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AUTHOR	Andre, Thomas; Whigham, Myrna; Hendrickson, Amy; Chambers, Sharon
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ABSTRACT

A descriptive study of elementary students' and parents' attitudes towards science and other school subjects was conducted. Iowa students in grades K-6 and their parents completed attitude surveys. Different versions of the surveys were used for students in grades K-3, 4-6 and their parents. Younger (K-3) students were asked about four school subjects: (1) math; (2) reading; (3) physical science; and (4) life science. Three attitudes were assessed about each subject: (1) positive affect (liking) toward the subject; (2) perceived self-competence in the subject; and (3) the degree to which the subject was seen as related to male-oriented, female-oriented, or neutral jobs. Older (4-6) students were asked about 12 school subjects and for each subject were asked about their positive affect, perceived self-competence, the effort expended, the perceived importance for their future, the grade expected, and the perceived sex-role stereotyping of jobs related to the subject. For each of the four subjects used for younger elementary students, parents were asked to indicate their own perceived competence, their perception of their child's competence, the importance for their child's future, their day-to-day usage, and how well they expected their child to perform. Major findings included: (1) girls perceived higher competence in reading and boys in physical science; (2) boys and girls did not differ in liking of science--girls liked reading more than boys; (3) parents perceived boys as more competent in science; (4) parents perceived reading and math as more important for younger students; (5) science was perceived as more important for boys by parents; and (6) both boys and girls saw jobs related to science as more male dominated than female dominated. This finding was as true for the younger students as the older students. These results provide a more comprehensive picture of the development of attitudes about science in the elementary school than had previously existed. In many ways they were consistent with expectations from research with older students; however, the results suggest that part of the genesis of gender differences in science achievement and science-related careers, particularly in physical science, may lie in attitudinal reactions that begin to develop even at the earliest elementary school years. Additional analyses and discussion are described in the full report. Contains 82 references. (Author/NB)

Science and Mathematics versus Other School Subject Areas: Pupil Attitudes versus Parent Attitudes

Thomas Andre

Myrna Whigham

Amy Hendrickson

Sharon Chambers

Iowa State University

Paper presented at the Annual Meeting of the National Association for Research on Science Teaching, Chicago, March, 1997. Requests for reprints may be sent to Myrna Whigham, Department of Curriculum and Instruction, N0005 Lagomarcino Hall, Iowa State University, Ames, IA 50011 (EMAIL: mwhigham@iastate.edu), or to Thomas Andre, Department of Psychology, W112 Lagomarcino Hall, Iowa State University, Ames, IA 50011-3180 (EMAIL: tandre@iastate.edu)

Abstract

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A descriptive study of elementary students' and parents' attitudes towards science and other school subjects was conducted. Iowa students in grades K-6 and their parents completed attitude surveys. Different versions of the surveys were used for students in grades K-3, 4-6 and their parents. Younger (K-3) students were asked about four school subjects: math, reading, physical science, and life science. Three attitudes were assessed about each subject: positive affect (liking) toward the subject, perceived self-competence in the subject, and the degree to which the subject was seen as related to male-oriented, female-oriented, or neutral jobs. Older (4-6) students were asked about 12 school subjects and for each subject were asked about their positive affect, perceived self-competence, the effort expended, the perceived importance for their future, the grade expected, and the perceived sex-role stereotyping of jobs related to the subject. Parents were asked, for each of the four subjects used for younger elementary students, to indicate their own perceived competence, their perception of their child's competence, the importance for their child's future, their day-to-day usage, and how well they expected their child to perform. Major findings included. Girls perceived higher competence in reading and boys in physical science. Boys and girls did not differ in liking of science; girls liked reading more than boys. Parents perceived boys as more competent in science. Parents perceived reading and math as more important for younger students. Science was perceived of as more important for boys by parents. Both boys and girls saw jobs related to science as more male dominated than female dominated. This finding was as true for the younger students as the older students. These results provide a more comprehensive picture of the development of attitudes about science in the elementary school than had previously existed. In many ways, they were consistent with expectations from research with older students. However, the results suggested that part of the genesis of gender differences in science achievement and science related careers, particularly in physical science may lie in attitudinal reactions that begin to develop even at the earliest elementary school years. Additional analyses and discussion are described in the full report.

Science and Mathematics versus Other School Subject Areas:

Pupil Attitudes versus Parent Attitudes

This paper focuses on the developmental pattern of students' attitudes toward school subject matters during the elementary years and the relationship of student attitudes and parental attitudes. A number of different attitudes toward school subjects can be assessed. In this paper, we provide an overview of previous research on attitudes toward science and then focus on five attitudes: positive affect or liking of the subject matter, perceived importance of the subject matter, perceived competence in the subject matter, degree to which the subject matter is perceived as masculine or feminine, and perceived effort required in the subject matter.

Reasons for studying attitudes

National Concerns. Much national concern has been expressed about the achievement and motivation of American students in science and mathematics (Hueftle, Rakow, and Welch, 1983; National Commission on Excellence in Education, 1983; National Education Goals Panel [NEGP], 1992). Achievement ofAmerican students in science is less than students in some other industrialized nations (NEGP, 1992). Few American students elect scientifically oriented careers (Astin & Astin, 1992; Berryman, 1983; Brookhart, 1994) Concern has also been raised about gender equity in scientifically-oriented careers. Data over the last twenty years haaa indicated that there has been differential involvement of males and females in science and mathematics education and careers. Females typically have taken science courses less frequently than males (Astin & Astin; Berryman; Brookhart; Kreinberg, Eccles, and Becker, 1987; NEGP; Simpson, Koballa, Jr. Oliver, & Crawley III, 1994), particularly in the physical sciences and engineering although the gap in bachelor's degrees has been narrowing (ACS Committee on Professional Training, 1983, 1984, 1994, 1995). Females have been less likely to pursue graduate degrees or careers that demand a technical physical science background (ACS Committee on Professional Training, Kahle & Meece, 1994). Attitudes appear to be related to entrance into and exit from the mathematics-science "pipeline" (Berryman; Brookhart; Simpson et al.).

Support for Science and the Science Standards. The attitudes of individual students that influence their own career paths are not the only concern. A related issue is the development of positive attitudes toward science in the overall population. Not all students will or should pursue science careers; but all students will encounter and use scientifically developed technology and will have to make decisions about issues in which science plays a role. Several authors have expressed concern that Americans have become less positive in their attitudes toward science and support for science (Anderson and Smith, 1988). This concern is reflected in the new national science education standards. Teaching standard E explicitly encourages the development of communities of learners that "reflect ...

attitudes and social values conducive to science learning". Teaching standard B calls for the encouragement of "curiosity, openness to new ideas ... and skepticism". These are ideas that reflect attitudinal/motivational as well as cognitive goals.

Dynamic Interrelationships. General positive affect toward science, motivation to achieve in particular domains, subject matter course selection and career choice, however, are not singly caused. Instead these outcomes are influenced by a number of interrelated variables. Students' prior acquired attitudes and values, combined with parental and social (peers and other significant adults) demands, values and beliefs, students' own abilities and achievements, opportunities afforded by economic status and locale and other exogenous variables interact with contextual factors to influence students' behaviors and choices at any given point in time. These variables are not independent but interact over developmental time. For example, attitudes at any given point in time are influenced by prior achievements, but future achievements may be influenced by prior attitudes. Parental values and behaviors influence children, but the child's temperament and pattern of abilities influence parents' behaviors toward the child (Scarr, 1996).

Attitudes and Achievement. Willson (1983) meta-analyzed the relationship between attitude toward science and achievement in science. The overall relationship was small, but positive (e.g. about .15). One interesting finding was that the relationships between attitude and achievement were greater in single sex classes than in mixed sex classes. Shrigley (1990) similarly concluded that there was a modest positive correlation between attitude and achievement. As Simpson, et al. (1994) point out, from this research it is not clear whether attitudes influence future behavior or result from prior achievement.

There are at least two factors that might contribute to the low level of relationship found in attitude and achievement. In their model of how attitude and behavior interact, Fishbein and Ajzen (1975; 1981) argue that only specific behavioral intentions assessed shortly before behavior are likely to show strong relationships with behavior. In their model, behavioral intentions are influenced by attitudes but also are influenced by social support and other contextual factors. General measures of attitude cannot be expected to predict future behavior strongly. A second factor may be that relative attitude is as important as the absolute level of attitude in influencing achievement behavior. For example, devoting time to biology homework versus English homework on a given evening might be as influenced by the relative strengths of a student's attitudes as by whether her attitudes are positive or negative overall. Of course, external factors will influence such choices as well. Most research on attitudes toward science and achievement has not examined the relative strength of attitudes toward subject matters.

Our own view is that the attitude - achievement relationship must be dynamically reciprocal and continually evolve as the individual develops. Prior achievement is likely to be one of many influences on attitude development; attitudes are one of many influences on subsequent achievement. In support of this position, Schibeci and Riley (1986) and Eisenhardt (1977, reported in Pederson and Carlson, 1979) found that, in a cross-lagged panel analysis of 70,000 students, evidence supported a substantial causal link between achievement and attitude. In contrast, Schibeci and Riley (1986), in a structural modeling study of National Assessment of Educational Progress data, found evidence of a causal link from attitude to behavior. Taken together these studies suggest complex and developmentally dynamic relationships. As noted above, examining relative attitudes may be important in understanding the attitude-achievement relationship. In an investigation of his internal-external model of self-concept development, Marsh (1990) found evidence that students' internal, relative assessments combined with external information in determining the strength of students' self-concept across domains. In an analogous manner, students' relative attitudes toward subject matters may be as important as their absolute level of attitudes in influencing subject matter specific achievement behaviors and motivation. These arguments support the need to investigate developmentally the patterns of subject matter specific attitudes.

Global Attitudes Toward Science. Developing an overall picture of how science attitudes develop over the school years is important for a number of reasons. In addition to achievement, attitudes influence course and career selection (Simpson et al, 1994; Steinberg, 1993, p. 411). Simpson et al. argue that attitudinal indicators are an essential component in determining the state of science education. Motivational factors such as interest contribute substantially to achievement (Kahle and Meece, 1994; Shirey and Reynolds, 1988). A meta-analysis of the relationship between interest and achievement revealed that approximately 10% of the variation in achievement (across all subject matters) could be attributed to variations in interest (Schiefele, Krapp, and Winterler, 1992). Unfortunately, positive affect (interest in) toward science and mathematics typically become more negative as children proceed through school (NEGP, 1992; Simpson and Oliver, 1990).

School interventions certainly can contribute to students' attitudes and aspirations. For example, Evans and Whigham, 1995) demonstrated that the use of female role models in 9th grade science classrooms improve females attitudes. Rosser and Kelly (1994) reported on a program that demonstrated that educational interventions could alter attitudes. Positive classroom climates and liking of science teachers appear to foster development of more positive attitudes toward science (Fraser, 1994; Ormerod, 1975).

Problems in Attitudinal Research. While considerable research has examined student attitudes toward science, the research has been criticized for weak methodology and theoretical analysis (Klopfer, 1976; Krynowsky; 1988; Peterson and Carlson, 1979; Shrigley, 1983; Simpson et al. 1994). In addition to problems with the reliability and validity of measures, research has not examined specific issues that are essential in gaining an understanding of the development of attitudes toward science. One such problem has been the lumping together of biological and physical science in much of the research. Gender differences seem to be larger in physical science than in biological science and studies that combine them may mask effects (see section on gender differences below). A second problem is that relatively little work on attitudes has been done at the elementary level and substantially more work has been done at the secondary levels. Thus we do not have a complete descriptive overview of how attitudes toward science develop. A related problem is that many of the studies have only focused on a limited number of grades. To obtain a valid developmental picture of student attitudes requires a more comprehensive approach.

Gender Differences in Attitudes Toward Science. Significant research effort has focused on analyzing the attitudes of male and female students about science and mathematics. Female students have been more likely to have somewhat less positive attitudes toward science that male students have had, but the effect size is small and variable across grade levels. Fleming and Malone (1983) have conducted a meta-analysis of research on student characteristics and science achievement and attitudes for studies conducted between 1960 and 1981. Males at the elementary and high school levels showed greater preferences for science than did females, but the effects sizes (ES) indicate weak relationships (.18 and .12 respectively). At the middle school level, females displayed more positive attitudes than did males (ES=-.11). It should be noted that, in this review, the number of studies available was small and the standard deviations of the effects sizes are larger than the means. Such large standard deviations indicate that extreme scores were likely to have influenced the effect sizes. A further complication was that the meta-analysis collapsed across a wide variety of attitude measures; that fact also may have influenced the size and variability of the relationships found.

In a review of meta-analyses, Anderson (1983) reported that gender differences in achievement and attitude were small, but did indicate that achievement differences seemed to be greatest at the middle school level. Haladyna and Shaughnessy (1982) similarly reported a weak relationship between gender and attitude toward science. In their meta-analysis of studies conducted between 1960 and 1980, gender accounted for approximately 3 percent of the variance in attitudes toward science.

While females typically have been regarded as having more negative attitudes toward physical science and mathematics (Kahle & Lakes, 1983; Kahle and Meece, 1994; Lawton & Bordens, 1995; Mullis & Jenkins, 1988; Nelson et al., 1990), Harvey and Stables (1986) reported that English high school girls' attitudes toward physics and chemistry were more positive in single-sexed schools than in mixed-sexed schools. Curiously, girls' attitudes toward biology were more positive in mixed-sexed schools than in single-sexed schools. A number of other studies conducted in England have found that girls' attitudes toward the physical sciences are more positive in single sexed schools (Harvey, 1984; Harvey and Stables, 1986; Lawrie and Brown, 1992; Ormerod, 1975).

Consistent with the proposition females have more negative affect toward physical science, Lawton and Bordens (1995), in an analysis of science fair project topics, reported girls were more likely to select biologically oriented projects and boys more likely to select physics oriented projects. Gross (1988) reported on a study done on the attitudes toward mathematics of 4^{th}, 6^{th}, 8^{th}, and 12^{th} grade students in Montgomery County, MD . Females liked math somewhat less than males. They perceived less utility in mathematics and that their mothers had less ability in math than their fathers.

Friedler and Tamir (1990) reviewed 15 years of research on gender differences in achievement and attitudes toward science among Israeli students. Gender differences were minimal in elementary school, but increased from middle school onward. Increasingly throughout secondary school, males had more positive affect toward science topics, elected more science courses, and displayed greater interest in science careers. However, there were subject-matter specific differences partially consistent with the results reported above. The attitudes of boys and girls toward chemistry were similar, but boys preferred physics and girls biology.

Much of the research on genders has focused at the middle or secondary school level and studies in elementary school have focused mainly on grades 4-6 (Lawton and Bordens, 1995). Science has also been treated generically in most studies at the elementary level. In the present study, in addition to increasing the number of studies that have examined student attitudes at the elementary level, we examine students opinions about biological and physical science separately. On the basis of this research, we would expect that any observed gender differences in attitudes would be smaller at the lower elementary level than at the higher elementary level. In addition, we would expect to find minimal differences in the biological sciences, but greater differences in the physical sciences.

Positive Affect Toward Subject Matter. With respect to positive affect or liking toward science, a variety of methods have been used to assess positive affect. A number of studies have asked students to select a few most liked and least liked subjects or to rank order a list of subjects. Such ranking or selection procedures lose information as compared to procedures that require students to rate each alternative on a Likert-type scale (see Andre, Dietsch, & Cheng, 1991; for a discussion of this issue). Aiken and Aiken (1969) reported that Greenblatt (1962), Powell (1962), and Kane (1968) found that, in elementary, high school and college students respectively, science held an intermediate preference rank with reading, art, and arithmetic having higher ranks. Shemesh (1990) reported that among Israeli junior high school students, girls preference for science, relative to preferences for art or social studies, declined from grades 7 to 9 while boys preference did not. Harvey (1984) apparently asked English secondary students to rank order secondary school subjects. He reported that that relative to each other, boys preferred chemistry, physics and math and girls preferred French, English, and religion. His paper does not make clear the nature of the survey items or the specific data on which the summary rankings were based. Ormerod (1975) had English grammar school children indicate their preferences for school subjects using a paired selection procedure. Rank orders were determined from the selections. Boys and girls ranked biology about the same and in the middle of the group of 16 (boys) or 15 (girls) subject-matters. Boys ranked physics and mathematics in the top half of the set of subjects; girls ranked physics and mathematics in the bottom half. Both genders ranked chemistry in the bottom half.

Frymier (1991) had seventh grade students rate their preferences for curriculum materials represented on photographic slides and, from this data, developed preference scores for mathematics, language arts, social studies, and science. He did not statistically analyze differences between the subject matters or report gender separated scores. In terms of raw means, social studies was the most preferred subject and science the third most preferred subject for students selected by their teachers as likely to attend college. Taber (1991) surveyed British students entering high school about science topics they would find most interesting. Boys indicated greater preference for more mechanical objects such as guns, bombs, motor cars and robots; girls indicated greater preference for more biologically related topics such as germs and illnesses, hair, skin, teeth, and chemical food additives. Archer and McDonald (1991) asked 43 British girls, aged 10-15, open-ended questions about their personal preferences for subject matters and their perceptions of the preferences of other girls. More girls named math and science than named English. But math was also the most frequently named disliked subject. It is difficult to make much sense of Archer and McDonald's data as the age and availablility of subject matters to the girls cannot be determined. The small sample of convenience also lessens the credibility of the data. Thus, biology, physics, and chemistry were infrequently named. It is impossible to determine if this occurred because there were few older girls for whom the subjects were available or because they were not much liked.

Overall, the results of research using ranking or selection procedures support two propositions: (One) science is not as preferred as some other subjects; (Two) boys prefer science and mathematics more than do girls.

Other studies have used Likert type scales to explore students' positive affect toward science and other subjects. Rating methods offer the advantage that strength of affect for each subject rated can be analyzed. In one of the more comprehensive studies, Haladyna and Thomas (1979) examined the attitudes toward eight school subjects of students in grades 1-8, but science was only asked about in grades 4-8. Science was rated higher than reading or math by both boys and girls, but girls were significantly lower than boys in attitudes toward science. Unfortunately, Haladyna and Thomas did not statistically assess differences between the subject matters. The National Science Foundation, Indicators of Science and Mathematics Education report (Suter,1992), using data from the Longitudinal Study of American Youth compared student liking of science classes in a sample of high school students enrolled in science classes. Gender differences were not reported. Enrolled students seemed to like physics slightly more than chemistry or biology. One problem in interpreting this data is that students self-select into advanced high school courses. The most typical order of teaching these topics is biology, chemistry and physics. Biology is more likely to be required. Thus self-selection may account for the observed differences. Students who didn't like science would have been more likely to drop out of chemistry and especially, physics. The sample sizes reflect this interpretation. The number of students enrolled dropped substantially from biology to physics. Overall percentage enrollment data for biology, chemistry, and physics, presented in the report, are also consistent with a self-selection hypothesis. This hypothesis is also supported by Iowa data. In Iowa, approximately half of the students drop out of the pipeline each years as they proceed from 10th grade biology to 11th grade chemistry to 12th grade physics.

Not surprisingly, and taken as a whole, the data suggest that for secondary students, science, and most academically oriented subjects tend to be liked less than subjects that are less academically oriented (such as physical education). In addition, boys seem to have slightly stronger preferences for mathematics and physical science subjects. In the present study, we further examined the positive affect that K-6 students have toward different school subject matters.

Perceived Importance. With respect to perceived importance, Aiken and Aiken (1969) reported that Perrodin (1966) found that science was rated as one of the more important school subject by fourth, fifth, and sixth grade pupils and that Anderson and Neeley (1967) reported that physics and chemistry had the highest prestige in a sample of eleventh graders. Harvey (1984) reported that physics and chemistry were ranked 3 and 4 respectively, in perceived importance among 15 school subjects in a sample of male English secondary students. For females, these school subjects were also ranked high (4 and 5 respectively, but slightly lower). The NSFISME report (Suter, 1992) asked enrolled students to indicate the perceived importance of mathematics, physics, chemistry and biology for future careers. Students who were on-grade level for taking the course, tended to rank mathematics and physics the highest in terms of their future careers. The students were generally positive in their perception of usefulness. Minimal average ratings tended to be around the midpoint of the 4 point scale (2.5) with ratings of mathematics and physics averaging closer to 3. However, the self-selection bias noted above may have influenced this data as well. The NSFISME report also asked students to indicate the degree to which they perceived that their parents thought science and mathematics were important. The data indicated that the students believed that their parents thought mathematics was more important than science. Perceived importance declined over the high school years. In the present study, we extend research that has examined perceived importance at the elementary level and we obtain measures of importance from both students and parents.

