

GENDER AND OCCUPATIONAL OUTCOMES: AN INTRODUCTION

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Why do men and women frequently end up in different kinds of careers? In particular, why are there fewer women in careers related to math, science, and technology, including the physical sciences, engineering, and information communication technology? Why, despite 25 years of research into gender differences for career choices related to math and science, does this phenomenon still appear robust across a range of different countries and cultural contexts? Although women have been making gains in entering traditionally male-dominated professions, gender differences persist. Women are both less likely to choose careers in these fields and more likely to leave them if they do enter (American Association of University Women, 1993, 1998; National Center for Education Statistics, 1997; National Science Foundation, 1999). In view of concentrated research into this question, numerous policy documents, and educational efforts—why do we see these patterns of gender participation in the 21st century?

A resurgence of interest in this question has been prompted in part by a general shortage of people entering the so-called “STEM” careers (in science, technology, engineering, and math) because women are an undertapped resource for filling the predicted shortfalls. Participation in advanced science and mathematics education has exponentially declined in the United States

over the past 2 decades, to the point where there is grave concern about the viability of those disciplines to sustain economic growth and development (see Jacobs, 2005; see also National Science Board, 2003; National Science Foundation, 2002). Similar concern exists in Australia (Dow, 2003a, 2003b; National Committee for the Mathematical Sciences of the Australian Academy of Science, 2006) and many other Western nations, whereas Asian countries do not show the same systematic pattern (Jacobs, 2005). For example, a recent examination showed only 32% of bachelor's degrees in the United States were in science or engineering (National Science Foundation, 2004), and declines in undergraduate mathematics, engineering, and physical sciences enrollments through the 1990s declined 19%, 21%, and 13%, respectively (National Science Foundation, 2000).

At the same time, the association of high-status, high-salary careers with advanced participation in the STEM disciplines has continued to fuel the concern of researchers with an interest in gender equity. Ever since Lucy Sells (1980) voiced social concerns about lower female participation in math courses in her identification of math as the "critical filter" limiting access to many high-status, high-income careers, others have also pointed out that many females prematurely restrict their educational and career options by discontinuing their mathematical training in high school or soon after (Bridgeman & Wendler, 1991; Heller & Parsons, 1981; Lips, 1992; Meece, Wigfield, & Eccles, 1990). This has important ramifications for women's well-being, both from an economic or sociological standpoint as well as a psychological point of view. First, gender differences in earning potential are important because women are more likely than men to be single, widowed, or single heads of households and therefore likely to need to support themselves and other dependents financially without assistance from a partner or significant other (Meece, 2006). Second, women (and men) need to develop and deploy their talents and abilities in their work outside the home because this substantially impacts their general life satisfaction and psychological well-being (Eccles, 1987; Meece, 2006).

The result of the underrepresentation of women in STEM careers is that these careers tend to reflect the values of majority male professionals. This in turn reinforces the gender imbalance through girls' and women's perceptions regarding the culture of those careers. This is most noticeable in relation to the ways in which such careers accommodate—or fail to accommodate—the familial obligations women often carry. The culture associated with male-dominated professions may affect girls' and women's aspirations toward those careers in the first place, stunt their development and progression should they enter those careers, and deter them from persisting. The potential talent pool for STEM careers has often been regarded as a "pipeline" that starts in secondary school and runs through university and then into the workforce. Consideration of gender differences and gendered influences at each of these critical points in the pipeline is key to interventions designed to promote women's participation.

Of course, there are not only gender differences in STEM careers. Considerably fewer men than women are represented in the arts and humanities and in the helping professions such as nursing, social work, and teaching (e.g., Carrington, 2002; Richardson & Watt, 2006). There has been less concern about the underrepresentation of men in these professions, perhaps because the potential earnings and prestige at stake are lower than in STEM careers. However, it is certainly possible that boys and men are not pursuing their interests and abilities in those domains, which may have ramifications for their satisfaction and well-being.

INTERVENTIONS TO INCREASE WOMEN'S PARTICIPATION IN MALE-DOMINATED PROFESSIONS

Over the past 15 years, educators have implemented significant reforms in both the curricula and teaching practices of elementary and secondary mathematics and science to incorporate more collaborative, problem-focused, and authentic instruction (Meece & Scantlebury, 2006). This has been due to research suggesting that girls take an active role and respond favorably in individualized and cooperative learning environments (Eccles (Parsons), Kaczala, & Meece, 1982; Kahle & Meece, 1994). Similarly, at the other end of the pipeline, interventions have been designed and implemented to meet professional women's needs within STEM careers. One example is outlined and reported in chapter 11 of this volume.

