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Sex Differences in Achievement Patterns

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Running Head:Achievement Patterns

Abstract

The underrepresentation of females in fields involving math and science has become an important policy concern. The possible causes of this issue are explored in this paper. A model of achievement choices is used to analyze the problem and the results of a large-scale longitudinal study of junior and senior high school students are presented. It is argued that the underrepresentation of females in math and science is part of the larger issue of sex differences in achievement choices and occupational development. The data suggest that sex differences in achievement patterns results from two processes. First, they are a function of sex differences in the value males and females attach to various achievement options; and second, they are a function of the fact that achievement choices are influenced differently in males and females. Males, in this study, appear to be influenced primarily by their performance history. In contrast, females' decisions are influenced by both their performance history and by the value they attach to the subject. Furthermore, the value females attach to various achievement choices is unrelated to their performance while the value that males attach to various achievement choices is related to their performance history in these activities.

Two areas of cognitive functioning reveal fairly consistent patterns of sex differences (see Eccles, 1983; Wittig & Petersen, 1979). Girls typically perform better than boys on verbal tasks while boys perform better than girls on quantitative tasks; these differences, however, are quite small, accounting for only 1-2% of variance (Hyde, 1981), and do not occur with regularity until the adolescent years. Sex differences in high school courses enrollment, college majors, and adult careers reflect a similar pattern. However, the sex difference on these variables are much greater. For example, among the B.A. degrees awarded in 1978, women received only 6% of those awarded in Engineering, 23% in Architecture, 26% in Computer and Informational Science, 22% in Physical Science, and 41% in Mathematics. In contrast, 57% of B.A.'s in Letters, 73% of B.A.'s in Education, 76% of the B.A.'s in Foreign Languages, and 88% of B.A.'s in Library Science went to women (N.C.E.S., 1979, 1980). Clearly, these sex differences are larger than one would expect based on the achievement differences reported above. This is especially true for the math-related achievement domains. For example, in 1978 37% of the pool of entering freshpersons eligible to major in engineering were women[1]. In contrast, only 13% of those actually planning to major in engineering were women, and only 6% of the bachelor degrees in Engineering in 1978 actually went to women. Similar, though less dramatic, results characterize the population planning to major in the physical sciences. Clearly, the proportion of female participation is much lower than the available pool would predict.

This underrepresentation of females in math and science is very costly for both females and for society at large. In almost all occupational fields, females can expect to earn less than their male peers. But the mean incomes for both males and females is particularly low in non-scientific, female-dominated occupations. Both males and females earn more in math-related occupations than in non-scientific occupations. In addition, among recent graduates, females are most likely to earn salaries commensurate with their male peers in scientific and technical fields (N.C.E.S., 1979, 1980). In addition, society is in need of as many mathematically trained and scientifically literate college graduates as it can get to fill jobs in a wide range of industries and service professions. This paper will explore some of the possible causes of this underrepresentation of females in these fields.

Sex Differences in Math Participation: Recent Explanations

Both that fact that females are underrepresented in math-related fields and that females earn such low salaries in female-dominated fields make the sex differences in math achievement especially important. Recent attention has focused on the origin of these differences. While some researchers still argue that these differences primarily reflect biologically based gender differences, the magnitude of the occupational differences outlined above casts doubt on the usefulness of this perspective (see Meece, Parsons, Kaczala, Goff & Futterman, 1982; Eccles, 1983 for reviews). The general consensus of opinion in the field is that attitudinal and motivational factors play a substantial role in shaping sex differentiated achievement patterns. Attitudes toward mathematics have received considerable recent attention as possible mediators of these differences.

Competence in mathematics has long been identified as a critical skill directly related to educational and occupational choices. Mathematical skills are important for admission to many college majors, for a number of professional occupations, and increasingly for computerized technical occupations. In fact, Sells (1980) has labelled math the critical filter for most scientific and technical occupations. Consequently, several researchers have investigated sex differences in math course taking. Compared to male students, fewer female students take high school and college mathematics beyond the minimal requirements. While females receive less encouragement from parents and teachers (see Eccles, 1983), it is not the case that they are being systematically excluded through discriminatory course availability. On the contrary, all too frequently females <u>choose</u> not to take more advanced mathematics courses and, as a consequence, effectively eliminate the option of majoring in physical science or engineering. The decision to stop taking math courses also limits women's access to other occupations including those associated with computer science and finance, as well as higher level occupations in the biological, medical, and social sciences. Why females choose to limit their options in this way has been the focus of much recent research. This research has yielded four basic explanations for this problem:

(1) Males outperform females on spatial problem-solving tasks and on other mathematics aptitude measures. Consequently, they are more able to continue in math (Aiken, 1976; Wittig & Pedersen, 1979).

(2) Males receive more encouragement than females from parents,

teachers, and counselors to enroll in advanced mathematics courses or to pursue math-oriented careers (Casserly, 1975; Luchins, 1980; Fox, Tobin, & Brody, 1979; Parsons, Adler, & Kaczala, 1982; Parsons, Kaczala, & Meece, 1982).

(3) Mathematics is commonly perceived as a male achievement domain. Consequently, because of its potential conflict with their gender-role identity, females are more likely to avoid mathematics (Fennema & Sherman, 1977; Nash, 1979; Sherman & Fennema, 1977; Stein & Smithells, 1960).

(4) Males perceive themselves as more competent and report greater confidence in learning mathematics than females (Eccles, 1983; Fennema & Sherman, 1977; Fox, Tobin, & Brody, 1979).

Each of these bodies of research has provided insights into the mechanisms contributing to students' math achievement behaviors. However, since researchers have approached this area of study from a variety of theoretical perspectives, each has tended to focus his or her research on a subset of possible causes. What has been missing is a comprehensive, theoretical framework which acknowledges the complex interplay of these many factors, takes into account the sociocultural context in which mathematics learning takes place, and provides a more comprehensive approach to the problem. Such an integrative model of math achievement and course choice would aid in the identification of the determinants of individual differences on the many proposed mediators of sex differences in math participation. It would provide a more formal specification of the relation of these differences to achievement decisions. Finally, it would generate research designed to disentangle the relative importance of all the many variables linked to the decisions both males and females make regarding math enrollemnt and broader career goals.

<u>Sex Differences in Math Participation: A Comprehensive model</u>

Decision, achievement, and attribution theorists (e.g., Atkinson, 1964; Weiner, 1972) have all addressed the issue of choice behavior. Applying these theories of behavior to students' decisions to continue taking mathematics, my colleagues and I have proposed a model of achievement behavior that links students' achievement decisions to their expectations for their performance on various achievement tasks and to their perceptions of the importance of these various achievement tasks (Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgely, 1983; Meece et al., 1982). Figure 1 presents an overview of this model. According to this model, choice is influenced most directly by students' values (both the utility value of math for attaining future goals and the attainment or interest value of ongoing math activities) and by students' expectancies for success at math. These variables, in turn, are assumed to be influenced by students' goals, and by their concepts of both their own academic abilities and the task demands. Individual differences on these attitudinal variables are assumed to result from students' perceptions of the beliefs of major socializers, the students' interpretation of their own history of academic performance, and the students' perception of appropriate behaviors and goals.