Sex Role Stereotyping and Careers. In a review of literature on career choice, Reid and Stephens (1985) indicated that gender role stereotyping of occupations contributed to lower election of mathematically/scientifically oriented careers by women as compared to men. This conclusion was supported in a recent review by Kahle and Meece (1994). These reviewers concluded that, in gender comparisons, females had particularly less positive attitudes about fields that are were male-dominated. Science and scientists have been perceived as masculine even in children as young as kindergarten (Chambers, 1983; Vockell and Lobonc, 1981). Ormerud (1975) reported that chemistry, physics, mathematics were seen as more associated with males than with females. On the basis of a review of prior British and American data, Archer and McDonald (1991) classified school subjects as masculine or feminine sex-role stereotyped. Mathematics and physical sciences (chemistry/physics) were reported more masculine sex-role stereotyped. Biology and English were classified as feminine. Archer and McDonald also reported that the available literature suggested that sex-role stereotyping of preferences and subject areas was less during the elementary school years than in middle and high school students.

This prior research implies that examination of elementary students perceptions of the sex-role stereotyping of occupations related to different school subject matters is an important component in understanding the development of attitudes toward science.

Perceived Competence. Several authors have suggested that even with equivalent levels of achievement, girls, as compared to boys, may perceive themselves as having less ability in science (Dweck, 1989; Horgan, 1995; Sadker, Sadker, and Klein, 1991). Kahle and Meece (1994) report that gender differences in perceived competence or ability may be greater than differences in interest. Some authors have found differences in elementary students (Willson, 1983), while others suggest that the differences are small in elementary students but increase as children reach middle school (Steinkamp & Maehr, 1983, 1984). In the Gross (1988) study mentioned above, females in grades4th, 6th, 8th, and 12th were reported to have lower self confidence in mathematics than males. Ryckman and Peckham (1987) obtained data consistent with the view that, as compared to males, females in grades 4-12 had attribution patterns with respect to science and mathematics that were more consistent with a learned helplessness view.

Tobin (1988) reported on a series of five studies that may be related to gender differences in perceived competence as well as perhaps to positive affect. Across five studies, boys and girls were observed in high school science classes. Boys were more likely to dominate class discussions and use of equipment. In off task behavior, males engaged in inappropriate use of the equipment; females tended to socialize. These patterns of behaviors may be consistent with a lower level of confidence on the part of females. Students who are less confident are less likely to engage in "risky" behavior such as responding to questions or publicly using equipment. Lockheed (1985) reported that in mixed sex groups, males show more leadership and females show more reticence.

Lowered perception of competence or ability may contribute to lowered persistence. Perception of competence or ability plays a role in theories of motivation. In self-efficacy theory, the expectation that one is able to carry out a behavior (the efficacy expectation) is one component in determining motivation (Bandura, 1977). The second component is the expected outcome of engaging in the behavior. If females, as compared to males, perceive they have lower ability in the sciences, they should have less motivation to perform and less persistence when faced with difficulties. Lower perception of ability should lower persistence and striving from the perspective of Marsh's differentiated self-concept theory (Marsh, 1990; Marsh, Chessor, Craven, & Roche, 1995), Weiner's attribution theory (1979), and other expectancy-value theories of motivation (Eccles, 1989: Fennema and Peterson, 1985). Given the potential importance of perceived ability, we examined students' perceptions of their abilities in several subject matters in the present study. In addition, parent perceptions of competence may be related to students' conceptions of competence. We assessed parent perceptions of their child's competence as well.

Parents and Attitudes. Parents also remain a main contributor to their children's' socialization, attitudes and career aspirations (Steinberg, 1993, p. 131). Steinberg and Silverberg (1986) found that adolescents' educational aspirations were more related to their mother's educational goals for them than to their best friends goals. Simpson, et al. (1994) concluded that attitude is a "crucial factor" in career choice (p. 219).

In a meta-analysis of factors that influence science achievement, Staver and Walberg (1986) argue that parental factors such as interest in the child's school work, facilitation of homework, and control of television watching, along with other external-to-school factors, contributed more to student achievement than did school controllable factors. Maple and Stage (1991) similarly found that parental variables such as parental education and interest in the child's school work contributed to choice of mathematics/science related majors. Schibeci and Riley (1986), using National Assessment of Educational Progress data, confirmed the importance of external-to-school variables in determining students' science attitudes and achievement, but their study did not separate SES from parental variables. Wang and Wildman (1995) reported that parental support behaviors related to science significantly contributed to science achievement in the Longitudinal Study of American Youth. Lockheed, Fuller, and Nyirongo, (1989) demonstrated that family background variables significantly contributed to students' achievement in third world countries. Yee and Eccles (1988) reported that parents perceptions and attributions about their children's success and failure in mathematics influenced their children's attributions. Thomas (1986) indicated that encouragement from parents, as well as peers, related to both interest in science classes and science career goals. In a review of the recent literature, Kahle and Meece (1994) reported that parents seem to encourage boys more in the math and science areas than they do girls; but did not report studies of the direct relationships of parent and children's attitudes toward science. Much of the research on students attitudes and perceptions of competence have involved students older than the elementary school years (Kahle & Meece; Lawton & Bordens, 1995).

Turner and Gervai (1995) summarize research on children toy preferences and parental variables related to them. As young as age 3-4, boys prefer playing with toy vehicles, balls, and blocks; girls prefer dolls, domestic items, dressing up and art. Importantly, that parents reinforce such gender-typed play activities and toys, especially for boys, is a consistent finding across studies. Such differences in play patterns may relate to later observed differences in preference for physics versus biology. Dierking and Falk (1994) reviewed evidence with respect to family interaction patterns in informal science settings such as museums. Two patterns of behavior may relate to attitudinal development and gender differences. Mothers rarely took the lead in initiating which exhibits to view and were led by either children or fathers. In addition, while fathers discussed exhibits equally with sons and daughters; mother daughter conversations was less often focused on the exhibits.

Such patterns are consistent with an attitudinal pattern that expresses that science is not for women. In addition, Dierking and Falk suggested that increased positive affect for science may be an important learning outcome of family interaction in such information settings.

Taken as a whole, the existing research suggests further research that examines the relationship between parental and student attitudes, particularly at the elementary level, is important.

Attitude Development. Despite the amount of research on student attitudes, a number of important questions remain unanswered. Research that compares students' attitudes toward different subject matters is not extensive, and is particularly rare at the lower elementary level. As noted above, students' career choices are probably influenced as much by their internal relative interest across subject matters as much as their absolute level of interest or external comparison with others. Such attitudinal patterns develop over time, but little research has systematically explored the development of attitudes over the school years. Haladyna and Shaugnessy (1982) specifically called for more developmental research on attitudes. Little research has explored the relationship between parental attitudes and the development of children's attitudes. Given that our society is undergoing change in gender roles and making efforts to reduce gender inequity in the sciences and in other areas, the creation of a data base that describes attitudinal development toward school subjects would provide a baseline from which changes could be assessed. Developing a descriptive database of typical patterns of attitudinal development is critical for monitoring the progress of efforts to change attitudes. This research presents some initial descriptive data on these issues.

As noted above, previous reviewers have criticized many of the instruments used in attitudinal research for limited reliability and validity (Peterson and Carlson, 1979; Shrigley, 1983). While their criticisms have validity, practical realities also influence the nature of research that can be conducted. In the real world, teachers are unwilling to give up much instructional time for attitudinal assessment and students may be unwilling to validly complete long instruments. Younger students have limited attention spans. Parents are unlikely to return lengthy questionnaires. These considerations limit the length of attitude assessment instruments that can be used.

The present study describes developmentally students' attitudes about a number of aspects of science, mathematics, and other subject matters. The present study is more comprehensive than the previous work in that a wider variety of attitudes across a wider variety of subject matters and grade levels were assessed. Specifically, we assessed: degree of liking of the subject matter, degree of importance attached to the subject matter, degree of self-perceived competence in the subject matter, degree to which the subject matter is perceived as masculine or feminine (sex-role stereotyping), and perceived effort required in the subject matter. We assessed these attitudes across four subject matters for younger children and twelve subject matters for older students. Because of the practical considerations described above, we were precluded from using lengthy questionnaires on any one attitude. Instead the instrument is best conceptualized as an opinion survey where a single item represents a subject matter specific attitude. The purpose of the research was to develop a descriptive data base that would provide answers to the following questions:

1. **What are the self-perceived competencies of male and female, younger and older, elementary students in mathematics, reading, life science, physical science and other school subject matters?**
2. **How do parents perceive their child competencies in mathematics, reading, life sciences, physical science and other school subject matters?**
3. **How much effort do male and female, and younger and older students expend in mathematics, reading, life sciences, physical science and other school subject matters?**
4. **For male and female and younger and older students and for parents, what is the perceived importance of mathematics, reading, life sciences, physical sciences and other school subject matters?**
5. **What are parents' expectations for their child's performance in mathematics, reading, life sciences, and physical sciences.**
6. **How much do male and female, younger and older, elementary students like mathematics, reading, life sciences, physical sciences, and other subject matters?**
7. **What are the sex-role stereotypes of male and female, younger and older, elementary students with respect to job that emphasize mathematics, reading, life sciences, or physical sciences.**
8. **For each of the attitudes above, are there differences in student and parent attitudes across subject matters?**
9. **For each of the attitudes above, do parents' attitudes vary with the gender of their child?**
10. **To what extent are parent and students attitudes related for each of the school subject matter specific attitudes above?**

Method

The data reported in this paper was collected as part of a larger project called Family Math and Science. Teachers in the participating classrooms were part of an extensive summer training program involving discussion and experiences with: (1) activity-based math and science, (2) gender and ethnic issues as they relate to participation and achievement in math and science , and (3) the importance of parent involvement in science and math education. The present data was collected from students and parents early in the school year before interventions had been implemented.

Participants

From those teachers indicating a willingness to participate, schools and classes were selected to represent diversity within Iowa in size, location, and characteristics of the student population served. About 10% of teachers indicating a willingness were selected. Classrooms from kindergarten to sixth grade were chosen and all students and their families from these classes took part. Table 1 presents the number of students and parents represented at each grade level. For analytic purposes, comparisons were made between the younger (K-3) and older (4-6) grade levels. In all, 238 male students and 199 female students (total=437) students and 271 mothers and 76 fathers (total=347) completed questionnaires.

Materials

Three questionnaires were developed for various groups of participants. One for students in kindergarten through third grade, another for students in fourth through sixth grade, and the last for parents. The questionnaires were developed in collaboration with master teachers from four school districts who were not participants in this program. They were also based on a review of the literature on students attitudes and gender differences in science and mathematics in secondary students.

Younger student questionnaire.

Because the attention span of younger students is limited, the survey for the younger students needed to be short. It consisted of 12 items that focused on only four subject matter areas: mathematics, reading, physical science and life science. The survey was designed to assess three attitudes: perceived self-competence in the subject matter area (hereafter called competence), the degree of liking or positive affect for the subject matter, and the degree which the participants perceived jobs that used a lot of the subject matter were male or female dominated. For the latter attitude, the questionnaire asked participants to rate whether they thought mostly men, mostly women, or both men and women equally held jobs that used a lot of the subject matter. Figure 1 illustrates the items. In the survey, items 1-4 focused on competence in mathematics, reading, life science, and physical science, respectively. Students were asked to rate how good they were in these four subject matters. For these four items, the response choices consisted of a smiling face (labeled: Good), a neutral face (labeled: OK.) and a frowning face. (labeled: Not Very Good). Items 5-8 focused on positive affect and asked students to rate how much they liked each of the same four subject-matter areas. For items 5-8, the response choices consisted of a smiling face (labeled: Yes, I like it), a neutral face (labeled: It is OK.) and a frowning face. (labeled: No, I don't like it.). As shown in Figure 1, for items 9-12, the response choices consisted of an icon of a male (labeled: Mostly Men), an icon of a male and female (labeled: Men and Women), and an icon of a female (labeled: Mostly Women). For all 12 items, students were told to put an X on the picture that represented their answer.

Older student questionnaire.

The older student questionnaire consisted of a 102 item survey instrument. The instrument included 12 subject matter areas: mathematics, reading life sciences, physical sciences, social studies, language arts, computer skills, music, arts, team sports, dance/gymnastics, social skills/getting along with others. For each of these areas, the competence, positive affect, and gender dominance of jobs attitudes, that were assessed for the younger students, also were assessed for the older students. In addition, attitudes dealing with how hard the students believed they worked in the subject matter, the grade expected in the subject matter, and the perceived importance of the subject matter for their adult life were assessed for each of the 12 subject matters. An additional 30 questions asked about reasons for their performance in various subject matters. These 30 items are not included in the present report and are not discussed further. Figure 2 illustrates the format and nature of the items on the older student survey.

Competence. Items 1-12 focused on competence. Students were asked to rate how good they felt they were in each of the 12 subject matter areas. Students responded on a five point scale with descriptors: 5-Really Good, 4-Good, 3-Just OK, 2-Not so good, 1-Not Good at All.

Effort. Items 13-24 focused on effort; students rated how hard they worked in each of the areas. Students responded on a five point scale with choices: 5-Really Hard, 4-Hard, 3-Just So, 2-Not So Hard, 1-Not Hard At All.

Importance. Items 25-36 focused on importance. Students rated each of the 12 subject matter areas on how important the area would be for them when they grew up. The five response choices were: 5-Really Important, 4-Important, 3-Some Importance, 2-Not Very Important, 1 Not Important At All.

Grades. Items 37-48 focused on expected grade. Students selected the grade they expected to earn for each of the 12 subject matter areas. Students were told to assume that grades were given in this area at their school. The response scale was: A, B, C, D, F.

Positive Affect. Items 79-90 asked students to rate how much they liked each of the 12 subject matter areas. Students rated their liking on a five point scale with choices: 5-Very Much, 4-Some, 3-Neutral, 2-Not Much, 1-Not at all.

Perceived Gender Dominance of Jobs. Items 91-102 asked students to indicate, for each of the areas, if jobs in the area were held mostly by men, women, or both men and women. There was a five choice response scale with three verbal anchors: 5-Mostly Men, 3-Equal Numbers, 1-Mostly Women.

Parent Survey.

The parent survey used the same twelve subject matter areas as the older student questionnaire and was similar in its construction. For each subject matter, five attitudes were assessed: the parents' perception of child competence in each subject matter, parents' perception of subject matter importance, parents self perceived competence in each subject matter, the parents' self-perceived day to day usage of each subject matter, and how well the parent expected their child to perform in each subject matter. Figure 3 illustrates the parental items and response scales. Because the construction of the parent questionnaire was similar to that of the older student questionnaire, it is not described further.

Procedure

The data were collected as part of the pretest data collection phase early in the school year before interventions were implemented. Students completed the surveys in their classrooms. For the younger students (grades K-3), the teacher guided the students through the questionnaire. The teacher read the directions aloud, had the student find each item, read that aloud, then had the student mark a response. For the older students (grades 4-6), the teacher distributed the questionnaires and answered student questions as needed.

As part of the Family Math and Science program, parents attended four family math and science nights conducted at their child's school over the school years. The parents surveys were distributed to the parents and collected on the first such night. In a few cases, when parents did not attend the first parent night, parent surveys were sent home and returned by students. The teachers collected the parent surveys and sent them to us.

Results

An alpha level of .05 was used for all statistical tests. Results are discussed below only if they were statistically significant. The results section is divided into three sections. The first section of the results focuses on analysis of the gender and grade level differences. The second section focuses on differences among subject matters. The third section focuses on relationships between parent and student variables.

Analysis of gender and grade level differences for each variable.

For each variable in the parent and student data sets, separate analyses were done for the combined sample, the younger sample and the older sample. A gender X grade level (younger K-3 vs older 4-6) ANOVA was done on the combined data. Gender ANOVAs were then done separately for each of the variables in the younger and older samples. As noted above, there were many more variables in the older than in the younger samples.

Self-Perceived Competencies of Students and Parents.

Figures 4-6 present the mean self-perceived competencies of elementary students and their parents in mathematics, reading, life science, physical science, and other school subject matters.

Combined Sample: For the entire sample, older students rated their ability in math, $F(1,356)=3.97$, reading, $F(1,354)=11.73$, life science, $F(1,353)=5.43$, and physical science, $F(1,351)=15.44$, higher than did younger students (See Figure 4). Consistent with cultural stereotypes, girls rated their reading ability higher than did boys, $F(1,354)=8.35$; and boys rated their physical science ability higher than did girls, $F(1,351)=4.14$ (See Figure 5).

Younger Sample: Among younger students, there were no significant gender differences in the children's perception of their ability in math, reading, life science, or physical science.

Older Sample: Among older students, girls rated their ability in reading, $F(1,184)=6.18$, language arts, $F(1,185)=6.29$, music, $F(1,185)=9.87$, dance/gymnastics, $F(1,184)=59.12$, and social skills, $F(1,185)=6.67$, higher than older boys assessed their ability in these same subjects. The boys, however, perceived their physical science $F(1, 182)=5.65$, and team sports ability $F(1,185)=11.46$, as higher compared to girls' perception of their own ability (See Figure 6).

Parent Sample: Parents rated their self-perceived reading competence as significantly better than both their math and science competence, $F(2,680)=17.58$ (See Figure 7).

Parent Perception of Child Competencies.

Figures 8-11 present the mean competencies parents perceived for the children in mathematics, reading, life science, physical science, and other school subject matters.

Combined sample: Within the entire sample of parents, no significant differences appeared in the parents' perceptions of their child's ability in math or reading across grade level or sex of the child. However, there were significant differences in parents' perceptions of their child's ability in the sciences based on the grade level and sex of the child. Parents perceived older students as more able in science than younger students, $F(1,323)=4.15$, and boys as more able than girls, $F(1,323)=5.06$ (See Figures 8 and 9).

Younger sample: Among parents of younger children, no significant differences appeared in the parents' perceptions of their child's ability in math or reading across sex of the child. However, there was a significant difference in parents' perceptions of younger children's ability in the sciences based on the sex of the child, such that parents perceived boys as more able than girls, $F(1,124)=5.95$ (See Figure 10).

Older sample: Among the parents of older children, no significant differences appeared in the parents' perceptions of their child's ability in math, reading, computer science, art, team sports, or social skills/getting along across sex of their child. However, there was a significant difference in parents' perceptions of older children's ability in the sciences based on the sex of the child; parents perceived boys as more able than girls, $F(1,326)=4.30$. Parents also perceived boys as more able than girls in social studies, $F(1,326)=7.47$. However, parents perceived girls as more able than boys in language arts, $F(1,323)=9.69$, in music, $F(1,324)=23.09$, and in dance/gymnastics, $F(1,307)=34.57$ (See Figure 11).

Amount of Effort.

Older Sample: Figures 12 and 13 present students' mean rated effort expended in mathematics, reading, life science, physical science, and other school subject matters. This variable was collected only for older students. The only significant sex difference in students' effort was for dance/gymnastics; girls rated their effort higher than did boys, $F(1,181)=6.87$ (See Figure 12).

Expected Grades.

Older Sample: Expected grades also were only collected on the older sample. Girls expected higher grades than did boys in math, $F(1,185)=5.04$, language arts, $F(1,182)=13.30$, computer science, $F(1,184)=4.58$, music, $F(1,185)=10.46$, dance/gymnastics, $F(1,182)=53.59$, and social skills/getting along, $F(1,184)=5.54$. Boys, however, expected better grades than did girls in team sports, $F(1,185)=5.60$ (See Figure 13). There were no significant gender differences in expected grades for reading, life science, physical science, social studies, or art.

Perceived Importance of Subject Matter.

Figures 14-19 present the older students' and parents' perceptions of the importance of mathematics, reading, life science, physical science, and other school subject matters. Perceived importance was only collected for the older and parent samples.

Older Sample: Among older students, girls perceived math, $F(1,184)=6.03$, reading, $F(1,183)=4.49$, life science, $F(1,184)=8.38$, language arts, $F(1,184)=7.56$, computer science, $F(1,184)=5.51$, music, $F(1,184)=4.06$, and dance/gymnastics, $F(1,181)=14.23$, as more important than did boys. On the other hand, older boys rated team sports as more important than did girls, $F(1,183)=7.98$. In fact, boys rated team sports equally as important as math (See Figure 14).