It is not clear at the present time how such reforms will change young women's motivation, performance, development, or persistence. Despite a plethora of intervention efforts particularly targeting the secondary school years, most of these programs have not been formally evaluated. There has also been a lack of longitudinal rather than "one-shot" examinations, a lack of large-scale and representative samples rather than small and opportune groups, a lack of representation across diverse samples and sociocultural settings, and a lack of representation and integration of diverse theoretical perspectives. Previous research into the question of why women are less likely to end up in traditionally male-dominated spheres collectively points to the importance of factors such as gender differences in individuals' motivations, self-concepts, interests, values, and life-goals (e.g., Bong, 2001; Eccles, 1985; Ethington, 1991; Wigfield & Eccles, 1992); influences of family planning, parents, and biology (e.g., Benbow & Stanley, 1982; Eccles, Jacobs, & Harold, 1990; Jacobs & Eccles, 1992; Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001); and sociocultural affordances and constraints on women's career development (e.g., Lee, 2002; Siann & Callaghan, 2001; Willis, 1989).

One explanation that is important to outline relates to superior male mathematics abilities. It is difficult to find a more controversial topic in recent

educational research than gender differences in mathematics performance. There is no dispute that in samples from the general population, male and female global mathematical performance is similar (e.g., Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Kimball, 1989; Rosenthal & Rubin, 1982; Tartre & Fennema, 1995). Two comprehensive meta-analyses using approximately 100 research articles each (Friedman, 1989; Hyde, Fennema, & Lamon, 1990) found that in samples from the general population, boys' and girls' secondary school mathematical performance is similar. In the meta-analysis of Hyde, Fennema, and Lamon (1990), girls outperformed boys by a negligible amount on overall scores, understanding of mathematical concepts, and computation, whereas boys outperformed girls by a negligible amount on problem-solving tasks. The Friedman (1989) meta-analysis found that a 95% confidence interval for the relative superior mathematical performance of males to females covered zero.

Other researchers have focused on gender differences in spatial skills (Linn & Petersen, 1985) and gender differences among very high achieving students (e.g., the *Study of Mathematically Precocious Youth*; Lubinski, Benbow, & Sanders, 1993). It has been pointed out that differential variability renders comparisons of gendered mathematical performances problematic (Feingold 1992, 1993), and an influential United States study found that the ratio of male to female variability in "space relations" scores on the Differential Aptitude Test generally decreased from 1947 to 1980 (Feingold, 1992), although an interaction effect between year and grade showed this variance ratio decreased from grades 8 to 12 in 1947, was constant across grades from 1962 to 1972, and increased over grades in 1980. Such findings imply an imperative for seeking explanations additional to biology, because these changes are occurring "rather faster than the gene can travel" (Rosenthal & Rubin, 1982, p. 711). Gender differences in mathematical performance favoring males have also been identified among moderately selective and precocious samples, although Hyde, Fennema, and Lamon (1990) have cautioned against mean-level comparisons because of the different variability within gender groups being compared. Males are in fact overrepresented at both the high and low extremes of mathematical performance (e.g., Lubinski et al., 1993), which some have argued relates to boys being more often selected for remedial help and for gifted programs in mathematics (Willis, 1989). It is clear that continued research is needed into the antecedents and influences additional to biology on gendered participation in mathematics and other male-typed occupational pursuits.

IMPETUS FOR THE BOOK

It is time to take stock of what the research literature from diverse fields tells us. This will inform the design of future intervention efforts and enable

researchers and educators to prioritize key "levers for change" (Roeser, 2006). To date, there has been no synthesis of the findings from across the different literatures specifically focused toward understanding gendered occupational outcomes. There is an absence of work drawing together the state of play from across different literatures and across a range of different cultural contexts. Although some books on gendered occupational outcomes are available, they have tended to focus on a narrower scope (e.g., math or science) and certainly do not represent the range of cultures, time points, data sets, and perspectives that are represented in the current volume.

A major impetus for our book was to draw together researchers from around the world who are each using multiwave longitudinal data to address the question of what factors contribute to gendered occupational outcomes, from a variety of perspectives and in a variety of cultural settings. A unique feature is our inclusion of studies that involve multiple waves of longitudinal data. Rather than speculating about how processes may unfold over time to produce certain outcomes, longitudinal studies allow us to draw strong conclusions regarding those processes and to tease apart and test out a range of theoretical models.

There is a growing imperative to explore gendered career outcomes across a range of cultural settings because this will facilitate a greater understanding of how career and life choices are made in contexts of varying gendered opportunity structures and levels of economic development (Roeser, 2006). To date, research into gendered career outcomes has been concentrated in the Western world, primarily the United States. However, even Western school populations are becoming more culturally diverse, creating a need to examine how explanatory models focusing on individual motivations, parental beliefs, and broader social and institutional influences operate across different ethnic, racial, and socioeconomic groups. Examining influences on women's career choices across a range of cultural contexts provides the opportunity to highlight distinctive contextual features that relate to culturally specific patterns and suggests circumstances that may be the most conducive to promoting and supporting women's development in STEM careers. For the most part, these issues have been largely unexamined in research on women's achievement-related decisions, and a global perspective and interdisciplinary approach is integral to this current endeavor. Our book includes large-scale longitudinal samples from the United States, Canada (Anglophile and Francophile), Australia, Turkey, Germany, Japan, and other countries of the European Union.

