of choices of girls (Column 1) and boys (Column 2). Table 1 indicates that boys tended to choose physics, social sciences, and computers, while girls are more inclined to take the social sciences, economics, and communications. Four of the nine fields in Table 1 exhibit distinct and significant gender distributions: girls are more likely to choose to advance in the social sciences and in communications, while they are under-represented in physics and computer science.

A common practice in studies on curriculum differentiation divides fields of study into two categories: the STEM-fields and the humanities and social sciences (Ayalon and Yogev, 1997). STEM-subjects are perceived as more highly regarded, and as providing better opportunities for advancement than humanities and social sciences. Girls usually concentrate in the humanities and social sciences, whereas boys tend to specialize in STEM-fields. The sociological debate focuses to a considerable extent on female under-representation in scientific fields, yet the degree of gender imbalance within STEM-fields is highly variable: women lag far behind men in physics and computer science, but are over-represented in biology and have made substantial inroads into chemistry (Barone, 2011; DiPrete and Buchmann, 2013). Moreover, success in biology and chemistry is less strongly related to performance in math than success in physics and computer sciences. Acknowledging the misleading sub-aggregations of the scientific-humanistic divide, we define our *dependent variable* as three clusters of field majors: hard-core math-related STEM-subjects (physics and computer sciences), 'light' STEM non-math-related subjects (biology and chemistry), and humanities and social sciences (history, economics,[3] literature, social sciences, and communication).[4]

Although students are only required to take one advanced subject to be eligible for a *bagrut*, there are strong incentives for taking more because students can then discount the advanced subject in which they scored lowest. The great majority (96 per cent) in our sample indicate they intended to take two or more advanced elective subjects. While constructing the dependent variables, we justified STEM choices over others, as STEM-majors are generally regarded as more prestigious and demanding than others (Ayalon and Yogev, 1997) and because humanities and social sciences are sometimes considered a default for those who cannot choose STEM-fields. Thus, students who intended to take physics and computer sciences were assigned to the hard math-related STEM-field cluster regardless of any other subjects they intended to take. Similarly, 'light' STEM-subjects (biology and chemistry) override humanities and social sciences. The distribution of the dependent variables is shown in Table 2.

Table 2. Percent distribution of elected clusters of fields by gender

Curriculum segmentation	Total	Girls	Boys
Hard core math-related STEM-fields of study	0.37	0.24	0.50
Physics and computer sciences			
'Light' non-math-related STEM-fields of study	0.22	0.25	0.19
Biology and chemistry			
Humanities and Social sciences	0.41	0.51	0.31
Literature, history, economics, social sciences, and communication			
N	(539)	(267)	(272)

Table 2, as expected, shows that most boys preferred STEM-fields; 50 per cent chose hard-core math-related STEM-majors and 19 per cent intended to take 'light' STEM-fields. Among the girls, only 24 per cent chose to major in hard-core math-related STEM-fields and 25 per cent intended to take the 'light' STEM-fields. As for humanities and social sciences, 51 per cent of the girls chose these fields compared with 31 per cent of the boys.

Independent variables

We measured *Gender* with dummy variables indicating boys. Our socialization and choice mechanisms pertain to three self-reported indicators for SOI and two indicators for rational cost-benefit calculus. *Parental curricular advice* and *Teachers' curricular advice* are dummy variables coded 1 if parents and teachers recommended the student to take hard-core math-related STEM-fields. *Peer curricular choice* is a dummy variable, coded 1 if student's best friends intended to select hard-core math-related STEM-fields.

We measured utility based on the following question: 'For each subject listed below, in your opinion, if a student (any student) succeeds in this subject at the 5-unit level, what are his or her chances of admission to a university?' (scale from 1—not high at all, to 5—very high). For each student, we computed the mean perception of success associated with hard-core math-related STEM-fields and with humanities and social sciences. The ratio of the former to the latter served as our measure of the *relative utility* that students attribute to hard-core STEM-fields as against humanities and social sciences. The Cronbach's alpha reliability estimate for utility expectation for the hard-core STEM-fields is 0.602, and 0.642 for the second cluster.