Parent Sample for Combined Sample: Parents rated the importance of subject matters for their child's future. Within the entire sample of parents, no significant differences appeared in the parents' perceptions of the importance of math and reading across grade level or sex of the child. However, there were significant difference in parents' perceptions of the importance of science based on the grade level of the child, sex of the child, and an interaction of the grade level and sex of the child. Parents perceived science as more important for older students than for younger students, $F(1,319)=4.82$, and as more important for boys than for girls, $F(1,319)=18.01$ (See Figures 15 and 16). Moreover, parents perceived science as equally important for younger and older boys, but significantly more important for older girls than younger girls, $F(1,319)=6.63$ (See Figure 17).

Parent Data for Younger Sample: Among the parents of younger children, no significant differences appeared in the parents' perceptions of the importance of math or reading as a function of sex of their child. However, there was a significant gender difference in parents' perceptions of the importance of science for their child's future. Parents perceived science as more important for boys than for girls, $F(1,124)=15.71$ (See Figure 18).

Parents' Data for Older Sample. Among the parents of older children, no significant differences occurred in the parents' perception of the importance for their child's future for math, reading, language arts, computer science, music, arts, or social skills as a function of sex of their child. However, there was a significant difference in parents' perception of the importance of science based on the sex of the child. Like parents of younger children, parents of older children perceived science as more important for boys' future than for girls', $F(1,323)=10.40$. Also, parents perceived social studies, $F(1,322)=8.08$, team sports, $F(1,324)=4.59$, as significantly more important for boys' future than for girls. Dance/gymnastics, however, was perceived by parents to be more important for girls' future than for boys', $F(1,320)=6.36$ (See Figure 19).

Parents' Expectations For Children's Performance.

Figures 20-25 present the mean parents' expectation of their children's performance in mathematics, reading, life science, physical science, and other school subject matters.

Combined Sample: In the combined sample of parents of younger and older children, grade level or sex of the child produced no significant differences in parents' expectation of their child's performance in math. However, parents expected older students to perform better than younger students in reading, $F(1,318)=5.84$, and in science, $F(1,316)=12.45$ (See Figure 20). Also, parents expected boys to perform better in science than girls, $F(1,316)=10.23$ (See Figure 21). Furthermore, parents expected similar performances in reading from younger and older girls, but significantly better performances in reading from older boys compared to younger boys, $F(1, 318)=5.65$ (See Figure 22). Finally, there was a second interaction such that parents expected similar performances in science from boys, regardless of grade, while older girls were expected to perform significantly better in science than were younger girls, $F(1,316)=9.21$ (See Figure 23).

Younger Sample. Among parents of younger children, no significant differences appeared in the parents' expectation of their child's performance in math or reading across sex of the child. However, parents expected boys to perform better in science than girls, $F(1,122)=10.80$ (See Figure 24).

Older Sample. Among parents of older children, no significant differences appeared in the parents' expectation of their child's performance in math, reading, language arts, computer science, art, or social skills as a function of the sex of the child. However, parents expected higher performances from boys than from girls in science, $F(1,320)=6.17$, in social studies, $F(1,321)=4.27$, and in team sports, $F(1,321)=5.20$. Conversely, parents expected higher performances from girls than from boys in music, $F(1,321)=4.47$ and in dance/gymnastics, $F(1,318)=16.94$ (See Figure 25).

Positive Affect Or Liking For The Subject Matter.

Combined Sample. Within the entire sample, older students indicated they liked math, $F(1,353)=20.81$, reading, $F(1,354)=5.27$, life science, $F(1,354)=6.68$, and physical science, $F(1,353)=17.59$, better than did younger students (See Figure 26). The only gender difference was that girls more often indicated they liked reading than did boys, $F(1,354)=8.70$ (See Figure 27).

Younger Sample: Among younger students there were no significant sex differences in the children's liking of math, reading, life science, or physical science.

Older Students: Among older students, girls more often indicated that they liked reading, $F(1,183)=7.47$, language arts, $F(1,183)=9.25$, music, $F(1,183)=11.03$, art, $F(1,183)=6.49$, dance/gymnastics, $F(1,183)=58.91$, and social skills, $F(1,183)=6.98$, better than did boys (See Figure 28).

Sex Role Stereotyping Of Jobs Related To The Subject Matters.

Combined Sample: Within the entire sample, younger students perceived jobs relating to reading as more male-dominated than did older students, $F(1,349)=16.02$; older students rated jobs relating to life science as more male-dominated than younger students, $F(1,347)=10.22$ (See Figure 29). While both boys and girls rated math, $F(1,349)=8.02$, life science, $F(1,347)=18.15$, and physical science jobs, $F(1, 348)=5.80$, as more male-dominated, the ratings for boys indicated more male-domination than did girls (See Figure 30).

Younger Sample: Among younger students, boys perceived jobs relating to math as significantly more male-dominated that did girls, $F(1,170)=7.95$. There was no significant sex difference in younger children's perception of sex-domination in jobs relating to reading. However, younger boys perceived life science and physical science related jobs as significantly more male-dominated than did younger girls, $F_{ls}(1,171)=11.12$ and $F_{ps}(1,171)=6.97$ (See Figure 31).

Older Sample: Among older students, boys perceived jobs requiring life science $F(1,176)=6.74$, computer science, $F(1,177)=3.91$, and team sports, $F(1,175)=21.04$, as more male-dominated than did girls (See Figure 32).

Parents' Reported Use of Subject Matters.

Combined Sample. Parents reported using reading skills significantly more often than math skills and, in turn, using math skills more often than those in science, $F(2,680)=157.63$ (See Figure 33).

Differences among the subject matters.

In this section, we discuss differences across subject matters areas for each of the above attitudes. The difference between this section and the previous section is that the focus in the present section was to statistically compare attitudes toward the different subject matters whereas in the previous section, the focus was on comparing gender and grade level differences for each subject matter. In this section separate analyses were conducted for the entire sample, the younger sample and the older sample. We first conducted a mixed gender X grade level X subject matter (math, reading, physical science, life science) ANOVA for the combined data on each variable. These analyses were followed by gender X subject matter ANOVAs for the younger and older samples. To identify where subject matters differed significantly follow-up Newman-Keul's post-hoc analyses were conducted. Thus, when subject matters are reported as significantly different, the analysis was a Newman-Keul's. To save space, details of the Newman-Keul's analyses are not reported. All results reported significant are based on an alpha level of .05 (See Figures 34-62).

Perceived Competence Across Subject Matters.

Combined Sample: Within the entire sample, students perceived their math competence as significantly better than their competence in reading or physical science. In turn, they perceived their reading and life science competence as equal and better than their physical science competence, F(3,1044)=19.46 (See Figure 34). There was a significant gender by subject matter interaction, F(3,1044)=5.76. The Newman-Keuls analyses indicated that kindergarten through sixth grade boys rated their math competence significantly higher than their reading and physical science competence, and their life science competence as higher than that in physical science. Girls indicated higher competence in math and reading as compared to life science and physical science. In turn, girls indicated higher competence in life science than in physical science (See Figure 35).

Younger Sample. Among younger students, there was a significant subject matter effect, F(3,504)=13.41. Students rated their math competence as significantly better than their reading and physical science competence. In turn, younger students perceived their life science and reading competence as similar and both as significantly better than their competence in physical science (See Figure 36).

Older Sample. Among older students, there was also a significant subject matter effect, F(11,1947)=37.41. Students rated their dance/gymnastics ability as lower than their ability in all other subject areas. They also indicated higher perceived ability in computer science, art, social skills, and team sports than in all other subject areas. In turn, students rated their math, life science, and reading ability as higher than their ability in physical science (See Figure 37). The subject matter effect was modified by a significant gender by subject matter interaction, F(11,1947)=16.45. Older boys also rated their dance/gymnastics ability as significantly lower than their ability in all other subject areas. They also indicated higher perceived ability in team sports, art, computer science, social skills, life science, social studies, and math to be higher than their ability in the other subject areas. Finally, older girls rated their ability in social skills, art, computer science, team sports, and reading as significantly better than in all other subjects. In turn, they perceived their music, math, language arts, and life science ability as higher than that in social studies, dance/gymnastics, and physical science (See Figure 38).

Parents' Perception of Child Competence Across Subject Matters. Among all parents and among parents of younger students, there were no significant differences in parents' perception of their child's ability across subject areas.

Older Sample. However, for the older students, there was a significant subject matter main effect, F(10,2970)=30.91 and a significant gender of child by subject matter interaction, F(10,2970)=11.10. Parents of older children perceived their child's ability to be highest in social skills as compared to all other subjects, while they perceived equally low ability in computer science, language arts, and social studies, and lowest in dance/gymnastics (See Figure 39). Parents of older boys also perceived their child's highest ability to be in social skills and their lowest in music, language arts, and dance/gymnastics. Furthermore, parents of older girls perceived their child's highest ability to be in social skills, but their lowest ability to be in dance/gymnastics and social studies (See Figure 40).

Reported Effort.

Older Sample: There were significant subject matter, F(11,1892)=2.12, and sex by subject matter effects, F(11,1892)=40.59, for older students' reported effort.

Students reported expending the highest effort in social studies and the lowest in dance/gymnastics and music, but this main effect was modified by the significant interaction. While boys displayed a similar pattern, girls reported their greatest effort in dance/gymnastics (See Figures 41 - 42).

Expected Grade.

Older Sample: There were significant subject, $F(11,1892)=2.66$, and sex by subject matter effects, $F(11,1892)=13.52$, for expected grade. Concerning grades across the different subject areas, older students expected higher grades in art, team sports, and social skills than in all other subjects. They also expected significantly lower grades in dance/gymnastics and in physical science (See Figure 43). Older boys expected equally higher grades in art and team sports compared to all other subject areas and a significantly lower grade in dance/gymnastics. Older girls, however, expected higher performances in art, social skills, computer science, reading, language arts, music, and team sports than in all other subject areas and lowest grades in physical science and dance/gymnastics (See Figure 44).

Importance Of Subject Matter.

Older sample. There were significant subject, $F(11,1936)=62.42$, and sex by subject effects, $F(11,1936)=4.98$, for older students' perception of the importance of the subject matter. Older students rated social skills, reading, and math as the three most important subjects, more so than all other subject areas. Art was rated the third least important subject, music the second to least, and dance/gymnastics as the very least important subject area (See Figure 45). Older boys rated social skills as most important, followed by reading, math, and team sports as equally more important than the other areas. They indicated the same pattern for the least important subject areas as the older students indicated overall. Finally, older girls rated social skills, reading, and math as the most important subject areas. Furthermore, they ranked language arts, computer science, and life science as significantly more important than the other subject areas and music and dance/gymnastics as the two least important areas (See Figure 46).

Parents' Data On Subject Matter Importance – Combined Sample. Within the entire sample of parents, there were significant subject matter, $F(2,636)=83.38$, grade level by subject matter, $F(2,636)=4.56$, sex of child by subject matter, $F(2,636)=14.52$, and grade level by sex of child by subject matter, $F(2,636)=6.02$, effects. Overall, parents perceived reading to be more important than both math and science and, in turn, math to be more important to their child's future than science (See Figure 47).

Furthermore, parents perceived math and reading to be equally important and more important than science for younger students. For older students, parents perceived reading to be most important and math to be more important than science (See Figure 48). Parents of boys perceived math and reading to be equally more important than science in their child's future. Parents of girls, however, perceived reading to be most important and math to be subsequently more important than science (See Figure 49). Finally, parents perceived math and reading to be equally more important than science for younger and older boys, as well as younger girls. However, for older girls they perceived reading to be significantly more important than the other two subjects and, in turn, math to be more important than science (See Figure 50).

Parents' Data On Subject Matter Importance – Younger Sample. Among the parents of younger children, there were significant differences in the perceived importance of subjects across the areas, $F(2,248)=46.12$. The sex of child by subject matter interactions was also significant, $F(2,248)=14.23$. Overall, parents perceived math and reading as equally important to the future of their child, and both as more important than science (See Figure 51). Parents reported similar ratings for younger boys and for younger girls (See Figure 52).

Parents' Data On Subject Matter Importance – Older Sample. Among the parents of older children, there were also a significant subject matter effect, $F(10,3160)=425.80$, and a sex by subject matter interaction, $F(10,3160)=5.26$. Parents perceived social skills and reading as more important than all other subject areas, followed by math and computer science. Furthermore, parents of older children perceived team sports, art, music, and dance/gymnastics as the four least important subject matters (See Figure 53). Parents reported similar ratings for older boys and older girls (See Figure 54).

Parental Expectations for Performance.

Combined Sample. Within the entire sample of parents, there were subject, $F(2,630)=18.28$, grade level by subject, $F(2,630)=4.38$, sex of child by subject, $F(2,630)=11.13$, and grade level by sex of child by subject effects, $F(2,630)=17.60$. Overall, parents expected equally better performances in math and reading than in science (See Figure 55). Parents expected similar patterns of performance from younger and older students, as well as from girls (See Figure 56). However, parents of boys expected equally high performances in math, reading, and science (See Figure 57). Parents expected younger boys to perform higher in math and science than in reading. Parents of older boys expected their sons to do better in math and reading as compared to science. Parents also expected younger girls to perform better in math and reading than in science, but they expected older girls to perform equally well in all three subjects (See Figure 58).

Younger Sample. Parents of younger students expected equally higher performances in math and reading than in science, $F(2,242)=11.64$ (See Figure 59). Also, parents expected young boys to perform better in math than in reading, while they expected young girls to perform better in math and reading than in science, $F(2,242)=16.90$ (See Figure 60).

Older Sample. There was a significant main effect of subject matter, $F(10,3130)=145.42$. Among parents of older children, parents expected highest performance in social skills, followed by science and social studies. Conversely, they expected lowest performance in music, art, and dance/gymnastics (See Figure 61). Also, there was a significant gender X subject matter interaction, $F(10,3130)=8.02$. Parents expected older boys to perform best in social skills followed by math, reading, and computer science, with lowest expectations for performance in music, art, and dance/gymnastics. Parents expected older girls to perform best in social skills followed by reading and computer science, with lowest expectations for performance in music, team sports, art, and dance/gymnastics (See Figure 62).

Positive Affect or Liking of the Subject Matters.

Combined Sample. Overall, students indicated they liked math, reading, and life science equally and each better than physical science, $F(3,1062)=12.28$ (See Figure 63). There was a significant gender X subject matter interaction, $F(3,1062)=2.74$. Boys rated math and life science as better liked than physical science, while girls indicated liking math, reading, and life science better than physical science (See Figure 64).

Younger Sample. Younger students reported liking life science, reading, and math equally well and each significantly better than physical science, $F(3,510)=8.23$ (See Figure 65).

Older Sample. There was a significant main effect of subject matter, $F(11,1980)=40.90$. Overall, older students indicated liking team sports better than all other subject areas and liking dance/gymnastics and music least of all subjects (See Figure 66). There was a significant gender X subject matter interaction, $F(11,1980)=11.28$. Older boys also indicated liking team sports better than all other subject areas and liking language arts, music, and dance/gymnastics least of all subjects. Older girls indicated liking arts and social skills best and physical science, dance/gymnastics, and music least (See Figure 67).

Sex Role Stereotyping of Subject Matters.

Combined Sample. For the entire sample, there was a significant main effect of subject matter, $F(3,1032)=82.72$ and a significant grade level X subject matter interaction, $F(3,1032)=9.48$. Overall, jobs requiring physical science competence were perceived as more male-dominated than jobs requiring math. In turn, jobs requiring life science were perceived to be more male-dominated than math, which was rated as more male-dominated, still, than reading (See Figure 68). Younger students perceived jobs requiring physical science as more male-dominated than those requiring math, reading, or life science. In turn, younger students perceived jobs requiring life science as more male-dominated than those in reading. Older students rated physical science and life science jobs as equally more male-dominated than jobs requiring math and jobs requiring reading (See Figure 69).

Younger Sample. Among younger students, there was only a significant main effect of subject matter, $F(3,510)=30.09$. Students perceived jobs requiring physical science to be more male-dominated than those requiring math, reading, or life science, . In turn, jobs requiring life science were perceived to be more male-dominated than those requiring reading (See Figure 70).

Older Sample. Only the main effect of subject matter was significant, $F(11,1804)=45.87$. Among older students, jobs requiring team sports and physical science were perceived to be more male-dominated than all other career areas. Life science and social studies were also perceived significantly male-dominated, while language arts, reading, and dance/gymnastics were perceived as the least male-dominated (See Figure 71).

Relationship Of Student Variables To Parental Variables.

To assess the extent to which parent and student attitudes related across each of the school subject-matter-specific attitudes discussed, we calculated correlation coefficients and conducted regression analyses between parent and student variables. In the present paper, only the correlation coefficients are discussed. (Appendix 2 briefly reports some of the regression analyses.) Because of the large numbers of correlations, only a limited subset are described in this section. Appendix 1 provides a verbal description of the correlations. Tables 2 and 3 report correlation coefficients between parent data and student data for mothers and father, respectively, for the combined sample. What is reported are the correlations between parallel items on the parent questionnaire and the student questionnaires.

In general, most of the signficant correlations between parent and child data are weak. Correlations also tend to be weaker for the younger than the older sample. Some of the interesting and more substantial correlations include the following. Both mothers' and fathers' perceptions of child competence are fairly strongly correlated with the students' self-perceptions of competence, particularly for the older sample. By the time students are in the upper elementary grades, parents and students have received considerable formal and informal feedback from the school relating to the child's performance. It seems plausible that these relatively strong relationships between mothers' and fathers' perceptions and childrens' perceptions are conditioned by the schools' feedback about the child. Consistent with this explanation is the fact that both mothers' and fathers' perceptions about competence tended to be correlated with the expected grades reported by the older children.

For the younger sample, mothers' perception of competence in reading was fairly strongly correlated with the children's perception. It may be that mothers are more likely than fathers to be involved in reading activities with the child or that mothers pay closer attention to their child's school performance at this younger age.

While the relationships are fairly weak, the pattern of differences between mothers and fathers in correlations among parent perceptions and child liking of subject matter matter were interesting. For older children, mothers' perceptions of competence were correlated with childs' liking of reading, math, and life science; fathers' perceptions of competence were correlated with childs' liking of physical and life science. For younger students, mothers' perception of competence was correlated with liking of reading; fathers' perception of the importance of physical science was correlated with childs' liking of physical science; mothers' perception of importance were correlated with childs' liking of math, reading, and physical science. While the importance of such weak relationships should not be overemphasized, the pattern is roughly consistent with a position that fathers emphasize achievement and performance in the science more than do mothers and mothers emphasize achievement and performance in reading more than do fathers.

It is important to note what was not significant. Children's ratings of subject matter importance bore no relationship to parents' perceptions of subject matter importance. In facts, students' importance rating did not relate to parent variables at all.

Of course, the reported correlations are descriptive and should not be over-interpreted. Many of the observed relationships are plausible and it is possible to speculate about theoretical connections. But the relationships should not be considered only in isolated pairs. We intend to pursue multiple regression analyses and path analyses to examine further relationships between parental variables and student variables. Even given their weaknesses, the present correlations are sufficiently interesting to suggest that more sophisticated research examining relationships between parental variables and students variables for specific subject matters would be worth pursuing.

Discussion

The primary purpose of this study was to describe attitudes toward science and other subject matter areas in a sample of elementary students and their parents. As noted in the introduction, much research on attitudes had used students older than elementary level studies of students' attitudes at the younger elementary level have been relatively rare. The present study included students at grades K-3 and 4-6. Thus it extended the available database of knowledge for students in younger grades. A wider range of attitudes (perceived competence, positive affect, perceived importance, sex-role stereotyping, perceived effort expended) was examined than in most previous research. A wider range of subject matters was examined than in most previous research. Parents' attitudes about their own and their child's competence in different subject matters, their expectations of subject matters, and parents' perceived importance of different subject matters were obtained. Thus, the primary contribution of the present study is to extend the descriptive database about the attitudes of children and parents about science and other subject matters. While we recognize that theoretically motivated research is essential, we also believe that the development of a descriptive database about attitudes is necessary to assess the influence of programs designed to change attitudes. For example, the new national science teaching standards promote more constructive learning experiences for students. The standards explicitly encourage more positive attitudes and the instructional procedures implied by the standards should promote affective as well as cognitive changes. Systematically surveying students attitudes could provide evidence of change (or no change) as the standards become more widely adopted.