The volume is timely, providing implications to further the knowledge base on development, intervention, and policy concerning gender differences in occupational outcomes. The book has been designed to have broad appeal—to educators, counselors, psychologists, and researchers. The contributors represent an international team of experts from several fields of study, including

developmental psychology, social psychology, cultural anthropology, human development, biology, education, and sociology, who investigate explanations for gendered occupational outcomes from diverse perspectives within different sociocultural contexts. Accordingly, the book will appeal to students and scholars in all of these areas. The chapters use a diverse range of current sophisticated techniques for analyzing longitudinal data—methodological and statistical advances enable research to shed new light on the persistent issue of gendered occupational representation. Consequently, we have asked all contributors to make a special effort to provide details on the methodologies they have used to conduct their studies. Further, the authors each discuss the intervention and policy relevance of their work.

OVERVIEW OF CHAPTERS

The book is structured into four broad sections. Part I addresses the question of math achievement and coursework as a critical filter and whether this limits women's access in particular to high-status careers in specific specialist domains. Part II contains chapters that primarily focus on the influences of individual factors in women's career choices and persistence in STEM fields, including motivations, self-concepts, values, and competing interests. Part III focuses on the importance of family considerations, parental influences, and biology. The final part (Part IV) considers broader social and institutional contextual constraints on women's career development. Findings from the 12 studies considered collectively are much more powerful than if they were taken individually, allowing us to reflect across the multiplicity of interacting influences shaping women's career outcomes, at levels of intensity ranging from individual characteristics through to national policies.

Part I: Mathematics as the Critical Filter?

Chapter 1 examines whether math achievement acts as a critical filter limiting later educational and occupational aspirations among Anglophone Canadian youth. The authors present evidence that early high school math achievement shaped the prestige dimension of their educational and occupational aspirations from Grade 9 up to 3 years following secondary school. High math achievers maintained high educational aspirations, whereas low math achievers' aspirations remained consistently low, even when general school achievement and perceived mathematical abilities were statistically controlled. Low math achievement in early high school also related to lower occupational aspirations and more rapid deterioration in occupational aspirations toward the end of high school compared with high achievement, which was related to only a gradual decline over the same period. These findings suggest

that math achievement in early high school acts as a critical filter more than 20 years after Lucy Sells (1980) first proposed her hypothesis. In this sample, mathematical success at school was associated with trajectories of both educational and occupational aspirations. The findings signal two priorities for future research: How does math achievement affect subsequent actual educational and occupational outcomes, and which aspects of math study and achievement are influential?

It is interesting that there were no gender differences in the prestige level of the occupations to which the young men and women aspired, raising the important question of whether gender differences in occupational pursuits are more differences of kind. This has important implications for our thinking about gendered occupational outcomes—what gendered career “outcomes” should we be concerned with? Is it problematic if women are choosing careers that are equally prestigious and highly paid yet nonmathematical? I return to this question later in this chapter (p. 11).

Chapter 2 also investigates the math as a critical filter hypothesis, using longitudinal data from the 6-year U.S. *Longitudinal Study of American Youth* (see Miller, Kimmel, Hoffer, & Nelson, 2000), which spanned Grades 7 through 12. The authors examined which among the various math courses in the United States secondary curriculum predicted subsequent actual college choices for different kinds of majors (science, engineering, economics, law, medicine, liberal arts, and education) as well as the prestige dimension of occupational aspirations. In the United States, secondary students select which math courses they wish to study at school. The authors identify how participation in each of the different math courses related to college and occupational choices over and above measured mathematical achievement.

They found that mathematics coursework played an important role, with Algebra II acting as a critical filter for the career choices of males and calculus as a critical filter that screened females from science and engineering majors and into majors in liberal arts. In the U.S. curriculum, Algebra II is the first highly theoretical mathematics course that requires considerable abstract thinking and reasoning for problem solving (see chap. 2, this volume). The authors speculate that many males may first encounter serious difficulties with math in this course and start to rethink their career choices. They argue that Algebra II could lead males to doubt their abilities to successfully handle the mathematics needed for their desired occupations. Part of their hypothesis is that males may have had unrealistic career expectations beforehand, and as a result of their experiences in Algebra II may put these into a more realistic perspective. The fact that males nominated more prestigious career choices than females across the preceding middle and high school years and did not show further negative coursework effects following Algebra II provides support for this hypothesis.

For females, taking calculus in Grade 12 was strongly associated with college enrollment in science and engineering and negatively associated with

majoring in liberal arts. It is possible that the females who were already planning to pursue STEM-related tertiary study were those who chose to undertake calculus in Grade 12 rather than calculus experiences having determined their college choices. The low percentage of females who undertook calculus in grade 12 and the importance of calculus for females' college major choices reflect the limited number of females entering STEM fields.