Insert Figure 1 about here

This theoretical model, originally proposed as a general model of achievement choices, seems particularly relevant to the problem of sex differences in students' academic choices. The model assumes that the effects of experience, in this case one's history of academic performance, are mediated by the individual's interpretation of the events rather than by the events themselves. For example, doing well in math is presumed to influence one's future expectations for math performance only to the extent that doing well is attributed to one's ability. Past research has shown that girls do as well in math as boys throughout their formative years, yet they do not expect to do as well in the future nor are they as likely to go on in math as are boys. This apparent paradox is less puzzling if we acknowledge that it is the subjective meaning and interpretation of success and failure that determine an individual's perceptions of the task and not the objective outcomes themselves. The extent to which boys and girls differ in their interpretation of outcomes and the extent to which they receive differential information relevant to their interpretation of their academic outcomes should account, in part, for the observed sex differences in student's course selection in math.

The model assumes that academic decisions such as the decision to take advanced mathematics, or the decision to major in education rather than engineering, are made in the context of a variety of choices which are guided by core value such as achievement needs, competency needs, and gender-role values, and by more utilitarian values such as the importance of math achievement for future goals. Thus, if a female likes math but feels that the amount of effort it will take to do well is not worthwhile because it decreases the time she will have available for more preferred activities (i.e., activities more consistent with her personal values), then she will be less likely to continue taking math than a female who both likes math and thinks her efforts at mastering it are worthwhile and important. Similarly, a female who stereotypes mathematics, or careers involving competency in mathematics, as masculine, or inconsistent with her own gender-role values, will be less likely to value mathematics learning and less likely to continue her mathematical studies, especially if she does not expect to do well, than a female who finds math-related courses to be consistent with her values and self-perceptions.

What distinguishes this model from other models of achievement behavior is this attention to the issue of choice. Whether done consciously or not, children (and later adults) are making choices among a variety of activities all of the time. For example, they decide whether to work hard at school or just to get by; they decide which intellectual skills to develop or whether to develop any at all; they decide how much time to spend doing homework; and they decide whether to take difficult courses or to spend their extra time with their friends, etc. We have tried to address this issue of choice directly and to develop a model that allows us to predict the type of choices being made. Furthermore, we have tried to specify the kinds of socialization experiences that shape individual differences on the mediators of these choices especially in the academic achievement domain.

Furthermore, because we have focused on choice rather than avoidance, we believe our model provides a more positive perspective on women's achievement behavior than is common in many popular psychological explanations for sex differences in achievement patterns. Beginning with the work associated with need achievement and continuing to current work in attribution theory, a variety of scholars have considered the origin of sex differences in achievement. The bulk of these scholars have looked for the origin in either motivational differences or in expectancy/attributional differences. For example, in the fifties and sixties, several studies focused on sex differences in need achievement. In 1966, Horner introduced the concept of fear of success and suggested that sex differences in achievement reflected high levels of fear of success in women.

In the early seventies, Weiner and his colleagues (see Weiner, 1972) introduced an attributional model of achievement motivation and paved the way for a new set of hypotheses regarding sex differences in achievement, a set focusing on cognitive-mediational variables. Within this new framework, sex differences in achievement have been attributed variously to expectation differences, self-confidence differences, differential causal attribution patterns, and female learned helplessness. So for example, it has been argued that women have lower expectations for success, are less confident in their achievement-related abilities, are more likely to attribute their failures to lack of ability, are less likely to attribute their success to ability, are more likely to exhibit a learned helpless response, etc. Furthermore, it has been argued that these differences mediate the sex differences we observe in achievement patterns.

There are several problems with this body of work, stemming primarily from the fact that it has assumed a deficit model of female achievement. This assumption has lead to three major consequences. First, it has focused researchers attention on the question of "How are women different than men?" rather than on the question of "What influences women's achievement behavior?". Second, the assumption that the differences uncovered in most studies actually mediate sex differences in achievement behavior has rarely been tested. Instead the bulk of the studies simply demonstrate a statistically significant difference between males and females and conclude that this difference accounts for sex differences in achievement behavior. Third, this perspective has limited the range of variables studied. Researchers have focused most of their attention on a set of variables that are linked to self confidence and expectancies since high self confidence is one of those "good" things that men have which facilitates competitive achievement.

The dominance of this deficit perspective in sex difference research has been especially marked in the last decade. Our model provides a very different perspective. By assigning a central role to the construct of subjective task value, we have offered an alternative explanation for sex differences in achievement patterns. This alternative explanation puts male and female achievement choices on a more equal footing. Our model makes salient the hypothesis that differences in male and female achievement patterns result from the fact that males and females have different but equally important and valuable goals for their lives. This view differs markedly from explanations which attribute sex differences in achievement patterns to females' lack of confidence, low expectations, and/or debilitating attributional biases. Instead of characterizing females as deficient males, our perspective, outlined in more detail in Parsons and Goff (1980), legitmizes females' choices as valuable on their own terms rather than as a reflection or distortion of male choices and male values.

Empirical Test: Overview

To test the utility of our model for explaining sex differences in math participation, we conducted a large scale, cross-sectional/ longitudinal study of the ontogeny of students' achievement beliefs, attitudes, and behaviors. Given our conceptualization of math participation as a task choice construct, we felt it was important to include measures of the students' attitudes toward at least one other subject besides math. The decision to take math might seem very logical in the face of evidence that a student really likes another subject much better. Since English is the other major achievement domain that evidences consistent sex differences, we assessed students' attitudes toward English as well as toward math. We also assessed the students' achievement plans and outcomes in both math and English.

We began our study with a cross-section of 300 students in grades 6-9, their parents, and their math teachers. A year later, 94 percent of these same students were retested. During the second year, an additional control group of 329 students in grades 5-12 was recruited. Selection of this sample allowed for comparisons suggested by Nesselroade and Baltes (1974) and Schaie (1965). In particular, we used this sample to assess test-retest effects and to rule out the possibility that our longitudinal findings reflected the impact of unique historical effects rather than general developmental processes. These analyses indicated that test-retest effects were minimal and the changes in the students' attitudes from Year 1 to Year 2 did not reflect the impact of unique historical events. Based on these results and on the fact that the questionnaire had been modified slightly from Year 1 to Year 2, the control and Year 2 sample were merged making a total Year 2 sample of 668 children. The cross-sectional data presented in this paper are based on this expanded Year 2 sample.

Data were collected in several forms: student record data, a student questionnaire, a parent questionnaire, a teacher questionnaire, and classroom observations. Information taken from each student's school record included final grades in mathematics and English for the four years (1975-1979) prior to the study, during the two years of the study, and each year following the study until the students graduated from high school. Any standardized achievement test scores available in the student's file were also recorded. Thus, we have comprehensive data on each of our student's participation and achievement in both math and English throughout their secondary school career. Only a small portion of these data are summarized in this paper. I will focus primarily on the student questionnaire data that are most directly related to the issue of sex differences in math and English achievement patterns. The parent and classroom observational data have been reported elsewhere (see Parsons, Adler, & Kaczala, 1982; Parsons, Kaczala & Meece, 1982).