One problem with descriptive databases is that they are difficult to summarize. In this discussion, we will focus on a few of the findings that seem particularly of interest in the light of previous research and contemporary issues.

Self-perceived competencies.

Self-perceived competencies appeared to follow the cultural stereotypes of girls rating their reading ability higher than boys and boys rating their physical science ability higher than girls. The cultural stereotypes appear to be true starting with the older age group. As self-confidence is a trait that is usually reported as being lower in females than males, it is positive to note that the difference was not found for the younger age group. This study separated science into the physical and biological sciences. Gender differences were found in the physical sciences only. In studies where the sciences are grouped as one, these differences may not appear.

Positive affect. Previous research had suggested that gender differences in attitudes are smaller at the elementary school level than at middle and secondary levels (Kahle and Meece, 1994). This finding was partially supported in the present data. Students in grades K-3 did not differ in their perceived competence in reading, math, physical science or life science. For students in grades 4-6, girls rated their reading competence higher than did boys; boys rated their physical science competence higher than did girls. Similarly there were no gender differences in positive affect or liking of the four subject matters for the K-3 students. For the grades 4-6 students, girls and boys also did not differ in their liking of life science or physical science; but girls indicated a stronger preference for reading and language arts than did boys. Thus, there was some support for greater gender differentiation in the older grades. But, as discussed more completely below, it was the case that even students in grades K-3 displayed attitudinal differences in the sex-role stereotypes associated with subject areas. Clearly, not all gender related attitudinal differences emerge only at the end of the elementary years.

The finding that boys and girls did not differ in science preference, but girls had a stronger reading preference in the older grades, may be important. Marsh (1990) has argued that internal frames of reference, as well as external frames of reference, play a role in developing subject matter specific self-concept. Subject matter self-concepts relate to motivation, and persistence in those subjects. Secondary school girls have lower persistence and enrollment in the physical science pipeline and women have lower participation in physical science careers. The present data suggests that the genesis of these gender differences may be different than is commonly believed. The differences may arise partially in the perception of elementary level girls, not that they are worse than boys in physical science or that they like physical science less than boys, but that they are better in reading and like reading more than they like physical science.

The mixed ANOVAs involving comparisons across subject matters bear on this issue. In the combined sample, students liked physical science less than they did reading, math, or life science. This same pattern held for students in the younger sample. Girls in the older sample rated physical science among their least liked subjects. That physical science is not liked at the elementary level is a cause for concern. Lucrative technically oriented careers require much training in physical science. The relatively negative attitudes of students at the elementary level portend that many students will find other areas more enjoyable and will elect to pursue other career options. If girls see their reading skills stronger and enjoy reading more, then, they should be relatively more likely than boys to select themselves out of careers that require physical science. It is interesting to think that girls are just as positive as boys about science, but they have several areas that they are very positive about to choose among. What the present data suggests is that, contrary to findings that

We believe that this finding suggests an important line of research. Some research has explored how parents interact with children in science museums; other research has examined differences in teachers' behavior to the genders. Almost no research has examined parental reactions to students' school related work. Are there differences in how parents behave when a girl or boy brings home a good or bad science paper as compared to a reading paper? Is the bad science paper for a girl more excused than a bad reading paper would be? Are girls not encouraged in particular areas because parents perceive they lack competence. Such research would be difficult to accomplish, but would be extremely valuable in teasing out the nature of parent and child interactions that influence attitudinal development.

Limitations.

There are a number of obvious limitations in the present data. The sample of students and parents, while selected to represent diversity in Iowa, was certainly not representative of the national school population. Because of the demographic make-up of Iowa, European-American students predominate; and African-American, Asian American, and Hispanic American students represent a lower proportion of the school population than they do nationally. While the sample reflected urban and rural diversity in Iowa, Iowa has no truly large urban area. The instruments used represent a survey of opinions and attitudes. Analyses were based on single items and thus reliability information cannot be ascertained. That the patterns of relationships found bear similarity to previous research supports the validity of the information obtained, however. The statistical approach in the present report could be questioned. For the overall sample, we did mixed ANOVAs involving Gender X Grade Level X Subject Matter and then also analyzed each subject matter with a Gender X Grade Level ANOVA. We repeated this same pattern in separate groups of analyses of the younger and older samples. Obviously this approach involves repeated analyses over common data. We believe that this does not represent a serious problem for a number of reasons. First of all, the number of significant results greatly exceeds that that would be expected by chance. Second, our purpose was descriptive and we were not assessing theoretical issues. Third, as noted, many of the patterns of differences found were consistent with previous research. Finally, that our purpose was descriptive is a weakness. Theoretically motivated research is important and, when done well, probably more of value than more descriptive research. But description is important as well, as we have argued above. Thus despite its limitations, we believe that the present study has value because it does describe more comprehensively than any research of which we are aware the attitudes of elementary students across a wider range of grades and wider range of attitudes . The inclusion of parental data also adds to the value of the present data.

Concluding Statement.

Overall, the findings in this study extend to younger ages cultural stereotypes relative to self-perceived competencies in various subject, parent perceived competencies for children, parent perceived importance of subjects, parent expectations for children based on gender, and stereotypes about the male or female dominance of professions. The surprising information was that many of the emphasize gender differences that emerge at the middle school level, the roots of gender differences in the physical science pipeline may stretch into early elementary school.

Sex-role stereotyping of jobs

Our data with respect to sex-role stereotyping support this hypothesis. Ratings of the sex-role stereotyping of jobs also followed the cultural stereotype with both boys and girls rating jobs that relate to math, life science and physical science as more male-dominated. Boys saw these jobs as more male-dominated than did girls. Clearly the stereotypes of jobs that relate to math and the sciences as male professions are present in both age and gender groups. Perception of a gender domination of a profession relates strongly to its selection by males and females (Reid and Stephens, 1985). The sex-role stereotyping of occupations that we observed by such young children points to a need for career education and work with positive role models to begin at an earlier age than may be the norm in most schools.

Parent perceived competencies of children and perceived importance of subject matters

Parents perceived their older students as more able in science than the younger students and perceived boys as more able than girls. These differences were not found for mathematics or reading. A similar pattern was true for the younger students also. Even at grade level K-3, parents perceive boys as more able than girls. Parent perceptions of the abilities of their children may be a powerful developmental influence on how the children will come to view their ability. In turn, children's perceptions of their abilities will influence expectations for success, achievement, interest in school subjects, and future careers.

Parents appear to recognize the importance of math and reading for both younger and older students and no gender differences were found. Math and reading are the two major focus subjects throughout elementary school and parents clearly have recognized the importance of these basic skills. Some interesting differences were noticed for science. Parents perceived science as more important for older students than for younger students and when gender was considered, science was perceived as equally important for younger and older boys. When older and younger girls were compared, science was perceived by parents to be significantly more important for older girls than younger girls. Science was considered to be more important for boys than girls in both age groups. Importance of a subject area to the child's future as perceived by the parents may have all kinds of implications. Perceived importance may directly affect the amount of encouragement a parent would provide to child and the opportunities provided to the child that may be manifest in the type of activities, toys, and reading materials provided. As a child becomes older, importance is undoubtedly related to the belief of certain subject areas being important because they are important for future jobs. Again our data raise the possibility that the stage for selection of science or non science careers may originate as early as the K-3 age level because parents already perceive science as more important for male students.

stereotypes were already present at the younger grade levels. Other unexpected findings were the information relative to positive affect towards biological and physical sciences. The data suggest that elementary school girls like these areas as much as do boys. If this is the case, then the differences observed in course selection and achievement at higher educational levels and career choice and retention as adults are likely to reflect cultural bias imposed on our youth.

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Table 1. Number of students and parents

	Boys	Girls	Mothers	Fathers
Kindergarten	10	12	0	0
First	31	20	28	7
Second	38	34	40	7
Third	27	22	40	3
Total	**106**	**88**	**108**	**17**
Fourth	34	20	25	16
Fifth	72	71	102	35
Sixth	26	20	36	8
Total	**132**	**111**	**163**	**59**

Table 2. Students' Attitude Correlations with Mothers' Attitudes.

Mothers' Variables	Students' Variables: Perceived Self-Competence		Reported Liking		Expected Grade	Perceived Importance
	Younger (N=102)	Older (N=126)	Younger (N=101)	Older (N=126)	Older (N=126)	Older (N=124)
Perception of Child's Ability						
Math	.14	.39*	.10	.20*	.43*	-.03
Reading	.47*	.52*	.33*	.30*	.44*	.13
Life Science	.06	.31*	-.02	.22*	.23*	-.04
Physical Science	-.01	.24*	.03	.10	.25*	.01
Perceived Self-Competence						
Math	-.11	.34*	.01	.35*	.29*	.16
Reading	.18*	.13	.05	.08	.32*	-.12
Life Science	-.10	.04	-.19	.15	-.01	.17
Physical Science	.05	-.03	-.04	.02	.01	.16
Reported Use						
Math	-.05	.24*	-.03	.25*	.17	.03
Reading	.28*	.04	.16	.02	.37*	-.17
Life Science	.02	.02	-.14	.09	-.04	.09
Physical Science	-.05	.06	-.13	.03	-.01	.03
Perception of Importance						
Math	-.03	.20*	.06	.27*	.04	.07
Reading	-.04	.27*	.03	.23*	.20*	-.05
Life Science	-.05	.25*	.10	.16	.09	.10
Physical Science	-.06	.27*	.02	.20*	.06	.08
Expectation for Performance						
Math	-.08	.23*	-.02	.10	.30*	.00
Reading	.21*	.22*	.06	.13	.24*	.15
Life Science	.01	.05	-.04	.12	.06	.03
Physical Science	.07	.13	.04	.07	.10	.07

*p<.05

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Table 3. Students' Attitude Correlations with Fathers' Attitudes.

	Students' Variables					
Fathers' Variables	Perceived Self-Competence		Reported Liking		Expected Grade	Perceived Importance
	Younger (N=17)	Older (N=52)	Younger (N=17)	Older (N=51)	Older (N=52)	Older (N=52)
Perception of Child's Ability						
Math	-.27	.40*	-.10	.06	.39*	.00
Reading	-.20	.45*	-.21	.08	.23	-.06
Life Science	.14	.44*	-.01	.39*	.26	.16
Physical Science	-.15	.42*	.19	.31*	.38*	.02
Perceived Self-Competence						
Math	.17	.07	-.34	.09	.13	-.02
Reading	.32	.12	.29	.08	-.04	-.02
Life Science	.05	.11	.19	.12	.20	.03
Physical Science	-.06	.14	-.03	.04	.14	-.16
Reported Use						
Math	-.18	.08	.	.13	.00	.21
Reading	.19	.13	.	-.05	-.07	.01
Life Science	.12	.03	.16	.17	.17	.23
Physical Science	.05	.06	.28	.24	.16	-.10
Perception of Importance						
Math	.	.20	.10	.05	.28	-.02
Reading	.	.01	-.22	.12	.13	.10
Life Science	.33	.01	.11	-.09	-.06	.04
Physical Science	.40	-.05	.48*	.01	-.01	-.03
Expectation for Performance						
Math	.34	.23	-.02	.06	.11	.02
Reading	-.28	.24	.06	.21	.10	.05
Life Science	.40	.14	-.04	.09	.04	-.04
Physical Science	.06	.04	.04	-.18	-.04	-.03

*p<.05

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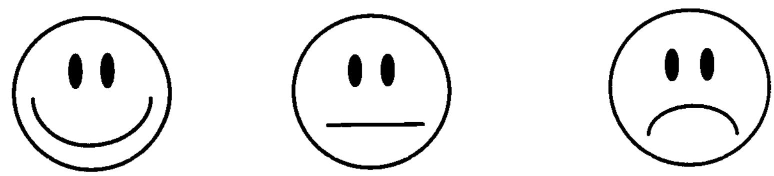
Directions: I am going to ask you some questions about certain subjects and activities. I'll read the questions aloud. Please listen carefully and follow along with me as I read each statement. Then put an X on the picture that is the best answer for you. Be honest with your answers. Remember there are no wrong answers.

Put your finger on number 1. Math. If you think you are good at math, put an X on the face with a smile. If you think you do OK in math, put an X on the face with a straight mouth. If don't think you are good at math, put an X on the face with a frown. (Teacher continues with same instructions for each subject.)

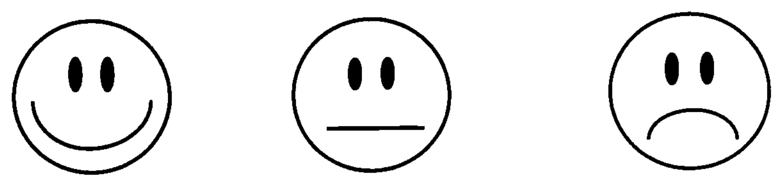
1. Math
Put an X over how good you feel you are at math.



Good | OK | Not Very Good

Do you like the following areas? Put an X over the face that is your answer.

2. Math
Do you like math?.



Yes, I like it! | It is OK. | No, I don't like it.

Put an X on the picture that is your answer.

9. Math

Who works at jobs that use a lot of math?

Mostly Men | Men and Women | Mostly Women

Figure 1. Sample of items used with the children in grades k-3.

1. Please circle how good you feel you are in the following areas:

	Really Good	Good	Just OK	Not So Good	Not Good At All
Math	5	4	3	2	1

2. Please circle how hard you work in the following areas:

	Really Hard	Hard	Just So	Not So Hard	Not Hard At All
Math	5	4	3	2	1

3. Considering what you want to be when you grow up, what subject/areas are really important for you?

	Really Important	Important	Some Importance	Not Very Important	Not Important At All
Math	5	4	3	2	1

4. If grades were given in your school for all of these subjects/areas, what grade would you expect to earn in the following:

Math	A	B	C	D	F

10. How much do you like the following areas?

	Very Much	Some	Neutral	Not Much	Not at All
Math	5	4	3	2	1

11. Circle the number that tells who you think holds jobs in the following areas.

	Almost All Men	More Men Than Women	Equal Numbers	More Women Than Men	Almost All Women
Math	5	4	3	2	1

Figure 2. Sample items from the survey administered to children in grades 4-6.

Perceived Child Competence. Please circle how good you feel your child (child listed above only) is in the following:					
	Really Good	Good	Just OK	Not So Good	Not Good At All
Math	5	4	3	2	1
Perceived Self-Competence: Please circle how good you feel *you* are in the following:					
	Really Good	Good	Just OK	Not So Good	Not Good At All
Math	5	4	3	2	1
Usage: On a scale of 5 to 1, with 5 being extensive usage, please circle how much *you* have used the following subjects/areas in your everyday life.					
	Extensive Use				Not Used At All
Math					
Importance. On a scale of 5 to 1, with 5 being really important, how important are the following subjects/areas for your *child* in order for the child to be successful at what he/she will be doing when he/she grows up.					
	Really Important				Not Important At All
Math	5	4	3	2	1
Performance Expectation. On a scale of 5 to 1, with 5 being excellent performance, how well do you .expect your child to perform in the following					
	Excellent Performan ce				Not Perform Well At All
Math	5	4	3	2	1

Figure 3: A sample of parent items that illustrates both the content and format of the scales.

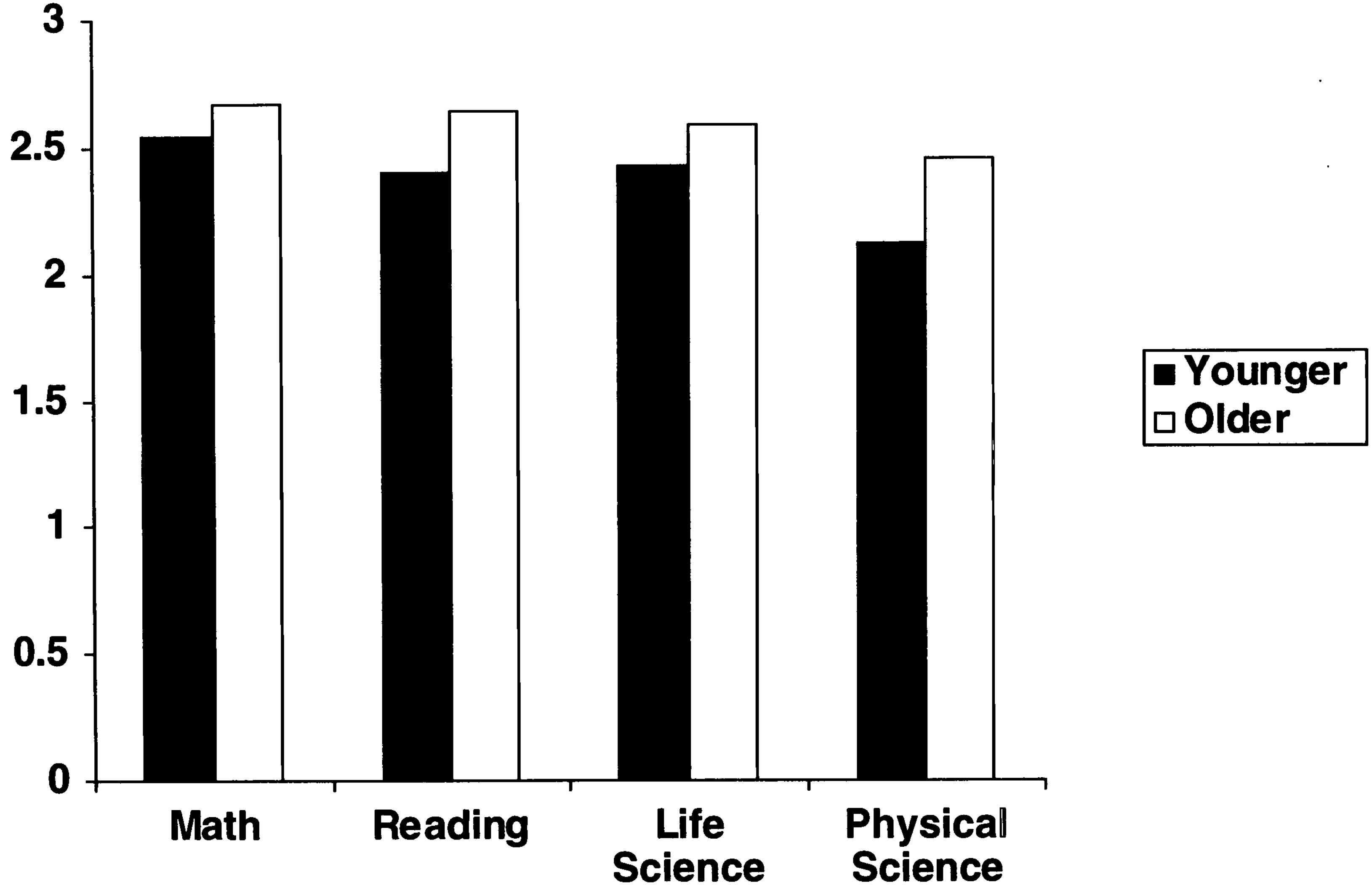


Figure 4. Mean self-rated ability of K-6 grade students as a function of subject matter and grade level. (Within subject matters, all grade level differences are significant.)