The findings raise several intriguing questions and provide an important step in the direction of identifying what math coursework experiences most shape young men's and women's educational and occupational aspirations. Future research should further examine the relationships between coursework sequencing in addition to the relationships this study has identified between discrete math courses and college and career choices. It is a strength of this chapter that actual college choices were included rather than educational aspirations; however, actual career choices remain a critical component for future research so we can understand how math filters eventual career choices or options young adults actually take up. One significant question raised by this chapter is, if the authors' hypotheses regarding the effects of Algebra II are correct, whether it is a bad thing that males' career aspirations become lower but more realistic as a result of their coursework experience.

The chapters in this first section together demonstrate that math continues to act as a critical filter, playing an important role in determining young women's and men's educational and occupational aspirations as well as their actual college majors. We therefore should be highly concerned about girls' and women's lower involvement in advanced math, which delimits their access to certain educational and occupational pursuits.

Part II: Psychological Processes and Gendered Participation in Math, Science, and Technology-Based Careers

The second section of the book follows naturally from the first: If math acts as a critical filter limiting women's (and men's) access to high-status, high-salary careers, what psychological processes and motivations lead to women's lower participation in STEM disciplines at critical points in the pipeline? Chapters in this section examine gendered STEM-related participation choices from senior high school enrollments through college majors, persistence, and the individual motivations and perceptions that shape these choices.

Chapter 3 describes a study of mine that investigated what motivates females and males among a sample of Australian youth to pursue sex-stereotyped careers. In this study, I included actual senior high enrollments and careers aspired to as outcome measures. In contrast to the first two chapters, I was not focused on the prestige dimension of young adults' career choices but rather on the extent to which their career aspirations involved math and English. The concentration of boys in "masculine" career types has caused less con-

sternation than that of girls in non-STEM fields. Whether boys may not be pursuing their other areas of interest and potential fulfillment has been less a topic for research concern or public interest (an issue also posed in chap. 9, this volume). It is likely that researchers who are concerned with gender equity have focused on gendered participation in male- rather than female-dominated domains (also argued in chap. 7, this volume) because female underrepresentation in stereotypically male-dominated domains (such as math) leads to careers of lower status and salary for women.

In the State of New South Wales, Australia, the options for math coursework selection are quite different from those in the United States or Canada that are outlined in Part I of this volume. In New South Wales, math courses are ordered by level of difficulty rather than topic area, providing a naturally occurring metric to investigate the extent of boys' and girls' chosen math participation. In this setting, results confirmed the persistence of greater male participation in both math-related educational and occupational choices. Conversely, and consistent with gender stereotypes, greater female participation occurred for English-related educational and occupational choices. The operationalization of different levels of involvement in math and English career aspirations provides an important extension to existing research in the area. Findings of gender differences according to the math- and English-relatedness of careers aspired to brings us back to the question posed earlier in this chapter (p. 9): Is it possible that young women are aspiring to equally prestigious careers as young men but that their career choices are nonmathematical? The collective findings from chapters 1 and 3 suggest this may well be the case. This is an important ingredient that needs to be incorporated in thinking about gendered career choices and what career dimensions are most critical for gender equity researchers to examine. Is career prestige the most important dimension, or is it differences in the kinds of careers young men and women choose?

Chapters 3 and 4 draw on a prominent, productive, and highly influential theoretical framework developed to explain gendered math participation: the *expectancy-value model* developed by Eccles (Parsons) et al. (1983). Within it, success expectancies and the subjective valuation of success are the most proximal influences on achievement-related choices and behaviors, and these are in turn predicted by ability beliefs as well as perceived task demands. Chapter 3 findings imply that a focus on boys' perceptions of English, compared with girls', as being less useful through secondary school will likely promote greater male participation in English-related careers should their lower participation be considered to require attention. For math, key factors will be a focus on girls' liking for and interest in math, their self-perceptions of mathematical talent and expectations for success, and their valuation of the utility of math.

Chapter 4 examines gendered math and English participation choices for senior high enrollments within the United States and Germany. Predictions

about processes linking gender to students' choices of advanced courses in high school were derived from both the Eccles (Parsons) et al. (1983) expectancy-value model outlined above and the internal/external frame of reference model (Marsh, 1986). A strength of the study examined in chapter 4 is the theoretical integration of both models to incorporate ipsative intraindividual processes in young women's and men's senior high enrollment choices. The authors found support for the merits of their combined model: Both self-concept and intrinsic value predicted high school course choices, and both internal and external comparison processes occurred.

This study included longitudinal data from two different educational systems, providing an in-depth investigation of how key contextual factors shape students' decision-making processes. The major relevant differences relate to the ways in which students are tracked and the freedom that they have to choose between courses. In the United States, all students attend high school, where within-school tracking usually starts at Grade 8 or 9 but where students have a great deal of freedom to choose between classes. Although it is possible to identify college-bound students from the courses they select, the distinction is far less clear than in the German system. From as early as age 10, German students are tracked into the different schools of the three-tiered secondary system. These differ greatly in the intensity and content of the curriculum, but within each, tracking is very unusual. The exception is the most academically competitive track—the *Gymnasium*—from which the German sample for this study was located. For the last 2 years of schooling in the *Gymnasium*, students have to select two, and only two, advanced elective courses, forcing even students who perform well across the board to specialize.