The Eccles et al. model imples that general beliefs influence task specific beliefs, which, in turn, influence achievement behaviors. To operationalize this model, we created variables to coincide with each of these three levels of the psychological variables. Given our concern with sex differences, we were especially interested the following general beliefs: gender-role schemata, sex-typing of math as a male domain, perceptions of encouragement to continue taking math by parents, teachers, and peers, and the reasons why one would take advanced level math courses. We developed measures of these general beliefs and of the following specific beliefs: expectancies for success, perceived ability, perceived task difficulty, perceived amount of effort, perceived importance of the subject, perceived cost of success, perceived worth of the amount of effort necessary to succeed, and perceived utility value of the subject. For achievement outcome measures, we asked the students whether they planned to continue taking math and English, and if so, how much; we asked their proposed college major and their career goals; we collected their grades in their math and English courses; and we recorded their actual course enrollment patterns.

The major attitudinal scales were factor analyzed using the maximum likelihood factor analytic procedure developed by Joreskog and Sorbom (1979). Three identical factors emerged for both math and English items: Self-Concept of Ability, Perceived Task Difficulty, and Subjective Task Value. The Self-Concept factor included all items tapping perceived ability, perceived performance, and expectations for success in current and future courses. The Task Difficulty factor included items tapping perceived task difficulty, perceived effort needed to do well, and estimates of actual level of effort. The

Subjective Task Value factor included all items related to perceived utility value, enjoyment of the subject, and perceived importance of doing well. Confirmatory Factor Analysis supported the reliability of this factor structure. Most of the data in this paper concerns these three factors.

Empirical Test: First Order Effects

Relatively few sex differences emerged but those that did formed a fairly consistent pattern. Across both years, boys, compared to girls, rated their math ability higher, felt they had to exert less effort to do well in math, and held higher expectancies for future successes in math, even though there were no sex differences on any of the objective measures of math performance. In addition, boys in Year 1 rated both their current math courses and advanced math courses as easier than did the girls; boys in Year 2 had higher expectancies for success in current (as well as future) math courses; and boys in Year 2 rated math as more useful than the girls ($p < .05$ in each case). Thus, to the extent that there are sex differences on these self and task perception variables, boys had a more positive view of both themselves as math learners and of math itself.

These differences are even more dramatic when one compares the students' attitudes toward both math and English from a developmental perspective. To assess developmental differences we looked at both the age effects within the cross-sectional sample and the test-retest effects in the longitudinal sample. Comparable developmental conclusions emerge in both sets of analyses. In general, the females got more positive toward English and more negative toward math as they got older. Boys attitudes toward both subjects remained fairly stable and fairly consistent across the two domains. Let me illustrate these effects with each of the three major attitudinal factors in the Year 2 sample. First let us consider Self-Concept of Ability. As is apparent in Figure 2, female students' estimates of their math ability declined linearly with age ($p < .05$). Two additional comparisons are important to note. By 8th grade the females rated their English ability higher than their math ability and by 10th grade they rated their math ability lower than the boys rated theirs. Neither of these effects are present in the earlier grades. Comparable effects emerge for Perceived Task Difficulty (see Figure 3), and for Subjective Task Value (see Figure 4). The sex differences are especially marked for Subjective Task Value. By 10th grade, the females rated English as more valuable than math. Furthermore, they rated math as less valuable and English as more valuable than did the males.

Insert Figures 2, 3, and 4 about here

This decline in the females' attitudes toward math is especially interesting given the nature of our sample. First of all, we have no indication that there is an observable difference in the math performance between the males and females in this sample for either their course grades or their scores on standardized achievement tests. Second, when one compares the students' standardized test scores across years, the older females ($p<.05$) in this sample had higher scores than the younger females. Consequently, the older female students, if anything, have higher math ability, on the average, than the younger female students. They also scored higher on tests of

English ability ($p<.05$) than did the younger female students. But male and female students had comparable test scores on English standardized achievement tests at each grade level, just as was the case for math. Finally, the female students earned higher grades than the male students in their English courses beginning at about the eighth grade. Thus, despite the fact that the female population got more select in terms of both English and math achievement scores with advancing grade level, and despite the fact that there were no apparent sex differences on math performance measures , the attitudes of the female students toward math declined with age while their grades did not. In contrast, both their attitudes and their actual performance in English increased with age. Given our perspective that choice is the critical mediator of achievement differences, these results certainly lead to the prediction that female students will elect less math than English while male students will continue to take courses in both subject areas. This is in fact what has happened in this sample. The females were less likely to take twelfth grade advanced math course than the males ($p<.05$) while their English enrollment patterns did not differ. There were no sex differences in math enrollment prior to the twelfth grade.

Let me now turn to a series of additional analyses focussing on math achievement.

We had the tenth to twelfth grade students rate the amount of encouragement to continue in math they had received from each of the following sources (listed in descending order of the mean encouragement score): father, mother, last year's teacher, guidance counselor, older friends, siblings, and peers. Of these, only fathers, mothers, and previous math teacher were perceived as having provided any encouragement. The other individuals were perceived as having neither encouraged nor discouraged the students. Interestingly, peers were not seen as having discouraged the students' decision by the female students. One sex difference emerged: boys, in comparison to girls, felt that their counselor had provided them with more encouragement to take advanced math courses ($p < .05$). Counselor encouragement did not, however, predict future course plans.

The students also rated the importance of various reasons in influencing their decision to take math. Three reasons emerged as the most influential: preparation for either a college major or career, gaining admission to a prestigious college, and the importance of math in a well rounded education. Intrinsic properties of math, such as its challenge, ease, or interest value were clearly seen as less important by all students. One sex difference emerged: boys rated the importance of future plans (college or career) in their decision higher than did girls ($p < .01$).

The students also rated the utility of math for males and females. Both male and female students rated math as more useful for males than for females. But male students endorsed this stereotype to a much greater extent than the female students ($p<.05$).

The analyses described thus far suggest several important sex differences in students' attitudes. Females in general have a more negative attitude than boys toward math learning and toward themselves as math learners. Females also have a more negative view of math than of English. These differences certainly could mediate sex differences in achievement patterns. But the mere existence of these differences does not support their importance as variables mediating sex differences in achievement patterns. The critical question is whether or not these differences, in fact, make a difference. To answer this question, we ran a series of correlational and multivariate regression analyses. Several important results emerged.

<u>Empirical Test: Relational Analyses</u>

First, we ran a series of analyses relating our gender-role constructs to student attitudes. Several researchers have suggested that the stereotype of math as a male domain inhibits female participation in math. To evaluate this hypothesis and its many variations, we correlated the students' rating of the usefulness of advanced math for both males and females, their perception of math as being more useful to males, their gender stereotyping of math ability, and their ratings of themselves on a simplified version of the PAQ (Spence, Helmreich, & Stapp, 1975) with the other student measures. Femininity (or, more appropriately, Expressivity) as measured by the PAQ was not related to either student attitudes or to their achievement patterns. Masculinity (or Instrumentality), however, was related positively to measures of both expectancy and Self-Concept of Math Ability for both males and females.

