2
Bringing Young Women to Math and Science

Jacquelynne S. Eccles

Appear in Mary Crawford and Margaret Gentry (Eds.), Gender and Thought. New York: Springer-Verlag, 1989.

A growing concern has been expressed by educators and policymakers alike over the small number of women pursuing careers in the scientific, mathematical, and technical fields (e.g., Sells, 1980). Despite efforts to ameliorate this through affirmative action and scholarship programs, employment statistics indicate that men and women are still entering these career fields in disproportionate numbers (Bureau of Labor Statistics, 1980). Women are less likely than men to enter professions that are math related. For example, in 1983, women received only 13.2% of all undergraduate degrees in engineering and only 27% of all undergraduate degrees in the physical sciences. In contrast, females received 68% of the undergraduate degrees in psychology and sociology and 75% of the undergraduate degrees in education (Vetter and Babco, 1986).

These differences are even more dramatic at the graduate and professional levels. In 1984, for example, less than 10% of the master's degrees and less than 6% of the doctorates in engineering went to women. In this same year, women received 50–51% of the doctorates in education, the humanities, and psychology, and they received 58% of the doctorates in health-related sciences (Vetter and Babco, 1986).

Many researchers have expressed an interest in this problem. Although females receive less encouragement to continue their mathematical and physical science studies and to pursue mathematical or technical careers, findings from a wide variety of sources indicate that the sex differences in career plans are not solely the result of systematic discrimination (see Eccles, 1987a, b). On the contrary, all too often females choose to limit, or to end, their math training while still in high school or soon after entering college. College-bound high school females take about one-half year less mathematics and about one year less physical science than their male peers—despite the fact that females, in general, get better grades in math and science than males (*Women and Minorities in Science and Engineering*, 1986). For these females, this choice effectively eliminates many career options related to math and physical science before they enter college. In fact, only 20–22% of female high school graduates have enough high

school mathematics to qualify them for a quantitative major in college. The comparable figure for male high school graduates is 28%. And only 4.5% of female high school graduates express any interest in a quantitative college major (Vetter & Babco, 1986).

Why do females limit their options in this way? The search for an understanding of the motivation/attitudinal determinants of achievement-related behaviors is not new to psychology. Much of the relevant work in the 1950s and 1960s was stimulated by the expectancy-value theory of Atkinson and his colleagues (e.g., Atkinson, 1964). This theory focused attention on individual differences in the motive to achieve and on the effects of subjective expectation on both this motive and the incentive value of success. Some investigators, using new techniques to measure achievement motives, have continued to explore the implications of motivational mediators for achievement behaviors (e.g., see Spence and Helmreich, 1978). Much of the work of the last decade, however, has shifted attention away from motivational constructs to cognitive constructs such as causal attributions, subjective expectations, self-concept of ability, perceptions of task difficulty, and subjective task value. The theoretical and empirical work presented in this chapter fits into this tradition.

Building on the works of motivational and attribution theorists such as Jack Atkinson (1964), Virginia Crandall (1969), Kurt Lewin (1938), and Bernard Weiner (1974), my colleagues and I have elaborated a model of academic choice. Drawing upon the theoretical and empirical work associated with decision making, achievement, and attribution theory, the model links academic choices to expectancies for success and to the importance of the task's incentive value. It also specifies the relation of these constructs to cultural norms, experience, aptitude, and a set of personal beliefs and attitudes associated with achievement activities (see Eccles-Parsons et al., 1983); achievement activities in this model are any activities that involve evaluating one's performance or products against a standard of excellence. We believe that this model is particularly useful for analyzing sex differences in students' course selection and career choice and in guiding future research efforts in this domain.

A general summary of the mediators and their relation to expectations, values, and achievement behaviors such as persistence, performance, and choice is depicted in Figure 2.1. This model is built on the assumption that an individual's interpretation of reality has a more direct influence on one's expectancies, values, and achievement behavior than one's actual past successes or failures. If actual performance directly predicted and accounted for subsequent academic choices, we would expect more females than males to enter math and science fields. By placing the influence of experience on achievement beliefs, outcomes, and future goals in a more complex cognitive framework, the model allows us to address several mediating factors, which may offer more sound explanations and remedies. These mediating factors include causal attributional patterns

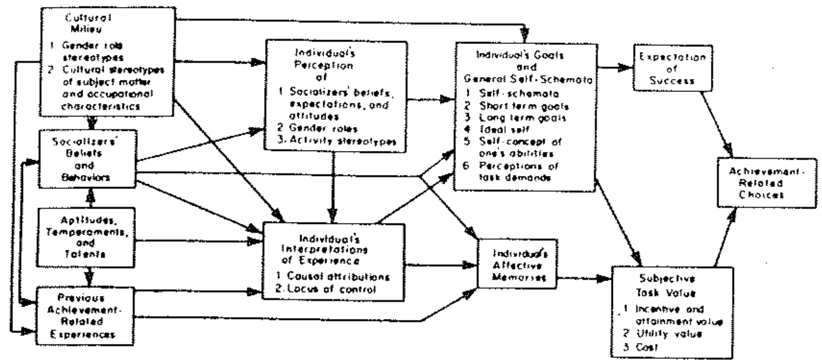

FIGURE 2.1. Developmental model of educational and occupational choices. (Adapted from Eccles, 1985a.) This model outlines the longitudinal relationships between the constructs listed in each box. The arrows indicate the hypothesized relationships and the presumed causal direction of the relationships at any one point in time. For example, it is assumed that the constructs in the boxes in the far left column are causally prior in their influence on all boxes to the right of this column. Similarly, it is assumed that the impact of the experiences implicit in the boxes in the far left column on expectations for success and subjective task value are mediated by the constructs listed in the boxes in the middle two columns (i.e., the individual's perceptions and interpretations of experience, the individual's emerging goal hierarchy and self-schemata, and the individual's affective memories of their experiences). Finally, it is assumed that the influence of all constructs in columns to the left of the fifth column on achievement-related choices (such as course enrollment decisions and occupational preferences) are mediated through their impact on the individual's expectations of success in the various options considered and the subjective value of the various options considered to the individual. Full elaboration of the model can be found in Eccles-Parsons et al. (1983); detailed discussion of the model's implications for an understanding of the impact of gender roles on achievement choices can be found in Eccles (1984, 1987a, b).

for success and failure, the input of socializers (primarily parents and teachers), gender-role stereotypes, and one's perceptions of various possible tasks. The model assumes that each of these factors contributes to both the expectations one holds for future success and the subjective value one attaches to any particular achievement task. Expectations and subjective value, in turn, directly influence achievement-related behaviors, including decisions to engage in particular achievement activities, the intensity of effort expended, and actual performance.