The authors argue that this process is likely to amplify gendered course participation through forcing ipsative decision making. This is in contrast to the United States system, in which high-achieving, college-bound youth may opt for several advanced courses in order to boost their chances of college acceptance—particularly advanced math and English classes, which are critical entrance criteria. Consistent with the authors' hypothesis, differences were more pronounced in the German sample, where high school course selection is based primarily on domain-specific self-concepts and intrinsic value rather than on achievement. The restriction to two advanced courses in Germany resulted in self-concepts and intrinsic value becoming paramount in the selection process, whereas in the United States, course choices were likely to be more ability driven, because high school coursework is one of the determinants for college admission. As a result, the authors caution that school systems that require early specialization can lead to the amplification of gendered course choices and may consequently increase the gender segmentation of the workforce.

Chapter 5 follows from the preceding two chapters, which demonstrate the importance of ability-related beliefs in students' gendered math and Eng-

lish choices. Chapter 5 examines the development of gendered self-concepts in math, English (or "language arts"), and science during high school. It explicitly illustrates the use of latent growth curve modeling within the framework of structural equation modeling. The author first introduces the basic concepts associated with latent growth curve modeling and then walks the reader through three related, increasingly complex applications designed to measure change. Application 1 tested for the extent of change in domain-specific self-concepts. Application 2 extended the multiple-domain model to include gender in order to identify gender differences in domain-specific self-concepts and possible gender differences in their rates of change over time. Application 3 tested for the influence of academic grades as concurrent time-varying predictors of change in self-concepts for math, English, and science. The chapter primarily demonstrates how the LGC modeling approach can be used to analyze the development of important psychological precursors to gendered occupational outcomes, enabling researchers interested in gendered processes to model directly how they unfold. The chapter additionally furthers understanding of how math, English, and science self-concepts develop through adolescence.

Chapter 6 examines gendered trajectories beyond high school for college students interested in studies and careers in science and technology (S&T) in Francophile Canada (Québec). The study adopted a sociomotivational framework incorporating contextual factors, (e.g., parent, teacher, and counselor) in addition to personal motivations, to examine gendered trajectories for persistence and graduation in S&T studies. Results supported the validity of a sociomotivational model. That is, youths' commitment to their studies, their self-determined motivation toward pursuing S&T studies, autonomy support from their parents in the process of choosing studies and a career, and the opportunities offered by their science teachers made unique contributions to the prediction of persistence. It is noteworthy that the motivational variables accounted for nearly twice as much variance in persistence as the social support variables and that persistence may result from the additive effects of motivation and parental and teacher support, even during early adulthood.

It is intriguing that as many girls as boys persisted in their S&T studies, and girls were more likely to start a career in the S&T field sooner after their graduation, commit and persist in their program, and leave the field only after having graduated from college. This profile of persistence reflected girls' higher levels of self-determination, academic involvement, and institutional attachment, identified in the authors' earlier research. Such motivational factors are likely to make girls' academic path less chaotic than that of boys. However, more girls than boys abandon S&T after having obtained their college diploma in this field. The authors argue that the girls who left S&T after having graduated probably had highly positive motivational dispositions without maintaining high intentions regarding careers in mathematics, physics, and computer science. They argue this on the basis that girls' motivational

dispositions and support received from parents and teachers contributed weakly to whether they went on to pursue S&T studies. This was in contrast to boys, for whom associations were strong. Results show the critical importance of examining the moderating effects of gender not only in describing the development of S&T-related motivation and support from the family, school, and society, but also in examining the links between these sociomotivational factors and youths' academic and professional trajectories. The next exciting stage of the authors' longitudinal study is to follow participants into the labor market, providing data on actual career choices, which are very much needed in this field of research.

These chapters collectively highlight the importance of individuals' own psychological processes and motivations through different stages of the pipeline—their choice to specialize in STEM domains, persistence in educational training, and professional entry. These influences appear to operate differently for women than for men.

Part III: The Importance of Family Considerations, Family, and Biology in Gendered Career Choices

Chapters 7 through 9 focus on the importance of family-related influences on gendered occupational choices. Chapter 7 draws on longitudinal data from the United States to examine two hypotheses regarding why young women abandoned, 7 years later, occupational aspirations toward male-dominated fields that they had espoused during late adolescence. The authors' first hypothesis concerns the young women's attitudes toward math and science and the second hypothesis their desire for job flexibility that allows for a balance between work and family responsibilities. The findings show that the desire for a flexible job, high time demands of an occupation, and low intrinsic value of physical science were the best predictors of women changing their occupational aspirations out of male-dominated fields. Positive attitudes toward math and science predicted persistence in aspirations toward male-dominated careers, and job inflexibilities predicted desistance away from those careers.