Several investigators (e.g. Nash, 1979) have suggested that gender-role identity, in interaction with gender stereotypes regarding the nature of the task, influence students' attitudes toward a subject. We used multivariate contingency tables to assess the impact of personality-type on math attitudes and achievement and to test whether gender-role identity, as measured by personality inventories, interacts with gender-role stereotypes of math, in influencing students' attitudes toward math. Gender-role classification had no significant influence on any of the student attitude or achievement measures either as a main effect or in interaction with the gender-role stereotyping of math as a masculine domain. Gender-role stereotyping of math did, however, influence Subjective Task Value. The extent to which a female judged math to be useful for women did not relate to its subjective value for her. Instead, it was the perceived usefulness of math for males that predicted positively math's subjective value for both males and females. One might conclude from these data that the stereotype of math as a male domain has a positive effect for everyone and ought to be encouraged; but results from other studies and the Year 2 data suggest that this conclusion is oversimplified. Instead, what it does suggest is that perceiving math as more useful for males than for females does not necessarily have a negative consequence for girls, perhaps especially when the stereotype reflects an awareness of the high status jobs which are both male-dominated and math-related. In this case, it may be the status of the job rather than its male domination that elevates the perceived usefulness of advanced math courses for both high ability boys and girls.

We next assessed the relations of the student attitudinal variables to achievement plans, performance, and actual enrollment patterns. As predicted, for both males and females, Self-Concept of Ability and Subjective Task Value correlated positively with students' plans to continue taking both math and English, with the students' grades in both math and English one year later, and with the students' actual course enrollment decisions in math measured 1-3 years later (see Table 1). These results provide initial support for the predicted influence of attitudinal variables on achievement behaviors. But these attitudinal variables are intercorrelated and are correlated with past grades. Before we can understand the impact of attitudes on achievement, we need to answer two additional questions: (1) which of these attitudes are most critical, and (2) are any of the attitudes as critical as past performance in shaping subsequent achievement behaviors. To answer these questions we used step-wise multiple regression procedures. Subjective Value of Math, Subjective Value of English, Self-Concept of Math Ability, and Self-Concept of English Ability were regressed on Subjective English Educational Plans and on Subjective Math Educational Plans in two stepwise (hierarchical) regression analyses. In both analyses, Subjective Task Value emerged as the most powerful predictor of educational plans (see Table 2). These results suggest that Subjective Task Values is the attitude that mediates sex differences in achievement choice patterns.

Insert Table 1 and 2 about here

To test for the hypothesized mediating role of Subjective Task Value in explaining actual sex differences in achievement choices, we tested for sex differences in course enrollment patterns for mathematics. We were unable to run a comparable test for English because English is required for all three years of high school in the school districts we sampled. There was a significant sex difference in course enrollment in the twelfth grade ($F=5.38$, $p=.02$). Females were less likely to enroll in math in the twelfth grade than males.

There were no sex differences in course enrollment prior to the twelfth grade. We next entered the relevant math variables into a path analysis. These results are depicted in Figure 5. The results are consistent with the hypothesis that sex difference in math course enrollment are mediated by the sex difference in Subjective Task Value.

Insert Figure 5 about here

Thus, as predicted by Parsons and Goff (1980), Subjective Task Value emerged as the most powerful predictor of students' Subjective Educational Plans. Furthermore, the significant sex by age by subject area interaction yielded results consistent with the developmental predictions of Eccles et al. (1983). High school females had a more positive attitude towards English and less positive attitude toward math than did the junior high school females especially in terms of Subjective Task Value. Projecting these developmental patterns into the late adolescent years should produce a marked sex difference in attitudes toward the value of math and English and in actual course enrollment decisions. In fact, our longitudinal follow up data support this hypothesis. The females were more likely to drop math prior to high school graduation than were the males. Finally, our data suggest that it is Subjective Task Value rather than Confidence in One's Math Ability that mediates this sex difference in course enrollment patterns.

Empirical Test: Males versus Females

The data discussed thus far were drawn from the entire sample, based on the assumption that comparable relationships would hold for both males and females. The zero-order correlations calculated with each sex separately support this assumption for the variables we have discussed thus far (see Table 1). But this is not case for the correlations of these attitudes with past performance. A very important sex difference emerged when we compared the correlations of students' attitudes to their past grades and to a composite score reflecting their relative position within grade on their course grades and standardized achievement test scores. These results are illustrated in Figure 6. The males' attitudes, across the board, were more directly related to their performance history than were females' attitudes. This is true for both math and English. Furthermore, it is especially interesting to note, given the importance of Subjective Task Value, that the value females placed on both math and English was unrelated to their history of performance in either subject.

Insert Figure 6 about here

These results suggest that different factors influence the achievement decisions of males and females. To test this hypothesis directly, we ran step-wise regressions separately for males and females. Since past performance is such an important predictor of course enrollment for both males and females we entered it in at the first step. This procedure allows us to assess whether attitudinal variables have any independent influence on achievement patterns over and above what they share with past performance. The results are illustrated in Table 3. As expected, past performance emerged as a strong predictor of course enrollment for both males and females. However it was a stronger predictor for males; and for males, it was the only significant predictor. Attitudes made no independent contribution to the males' course enrollment decision. In contrast, Subjective Task Value is an important, independent predictor for females. Independent of how well or how poorly they were doing in math, women who enjoy math and think it is important were more likely to enroll in advanced math courses than were women who either did not enjoy math or who did not think that advanced math courses are particularly important or useful.

Insert Table 3 about here

Taken as a package, these results suggest that sex differences in achievement choice patterns are a function primarily of two processes. First, they are a function of the sex difference in Subjective Task Value; and, second, they are a function of the fact that achievement choices are influenced differently in males and females. Males appear to be influenced primarily by their performance history. In contrast, females' decisions are influenced by both their performance history and by the value they attach to the subject.

We find these results encouraging because, in our view, they suggest a more positive view of women's achievement motivation than is inherent in other theories. Many popular explanations of sex differences in achievement choices are based on deficit models of female achievement orientation. For example, sex differences in achievement patterns have been attributed to females' learned helplessness, low self-concepts, low expectancy attributional patterns, fear of success, etc. Each of these theories suggest that females are deficit on some critical component of achievement motivation. They imply that if females only had as much of this component as males they would make the same achievement choices as males. While we did find some sex differences that might be interpreted as reflecting these types of deficits, we found virtually no support for the suggestion that females' achievement patterns were being driven by these variables. Instead, our data suggest that sex differences reflect the fact that females weight the subjective value of the activity more heavily in their achievement decisions than males and that the value they attach to various achievement activities is influenced by different factors than is the value males attach to the same activities.

We are now exploring the variables that shape the value males and females attach to various achievement activities in an effort to broaden our understanding of the ontogeny of sex differences in achievement choice patterns. We are currently focussing on two sets of variables. The first set relates to the impact of sex-role stereotyping on beliefs and attitudes. We now believe that sex-roles influence achievement paterns primarily through their impact on the value individuals attach to the many achievement options available to them. To test this hypothesis, we are evaluating the relation between sex-role salience, sex-role stereotypes of various activities, and achievement beliefs and choices.