Eccles-Parsons et al. (1983) review extensively the literature supporting the importance of these cognitive mediators for career choice. Readers interested in a full discussion of these factors will find that article germane. The general trend in the literature, however, based on studies ranging from such diverse fields as mathematical modeling of decision making to career

counseling and guidance, supports the importance of these mediating constructs in achievement task and/or career choice (see Betz & Hackett, 1981, and Eccles, 1987a, b for additional reviews).

In this chapter, I summarize the findings from work conducted with my colleagues on the importance of expectancies (defined in terms of confidence in one's abilities and performance) and values (defined in terms of interest in the subject matter, and the perceived importance and utility of the subject area) on math course enrollment decisions. Throughout, I discuss in particular the role teachers and parents play in socializing males and females to hold different expectancies and values toward math. The findings discussed come from two large-scale longitudinal studies my colleagues and I have conducted at the University of Michigan over the last ten years. These studies differ only in the samples included. The measures used are either quite comparable or exactly identical across these studies. Separate studies were run to test the generalizability of our findings across populations and to extend our study to the parents and teachers of our student samples. The findings reported in this chapter replicate across the studies. For ease of presentation, most of the specific data outlined in this chapter come from a single two year longitudinal study of approximately 500 predominantly white, middle-class fifth to twelfth graders in southeastern Michigan and their parents and math teachers. Details of the method of this study can be found in Eccles (1985a), Eccles, Adler, and Meece (1984), Eccles-Parsons (1984), Eccles-Parsons, Adler, and Kaczala (1982), and Eccles-Parsons, Kaczala, and Meece (1982). We refer to this sample in this chapter as our primary sample.

Confidence and Values

Given both the empirical and theoretical importance of confidence and value in mediating course choice and occupational decisions, we assessed the role these beliefs have in explaining sex differences in the choice of mathematics. But before we could do this, we needed to translate these theoretical constructs and the relationships implied in our model into the concrete beliefs and specific relationships that operate in the complex environment in which students actually make course enrollment and occupational choices. As a first step in this process, we investigated secondary school students' decisions about enrolling in optional high school courses. In analyzing this specific context, it became clear immediately that we needed to study more than just mathematics and science. Too often researchers think about math and science enrollment decisions as if these are the only subjects that students are choosing to take. This is clearly not the case. Students at the senior high school level have to make some very complex decisions about what they want to spend their time doing. The decision to drop mathematics is rarely made in isolation from the students' decisions regarding other subjects. Math courses must compete with an array of subjects, such as a second foreign language, band, art, and home economics. With very few slots available for electives, students make scheduling trade-offs among those subjects they expect either to enjoy the most or to benefit their long-range goals. The decision not to take an advanced math or a physical science course often reflects a preference for other goals or subjects rather than a fear of math or physical science. Since, for college-bound females, these competing concerns are often related to language, our studies have examined attitudes toward both mathematics and English in order to gain a richer picture of this complex choice process.

Both our understanding of the factors leading females away from math and science and our ability to develop effective intervention strategies depend on our obtaining this richer and more ecologically valid picture of the decision making process underlying course choice. Obtaining such a picture requires our understanding of the courses taken as well as the courses not taken and of the reasons behind each type of choice. Studying secondary school students' confidence in their own abilities in math and English (defined in terms of how good they think they are in the subject area and how well they expect to do in the subject area) and secondary school students' perception of the value of math and English (defined as interest in the subject, and perceived importance and utility value of the subject area for long- and short-term goals) seemed a reasonable first step.

Empirical Findings

Males' and females' attitudes toward math and English, and toward themselves as learners of math and English, diverge consistently in all studies of people over the age of 12. In our samples, these differences begin to emerge at about the seventh grade and become stronger over the high school years. Figure 2.2 illustrates the relative confidence males and females from our primary sample reported in their math and English abilities (Eccles, 1985).

In this sample, there were no major sex differences in confidence for either subject prior to seventh grade. In fact, if anything, the elementary school females reported slightly more confidence than the males in their English ability. Sex differences, however, began to emerge in junior high school, at which point the females had lower estimates of their math ability than did the males. The size of this sex difference grew as the students moved into high school. This general developmental pattern characterizes the results for our second sample as well. In the second sample, however, the sex difference favoring English for females was stronger.

Even more striking than the sex differences within subject area is the subject matter difference among the females. As these females moved into junior high school, a growing discrepancy between their view of their math skills and their view of their English skills emerged. Apparently even

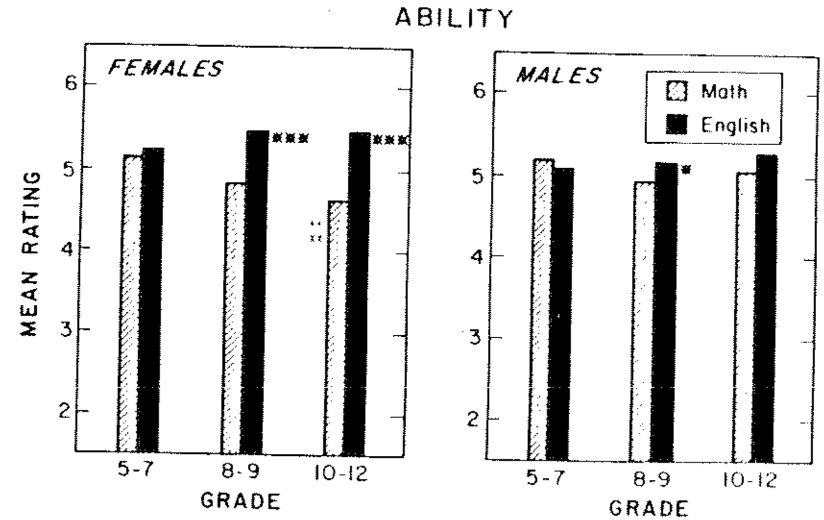

FIGURE 2.2. Grade level, sex, and subject matter differences in self-concept of ability. (Adapted from Eccles, 1985a.) This figure illustrates the mean ratings of males and females from different grade levels on a measure of their self-concepts for their math and English abilities. The measure has a score range from 1.0 to 7.0 and is based on the mean of several items that consistently factor together across our various samples. These data are taken from a cross-sectional study of 668 students from a predominantly white middle- to upper-class, Midwestern community designated as our primary sample in the text of this chapter. Significance levels are indicated with three symbols: asterisks (*) indicate the subject domain comparisons within sex and age group; pluses (+) indicate sex comparisons within age group and subject domain; crosses (×) indicate age comparisons within sex and subject domain. In each case, one symbol indicates a significance level of at least .05; two symbols indicate a significance level of at least .01; and three symbols indicate a significance level of at least .001.

among females who are doing very well in mathematics, who are on a college track, and who are enrolled in advanced level high school math courses, females express greater confidence in their English abilities than their math abilities. The males in this sample did not show this difference. Unlike the females, these males on the average did not seem to favor one subject area over the other. It is possible that there may be more individual variation among males with some favoring English and others favoring math. If so, then as a group, males' preferences would average out and result in nearly equal group levels of confidence. In support of this suggestion, the variability in these males' scores was significantly greater than the variability in these females' scores. In contrast, among the females we found a consistent average population effect. In general, these data suggest that most females underestimate their math abilities as they get older and feel increasingly more confident about their English abilities than about their math abilities.