Failure expectation was probed by the question, 'For each subject listed below, how high do you think your grade would be if you took the final exam on the five-unit level?' [scale from 1—insufficient (0–54) to 6—excellent (95–100)]. For each student, we constructed dummy variables for each subject, indicating whether the student expected to obtain a low grade (64 or less) in the subject. Then for each student, we computed the mean proportion of failure associated with hard-core STEM-fields and with humanities and social sciences. We defined a *relative failure expectation* as the differences between the proportion of students who expected to obtain a low grade in the hard-core math-related STEM-fields and in the humanities and social science subjects if they took them at an advanced level. The Cronbach's alpha reliability estimate for failure expectation for the first cluster is 0.696, and 0.850 for the second.[5]

Control variables

Three variables controlled for social origin. *Parental education* was measured as the highest qualification obtained by father or mother measured by a six-category classification, which maintains a clear hierarchical order. *Family economic resources* was measured as the sum of available durable goods at parents' household (e.g., air-conditioning, computer, dishwasher, car, etc.), with Cronbach's alpha reliability of 0.62. *Students' reading habits,* a proxy for cultural capital, was measured by a five-category classification of reading behaviour, which maintains a clear hierarchical order of number of books per month.

In addition, we controlled for two academic performance variables as prior achievements likely to impinge on educational choice. *Previous school performance* was measured as the mean of students' self-reported grades in Hebrew, English, and math on the most recent report card. *Grouping in math* was the student's placement level in 10th-grade math (1—three units, 2—four units, 3—five units).

Empirical Findings

Descriptive Analysis

Table 3 presents descriptive statistics for our independent variables, for all students and by gender, with asterisks indicating statistically significant gender differences (in the second column, we also present the range). The last column presents a one-way multivariate analysis of variance (MANOVA) test for gender differences in SOI and cost-benefit calculus mechanisms, net of social and academic background. The means in Columns 4–5 display, with one exception, statistically significant gender differences in SOI. Boys are more likely than girls to be encouraged by their parents to choose hard-core math-related STEM-fields and to have friends who choose hard-core STEM as advanced courses. There were no gender differences in teachers' advice. The results also indicate statistically significant gender differences in choice motivations: compared with girls, boys perceive relatively higher utility from hard-core STEM-fields, and hold relatively low failure expectations in these field majors. As expected, no gender differences are found in socio-economic conditions and in previous school performance. Nevertheless, girls read more books than boys, and are less likely to be placed in advanced math groups.

Table 3. Means (and standard deviations) of key variables by gender

Independent variables	Range	All		Girls		Boys[a]		MANOVA[b] (F-value)
Significant other influences								
Parental curricular advice	0–1	0.27	(0.44)	0.22	(0.41)	0.33**	(0.47)	8.454**
Peers' curricular choice	0–1	0.39	(0.49)	0.30	(0.46)	0.48***	(0.50)	25.139***
Teachers' curricular advice	0–1	0.07	(0.25)	0.07	(0.25)	0.07	(0.25)	0.223
Rational choice calculus								
Relative utility	0.31–3.13	1.26	(0.33)	1.20	(0.29)	1.31***	(0.35)	17.488***
Relative failure expectation	−0.67–1	0.11	(0.30)	0.16	(0.34)	0.06***	(0.23)	10.768**
Social and academic background								
Parents' education	1–6	4.69	(1.53)	4.68	(1.52)	4.70	(1.55)	
Economic resources	0–9	6.38	(1.99)	6.36	(2.01)	6.40	(1.97)	
Reading habits	1–5	2.23	(1.14)	2.41	(1.14)	2.06***	(1.11)	
Previous school performance	0–100	83.02	(10.59)	83.22	(10.23)	82.83	(10.95)	
Grouping in math	1–3	2.22	(0.78)	2.11	(0.77)	2.33**	(0.76)	
N		539		267		272		

Notes: [a]Asterisks in this column indicate a statistically significant difference between boys and girls.

[b]According to the overall MANOVA, there were statistically significant gender differences in socialization and choice mechanisms net of social and academic background, F (5, 528) = 8.349, $P = .000$, Wilk's $\lambda = 0.927$ partial $\varepsilon^2 = .073$.

$*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

Thus far, Table 3 results support our expectations for gender differences in socialization and choice mechanisms, yet do these differences disappear once we control for gender compositional differences? To address this issue, we applied the MANOVA technique that enabled us to test whether gender simultaneously explains a significant amount of variance in SOI and cost-benefit indicators, net of family and academic background. The results are displayed in a note at the bottom of Table 3, indicating that net of social and academic background, simultaneous differences by gender on socialization and choice factors (*as a group*) do exist. The returned partial eta squares ($\varepsilon^2 = 0.073$) indicate that 7.3 per cent of the variance in socialization and choice mechanisms is explained by gender. Finally, the last column in Table 3 displays the results of univariate analysis (F-values), which replicate our results above. Net of social and academic background, girls are less likely than boys to be encouraged by their parents to opt for hard-core STEM-fields, to have friends who will probably dismiss these fields as major, to perceive relatively lower utility and to expect greater risk of failure in these courses. Thus, hypotheses H1, H3, and H5 are supported, with the exception of the gender differences in teachers' advice.