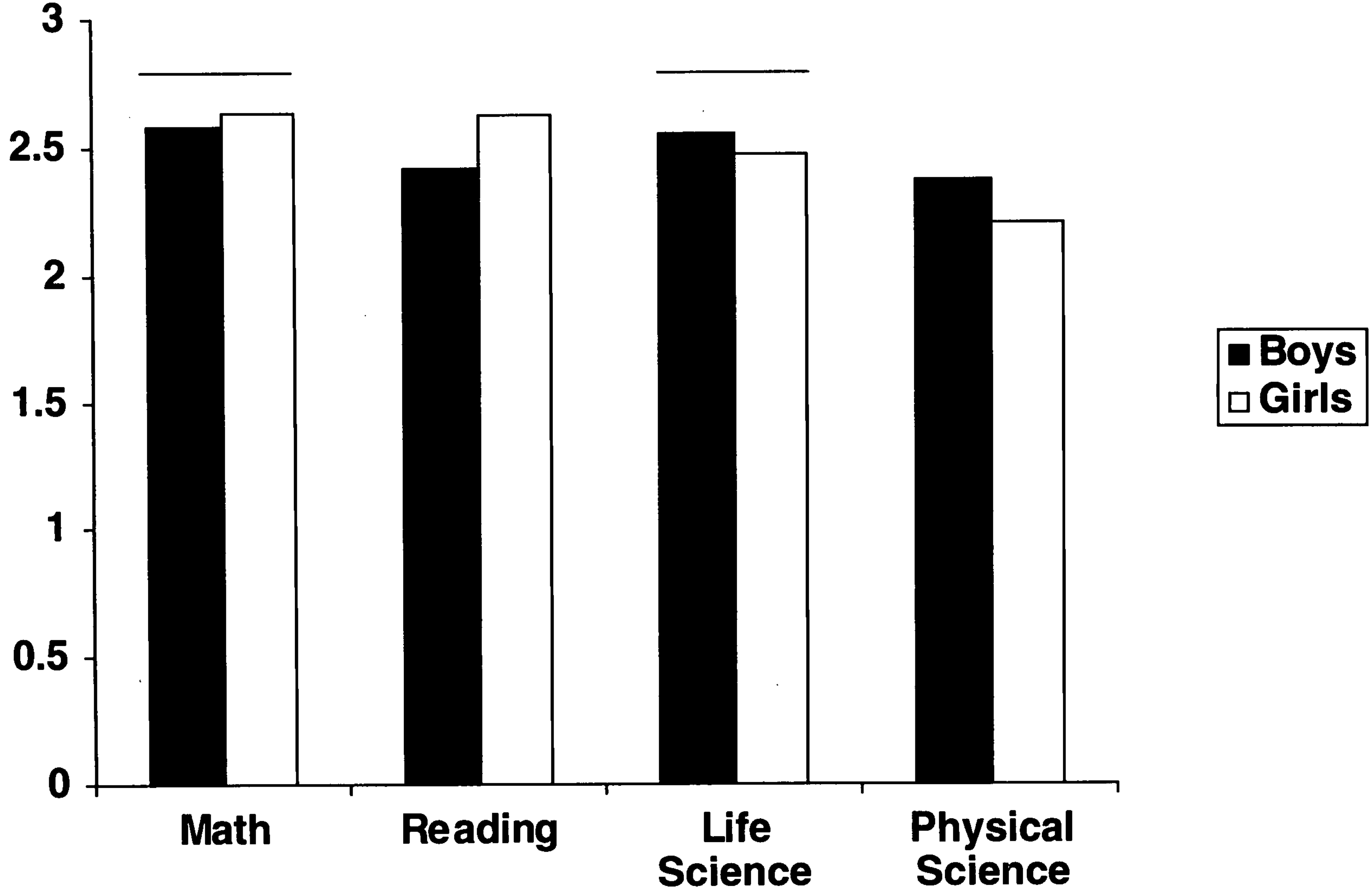


Figure 5. Mean self-rated ability by K-6 grade students as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

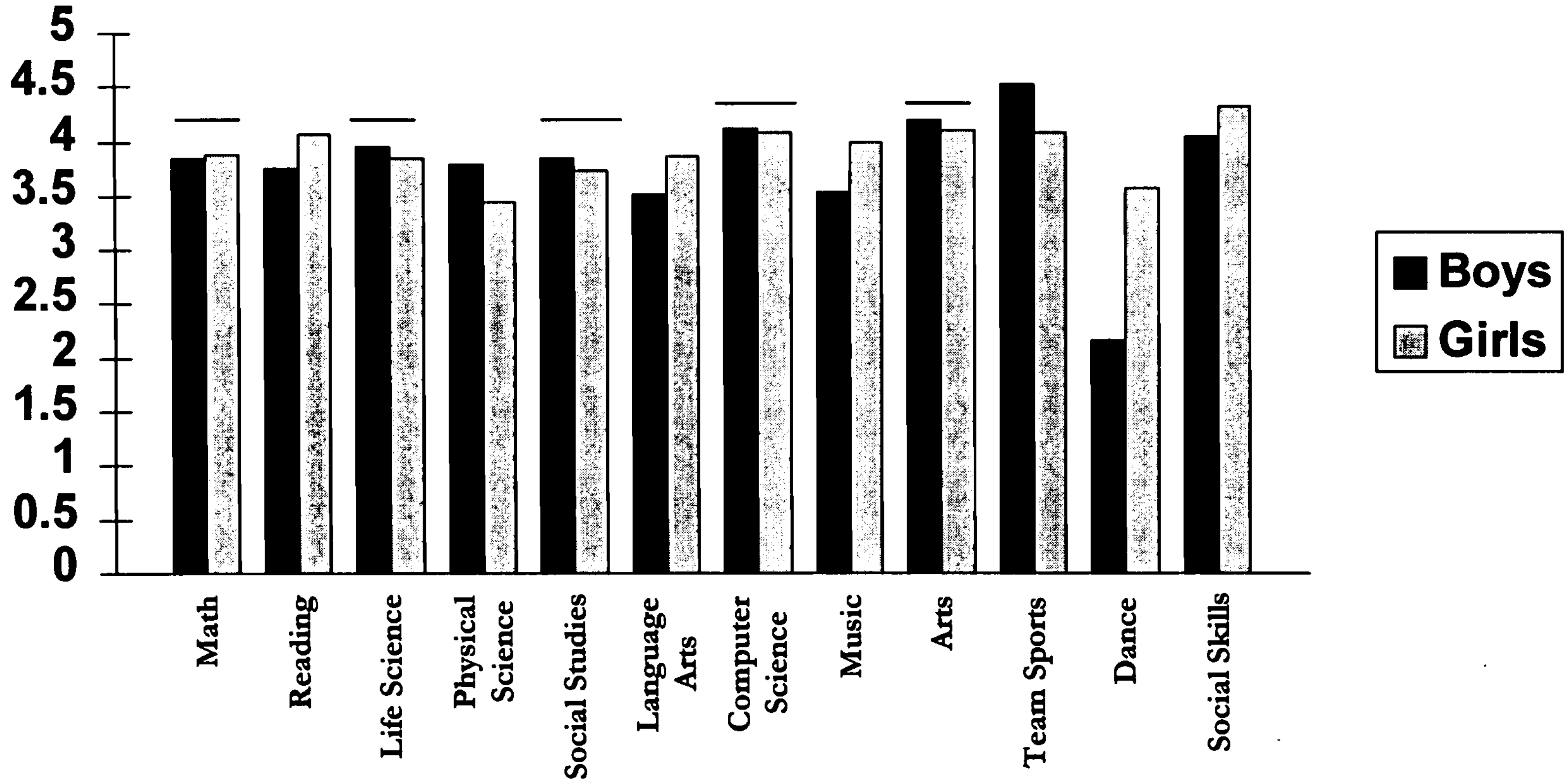


Figure 6. Fourth-sixth grade students' mean self-rated ability as a function of subject matter and gender. (Within subject matters, bars with overlines are not significantly different.)

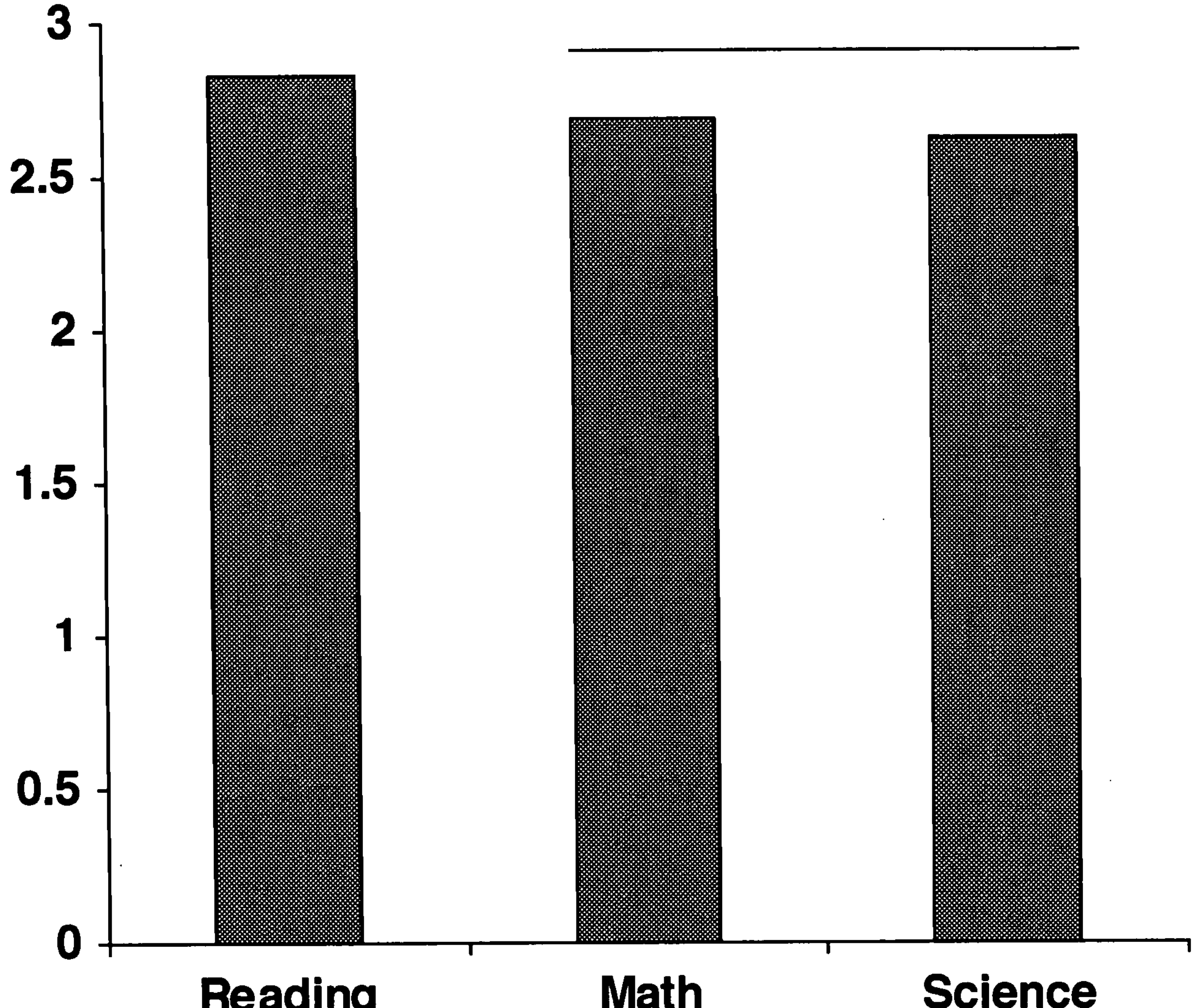


Figure 7. Mean self-rated ability of parents as a function of subject matter. (Bars with common overlines are not significantly different.)

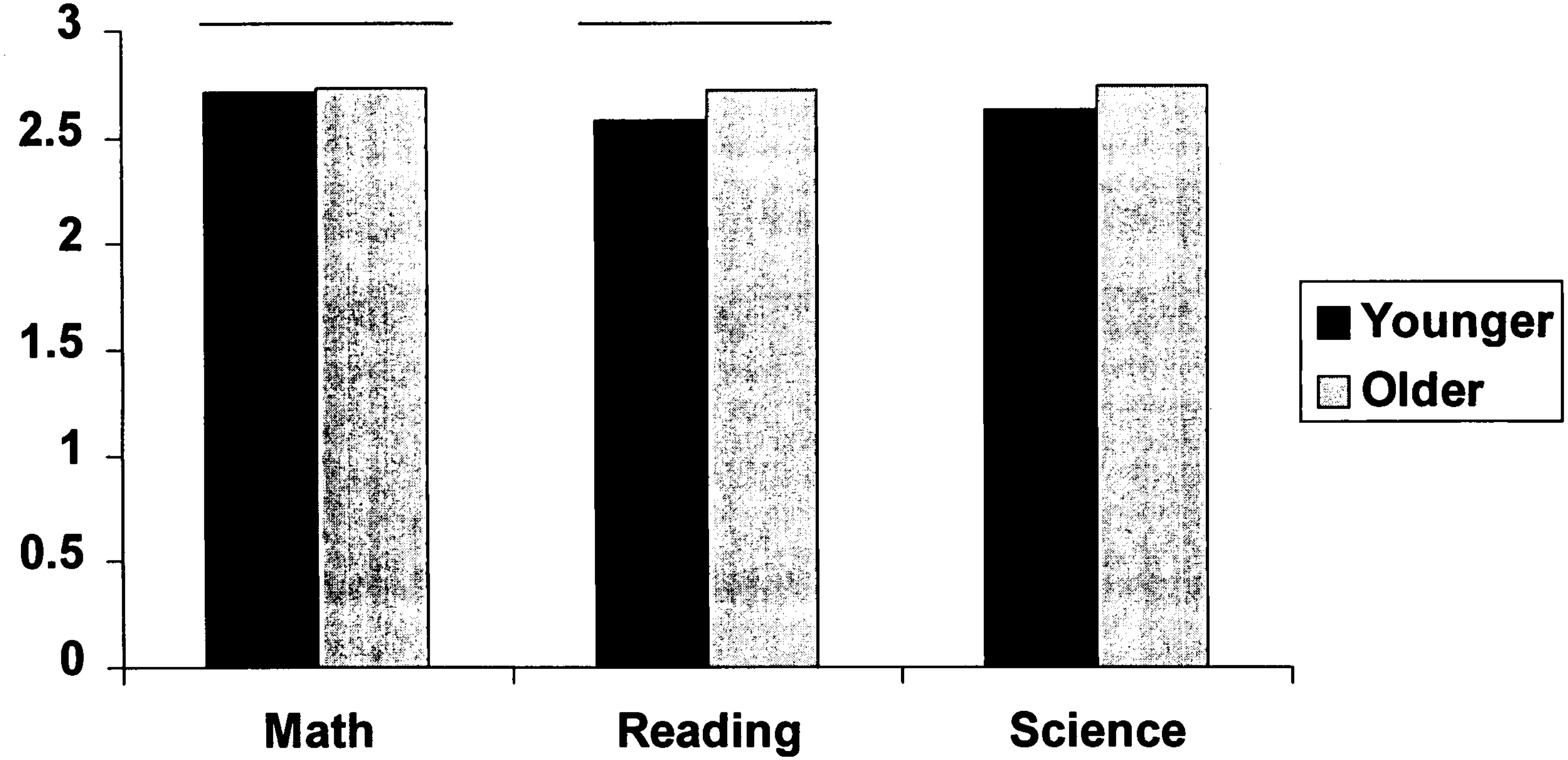


Figure 8. Parents' mean rating of K-6 grade students' ability as a function of grade level. (Bars with common overlines are not significantly different.)

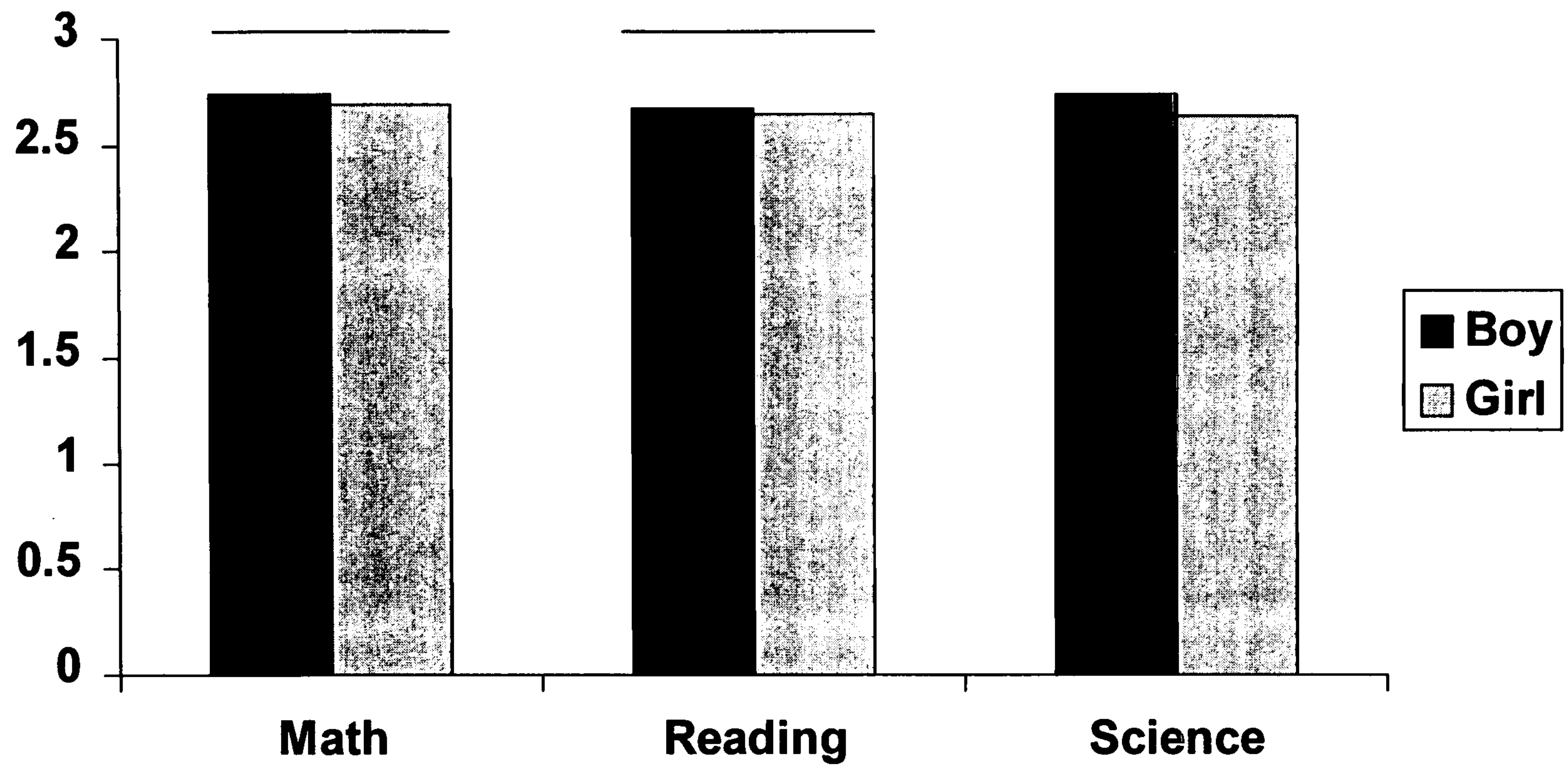


Figure 9. Parents' mean rating of K-6 grade students' ability as a function of gender. (Bars with common overlines are not significantly different.)