These findings suggest that despite the women's movement and increased efforts to open occupational doors for women, concerns about balancing career and family, together with less positive attitudes toward science-related domains, continue to steer young women away from occupations in traditionally male-dominated fields even if that is where their abilities and ambitions lie. An examination of the women's actual careers and life circumstances at the second measurement occasion, when they were age 25, also would have been interesting. Future research could additionally include men as well as women to determine whether, and the extent to which, these influences identified among the women may be gender specific. Do the same factors deter both men and women who turn away from traditionally male-dominated careers, or only women?

Chapter 8 focuses on the role that parents play in their children's gender-typed occupational choices. The authors use the parent socialization model (Eccles (Parsons), Adler, & Kaczala, 1982) as a framework to analyze longitudinal data from the United States across a 13-year period. The theoretical model posits that characteristics of parents, family, and neighborhood as well as characteristics of the child shape parents' behaviors and their general beliefs about the world and specific beliefs about their child. The authors focus on how parents' general world beliefs (including their gender role beliefs and attitudes), as well as their child-specific beliefs (occupational expectations and aspirations for their children), shape the opportunities they provide for their children, the children's own motivations, and consequent future behaviors and choices.

The authors present three related studies to unpack their theorized relationships. The first examined the relation between parents' gender role beliefs and children's gender-typed occupational choices. The second study examined the relation between parents' expectations for their children's occupational prestige and the prestige of their children's actual occupations, and the third examined the relation between parents' gender-typed occupational expectations for their children and the gender-typing of their children's actual occupations.

The nature of parent influence differed for mothers versus fathers and according to the child's sex: Fathers' gender-typed occupational expectations were related to both their sons' and daughters' actual gender-typed occupational choices, but mothers' related only to sons' choices. From this, the authors conclude that fathers may play a more powerful role in shaping both their sons' and daughters' career choices than mothers. Parents' gender role beliefs were also more strongly related to their adult children's decisions to enter male- rather than female-typed occupations. Young adults made their career choices within the context of gender-typed parental expectations and within a gender-typed world of occupational opportunities. Together, these findings provide strong evidence for the important role of parents' beliefs and expectations in shaping their children's occupational choices from adolescence through young adulthood, up to 13 years later.

Chapter 8 signals as a clear priority for future research the examination of ways in which parents communicate their expectations to their children. The theoretical model on which the three studies were founded suggests that parents shift from sharing perspectives and providing exposure, opportunities, and role modeling at early ages to providing encouragement and guidance for activities that continue to be supportive of the child's developing interests in certain occupations. How these processes occur and the mechanisms by which they come to shape children's career choices in young adulthood are critical next steps.

Chapter 9 addresses the highly important and topical role of biological predispositions as a contributor to the causes of sex differences in occupational

outcomes. Much evidence has focused on social contributors to these gendered outcomes, but it is also important to consider the role of biology. The authors describe evidence that sex hormones present during prenatal development affect a variety of psychological characteristics that may contribute to gendered occupational choices. Much of this evidence was from females with *congenital adrenal hyperplasia* (CAH), a condition caused by exposure to moderately elevated androgens during prenatal development. Compared with their unexposed female relatives, females with CAH were more male typical and less female typical in activity interests, some personal and social characteristics, aspects of social relationships, and some cognitive abilities (especially spatial abilities). In contrast, gender identity in females with CAH was female typical.

The authors caution that biology does not operate in a vacuum, and they highlight the necessity to understand the mechanisms through which hormones influence behavior. In particular, how do hormones alter individuals' selection and interpretation of their social environment? They emphasize that biology is not destiny, that social factors also affect psychological sex differences, that sex-differential representation in different occupations reflects social practices as well as individual characteristics, and that findings of hormonal influences on psychological characteristics related to gendered occupational outcomes do not provide justification for the unequal treatment of men and women.

Collectively, the chapters in this section show that biology, early and continuing parental influences, and individuals' own family intentions all contribute to women's lower participation in traditionally male-dominated occupational pursuits.

Part IV: Social and Institutional Constraints on Women's Career Development

Chapter 10 examines gendered occupational outcomes in the field of professional training and work in Turkey. The results of three empirical studies (the case of engineering students, the case of professorial workers, and the case of banking sector employees) informed the authors' work. They use historical and institutional data sources to supplement data from the three studies to present a multilayered and relational account of the gendered outcomes of professional employment and education, situating the phenomenon at macro sociohistorical, meso-organizational, and microindividual levels. They present Turkey as a complex and paradoxical example for the study of gender and occupations, with high levels of female representation in professional work in contrast to persistent gendered prejudices upholding a male-centered organization of work life.