This pattern of results is mirrored in students' attitudes toward the value of math and English. We asked males and females how useful math and English were for their future goals. We also asked them how much they liked math and English, and how important they thought being competent in each subject was for their own self-concept. Figure 2.3 illustrates the findings in our primary sample (Eccles, 1985a). As was true with confidence in their abilities, the females showed a linear decrease over age in their assessment of the value of mathematics. This pattern was not evident in the male population as the males moved through these secondary school

SUBJECTIVE TASK VALUE

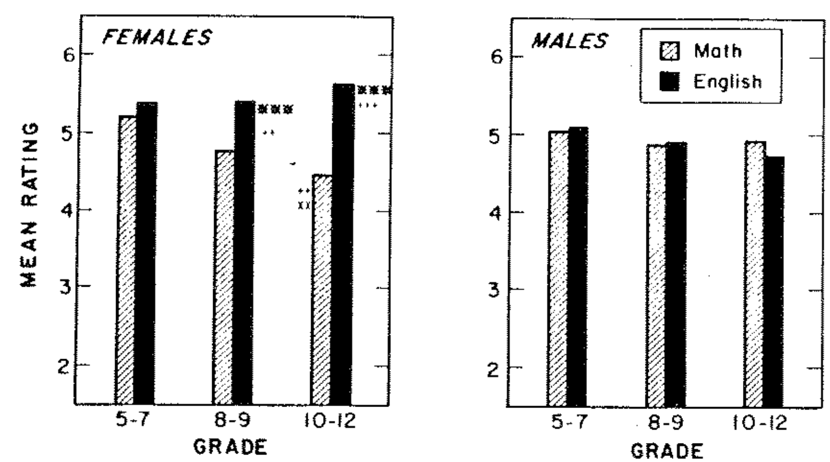

FIGURE 2.3. Grade level, sex, and subject matter differences in subjective task value. (Adapted from Eccles, 1985a.) This figure illustrates the mean ratings of males and females from different grade levels on a measure of their self-concepts for their math and English abilities. The measure has a score range from 1.0 to 7.0 and is based on the mean of several items that consistently factor together across our various samples. These data are taken from a cross-sectional study of 668 students from a predominantly white middle- to upper-class, Midwestern community designated as our primary sample in the text of this chapter. Significance levels are indicated with three symbols: asterisks (*) indicate the subject domain comparisons within sex and age group; pluses (+) indicate sex comparisons within age group and subject domain; crosses (×) indicate age comparisons within sex and subject domain. In each case, one symbol indicates a significance level of at least .05; two symbols indicate a significance level of at least .01; and three symbols indicate a significance level of at least .001.

years. The confidence pattern was further paralleled by a growing discrepancy between the value that the females attached to mathematics and English. Again, in contrast, the males' responses were about equal for the two subjects. As the females moved through high school, they reported valuing English increasingly more than they valued mathematics.

Given these results, is it any wonder that these females elect to drop mathematics in the twelfth grade when they must choose between taking an advanced math course and another subject in which they are more interested? In general, these females were more likely to elect advanced level courses in English, foreign languages, or social science than advanced level courses in either mathematics or physical science. As a consequence, they were less likely than the males to enroll in an advanced math or physics course (Eccles et al., 1984). We would predict exactly this result *unless* someone intervened and gave the females new information that would lead them to reevaluate either their assessments of the importance of mathematics or their estimates of their mathematical aptitude, or both.

Origins of Sex Differences in Confidence and Subjective Task Value

From where do these attitudinal differences come? Several mechanisms are suggested in Figure 2.1. Beginning at the far left of Figure 2.1, we hypothesized that these differences are due to general cultural factors such as the gender-role stereotypes both of different subject areas and of the sex differences in the distribution of specific talents in the population. These stereotypes are hypothesized to have a direct effect on the individual's self-perceptions and subjective task values. I discuss the evidence for this link first. In addition, these stereotypes are hypothesized to have an indirect influence on the individual through their influence on socializers' beliefs and behaviors. That is, culturally held gender-role stereotypes are presumed to affect the attitudes and behaviors of socializers (in this case parents and teachers), which in turn affect the self-perceptions and task values that males and females develop as they grow up. I discuss the evidence for these links second, focusing first on parents and then on teachers. Finally, in the model in Figure 2.1, we hypothesized that previous achievement-related experiences influence the development of females' and males' attitudes toward mathematics both directly through their impact on the individual's affective memories and indirectly through their impact on the individual's interpretative framework. I discuss evidence for these links last, focusing on classroom experiences. The fourth and final set of influences listed in the far left column is aptitudes, temperaments, and talents. Although much debate has occurred regarding the possible role these factors may play in shaping sex differences in math and science, no definitive conclusions have been reached by the scientific community (see Eccles, 1987b; Eccles-Parsons, 1984; Halpern, 1986; Steinkamp & Maehr, 1984, for discussion). In contrast, it is quite clear that social forces do affect females' interest in math and science, as is documented in the next sections. Consequently, given the focus in this book on gender role as a belief system and given my commitment to studying intervenable causes of females' under representation in math and science, I do not discuss the possible influence of sex differences in aptitudes, temperaments, and talents further. In summary, in this chapter I discuss three of the possible mechanisms outlined in Figure 2.1: gender-role congruence, parent influences, and teacher influences.

Gender-Role Congruence

Gender roles can affect both confidence and value. One critical feature of the female gender role in this culture is a belief in the relative incompetence of females in mathematical and technological fields—a belief that females are unlikely to have math talent or to be very skilled in technical areas. To the extent that a female incorporates this cultural belief into her self-concept, she is likely to have less confidence in her math abilities than in her English abilities.

To test this prediction among the secondary school students in our primary sample, we compared the females' ratings of themselves on the Personality Attributes Questionnaire (PAQ) to their ratings of their own math ability and of the difficulty of math as a subject area. The PAQ is a scale designed to assess self-perceptions of one's femininity, masculinity, and androgyny (Spence & Helmreich, 1978). As predicted, the masculine and the androgynous females had more confidence in their math ability, higher expectations for their own performance in math, and rated math as easier than did the feminine females (Kaczala, 1981).