Socialization and Choice Effects on the Gender Differences in Fields of Study

Next, we tested whether and how far socialization and choice mechanisms mediate the effect of gender in the selection of gender-typical field majors (hypotheses H2, H4, and H6). Again, we distinguish between three clusters of choice: hard-core math-related STEM-subjects, 'light' non-math-related STEM-subjects, and humanities and social sciences. Thus, we applied a series of nested multinomial logit models. As the estimated parameters in the nested logit models depend on the error variance of the model, which in turn depends on other covariates in the model, we applied the Karlson, Holm, and Breen's (KHB) method which sets identical error variance across nested models and thus generates unbiased estimates of change in any dependent variable across nested models (Karlson, Holm and Breen, 2012). We estimated four models: in Model I, we regressed gender-typical curricular choice on gender, net of social and academic background. In Models II and III, we added three socialization factors and two choice mechanisms to each model, respectively. In Model IV, we included all variables simultaneously. We adjusted our analysis for school clustering.[6] Tables 4–6 preset the parameter estimates of the contrasts between hard-core math-related STEM-majors and humanities and social sciences (Table 4), between 'light' non-math-related STEM-majors and humanities and social sciences (Table 5), and the contrast within the STEM clusters (Table 6). To facilitate comparison of the effects of the continuous independent variables within the models, we standardized them to a mean of zero and a unit standard deviation. Dummy variables retained their original metric.

Table 4. Multi-logit coefficients (and robust standard errors) of choice mechanisms on the odds of hard core math-related STEM-fields (physics and computer sciences) rather than humanities and social sciences ($N = 539$)

	I		II		III		IV	
Gender (boys)	1.894***	(0.37)	1.560***	(0.33)	1.262***	(0.76)	1.115***	(0.27)
Social and academic background								
Parents' education	−0.243	(0.22)	−0.300	(0.22)	−0.242	(0.22)	−0.279	(0.22)
Economic resources	−0.294	(0.15)	−0.300*	(0.15)	−0.219	(0.16)	−0.227	(0.16)
Reading habits	0.451***	(0.21)	0.297	(0.20)	0.337	(0.19)	0.234	(0.19)
Previous school performance	0.237	(0.33)	0.107	(0.32)	0.129	(0.32)	0.050	(0.32)
Grouping in math	0.868***	(0.18)	0.608***	(0.15)	0.652***	(0.15)	0.482***	(0.14)
Significant other influences								
Parents' curricular advice			1.473***	(0.28)			1.229***	(0.26)
Peers' curricular choice			0.893***	(0.34)			0.544	(0.31)
Teachers' curricular advice			1.340***	(0.38)			1.137**	(0.36)
Rational choice calculus								
Relative utility					0.488***	(0.13)	0.382**	(0.12)
Relative failure expectation					−0.978***	(0.13)	−0.861***	(0.12)
Constant	−1.356*	(0.54)	−1.978**	(0.62)	−1.026*	(0.48)	−1.540**	(0.55)
Bootstrapping (rep = 250)			−.350**	(0.12)	−.635***	(0.18)	−.808***	(0.19)
$\Delta = \beta_{gender(model\_i)} - \beta_{gender.model\_I}$								
Δ, 95 per cent CI			−0.585, −0.115		−0.585, −0.115		−1.186, −0.429	

Notes: Adjusting for school clustering.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Table 5. Multi-logit coefficients (and robust standard errors) of choice mechanisms on the odds of 'light' non-math-related STEM-fields (biology and chemistry) rather than humanities and social sciences ($N = 539$)