Their first study of engineering students revealed that males believed women had lower interest in and were less suited to engineering, tacitly sug-

gesting lower female representation in engineering fields as a matter of choice rather than an outcome of structural conditions. Their second study showed that professors of both genders mostly perceived the academic domain to be free from gender inequality and discrimination. However, male professors reported experiences of institutional barriers such as promotion procedures, and female professors reported experiencing barriers due to their family and child-care responsibilities. It is interesting that this situation was perceived as "normal" by both male and female professors. In their third study, case studies of three banking companies demonstrated both vertical and horizontal gender segregation, with women's employment heavily concentrated in customer relations such as marketing, investment, and stock exchange and at the middle ranks rather than senior or low rank positions. The exclusion of women from areas such as auditing was reinforced by a lack of organizational procedures for combating the sexual harassment they received in the field. However, the home offices were also not free from sexual harassment, and complicated grievance procedures combined with a culture of low awareness did not support the victims. The culture of long working hours further circumscribed women's development. Long hours are one of the main features of the male-centered organization of work life in the banking sector in Turkey; they are equated with strong commitment and provide networking opportunities that promote career advancement. This consequently serves as an exclusion mechanism for women having domestic and child-care responsibilities. The implications of this study were again that gender inequality is perceived as a matter of personal lifestyle rather than institutional culture. Although women have been encouraged to take up employment in the banking sector, there has been no accompanying reform of male dominated cultures and practices.

The authors describe the important symbolism of professional representation of women during the modernization of Turkey while gendered patterns of life in the private space remained intact and unquestioned. Absence of work-life balance supports at institutional and national levels has meant that professional Turkish women find themselves serving "double shifts" because of their disproportionately heavy domestic roles, which has negative effects on their careers. Unlike in the developed countries, where legal protectionism to combat gender discrimination in the workplace has been a long-standing tradition, in Turkey sex equality depends heavily on employers' initiative, willingness, and ideology. The authors conclude that although ideological state support has been an important medium for promoting sex equality, it should be incorporated within a progressive equal opportunities legislation. In addition, because it is individuals who can practice, promote or obstruct any action taken at a policy level, a strong personal awareness and critical understanding of the gendered nature of employment will need to be developed.

Chapter 11 outlines the impetus for and development of ongoing interventions by the University of Michigan's ADVANCE program, part of a

nationwide effort by the National Science Foundation to increase the participation of women at the highest levels of science and engineering. Thus far, 19 universities have received multimillion dollars worth of grants to fund efforts toward institutional transformation—to increase the hiring and promotion of women faculty members and to improve the academic climates in which they work. Slow progress toward gender equity among faculty in science and engineering over the past 20 years, particularly at the highest ranks, has led researchers to investigate ways in which the climate of academic science might contribute both to women “leaking” from the academic pipeline and to their low status within the academy. It is a fair assumption that the relative absence of women at the end of the pipeline, their low status, and their low morale might all be important factors in the choices being made by girls and younger women to be less likely to pursue those careers. The authors discuss likely interactions among and cumulative effects of the interventions as well as their potential influence on young women still in the pipeline.

Specific interventions included invitations to individual faculty members to compete for grants to help bolster individual women’s careers; invitations to departments to apply for grants to allow them to design their own new approaches to recruiting, retaining, and promoting women faculty; and the development of university-wide policies to address family friendly issues, particularly related to recruitment and the timeline available in which to obtain tenure. These interventions are intended to improve the recruitment, retention, and promotion of women faculty and to increase the visibility and authority of women scientists and engineers in leadership positions.

Viewing the university as a system allowed the researchers to approach the climate problems from multiple points of entry, intervening at several levels. Although it is too early to evaluate the combined effects of the interventions, if the experiments at this and the other 18 institutions involved succeed, climate improvement for women faculty in science and engineering will continue. The authors point out that institutions need to remain committed to the project over a long period to allow for meaningful change in the demographic makeup of departments and the development of a critical mass of tenured women faculty thereby guaranteed long and secure careers. They suggest that this “price” should be acceptable because the cost of continued underrepresentation of women in science and engineering is already known. Large-scale, systemwide, and long-term interventions such as these are critical to the understanding of how women’s development at the far end of the pipeline may best be fostered and promoted. It is important to note that this intervention is being continually monitored and evaluated, and the evaluation findings will be invaluable in an area lacking in formal evaluation data.

The final chapter gathers women’s employment and educational statistics from the United States, the European Union, and Japan to present an “equal-

ity profile” of these regions, selected because more than 90% of new technologies are patented via these countries’ trilateral system. Because most efforts to remedy gendered participation in STEM-related fields have been through targeting female educational preparation, the author empirically tested whether equivalent educational preparation translated into equitable occupational outcomes for males and females across these three geographic regions. Equity measures included the Convention Against Elimination of Discrimination Against Women (CEDAW) reports, of which about 150 countries are signatories, for which CEDAW monitors progress in policy and practice. These reports are highly significant in monitoring policy and implementation of gendered occupational outcomes at the national level. On examination of these and other indicators, the author found that despite antidiscriminatory legislation and policies for equality, women experience gendered economic disadvantage throughout their working lives.