It is also probable that the extent to which parents have incorporated this belief system into their view of the world will influence their judgments of their daughter's math abilities. To test this hypothesis, we compared the strength of parents' ratings of mathematics as a stereotypically male talent with their ratings of their own sons' or daughters' math talent controlling for the actual performance level of the children. As predicted, parents who endorsed the gender-role stereotype that males have more math talent than females either underestimated their daughters' math talent or overestimated their sons' math talent depending on the sex of their child (Jacobs, 1987).

Gender-role beliefs should also affect parents' attributional explanations for their children's performance in mathematics. Given that parents in general believe that males have more math talent than females, they should be less likely to attribute a female's successes in math and physical sciences to high ability than to her hard work, diligence, and effort. And in fact, we found exactly this attributional pattern. Parents in our follow-up studies were more likely to attribute their sons' math successes to talent and their daughters' math successes to effort and, as a consequence, to rate their sons as more talented in math (Yee & Eccles, in press). These attributional biases, in turn, were linked to a decline in their daughters' confidence in their own math abilities, even though the young women continued to get just as high grades in their math and science courses as their male peers (Eccles et al., 1987; Eccles-Parsons, Adler, & Kaczala, 1982). Thus gender roles do appear to undermine females' interest in mathematics by diminishing both females' own confidence in their mathematical abilities and parents' view of their daughters' math talent.

Gender roles can also influence enrollment and occupational choices through their direct impact on interests and values. In particular, gender roles can undermine females' interest in mathematics and physical sciences by their impact on females' personal values and perceptions of the importance of mathematics and technological professions. Through their impact on both the view one has of oneself and the view one has of the world, gender roles can affect the value individuals come to attach to various school subjects, college majors, and future occupations. As we mature, we develop a view of who we are and who we would like to be. Obviously, this view includes many characteristics. The professional and academic goals we set will depend not only on our intellectual confidence and values but also on our personal values and self-definition. Just as students do not schedule elective math courses in a vacuum, females do not define their adult career choices as if severed from their other interests and images of themselves as females. Two major differences in the male and female gender role may generate different views of "appropriate" professions. Females show a greater interest in other people, as opposed to things; and they show a greater interest in helping and nurturing, as opposed to trying to take things apart and manipulate mechanical objects (Eccles, 1987b; Gilligan, 1982; Huston, 1983). We would expect this distinction to be reflected in a divergence in the occupational goals that males and females adopt.

During our childhood, we also develop images of different occupational fields, for example, engineers, physicists, or scientists. Sally Boswell (1979) asked elementary and senior high school students what they thought scientists did. Not surprisingly, the children, both males and females, conjured up an image of a person wearing a white coat and working in front of an array of test tubes. *He* was isolated in a laboratory, worked long hours, and had no time for *his* family or *his* friends. When the children were asked to imagine an engineer, they conjured up an image of a man in a hardhat looking for oil in the Arabian desert. Most females, who are developing images of themselves as helpful and nurturing toward other people, would not find the image of scientist or engineer very attractive or very compatible with their self-image. Thus, we would expect them to have difficulty imagining themselves doing such work for the rest of their lives. As a consequence, these occupations should have—and in fact do have—less positive value for females (see Eccles, 1987b).

As mathematics and physical science courses are often prerequisites for entry into these professions, we would accordingly expect these subject areas to have less value to females, especially those who have incorporated the female gender role into their own identity. To test this suggestion, we compared the females' PAQ classification score with their ratings of the value of mathematics. Consistent with the findings for confidence in one's math ability, androgynous females rated math as more interesting, more important, and more useful than did feminine females (Kaczala, 1981).

If, as I have argued, these stereotypical gender-role beliefs undermine the value females might otherwise attach to technological occupations, then they can obviously undermine the value females attach to the mathematics courses that are prerequisites to entry into such fields. When we asked our primary sample why they were taking mathematics, only a few claimed they were taking math for the love of the subject. Most reported taking mathematics because it was required for their occupational goals, or because it was required to get into a good college (Eccles-Parsons et al., 1983). If one is not going into a field that requires math, why (they argue) should one bother taking nonrequired math? Unfortunately, few educators and parents give the students a positive answer to this question. In addition, these adults often give students erroneous information about the level of mathematics required in various fields (see Eccles, 1985b; Fox, Brody, & Tobin, 1980; Steinkamp & Maehr, 1984). Thus females are likely to have had insufficient math training for even those scientific fields that they are likely to enter, such as psychology.

This pattern of misinformation and lack of encouragement is compounded by the lack of role models available to children in either the media or their own experience. Females rarely observe examples or images of women performing in math-related technical professions. As a result we have a situation in which there are few incentives for most females either to take advanced courses in math and physical science or to consider seriously math-related occupations, and strong, and fairly consistent, gender-role prescriptions against consideration of nontraditional educational and occupational choices. Is it any wonder then that females are less likely to make such nontraditional choices when it comes time for them to make these decisions?

Social Forces: Parent Influences and Teacher Influences

Neither sex-differentiated beliefs and self-perceptions nor gender-role beliefs develop in a vacuum. Ample evidence documents the fact that peers, friends, siblings, parents, TV, and school personnel all contribute to the shaping of these beliefs over time (see Huston, 1983; Eccles, 1985b; Eccles & Hoffman, 1984; Eccles-Parsons, 1984). The model depicted in Figure 2.1 focuses attention on the role parents and teachers play in shaping children's self-perceptions and task values. And, not surprisingly, the studies we have done based on this model reflect this orientation. Our data document the role of parents and teachers in shaping and perpetuating sex-differentiated self-perceptions, and both educational and occupational preferences. In the next sections, I summarize these findings separately for parents and teachers. But first I summarize briefly our general findings on the relative influences of parents and teachers.

In our studies, parents appear to play the more central role in the creation of sex-differentiated values and self-perceptions. As I argue below, these effects are not necessarily intentional; in fact, the parents are often unaware of the things they do that discourage their daughters from studying math and science. Consequently, their gender-role stereotyped behaviors and expectations are often immune to modification based on their children's actual talents and performance. In contrast, the teachers' role is more one of reinforcing children's gender-role stereotyped beliefs than one of creating them. Because of the demands inherent in teaching and supervising a large number of children at one time, teachers are usually more reactive than proactive in their interactions with students. Consequently, teachers often unintentionally reinforce the gender-role–related beliefs the children bring with them to the classroom. In our numerous hours of classroom observation, we rarely saw a teacher attempt either to modify their students' beliefs or to expose the children to experiences that would challenge their preconceived beliefs, self-perceptions, and aspirations. Consequently, although teachers could be a powerful force for change, they typically are too reactive and too overwhelmed with the day-to-day realities of their classrooms to have much of an impact on most children's gender-role stereotyped self-perceptions and values. These points are elaborated below.