	I		II		III		IV	
Gender (boys)	0.391***	(0.07)	0.254***	(0.07)	0.319***	(0.05)	0.207***	(0.05)
Social and academic background								
Parents' education	0.050	(0.10)	0.020	(0.10)	0.019	(0.10)	−0.004	(0.11)
Economic resources	−0.085	(0.18)	−0.104	(0.18)	−0.094	(0.18)	−0.110	(0.18)
Reading habits	0.335***	(0.07)	0.274***	(0.07)	0.340***	(0.07)	0.287***	(0.07)
Previous school performance	0.266*	(0.12)	0.232	(0.12)	0.211	(0.13)	0.187	(0.13)
Grouping in math	0.324***	(0.05)	0.211***	(0.05)	0.241**	(0.08)	0.154*	(0.07)
Significant other influences								
Parents' curricular advice			0.797***	(0.19)			0.686**	(0.25)
Peers' curricular choice			0.637*	(0.28)			0.564*	(0.24)
Teachers' curricular advice			0.237	(0.28)			0.271	(0.78)
Rational choice calculus								
Relative utility					0.357*	(0.15)	0.313*	(0.15)
Relative failure expectation					−0.241	(0.14)	−0.197	(0.15)
Constant	−0.824***	(0.06)	−1.123***	(0.10)	−0.708***	(0.05)	−0.990***	(0.06)
Bootstrapping (rep = 250)			−0.132	(0.08)	−0.080	(0.06)	−0.185*	(0.09)
$\Delta = \beta_{gender(model\_i)} - \beta_{gender.model\_I}$								
Δ, 95 per cent CI			−0.287, 0.024		−0.196, 0.035		−0.366, −0.004	

Notes: Adjusting for school clustering.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Hard-Core Math-Related STEM-Fields Versus Humanities and Social Sciences

Model I in Table 4 indicates that boys are almost seven times more likely to opt for hard-core math-related STEM-fields than for humanities and social sciences ($e_{gender}{}^{1.894} = 6.65$).[7] Parental education and economic resources are negatively associated with the hard-core math-related STEM; yet, for the most part the

Table 6. Multi-logit coefficients (and robust standard errors) of choice mechanisms on the odds of 'light' non-Math-related STEM-fields (biology and chemistry) rather than hard core math-related STEM-fields (physics and computer sciences) ($N = 539$)

	I		II		III		IV	
Gender (boys)	−0.989***	(0.25)	−1.017***	(0.24)	−0.867***	(0.25)	−0.908***	(0.24)
Social and academic background								
Parents' education	0.235	(0.24)	0.274	(0.24)	0.244	(0.23)	0.275	(0.23)
Economic resources	0.048	(0.06)	0.099	(0.06)	0.079	(0.05)	0.117*	(0.05)
Reading habits	0.081	(0.14)	0.103	(0.13)	0.026	(0.13)	0.053	(0.13)
Previous school performance	0.106	(0.27)	0.126	(0.27)	0.121	(0.25)	0.138	(0.26)
Grouping in math	−0.467**	(0.18)	−0.382*	(0.18)	−0.411*	(0.20)	−0.328	(0.20)
Significant other influences								
Parents' curricular advice			−0.610***	(0.06)			−0.543***	(0.05)
Peers' curricular choice			0.029	(0.07)			0.021	(0.09)
Teachers' curricular advice			−0.970***	(0.18)			−0.866***	(0.15)
Rational choice calculus								
Relative utility					−0.075	(0.12)	−0.068	(0.13)
Relative failure expectation					0.714***	(0.15)	0.664***	(0.14)
Constant	0.209	(0.47)	0.500	(0.51)	0.298	(0.47)	0.551	(0.51)
Bootstrapping (rep = 250)			−0.015	(0.09)	0.116	(0.08)	0.100	(0.12)
$\Delta = \beta_{\text{gender(model\_i)}} - \beta_{\text{gender.model\_I}}$								
Δ, 95 per cent CI			−0.199, 0.169		−0.044, 0.277		−0.133, 0.332	

Notes: Adjusting for school clustering.
$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

coefficients are statistically insignificant. Reading habits are positively associated with the hard-core STEM, but once we control for SOI (Model II) the effect is reduced and becomes statistically insignificant. Moreover, the effect of performance was statistically insignificant, while the effect of advanced math grouping was significant and positively associated with the hard-core math-related STEM cluster. This is not a surprising result, as grouping in math is highly correlated with previous school performance and positively associated with hard-core STEM.

Adding SOI indicators to Model I reduced the gender effect by 18 per cent in Model II, and through the addition of cost-benefit factors to Model I, the gender effect in Model III declined by 33 per cent, implying that choice mechanisms have stronger impact than SOI factors in understanding gender differentiation in this choice contrast. Nevertheless, the gender coefficient was still statistically significant. All three SOI indicators proved statistically significant: students whose parents and teachers encouraged them to choose hard-core STEM-fields tended to accept this advice, and similar results were found for peer effect. Moreover, students who expected relatively higher utility from hard-core math-related STEM-fields and were confident in their chances of success in these subjects were more likely to select these as field majors rather than humanities and social sciences.