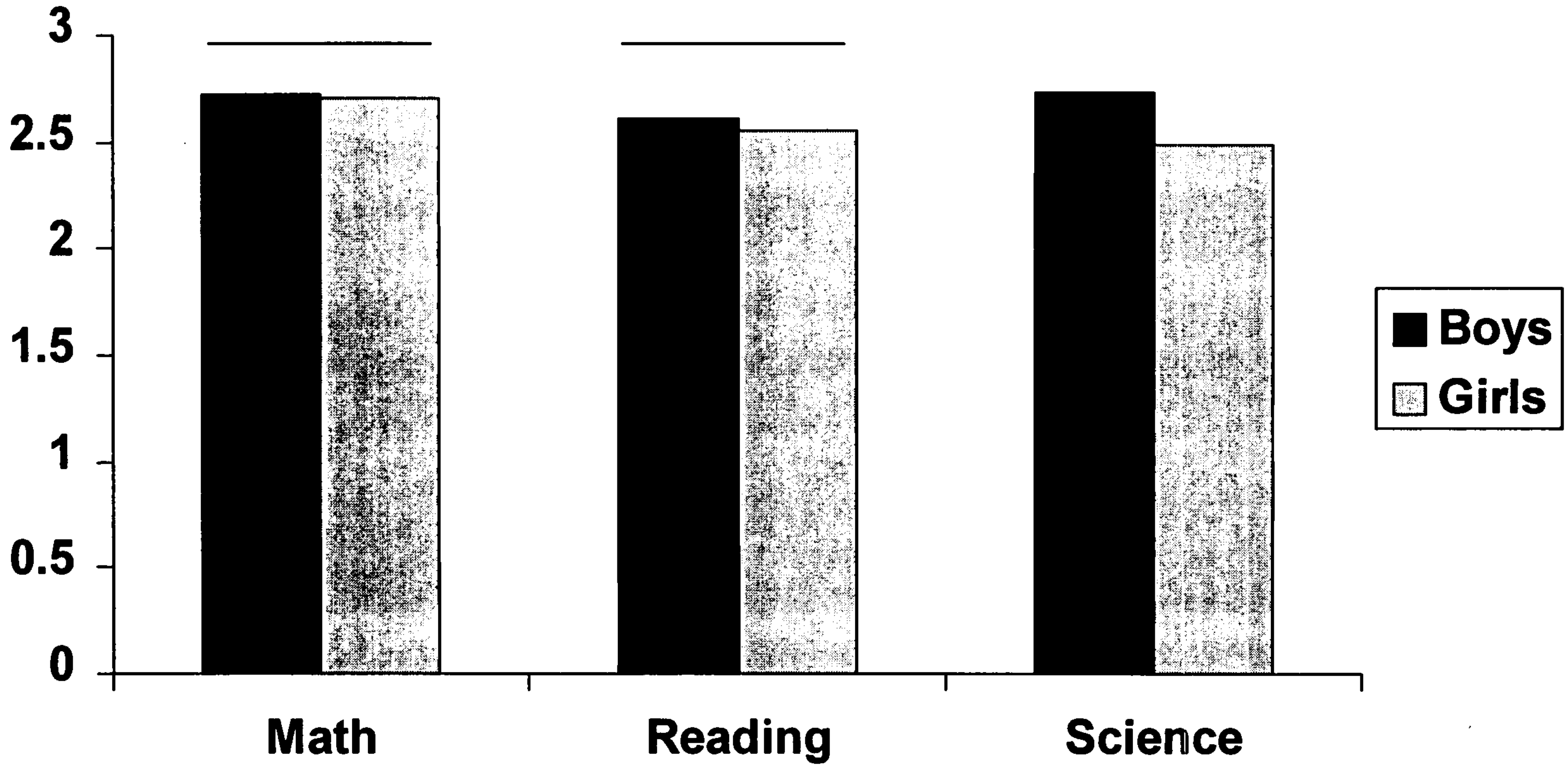


Figure 10. Parents' mean rating of K-3 grade students' ability as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

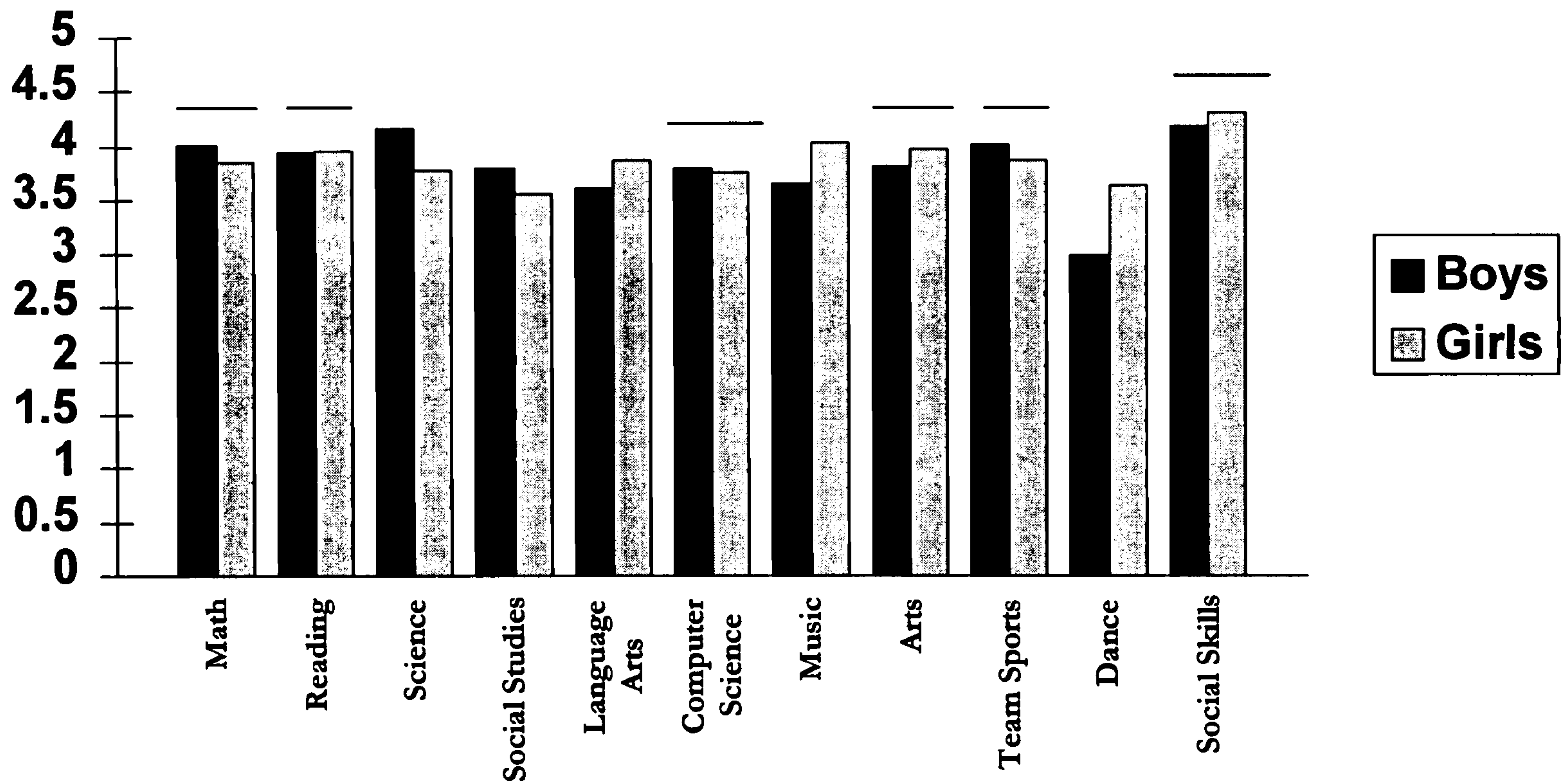


Figure 11. Parents' mean rating of 4-6 grade students' ability as a function of subject matter and gender. (Within subject matters, bars with overlines are not significantly different.)

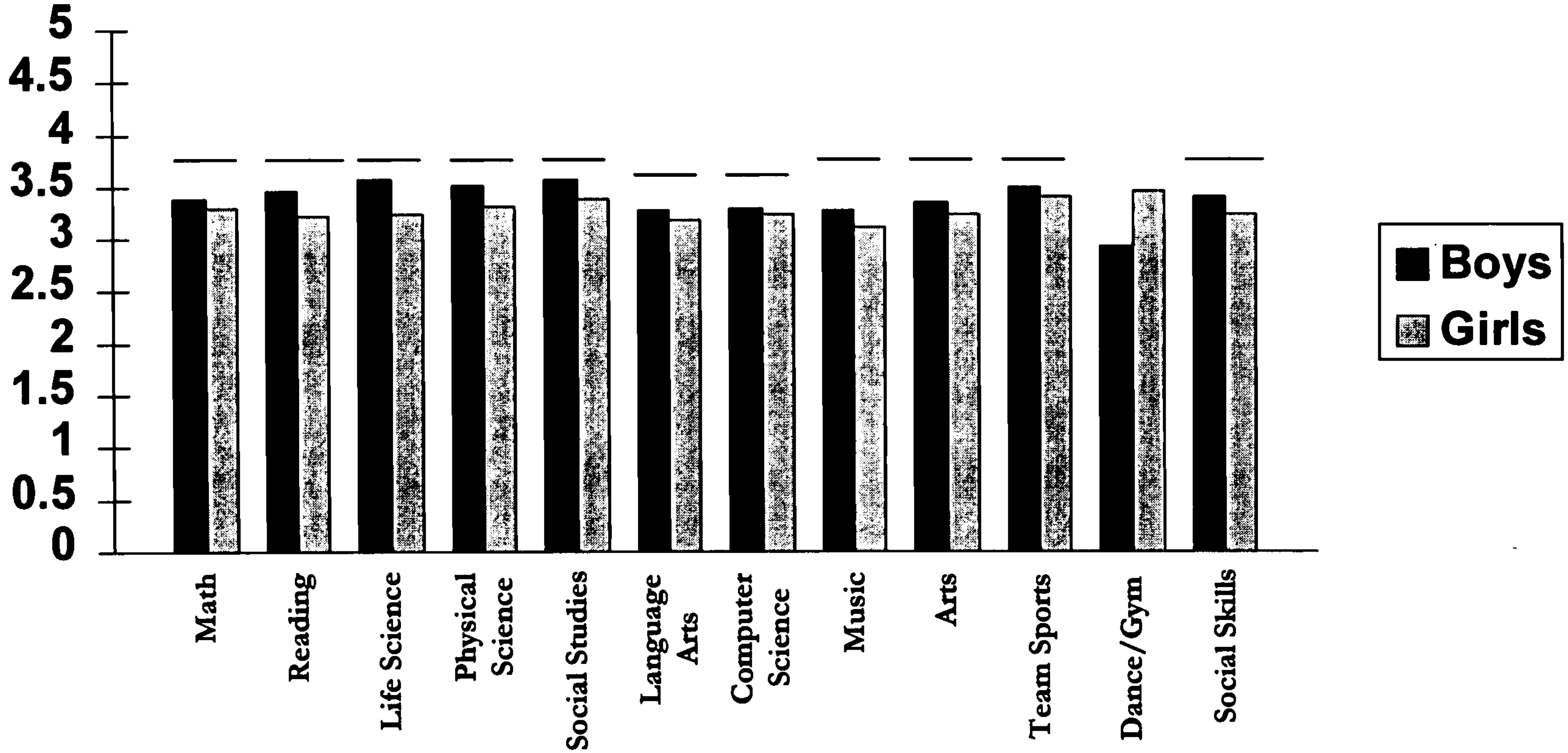


Figure 12. Fourth-sixth grade students' mean reported effort as a function of subject matter and gender. (Bars with overlines are not significantly different.)

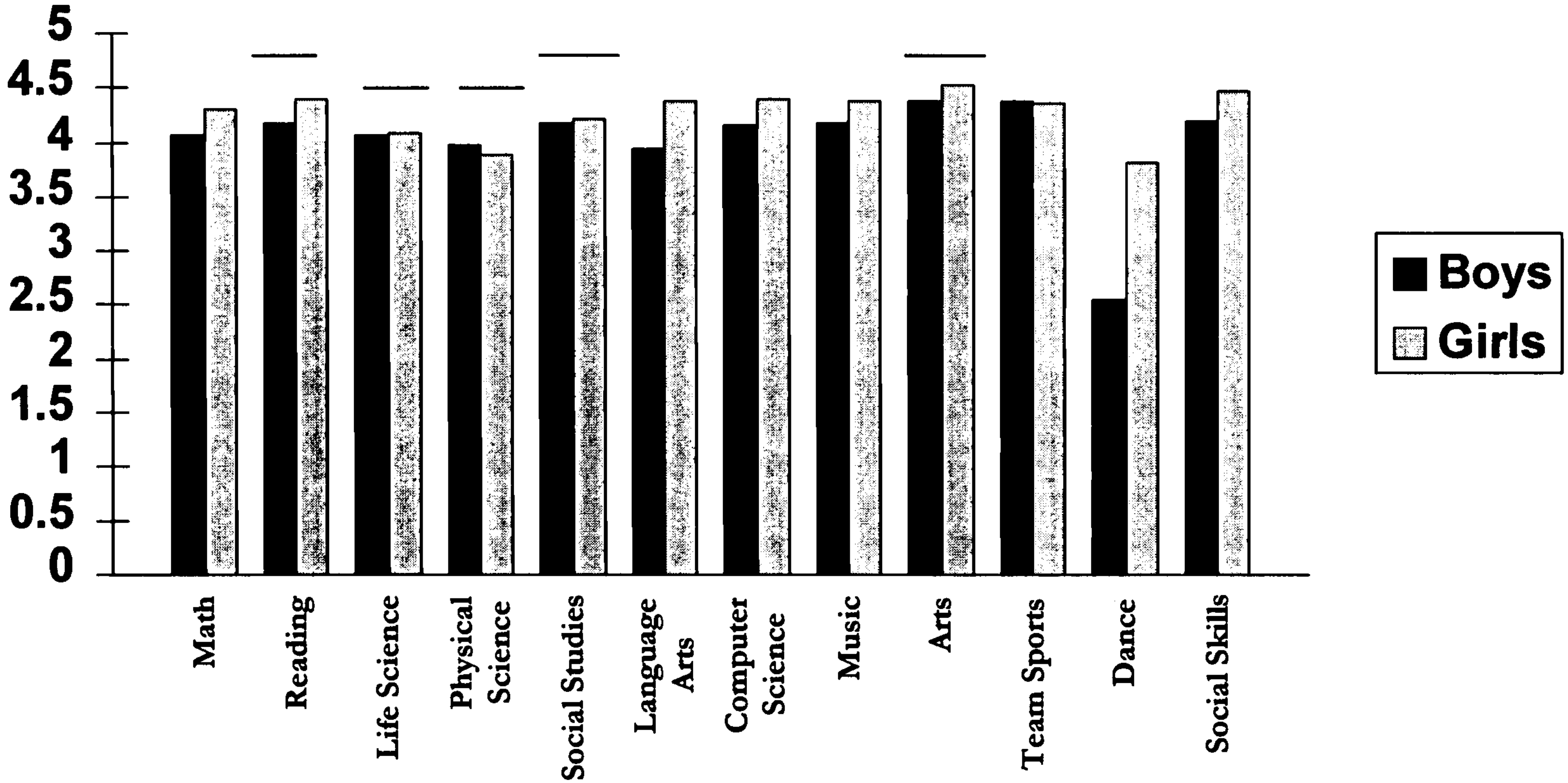


Figure 13. Fourth-sixth grade students' mean expected grade as a function of subject matter and gender. (Within subject matters, bars with overlines are not significantly different.)

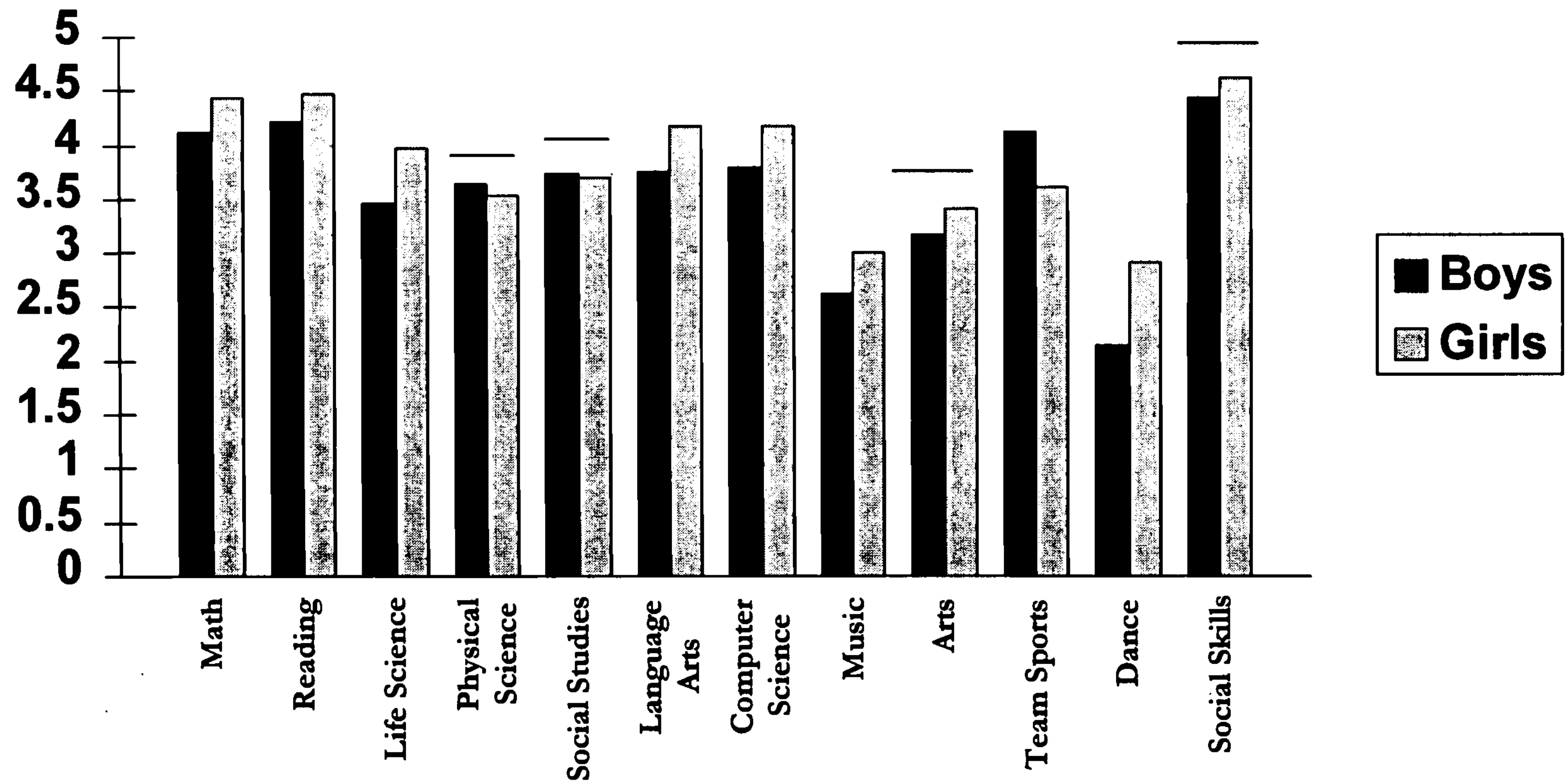


Figure 14. Fourth-sixth grade students' mean perceived importance of subject matter as a function of gender. (Within subject matters, bars with overlines are not significantly different.)

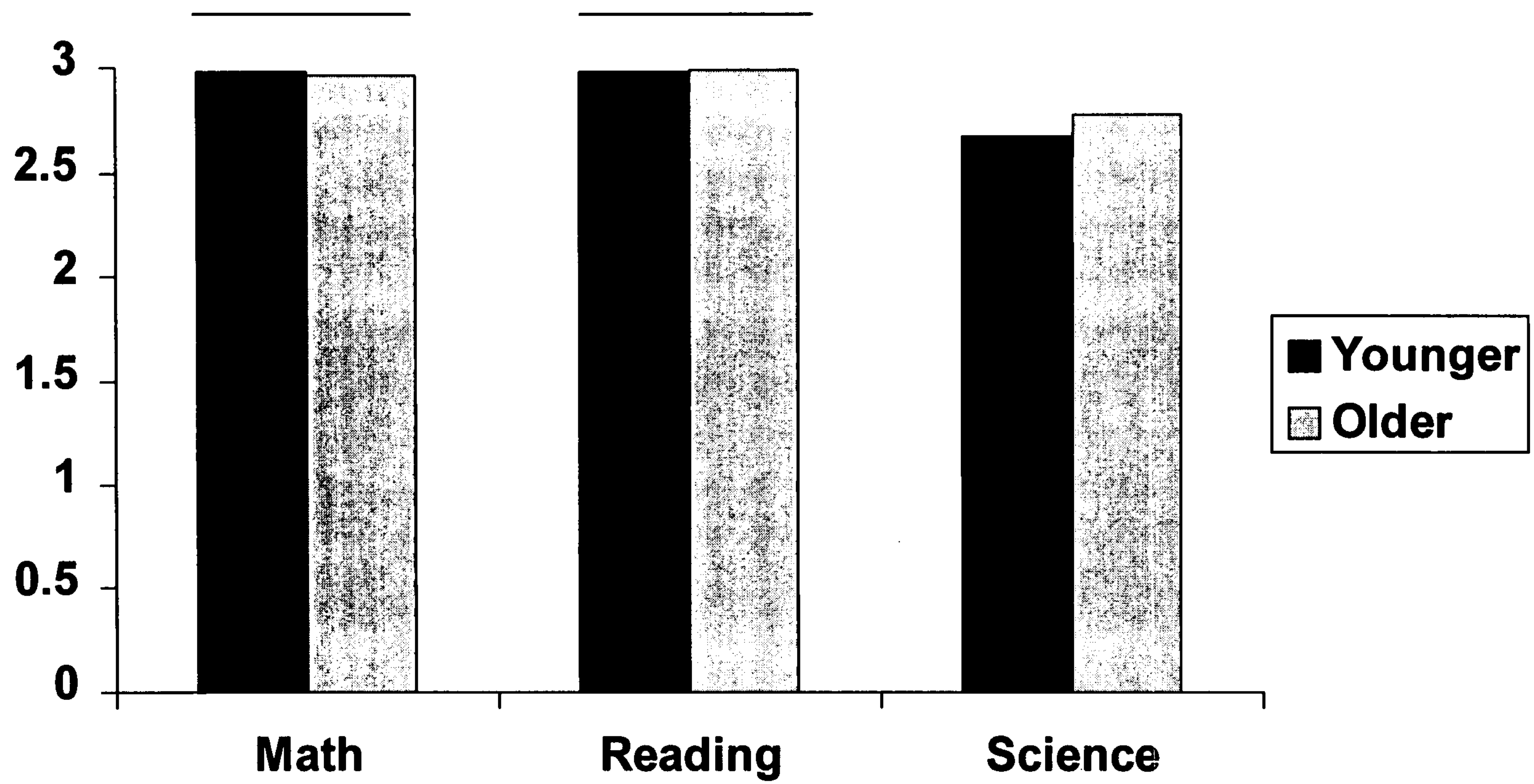


Figure 15. Parents' mean rating of the importance of subject matter for K-6 grade students as a function of grade level. (Within subject matters, bars with common overlines are not significantly different.)