Parents

Our data quite consistently show that parents, to a greater extent than teachers, have gender-role stereotyped beliefs about their children's academic competencies (Eccles & Jacobs, 1986; Eccles et al., 1987; Eccles-Parsons, Adler, & Kaczala, 1982). Let me give some examples from the parents of our primary sample. As noted earlier, these males and females had always done equally well in mathematics. In addition, their teachers reported that they had worked equally hard in mathematics. Yet, when we asked their parents how much effort they thought their daughter or son needed to exert in order to do well in math, both mothers and fathers of daughters reported that their child had to work harder than did the mothers and fathers of sons. When we asked them how hard math was for their child, both parents agreed that math was more difficult for daughters than for sons. When we asked them how important it was to take math, both parents rated math, especially advanced high school math, and both physics and chemistry, as more important for sons than for daughters. Similarly, parents of sons were more likely to report that math is relatively more important than other subjects than parents of daughters. In contrast, parents rated English and American history as more important for daughters to take than for sons. Finally, both mothers and fathers agreed that they would be more likely to encourage their sons to take advanced math.

These results did not reflect a general lack of confidence in their daughter's academic abilities. In general, these females got better grades in school than their male peers. And when we asked the parents to indicate their perception of their child's general school performance, both fathers and mothers reported that the females were doing better in school than the males were (Eccles-Parsons, Adler, & Kaczala, 1982).

Similar sex-of-child effects characterized the parents' causal attributions for their children's success in mathematics. We asked parents in a second sample to recall a time when their child had done especially well in mathematics and to rate how important they felt natural talent, skill, and effort were in accounting for this performance. Parents of sons rated natural talent a more important reason for their child's performance than parents of daughters. In contrast, parents of daughters rated hard work (effort) as a more important reason for their child's performance than parents of sons (Yee & Eccles, in press).

These causal attributions, in turn, have the expected impact on parents' views of their children's mathematical talent (Yee & Eccles, in press). Parents who attributed their child's math success more to natural talent than to effort (the male pattern) developed more confidence in their child's math ability than parents who attributed their child's math success relatively more to hard work than to natural talent (the female pattern)—even though both groups of children had earned equivalent grades in mathematics.

Furthermore, longitudinal analyses indicate that parents' confidence in their child's math abilities has a direct impact on their children's self-perceptions and values as predicted by the model illustrated in Figure 2.1 (Eccles-Parsons, Adler, & Kaczala, 1982). Parents', especially mothers', confidence in their children's math abilities and parents' estimates of how hard their child is having to work in math seemed to mediate the impact of the children's grades on the children's confidence in their math abilities. Apparently, parents provide their children with an interpretative framework for understanding what grades mean about one's abilities. And since parents think math is harder for daughters than for sons, females develop less confidence in their math abilities than males.

In addition, perhaps because parents think math is harder for daughters than for sons, and English is easier for daughters than for sons, they rate advanced math and the physical sciences as less important than other subjects for daughters but not for sons. Consequently, parents are less likely to encourage females to take advanced math courses. Since parental advice is noted by students as one of the most important influences on high school course decisionmaking (Eccles-Parsons et al., 1983), these parental beliefs about the relative importance of mathematics appear to play a major role in determining sex differences in math course enrollment decisions.

Teachers

A great deal of research has focused on the role teachers may play in either creating or perpetuating sex-differentiated self-perceptions and educational choices. Social scientists have taken two approaches to this topic.

The first and most classic approach has been to look for differential treatment in the classroom by using carefully designed observational systems. This approach investigates whether teachers treat males and females differently, and whether these differences convey the subtle message that females are not expected to go on or to excel in math and physical science. There has been a long tradition of research on these issues involving many studies looking at teacher–student interaction. Three findings emerge with some consistency. First, there has been a major historical change. The differences reported by researchers in the 1960s are more difficult to document today. Either teachers have become more sensitive to the differences on which observers focus and therefore act more equalitarian when the observers are there, or teacher training has been effective at producing teachers who are more equalitarian in their treatment of males and females in their math classrooms.

Despite this historical change, however, two differences still characterize many classrooms: (1) males are yelled at and criticized publicly more than females, and (2) males are more likely than females to monopolize teacher–student interaction time (see Eccles & Blumenfeld, 1985). The second characteristic emerges only in some classrooms and seems to reflect the fact that a few males are allowed to dominate the class time in these classrooms. The teachers are not interacting more in general with the males in these classrooms: rather, a few males are receiving much more interaction than all the other students. We have now observed in over 150 math classrooms in southeastern Michigan; in 40 of them, we coded every interaction the teacher had with each student over a ten-day period. Over half the students *never* talked to the teacher during the ten days. Others had 14 or more interactions with the teacher *every hour*. Most of these latter students were males.

The second approach to the study of teacher influences has used a very different strategy. Researchers in this tradition identify a set of characteristics that makes some classrooms special and then observe and compare these classrooms to more typical ones. For example, both Pat Casserly (1975) and Jane Kahle (1984) have identified "superb" teachers and then compared their classroom techniques with those used by more "mediocre or average" teachers. Casserly and Kahle used criteria such as average student achievement level to define these "superb" and "average" teachers. Following a similar strategy, we have identified classrooms in which there were few sex differences in the students' attitudes toward math and compared them to classrooms in which the males had more positive attitudes toward math and more confidence in their math ability than the females.

Even though researchers have used a variety of criteria to define their classroom types, there has been reasonable consistency across studies regarding the distinguishing characteristics of good and/or "nonsexist" classrooms. In our study, for example, we compared classrooms in which the males and females had similar confidence in their mathematical ability to classrooms in which the males had substantially higher confidence in their math ability than the females (Eccles, MacIver, & Lange, 1986; Eccles-Parsons, Kaczala, & Meece, 1982). Important procedural differences emerged. Classrooms in which there were no sex differences were more orderly, had less of both extreme praise and criticism, and were more businesslike. The teacher also maintained tighter control over student–teacher interactions, ensuring equal student participation by calling on everyone, rather than focusing on the small subset of students who regularly raised their hands. In contrast, classrooms marked by sex differences in the students' attitudes were characterized by student–teacher interactions dominated by a few students. Essentially, these teachers were more reactive, focusing their attention primarily on those students who raised their hand or insisted on attention in other ways. Consequently, a running dialogue emerged between the teacher and two or three students, who usually sat in the front of the room and regularly raised their hands. More often than not these "stars" were white males. Other students rarely volunteered and were never called upon to participate. They sat out of the teacher's view, and as long as they did not cause a disturbance or start trouble, they were allowed to be nonparticipants. The latter group of students included both the males for whom the teacher had low expectations and most of the females.