The author further analyzed differences between the levels of gender equity measures across the three regions by comprehensive review of international and national policy and legal initiatives and their corresponding effects on labor force demographics. She, like others in this volume, argues the paramount importance of women’s participation in STEM fields because of the economic boundary that separates the technologically powerful and the technologically disadvantaged. Her recommendations include continued access strategies for women’s employment in nontraditional careers alongside the transformation of workplaces to accommodate women’s dual home–work responsibilities.

This chapter paints a portrait of women’s opportunities and representation across a range of different countries and contexts, providing detailed statistics for a number of regions, which also help us to better interpret findings from the other chapters, which are situated across those settings. The author argues that women worldwide tend to perceive that higher levels of education help them to compete in the labor market but that higher levels of education may create greater pay inequality; that gender inequalities are most pronounced in high-level positions in the scientific world, whether academic, government, or private sectors; that hiring more women into the technical labor force may result from an impetus to reverse the shortages in this sector rather than a genuine concern with gender equity; and that women are penalized because of their combined responsibilities at work and in the home. As she eloquently states, these historical factors continue to deal women a losing hand in the labor market, especially as they age.

These chapters together analyze social and institutional barriers to women’s development and success in male-typed occupational fields, emphasizing the need for explicit policy reform agenda and multipronged initiatives aimed at accommodating women’s outside-work responsibilities while changing the values of the workplace culture. Until this can be achieved, it is small

wonder that girls and young women elect to specialize in non-STEM occupations as they look forward to the situation at the further end of the pipeline.

IMPLICATIONS AND OUTLOOK

The present volume is the first book to draw together this range of perspectives, contexts, and time points to consolidate and expand existing knowledge about the internal and external forces that lead to gendered occupational outcomes. This approach is consistent with a developmental systems perspective, which examines individuals' development across different stages in the life span and within the contexts in which individuals are embedded (Roeser, 2006; Roeser, Peck, & Nasir, 2006). Individual, local, and distal social environments shape individuals' occupational choices, and more research is needed on these "embedded" contexts of life choices (Roeser, 2006). Collectively, the chapters highlight the range of key psychological, familial, biological, social, and institutional factors that together shape women's occupational entry and progression.

Most of the chapters focus on occupations in which women are underrepresented relative to men, reflecting our concern with gender equity and the fact that women are underrepresented in those high-status, high-salary careers. Our aim is to raise awareness about the complex interplay of internal and external forces that together shape women's occupational choices and behaviors; to inform policy, education, individuals' own choices; and to highlight the influences we each exert on others. This collection of chapters makes a far more powerful contribution than any single chapter could on its own, each focusing intensively on particular explanations situated within different contexts. The fact that each chapter makes use of longitudinal data and uses sophisticated analytic techniques also enormously strengthens the conclusions that we can draw.

The major messages we want readers to take from the book concern the continuing importance of math as a critical filter that limits access to traditionally male-dominated high-status, high-income careers; the critical role of girls' and women's own motivations and beliefs in steering them away from STEM-related domains; gender differences in biological predispositions that may contribute to gendered occupational outcomes; the enduring effects of parental influences; and the social and institutional constraints on women's career development. Administrators should find valuable information here to help them improve ways to attract girls and women into STEM-related domains and sustain their persistence during educational training. Legislators will appreciate the need to target both ends of the pipeline at once, working to both attract girls and women to the educational opportunities at its entry and also, at the career end, to sustain women's development in traditionally male-dominated occupations by enforcing explicit policies to change the often

unfriendly and unsupportive workplace cultures that conflict with women's frequently held family responsibilities.

There is still more we need to know. I view the most important next steps for research in the field as continuing to draw together longitudinal studies from across different cultural settings and further exploring how multiple domains of individuals' lives jointly interact to produce occupational choices. Longitudinal research is necessary to really test out and tease apart how processes unfold over time and the long-term effects for different influences, which cannot be determined by single-shot or cross-sectional studies. Of course, long-term longitudinal studies are expensive, resource intensive, and take a long time to do, but more such studies, situated within a range of different settings, are needed. Cross-cultural research provides opportunities to contrast how different salient cultural features relate to different gendered outcomes. As one example, by contrasting the United States with the German segregated school system, the authors of chapter 4 are able to show that forced early specialization may amplify gender differences in students' course selections. Cross-cultural comparisons provide wonderful natural experiments for investigating how different structural features may shape different occupational outcomes for men and women. Research that incorporates multiple domains of individuals' lives further allows us to look at how these interact to shape young men's and women's career decisions. It is vital that we better understand what girls and women are choosing to do instead of pursuing traditionally male-dominated occupations and why they are choosing those other paths. To conduct research in this vein implies the need for large-scale, longitudinal, international, interdisciplinary, and collaborative programs of research, involving teams of experts from across different specializations. Our book takes important steps in this direction.

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MATHEMATICS AS THE CRITICAL FILTER?