The second set of variables we are exploring relate to the socialization of achievement values. Parental beliefs and attitudes appear to be particularly important. Parents, more so than teachers, have sex differentiated perceptions of their children's math aptitude, despite the similarity in the actual performance of their sons and daughters. Parents also believe that advanced math is more important for boys than for girls. Finally, our initial work suggests that parents' beliefs regarding their children's math aptitude are stronger predictors of the students' attitudes toward math than are indicators of the students' actual performance in math.

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Footnotes

[1]We estimated the proportion of women eligible to enter these fields by calculating at the number of women scoring above 500 on the Math SAT (E.T.S., 1979). 500 is approximately the mean score on the Math SAT of students expressing an interest in majoring in math or the physical sciences. Hyde (1981) using a different method of estimating the available pool of female potential scientists and engineers arrived with a comparable figure of 37%.

Figure Caption

Figure 1. General model of academic choice. (Adapted from Parsons, J. E., Adler, T. F. et al., in press.)

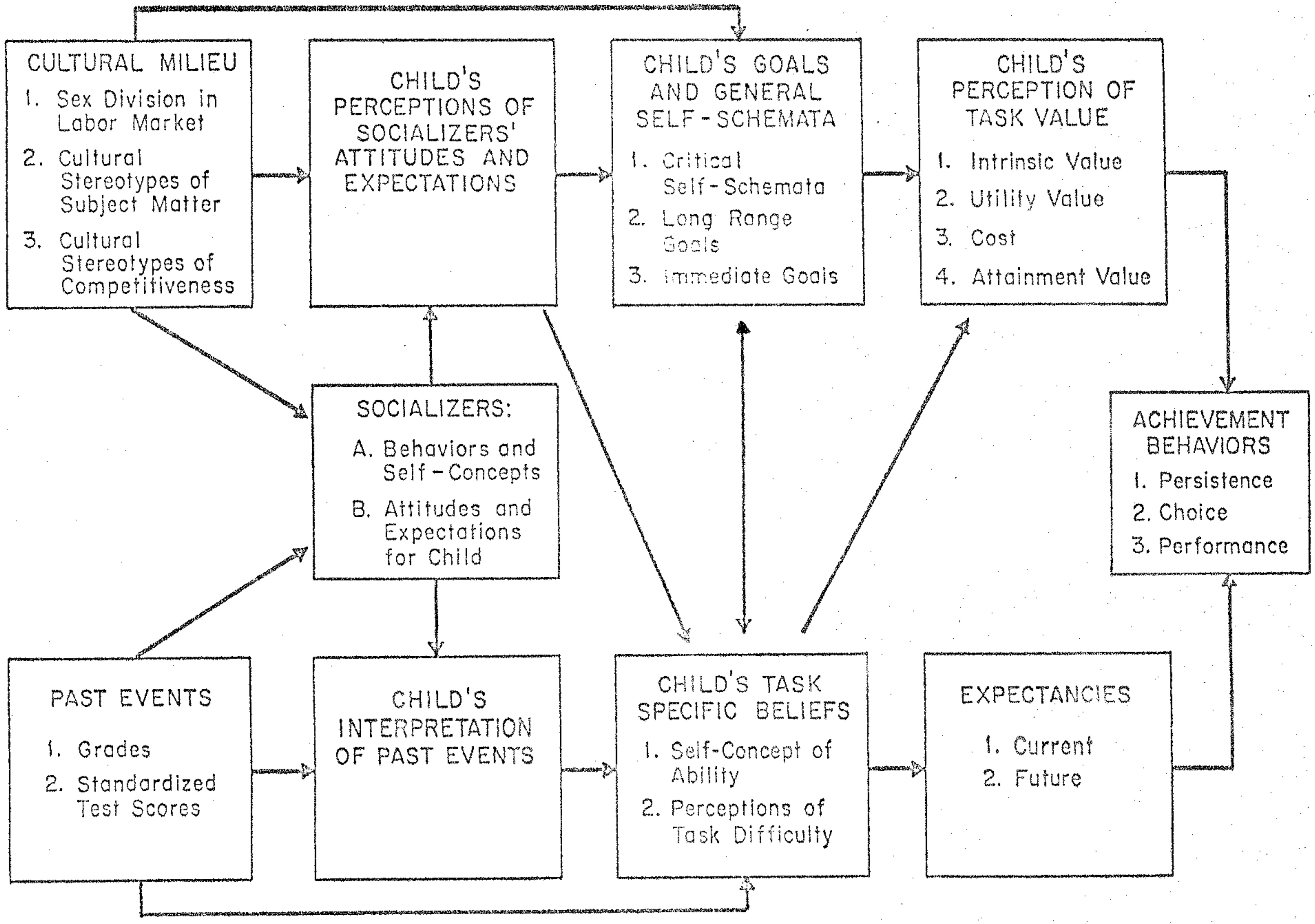
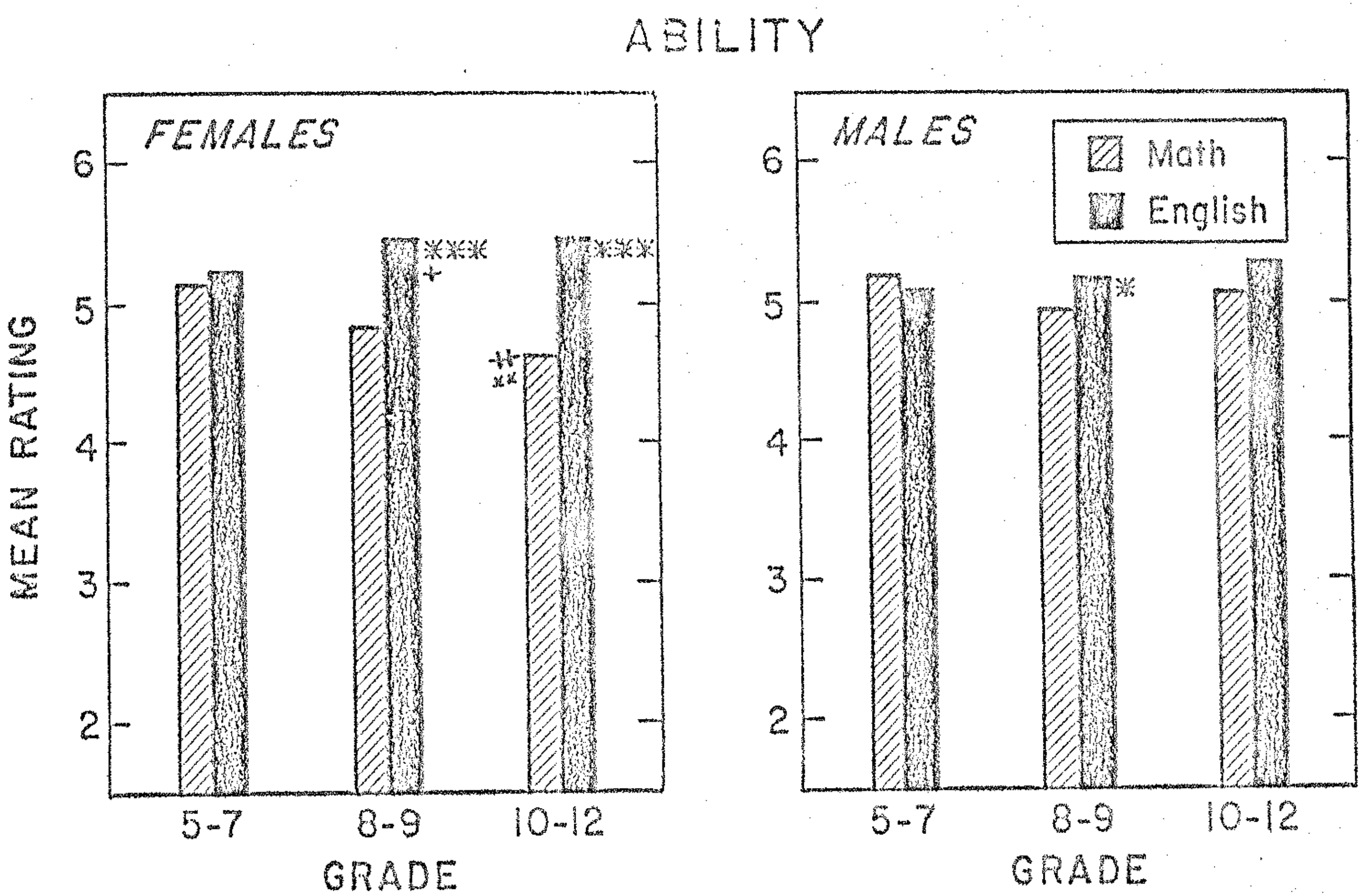