A further difference emerged with some consistency. The classrooms in which males and females had similar views of their abilities were less public and more private. Essentially, these classrooms were characterized by more dyadic interactions between the teacher and the student and less public drills involving the whole class. Consequently, the students spent less time waiting to be called on and competing for public attention, and more time working on problems and consulting individually with the teacher when help was needed. This teaching style appears to have a beneficial effect on females, perhaps because it induces a less competitive classroom environment. It is an environment that allows students to work individually

and receive feedback without the entire class focusing publicly on the interaction.

The importance of general classroom climate, especially competitiveness, has emerged in a study we just completed that looks intensively at math instruction in sixth and seventh grades (Eccles, MacIver, & Lange, 1986). In this study we gathered information on general classroom climate from the students, observer, and the teachers in 110 mathematics classrooms. We used the students' reports of their confidence in their math abilities and the value they attached to mathematics to classify each classroom into one of the following three categories: (1) girl-friendly classrooms—the classrooms in which the females had more favorable attitudes toward mathematics than the males, (2) boy-friendly classrooms—the classrooms in which the males had more favorable attitudes than the females, and (3) neutral classrooms—the classrooms with no consistent pattern of sex differences in the students' self-perceptions and perceived math values. We then compared the classroom climate measures for the girl- and boy-friendly classrooms. The girl-friendly classrooms, relative to the boy-friendly classrooms, were characterized by less social comparison and competition among the students, by more teacher stress on the importance and value of mathematics, and by a warmer, fairer teacher as perceived by the students themselves. These results suggest that females develop more favorable attitudes toward math and more confidence in their math abilities in classrooms characterized by relatively low levels of competition, relatively high levels of personal contact with the teacher, and relatively low levels of public drill and practice.

Casserly (1980), using a different criterion for excellence, found a very similar pattern of results. She identified the 20 school districts in the United States that had the most favorable record of females going on to take Advanced Placement courses in math and science.[1] She then observed and interviewed these districts' teachers in an effort to identify their particular teaching skills and strategies. Five characteristics emerged with great regularity: (1) These teachers were more likely to use either cooperative learning strategies or individualized learning strategies than public drill. (2) They were less likely to use competitive motivational strategies; that is, they did not try to pit the students against each other in order to motivate their performance. (3) They used more hands-on learning and more problems with practical implications and opportunities for creative solutions. (4) Rather than drilling their math and science students on a canon of "correct" textbook information, these teachers designed more active, open-ended learning situations. They would pose a problem (e.g., "build a

[1]These districts also had the best record with males. Apparently, the techniques that worked for females also worked with males.

bridge that can bear a maximum amount of weight") and then divide students into teams. These teams could solve the problem in a variety of ways. (5) These teachers also engaged in a great deal of active career guidance in the classroom, stressing the importance and usefulness of math and science for the students' other courses and for their future career choices.

Kahle (1984) has done a similar study in science classrooms. She found that a very similar cluster of techniques were characteristic of science teachers who have been labeled as "outstanding." These teachers tended to use multiple texts, to carefully supplement their texts with information and pictures indicating the involvement of all nationalities, races, and both genders in math and science, and to avoid the use of sexist or racist material. Like the teachers in Casserly's study, they provided active career guidance during class time.

The "outstanding" teachers Kahle studied also relied heavily on hands-on experiences in which all students were required to participate actively. Use of computers in the classroom provides an excellent example of the importance of this type of teacher control. Too often, when computers are introduced into classrooms (especially at the elementary level), the pattern of a single male dominating their use emerges. This pattern is most evident in classrooms where the students are allowed to control access to the computers. A similar pattern often emerges with other types of scientific or laboratory equipment (Wilkinson & Marrett, 1985). In Kahle's optimal classrooms, opportunities were more evenly distributed and enforced: everyone participated, the "boss" in laboratory groups rotated, everyone took a turn with the equipment, and students had equal time on the computer. Enforcing this pattern is not easy. Teachers must be extremely organized and committed to equal distribution of opportunities for working with the equipment. Instead, all too often, a few students, usually white males, take over and other students, usually females, watch or play a more passive role (Wilkinson & Marrett, 1985). The monopolizing of computer time occurs particularly when the teacher is uncomfortable with this new technology. Such teachers often find a confidant in the classroom, usually a student familiar with computers and to whom the teacher delegates authority. This person then monitors who gets access to the computer, and how long they may use it. More often than not, this person is a white male since this is the group of children who, by a large margin, are most likely to have had the privilege of someone buying them a computer to use at home and providing them with the opportunity to learn about computers in either computer camps or out-of-school computer classes (Kiesler, Sproul, & Eccles, 1985b).

These studies, and several others like them, suggest that teachers may be providing a subset of males with more opportunities to learn and to practice leadership skills in science and math classrooms than they provide for the vast majority of females. In some cases, this may be due to conscious sexist attitudes and beliefs. For example, some teachers may believe that males are more talented in math and science and therefore focus their mentoring efforts on the males. But more often this appears to be due to the teachers' unconscious passive reactions to individual differences in behaviors and skills which the children bring to the classroom. Gender-role socialization outside the school leads males and females to have different skills and interests. Consequently, in the classroom, males and females display different behaviors—with males demanding more attention and more leadership opportunities by being more assertive and by having more out-of-school experience with math and science equipment such as computer and laboratory equipment. Since females typically do not protest the differential treatment that results, even well-intentioned teachers may fail to see the sex inequity of their classroom protocols for equipment use and participation. And unless truly committed to sex equity, even these teachers will do little to ensure equal participation and to try to counteract and modify males' and females' gender-role stereotyped self-perceptions and values.

In conclusion, it appears that there are certain kinds of learning environments that are not particularly conducive to most females' motivation to study math and science. These characteristics include competition, social comparison, high use of public drill, and domination of student–teacher interaction by a few students. In contrast, there are certain kinds of learning environments that appear to be more beneficial to females. These include controlled hands-on experience, use of nonsexist and nonracist materials, cooperative or individualized learning formats that ensure full participation by *all* children in the class, and active career counseling. Kahle has labeled this latter type of classroom a "girl-friendly" classroom. What is interesting about this set of characteristics is that they facilitate the motivation and performance of minority students and low achieving males as well (Malcolm, 1984). Apparently, only a few students benefit from competitive environments in which a select group of students tend to monopolize the teacher–student interaction. The rest of the class suffers either in terms of their motivation or in terms of their actual learning. Looked at in this light, the call for structuring classes and materials "more effectively" for females is *not* a call for special or remedial attention. Rather, it is a call for more conscientious distribution of the teacher's efforts as a resource for all students and for the use of instructional techniques that foster interest in mathematics and science even among students who are not intrinsically interested in the subject matter.