Model IV, in which all independent variables were entered simultaneously, indicates that socialization and choice mechanisms operate to some extent independently to reduce the gender differences in field majors. The gender effect in Model IV was 41 per cent lower than in Model I, yet remains statistically significant. As we have hypothesized by incorporating SOI, students' utility considerations and failure expectations, we explain a considerable amount of the gender-typical curricular choice of Israeli high school students. Nevertheless, some gender differences remain to be explained.[8] In our final model, all socialization and choice coefficients slightly decreased but their statistical power remains, except for peers' choice.

Given the relative small sample size, we checked the robustness of these results using a bootstrapping technique to construct confidence intervals (CI) for the gender coefficient (reduction) decomposition. The results are displayed at the bottom of Table 4, indicating that the average difference between the final model and the base model is −0.0808 with 95 per cent CI of −1.186 and −0.429. Alternatively, one can say that SOI and success expectations 'explain' between 23 and 63 per cent of the gender differentials in course taking. We conclude that both SOI and rational choice motivations significantly mediate the gender effect of advanced major choice.

'Light' Non-math-related STEM-fields Versus Humanities and Social Sciences

The gender coefficients in Table 5 yield similar results to those obtained in Table 4. Model I indicates that boys are almost one-and-a-half times more likely than girls to opt for 'light' non-math-related STEM-fields than for humanities and social sciences ($e_{gender}^{0.391} = 1.478$). Comparing the gender coefficient across the models to Model I, we can see a parallel decline in its effect on major choice once we control for SOI (by 35 per cent), for rational motivations (by 18 per cent), and for simultaneity of both mechanisms (by 47 per cent). Interestingly, and contrary to Table 4, it seems that SOI is much more effective than rational choice mechanisms in understanding gender differences when considering the contrast between 'light' STEM-fields and the humanities and social sciences.[9] Our final model indicates that parent and peer influence, as well as utility expectation, were statistically significant and in the direction expected. Again, using a bootstrap technique, we find that the reduction in the gender coefficient between Models IV and I is large and statistically significant at the 5 per cent level, average of −0.1848 and 95 per cent CI of −0.366 to −0.004. Thus, we conclude also here that SOI and rational choice motivations mediate the gender effect on subject choice.

'Light' Non-math-related STEM-fields Versus Hard-core Math-related STEM-fields

The analysis for the third contrast, 'Light' non-math-related STEM-fields versus hard core math-related STEM-fields, is presented in Table 6. As expected, deliberating between STEM-fields, girls, compared with boys, are more likely to prefer biology or chemistry than physics or computer sciences. Choosing 'light' over hard-core STEM is affected by parental and teachers' advice, and relative failure expectations. However, these mechanisms hardly reduce gender differences in curricular choice, and much of the gender gap remains unexplained.

Considering the choice between STEM-fields and humanities and social sciences, we argue that sex-role stereotypes are more pronounced, and thus socialization and rational choice partially mediate the gender gap in major choice. However, socialization and rational choice mechanisms are not sufficient for explaining the choice between the STEM clusters, as this contrast is a less 'straightforward' classic sex-typical distinction. Biology and chemistry are more related to the STEM-fields cluster than humanities and social sciences.

Summary and Discussion

Seeing gender-typical educational choice as a reflection of gender differences in educational preferences, we conceptualized the gender gap in field majors as an outcome of both socialization processes and rational choice factors. Incorporating the influences of significant others (SOI), utility considerations, and failure expectations, we answered Morgan's (1998, 2005) call for empirical work in which status attainment theories and rational choice theories are combined. Moreover, distinguishing between hard-core math-related STEM-majors, 'light' non-math-related STEM-majors, and the humanities and social sciences, we go beyond the sciences-humanities divide to provide a more comprehensive picture of the gender gap in curricular choice.

Our results show gender differences in SOI and cost-benefit considerations: girls attribute lower utility and greater risks to hard-core math-related STEM-majors, and are also less likely than boys to be encouraged by their parents and peers to choose these subjects. Importantly, gender-typical educational preferences are partially explained by these motivations: constrained by family resources and scholastic ability, young girls will be less likely to pursue STEM-majors unless they were encouraged by their parents and peers to choose these subjects, and if they expect higher utility and greater success in these majors.