CULTURAL MILIEU
1. Sex Division in Labor Market
2. Cultural Stereotypes of Subject Matter
3. Cultural Stereotypes of Competitiveness
CHILD'S PERCEPTIONS OF SOCIALIZERS' ATTITUDES AND EXPECTATIONS
CHILD'S GOALS AND GENERAL SELF-SCHEMATA
1. Critical Self-Schemata
2. Long Range Goals
3. Immediate Goals
CHILD'S PERCEPTION OF TASK VALUE
1. Intrinsic Value
2. Utility Value
3. Cost
4. Attainment Value
SOCIALIZERS:
A. Behaviors and Self-Concepts
B. Attitudes and Expectations for Child
ACHIEVEMENT BEHAVIORS
1. Persistence
2. Choice
3. Performance
PAST EVENTS
1. Grades
2. Standardized Test Scores
CHILD'S INTERPRETATION OF PAST EVENTS
CHILD'S TASK SPECIFIC BELIEFS
1. Self-Concept of Ability
2. Perceptions of Task Difficulty
EXPECTANCIES
1. Current
2. Future

FIGURE CAPTION

Figure 2. Grade by Sex by Content Area Effects: Self-Concept of Ability Construct

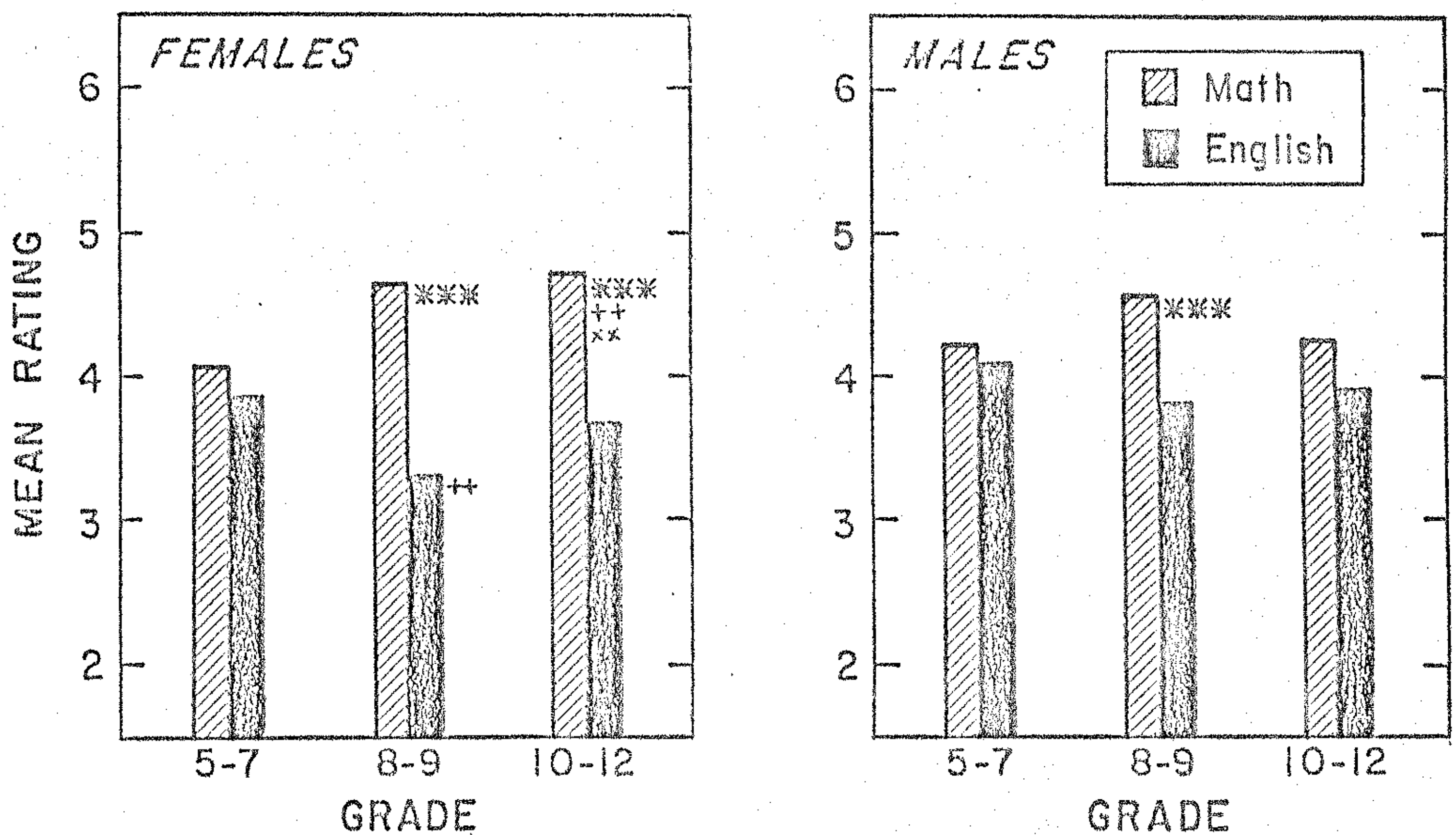


Subject Domain Comparisons *** $p < .001$
Sex Comparison within Subject Domain ++ $p < .01$
Age Comparison within Subject Domain xx $p < .01$

FIGURE CAPTION

Figure 3. Grade by Sex by Content Area Effects: Perceived Task Difficulty Construct