Conclusions

I began this chapter by presenting a model for understanding individual differences in achievement choices and then used this model to analyze why females are underrepresented in fields related to mathematics and the physical sciences. Consistent with the expectancy-value theoretical framework on which the model is based, I argued that the underrepresentation of females in mathematics and science resulted most directly from sex differences in students' confidence in their math and English abilities and the relative value they attach to activities and careers involving mathematics and physical science compared to the value they attach to other subject matter areas and occupational fields. Evidence was presented to support this hypothesis.

Again consistent with the model, I argued that these sex differences in beliefs result from the impact of our culturally based gender-role system on the beliefs and behaviors of those individuals responsible for the rearing and education of our children. Adults in this culture both act out and believe in traditional gender-role prescriptions regarding appropriate activities for males and females. They also believe that the sexes differ in their "natural" talents and interests, and these beliefs influence their perceptions of their own children's talents and interests despite evidence that the distribution of particular talents is very similar for males and females during the preadolescent years. As a consequence of these nonconscious beliefs, parents and teachers treat males and females differently, form different expectations and aspirations for females and males, and provide males and females with different interpretations of reality and different advice regarding their future options. As a result of these experiences, and in the absence of accurate information on which to base their stereotypes of adult occupations, young women, compared to young men, develop less confidence in their math abilities, less interest in studying math and physical science, and less interest in pursuing careers in math and science-related fields.

How can we change this cycle? Although parents seem to have the most powerful direct influence on the origins of these differences, teachers are well situated to intervene in this system. As I argued earlier, much of the problem stems from gender-role stereotyped values and self-perceptions. One of the ways that "superb" teachers produce positive outcomes is by active career counseling, equalitarian creative hands-on teaching practices, and active attempts to change their students' gender-role stereotyped beliefs, self-concepts and values. They change the females' views of who they are and who they can become. In so doing they change the value females attach to mathematics. By providing students with a reason for studying math and/or science, and by telling them how these subjects relate to the occupational world, these teachers give students a reason for wanting to learn math. In essence they provide an answer to the question "Why should I study more mathematics?" for those students who do not find math especially interesting or enjoyable. By providing all students the opportunity to participate fully in the class, they facilitate the acquisition of confidence in one's abilities and interest in the subject. Although teachers do not generally have a lot of influence, these exemplary teachers suggest

that teachers make a difference if they decide to. But to do this requires an active commitment to nonsexist, nonracist instruction and guidance.

Even more importantly, it involves a commitment to go out of one's way to encourage young women to consider the fields of math and science. Teachers are in a unique position to identify talented, motivated students and to communicate their confidence in these students to both the students and their parents. This feedback is especially important for females and minority children, who appear less likely than males in general to label themselves as talented in math or science. By providing good female students and their parents direct explicit feedback regarding their talents and potential, teachers can counter the tendency of females and their parents to attribute young women's academic successes to hard work rather than talent. Providing this feedback also enlists the parents as allies in the resocialization process. Most parents want the best for their children, but because they themselves were raised in a gender-role stereotyped culture and have had little exposure to nontraditional models or information, they often overlook nontraditional career possibilities for their children and misinterpret their children's school performances. If a teacher, as a recognized expert, takes time to discuss their child's math or scientific talent and the vocational options it opens to her, parents of daughters may become as willing to encourage their children to think about careers in fields related to math or science as parents of sons are.

All these recommendations require very active involvement on the part of the teachers. Such involvement has been made easier by the development of good curricular materials for women students. These materials provide teachers with films and posters that will expose the students to minority and female role models in fields associated with math and science. Such materials can suggest new job options to students which they might otherwise not have known or not have considered. Students may also glean more realistic images of the familiar professions they had viewed in simpler, more stereotypic terms. By pointing out these options to females, teachers can motivate them to imagine themselves in these fields and thus to open themselves to the possibility of pursuing such occupations.

In closing, it seems evident to me that at this historical point in our culture, "equal treatment" in schools is not enough to increase the probability that young women will seriously consider nontraditional educational or vocational options. It certainly is the minimum to which we must aspire. But since children are exposed to a heavy dose of gender-role socialization outside school, they come into the classroom with well-formed, gender-role stereotypic beliefs about what is appropriate for them to think about in terms of their long-range vocational goals and their view of their own competencies. And their typical experiences in school and at home do nothing to counteract these beliefs. Consequently, when they reach the age where affirmative action programs are in place, they have already lost access to many possible options as a result of earlier educational and occupational

Kiesler, S., Sproull, L., & Eccles, J.S. (1985). Pool halls, chips, and war games: Women in the culture of computing. *Psychology of Women Quarterly, 9*, 451–462.
Lewin, K. (1938). *The conceptual representation and the measurement of psychological forces.* Durham, NC: Duke University Press.
Malcolm, S. (1984). *Equity and excellence: Compatible goals.* Washington, DC: AAAS Publications.
Sells, L.W. (1980). Mathematical filter and the education of women and minorities. In L.H. Fox, L. Brody, & D. Tobin (Eds.), *Women and the mathematical mystique.* Baltimore: Johns Hopkins University Press.
Spence, J.T., & Helmreich, R.L. (1978). *Masculinity and femininity: Their psychological dimensions, correlates, and antecedents.* Austin: University of Texas Press.
Steinkamp, M.W., & Maehr, M.L. (Eds.) (1984). *Women in science, Vol. 2; Advances in motivation and achievement.* Greenwich, CT: JAI Press.
Vetter, B., & Babco, E. (Eds.) (February 1986). *Professional women and minorities.* Washington, DC: Commission on Professionals in Science and Technology.
Weiner, B. (1974). *Achievement motivation and attribution theory.* Morristown, NJ: General Learning Press.
Wilkinson, L.C., & Marrett, C. (Eds.) (1985). *Gender influences in classroom interaction.* Hillsdale, NJ: Erlbaum.
Women and minorities in science and engineering (January 1986). (NSF 86–301). Washington, DC: National Science Foundation.
Yee, D., & Eccles, J. (in press). Parents' causal attributions for their children's mathematical performance. *Sex Roles.*

3
Molehill or Mountain? What We Know and Don't Know About Sex Bias in Language

Nancy M. Henley

Language is at the core of human interaction, and it is at the core of our beings, our sense of self. An attack on our language is in a very real sense an attack on ourselves; as we know, wars large and small have been fought over language. Small wonder then that people are upset about the issue of sex bias in language. We are upset as speakers of the language because we identify with it: an attack on our language as unfair says that we are ourselves unfair. And we are upset as referents of the language (particularly women and girls) because in referring to us the language often seems to be attacking us. Why do I say the language, and not its speakers, are attacking us? Because well-meaning, nonsexist speakers may, simply by conventional usage, unwittingly use the language as conscious misogynists do: to trivialize, ignore, and demean females. Thus the problem is located in the common language, not solely or necessarily in the intents of its speakers.