Nonetheless, the explanatory value of socialization process and rational choice theories for horizontal gender differentiation is valuable, though some gender differences remain to be explained. The current study was only able to scratch the surface, and much is unknown about the origin of these gender-typical educational preferences—So how can we further extend our understanding? As our hypotheses were derived from socialization and rational theories, our measurements possibly could not capture the whole story. For example, boys and girls possibly have deeply embedded gender-typical preferences on which they act and behave. One possible avenue for future research should take into account not only SOI as socialization determinants of curricular gender segregation but also the merit of measuring gender-role norms itself. Although our data have no measure for such a variable, we would note the following.

Behaviour is sometimes guided by social norms in an 'autonomous' rather than an 'outcome-oriented' way (Elster, 1989). Actors with strongly held normative convictions occasionally will try to follow them without considering cost-benefit incentives. While making educational choices, girls and boys may follow a common perception of the 'appropriate' choice and behaviour for their gender. While considering future majors, female students perceived themselves to be less similar to those who advance in computer science compared with men, and men perceived themselves to be less similar to those studying English as a major (Cheryan and Plaut, 2010). To choose hard-core STEM, women must feel similar to those in the field, or at least believe that it is worth pursuing despite feelings of dissimilarity. Gender-role norms are embodied in a set of stereotypical beliefs about how women and men should be, and how they should behave in different spheres of life (Sagebiel and Vázquez-Cupeiro, 2010). Following Elster and others (Kroneberg, Yaish and Stocké, 2010), we need to consider the possibility that when people are very committed to their gender stereotypes and identities, their decision is primarily based on social gender norms and stereotypes rather than on rational calculus alone. This suggests that gender norms, stereotypes, and beliefs might interact with rational calculation. Future research should address this issue more directly.

Notes

1 Although perceived cost (direct and indirect financial costs) is an important variable in rational-choice theory, it is not discussed or measured in this study because in the Israeli school system the alternative advanced courses do not differ in their associated costs.

2 In one school, we included ninth graders who were also encouraged to choose a major.

3 Classifying economics classes to the third cluster deviates from the standard gender typecasting of economics as a male and math-related field (Jacobs *et al.*, 1998). However, in the Israeli setting economics classes are considered to be part of the social science classes along with sociology, psychology, and communications. In our sample, the great majority (96 per cent) of students who intended to take economics also chose other social science subjects; thus, its allocation to the humanities and social science category seems justified.

4 One might claim that analysis of gender differences in curricular choice hinges on a specific definition of male and female subjects (Barone, 2011). In unreported analyses, we experimented with various definitions of the dependent variable, including a classifications that contrast between STEM versus non-STEM-fields, between hard and soft sciences, between 'gender authentic' fields for men (computer sciences) and women (history) and 'gender balanced' fields (chemistry), and we also employed a 3-fold classification which consists of three 'pure' categories (only physics or computer science, only biology or chemistry, and pure humanities and social sciences). Changing the dependent variable composition did not alter the substance of our results in any way.

5 These measurements of relative utility and failure expectations have the tendency to be non-linear on subject choice, yet using dummy variables for utility and failure expectations (coded as higher, same, lower) our results remain robust. Due to our restricted sample size and parsimonies considerations, we decided to keep these measurements in their linear ordered form.

6 Applying robustness checks to our results we adjusted our analysis for class and school fixed effects. Adjusting for class fixed effects we found the same results, while adjusting our key results for school strengths; the gender coefficient in Table 5 reaches statistical significance. Also, testing for variance differences, we found for most of our independent variables a relatively greater variance between schools than within compared to classes.

7 Dropping school performance and math grouping from the model, the effect of gender is ${e_{gender}}^{2.26}$, indicating that scholastic ability explains 16 per cent of the gender differentiation in major choice.

8 Some might expect significant interactions between socialization and choice mechanisms with gender. For example, high school girls are more likely than boys to consider the norms of their peers when making decisions about math course taking (Frank *et al.*, 2008). In unreported analyses, we tested for all possible two-way interactions and found none statistically significant. Thus, in our data and setting boys' and girls' choices are equally affected by socialization and choice mechanisms.

9 The CI of the differences in the gender coefficient are marginally significant ($P = 0.097$) considering only SOI and statistically insignificant for rational choice mechanisms solely ($P = 0.171$).

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