PERCEIVED TASK DIFFICULTY

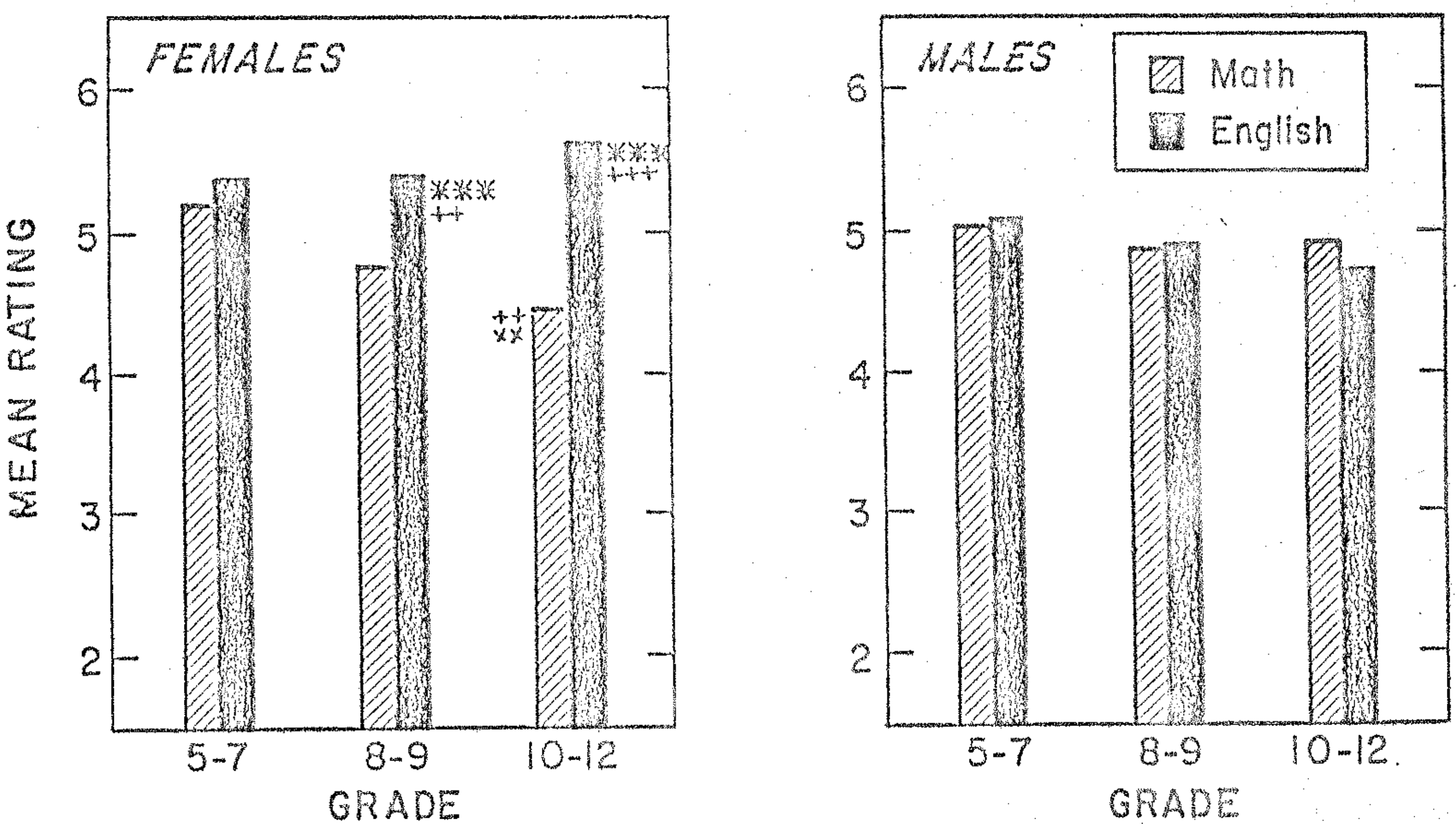


Subject Domain Comparisons *** $p < .001$
Sex Comparison within Subject Domain ++ $p < .01$
Age Comparison within Subject Domain xx $p < .01$