In this chapter, I examine what we know and must learn about sex bias in American English. Many readers are already familiar with arguments against sexist language and perhaps tired of protests whose empirical base they have not seen. But much empirical evidence has accumulated. *My intent here is to examine and evaluate the evidence*, not just to repeat arguments. A burgeoning of research on language and gender in recent years has produced new evidence that is not yet widely known. This body of work raises theoretical and practical issues that go beyond those usually addressed.

Two things should be made clear at the outset. First, this chapter is not about sex *differences* in language usage, but about sex *bias* in language itself (though sex differences, where they exist, are also implicated in sex bias). Second, I do not intend the following evidence to test the question of whether we should or should not use sex-biased language. We do not need to prove that language of itself influences behavior to find sex bias in language offensive, just as we find racist language inexcusable and intolerable apart from any empirical findings of actual harm. The evidence is presented here to address a series of questions that arise in the investidecisions. If we are to get women involved in math and science, and if we are to change the impact of gender-role beliefs on females' self-perceptions, then we must use the classroom to counteract the years of socialization messages the children have received from billboards, parents, TV, and the culture at large. Equal *access* to classes and even equal performance in lower level classes are not adequate for overcoming what parents and teachers may consider (or fail to see) as "trivial" daily inequities in classroom structure and home environments. "Equal opportunity" must be viewed more hour-by-hour, rather than solely by policy decree, and it must begin very early for the effects of unequal treatment and gender-role stereotypes are already evident when children enter elementary school. Only active interventions will get students to reconsider their view of themselves, of math and science, and of the options that they should consider open to them in adulthood.

Acknowledgments. Work for this chapter was supported in part by grants to the author from the National Institute of Mental Health (MH31724) and the National Institute of Child Health and Human Development (HD17296).

References

Atkinson, J.W. (1964). *An introduction to motivation.* New York: Van Nostrand.

Betz, N.E., & Hackett, G. (1981). The relationship of career related self-efficacy expectations to perceived career options in college women and men. *Journal of Counseling Psychology, 28*, 399–410.

Boswell, S. (1979). *Nice girls don't study mathematics: The perspective from elementary school.* Symposium paper presented at the meeting of the American Educational Research Association, San Francisco.

Bureau of Labor Statistics (1980). *Employment and earnings.* Washington, DC: U.S. Department of Labor.

Casserly, P. (1975). *An assessment of factors affecting female participation in advanced placement programs in mathematics, chemistry, and physics.* Report to the National Science Foundation, Washington, DC.

Casserly, P. (1980). An assessment of factors affecting female participation in advanced placement programs in mathematics, chemistry, and physics. In L.H. Fox, L. Brody, & D. Tobin (Eds.), *Women and the mathematical mystique* (pp. 138–163). Baltimore: Johns Hopkins University Press.

Crandall, V.C. (1969). Sex differences in expectancy of intellectual and academic reinforcement. In C.P. Smith (Ed.), *Achievement-related behaviors in children.* New York: Russell Sage Foundation.

Eccles, J.S. (1985a). Sex differences in achievement patterns. In T. Sonderegger (Ed.), *Nebraska Symposium of Motivation, Vol. 32.* Lincoln, NE: University of Nebraska Press.

Eccles, J.S. (1985b). Why doesn't Jane run? Sex differences in educational and occupational patterns. In F.D. Horowitz & M. O'Brien (Eds.), *The gifted and talented: A developmental perspective.* Washington, DC: APA Press.

Eccles, J.S. (1987a). Gender-roles and achievement. In J. Reinisch, L.A. Rosenblum, & S.A. Sanders (Eds.), *Masculinity and femininity, Vol. 1.* New York: Oxford University Press.

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

Eccles, J.S., Adler, T.F., & Meece, J.L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46*, 26–43.

Eccles, J., & Blumenfeld, P. (1985). Classroom experiences and student gender: Are there differences and do they matter? In L.C. Wilkinson & C. Marrett (Eds.), *Gender influences in classroom interaction.* Hillsdale, NJ: Erlbaum.

Eccles, J., Flanagan, C., Goldsmith, R., Jacobs, J., Jayaratne, T., Wigfield, A., & Yee, D. (April 1987). *Parents as socializers of achievement attitudes.* Symposium paper presented at the biennial meeting of the Society for Research in Child Development, Baltimore.

Eccles, J.S., & Hoffman, L.W. (1984). Socialization and the maintenance of a sex-segregated labor market. In H.W. Stevenson and A.E. Siegel (Eds.), *Research in child development and social policy, Vol. 1.* Chicago: University of Chicago Press.

Eccles, J.S., & Jacobs, J. (1986). Social forces shape math participation. *Signs, 11*, 367–380.

Eccles, J., MacIver, D., & Lange, L. (April 1986). *Classroom practices and motivation to study math.* Symposium paper, AERA, San Francisco.

Eccles-Parsons, J. (1984). Sex differences in math participation. In M.L. Maehr and M.W. Steinkamp (Eds.), *Women in science.* Greenwich, CT: JAI Press.

Eccles-Parsons, J., Adler, T.F., Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L., & Midgley, C. (1983). Expectations, values and academic behaviors. In J.T. Spence (Ed.), *Achievement and achievement motivation.* New York: Freeman.

Eccles-Parsons, J., Adler, T.F., & Kaczala, C.M. (1982). Socialization of achievement attitudes and beliefs: Parental influences. *Child Development, 53*, 310–321.

Eccles-Parsons, J., Kaczala, C.M., & Meece, J.L. (1982). Socialization of achievement attitudes and beliefs: Classroom influences. *Child Development, 53*, 322–339.

Fox, L.H., Brody, L., & Tobin, D. (Eds.) (1980). *Women and the mathematical mystique.* Baltimore: Johns Hopkins University Press.

Gilligan, C. (1982). *In a different voice.* Cambridge, MA: Harvard University Press.

Halpern, D.F. (1986). *Sex differences in cognitive abilities.* Hillsdale, NJ: Erlbaum.

Huston, A.C. (1983). Sex-typing. In P. Mussen and E.M. Hetherington (Eds.), *Handbook of child psychology, Vol. IV.* New York: Wiley.

Jacobs, J.E. (April 1987) *The relation between parents' and adolescents' gender role stereotypes and ability beliefs.* Symposium paper presented at the biennial meeting of the Society for Research in Child Development, Baltimore.

Kaczala, C.M. (April 1981). *Sex-role identity, stereotypes and their relationship to achievement attitudes.* Symposium paper presented at the biennial meeting of the Society for Research in Child Development, Boston.

Kahle, J. (1984). *Girl-friendly science.* Paper presented at the meeting of the American Association for the Advancement of the Sciences, New York.