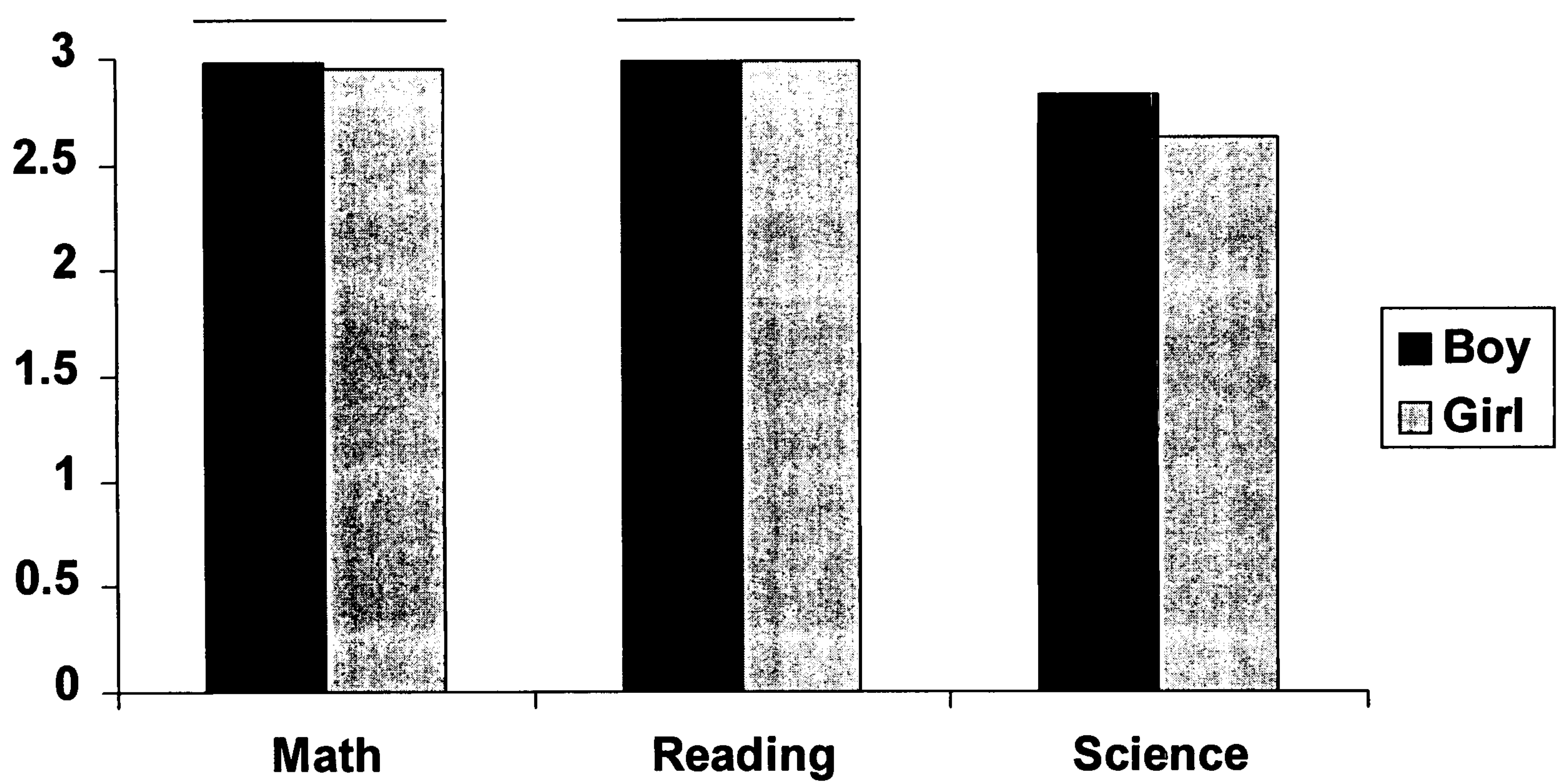


Figure 16. Parents' mean rating of the importance of the subject matter for K-6 grade students' as a function of gender. (Within subject matters, bars with common overlines are not significantly different.)

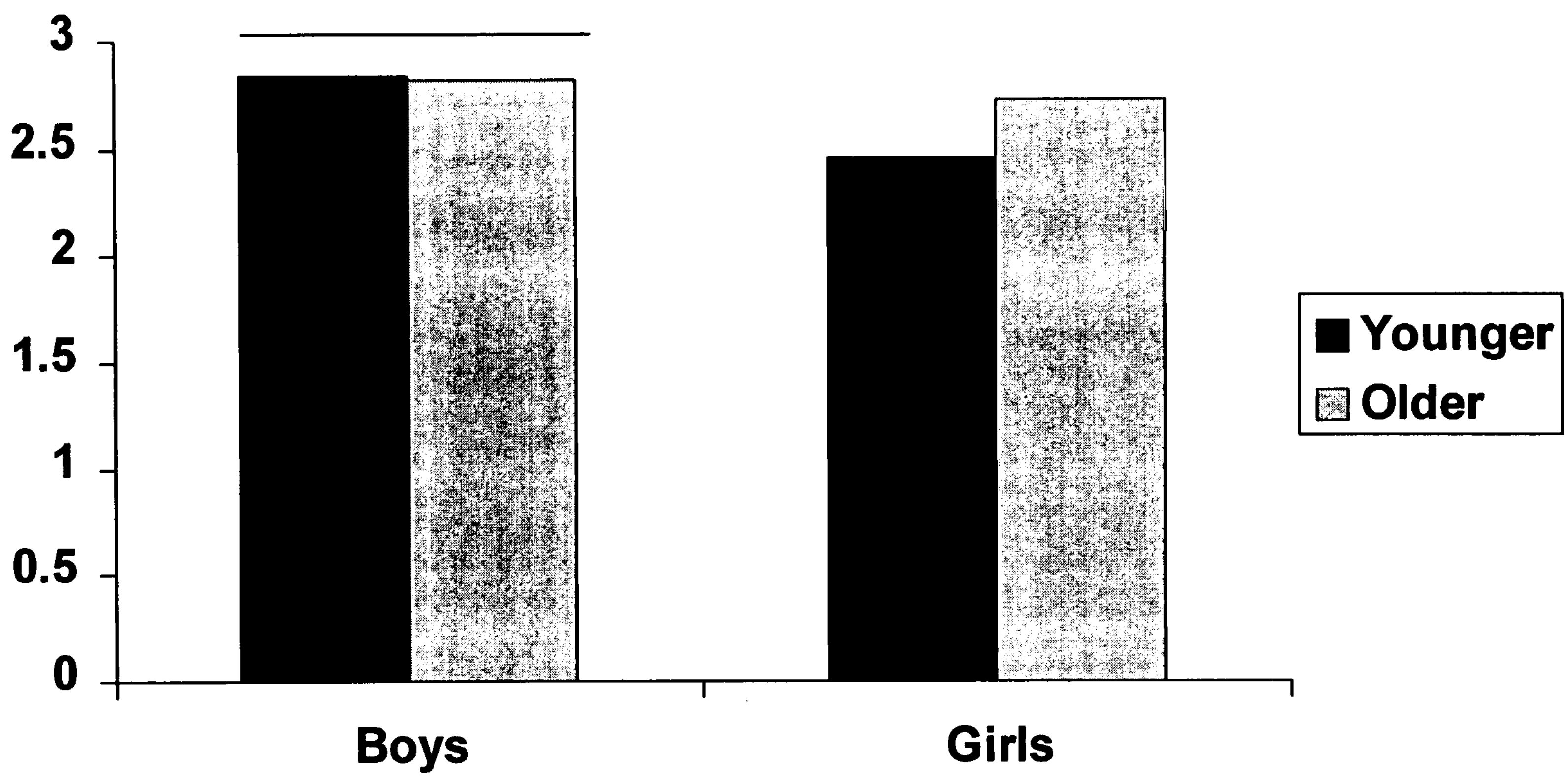


Figure 17. Parents' mean perception of the importance of **science** to their K-6 grade students' future as a function of grade level and gender. (Bars with common overlines are not significantly different.)

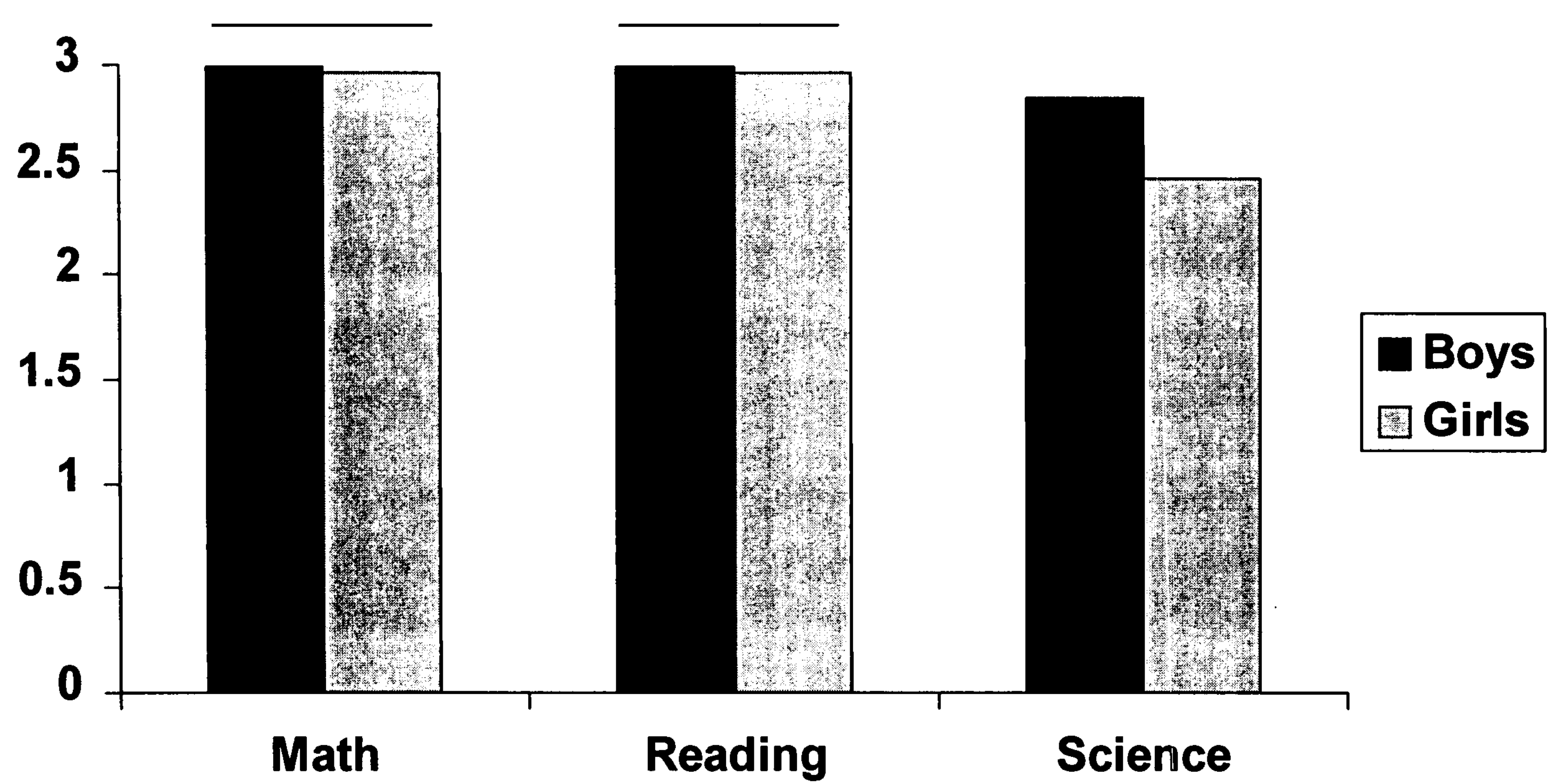


Figure 18. Parents' mean rating of the importance of subject matter for K-3 grade students' as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

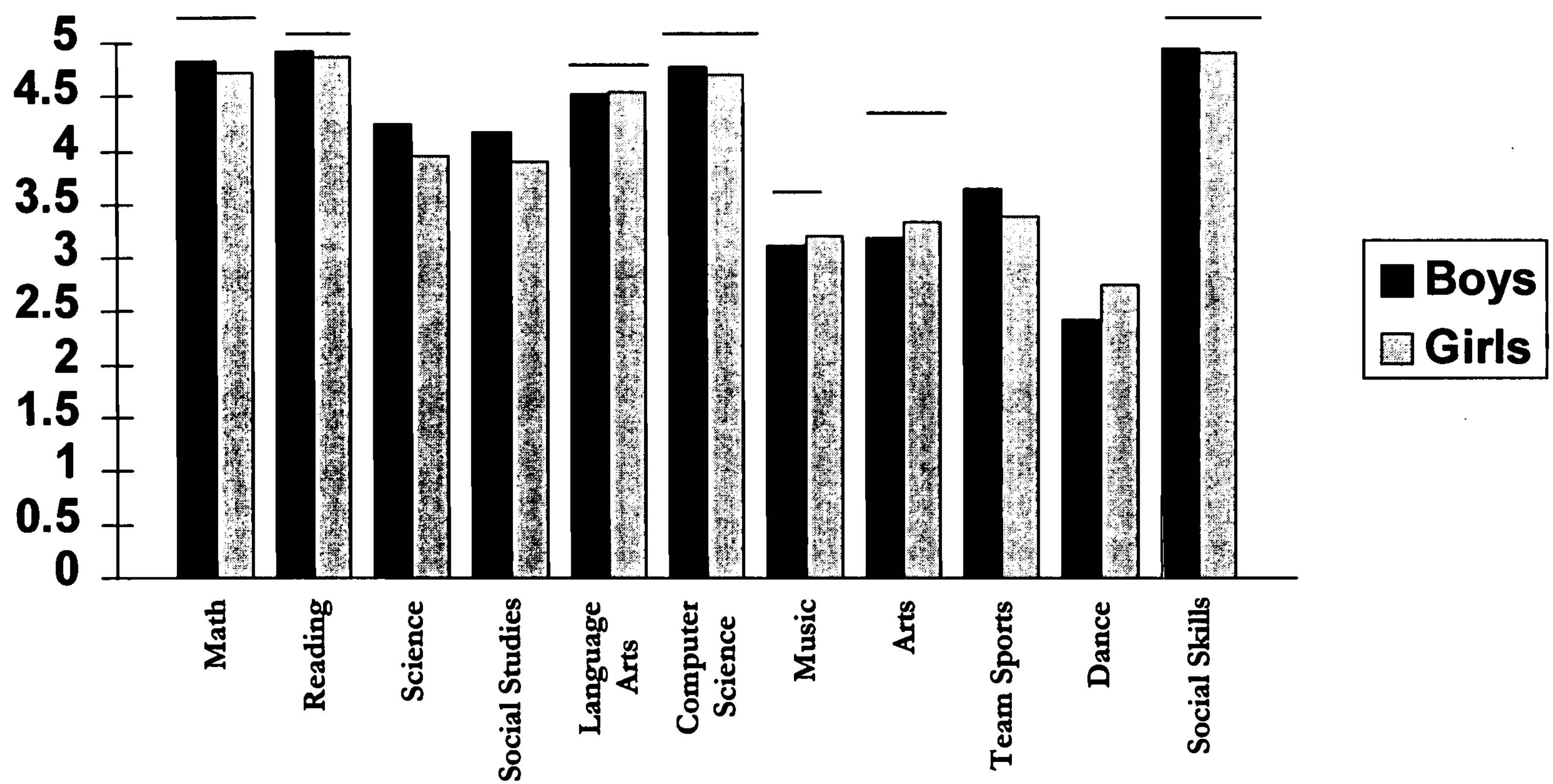


Figure 19. Parents' mean rating of the importance of subject matter for 4-6 grade students as a function of subject matter and gender. (Within subject matters, bars with overlines are not significantly different.)

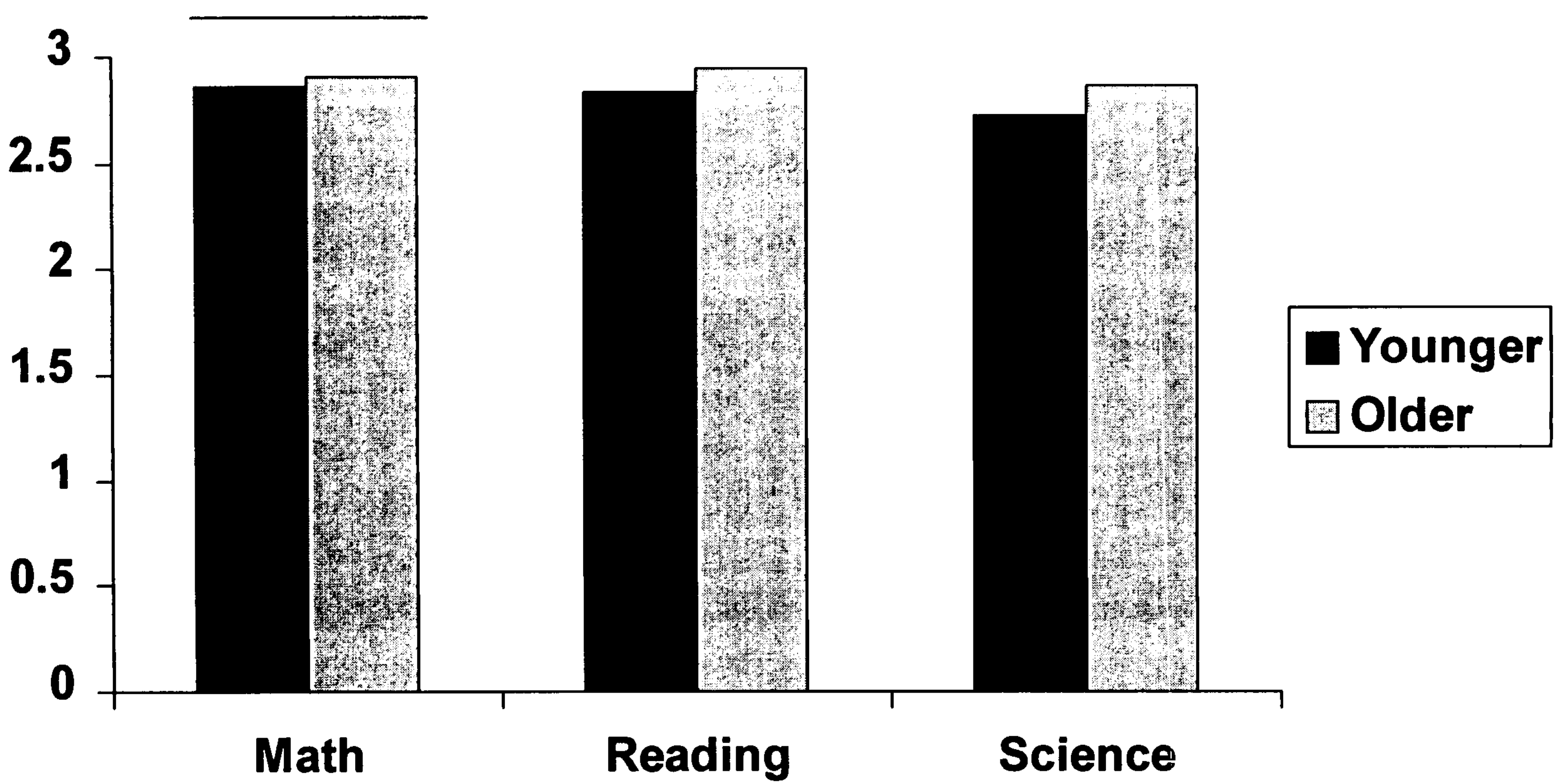


Figure 20. Parents' mean expectation for perfomance from K-6 grade students as a function of subject matter and grade level. (Within subject matters, bars with common overlines are not significantly different.)