FIGURE CAPTION

Figure 4. Grade by Sex by Content Area Effects; Subjective Task Value Construct

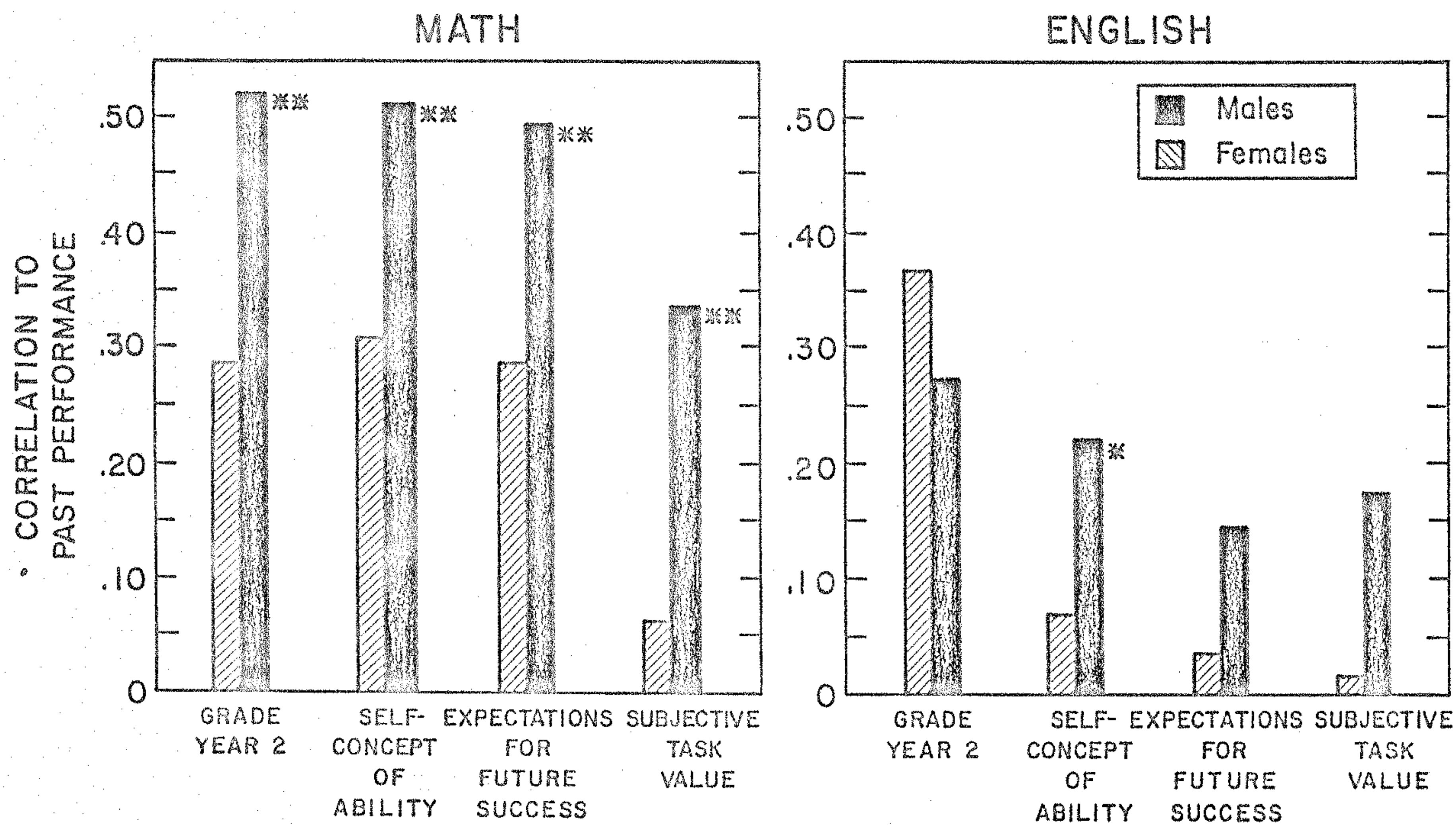
SUBJECTIVE TASK VALUE



Subject Domain Comparisons *** $p < .001$
Sex Comparison within Subject Domain ++ $p < .01$ +++ $p < .001$
Age Comparison within Subject Domain xx $p < .01$

FIGURE CAPTION

Figure 5. Correlation of Beliefs and Performance to Past Performance



Sex Comparison * $p < .05$ ** $p < .01$

Figure Caption

Figure 6. Path Analysis of Math Variables. (Column-wise multiple regression equation procedures were used to estimate the path coefficients. The standardized path coefficients, which are regression coefficients, reflect the relative predictive power of each variable. All paths are significant at the $p < .05$ level or better.)

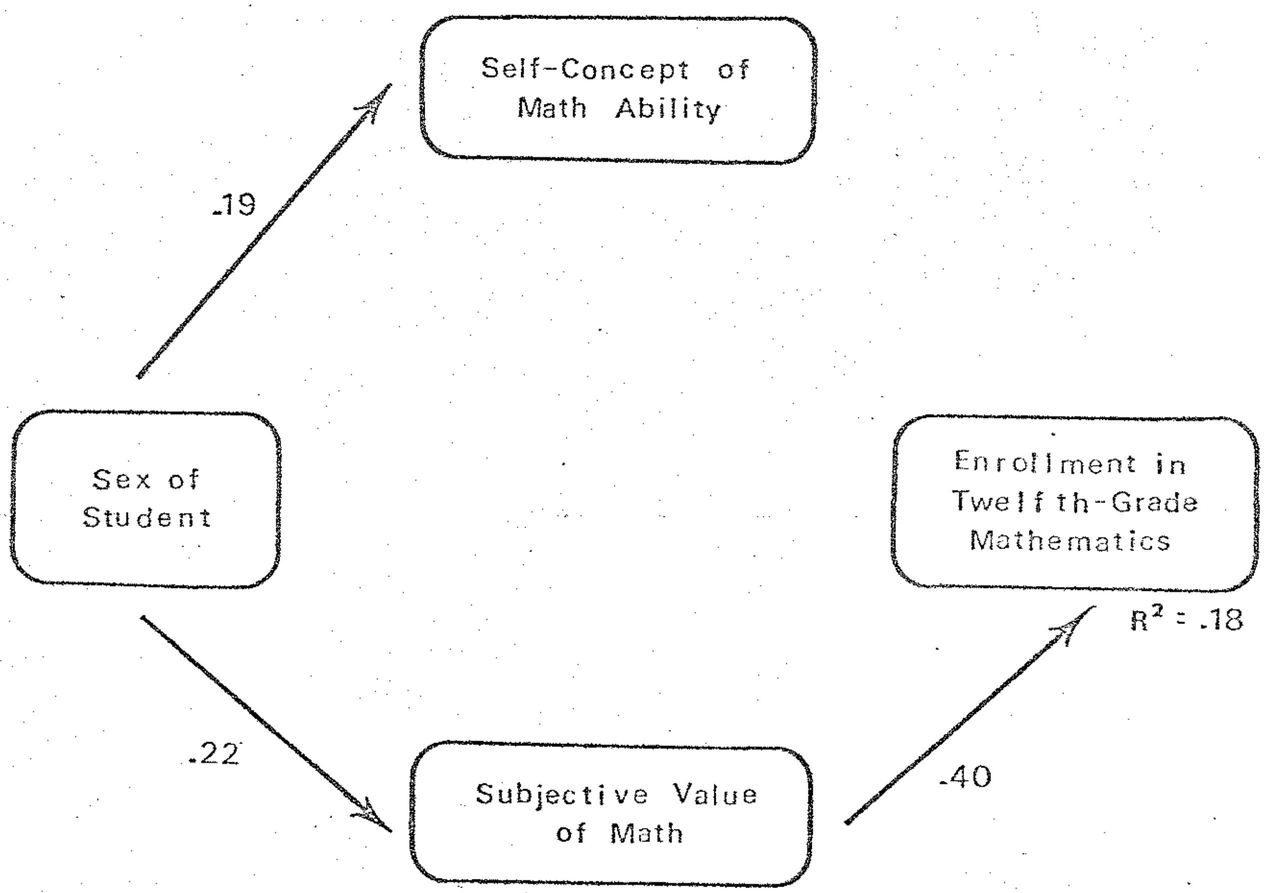

Self-Concept of Math Ability
.19
Sex of Student
Enrollment in Twelfth-Grade Mathematics
R² = .18
.22
Subjective Value of Math
.40

Table 1

Correlation Matrix

		1	2	3	4	5	6
1	Past performance	--	.50**	.30**	-.10	.14	.25**
2	Grade Year 1	.44**	--	.36**	-.19*	.11	.23**
3	Self concept of ability	.35**	.27**	--	-.49**	.50**	.46**
4	Perceived task demands	-.15	-.05	-.54**	--	-.09	-.21**
5	Subjective task value	.12	.16	.59**	-.13	--	.60**
6	Plans to continue taking subject	.17*	.16	.35**	-.04	.44**	--
7	Course enrollment: Grade 12, Math only	.39**	.42**	.17	.15	.36**	.17

Note: Correlations are based on Year 2 data base
Results for English items are in upper triangle
Results for Math items are in lower triangle

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

Table 2

Stepwise Multiple Regression:

Predictors of Subjective Educational Plans

English			Math		
Step	Multiple R^2	Predictor	Step	Multiple R^2	Predictor
1	.51	Subjective Value of English	1	.22	Subjective Value of Math
2	.54	Self-Concept of English Ability	2	.29	Self-Concept of Math Ability
			3	.33	Subjective Value of English

Table 3

Step-Wise Regressions: Math Enrollment

Female					Male				
STEP	R^2	VARIABLE	PARTIAL R	SIGNIFICANCE	STEP	R^2	VARIABLE	PARTIAL R	SIGNIFICANCE
0	.18	Past Performance	.43	.0005	0	.26	Past Performance	.51	.0004
1	.25	Subjective Task Value	.37	.004					
2	.30	Self-Concept of Math Ability	-.27	.03					