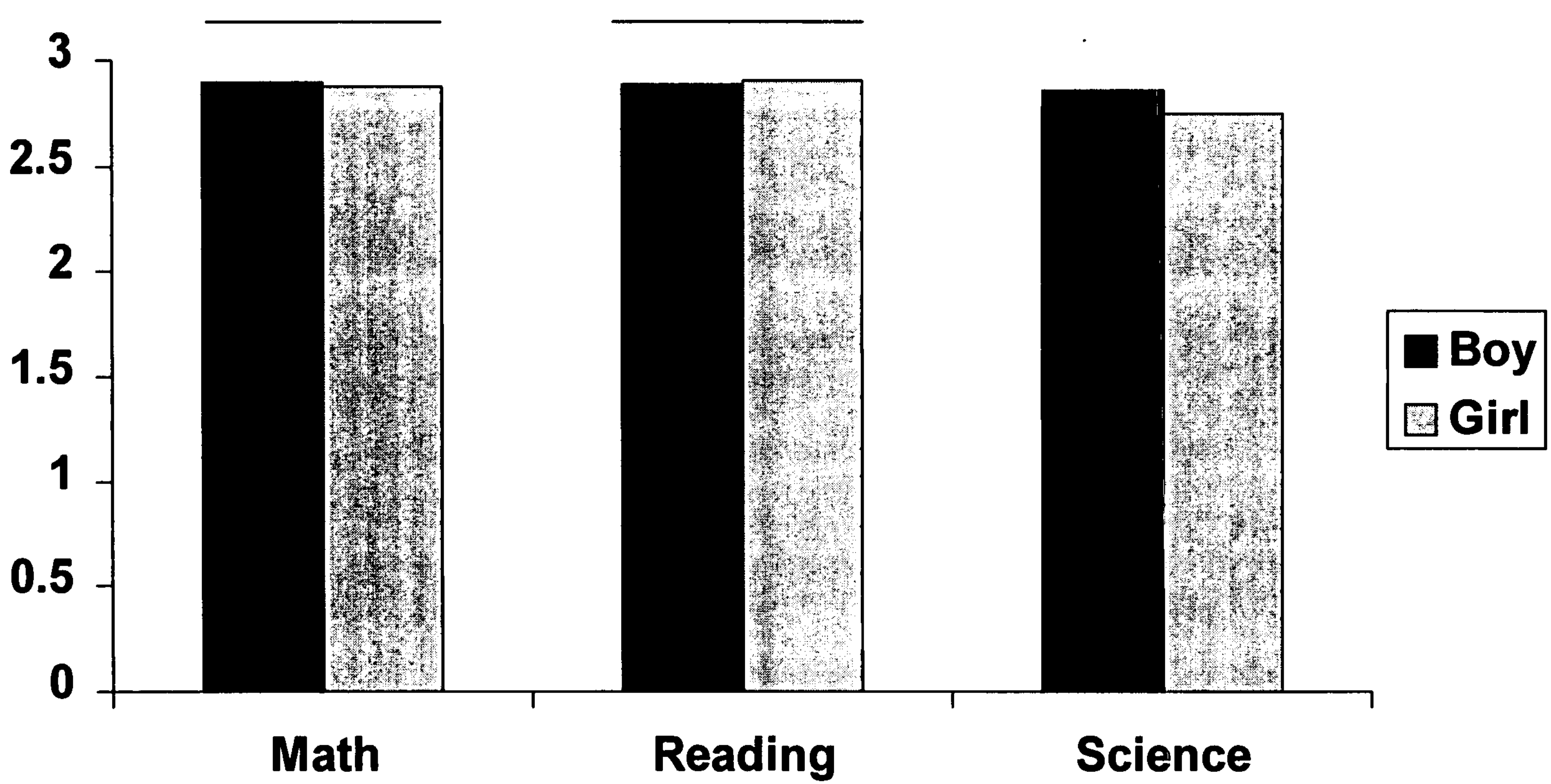


Figure 21. Parents' mean expectation for perfomance from K-6 grade students as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

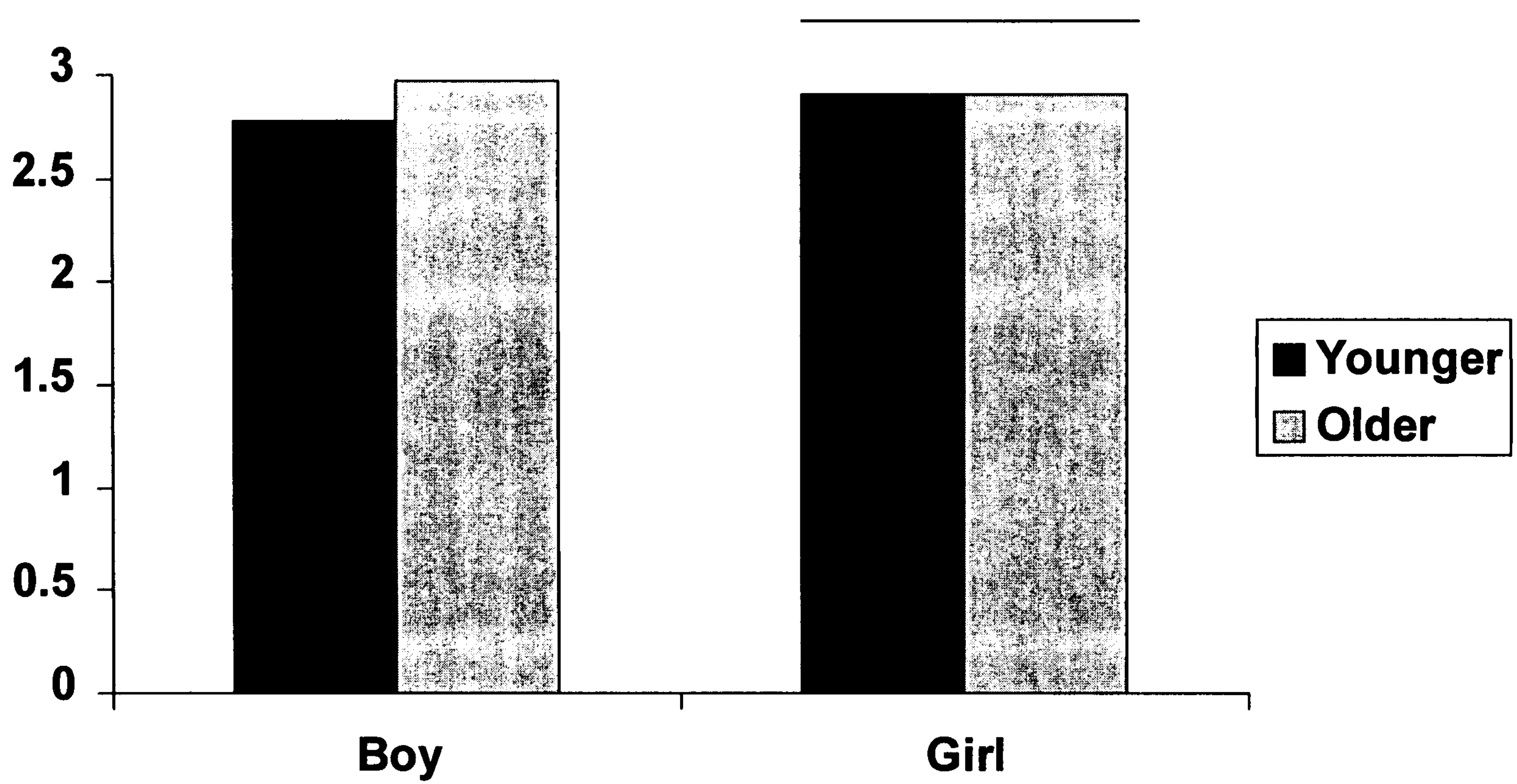


Figure 22. Parents' mean expectation for perfomance from K-6 grade students in **reading** as a function of grade level and gender. (Bars with common overlines are not significantly different.)

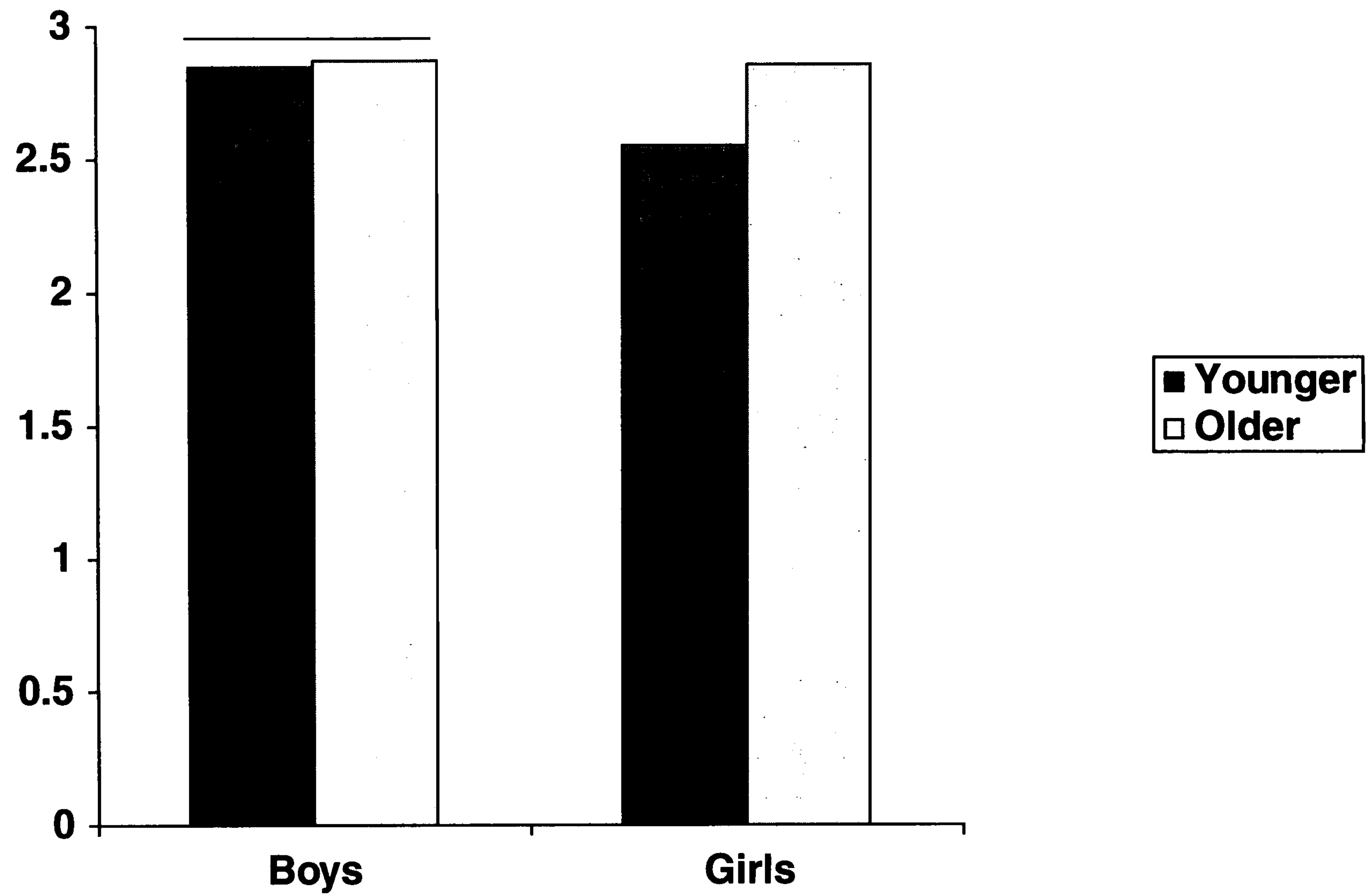


Figure 23. Parents' mean expectation for performance from K-6 grade students in science as a function of grade level and gender. (Bars with common overlines are not significantly different.)

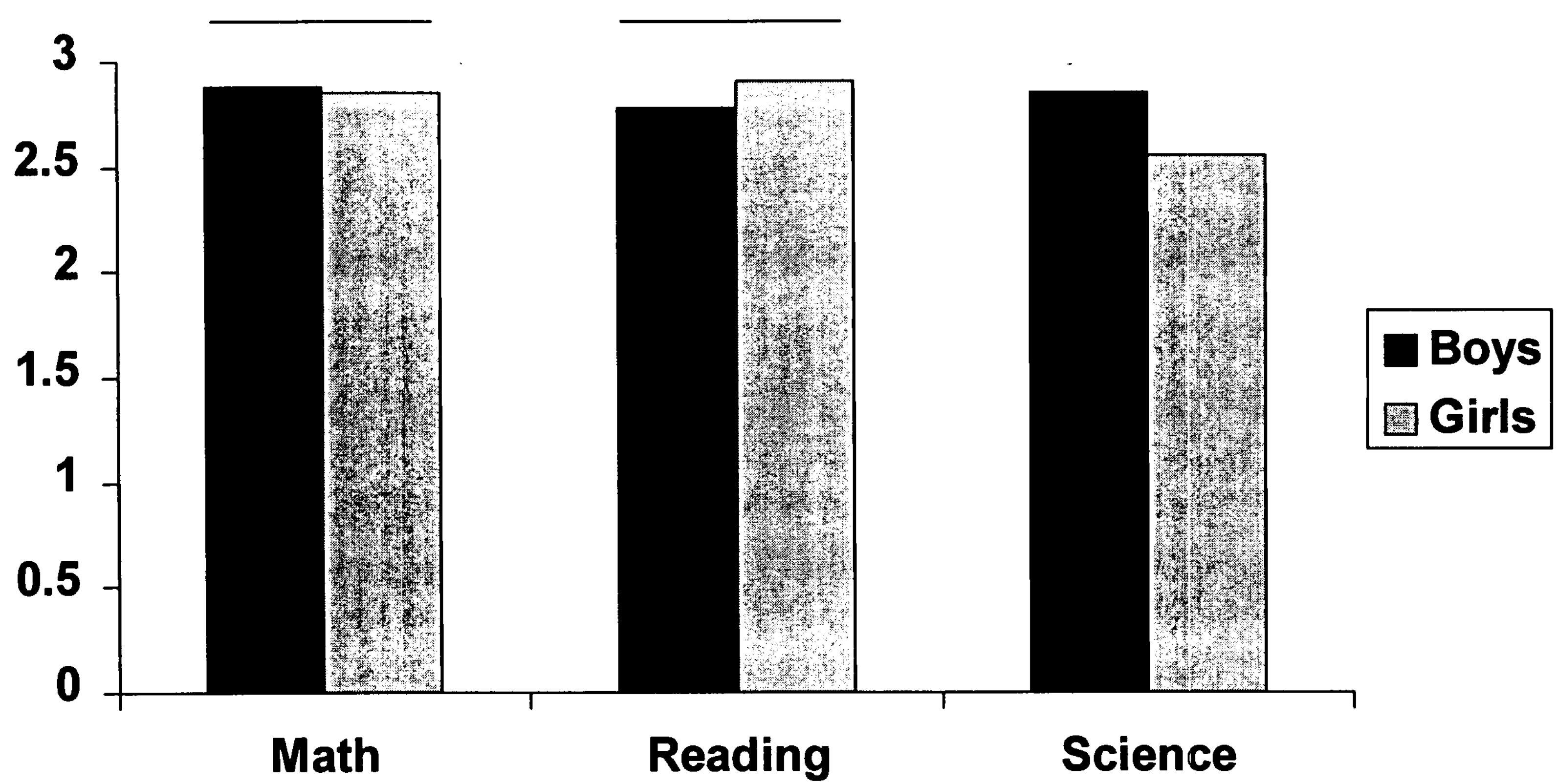


Figure 24. Parents' mean expectation for performance from K-3 grade students' as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

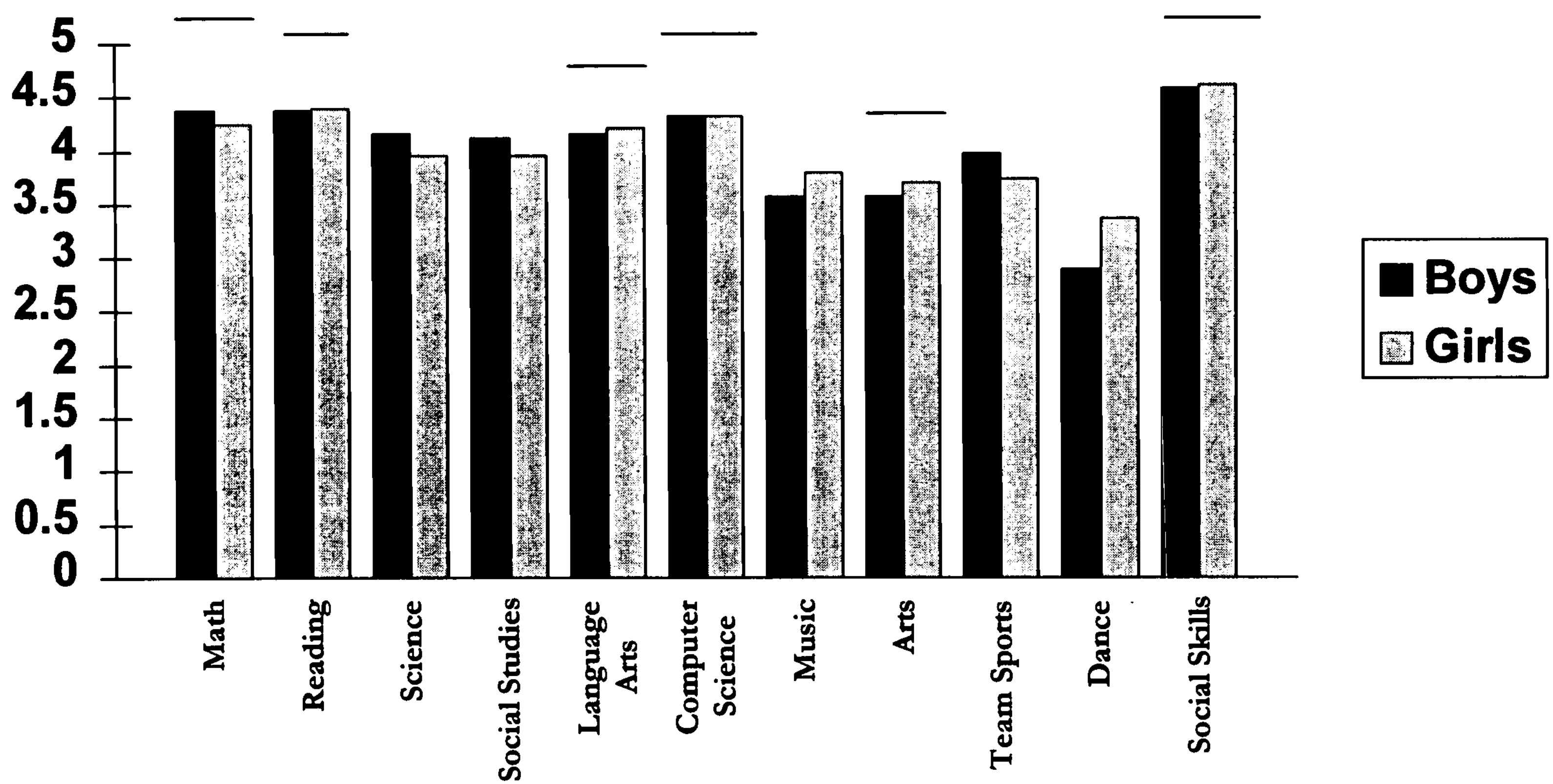


Figure 25. Parents' mean expectation for performance from grade students as a function of subject matter and gender. (Within subject matters, bars with overlines are not significantly different.)

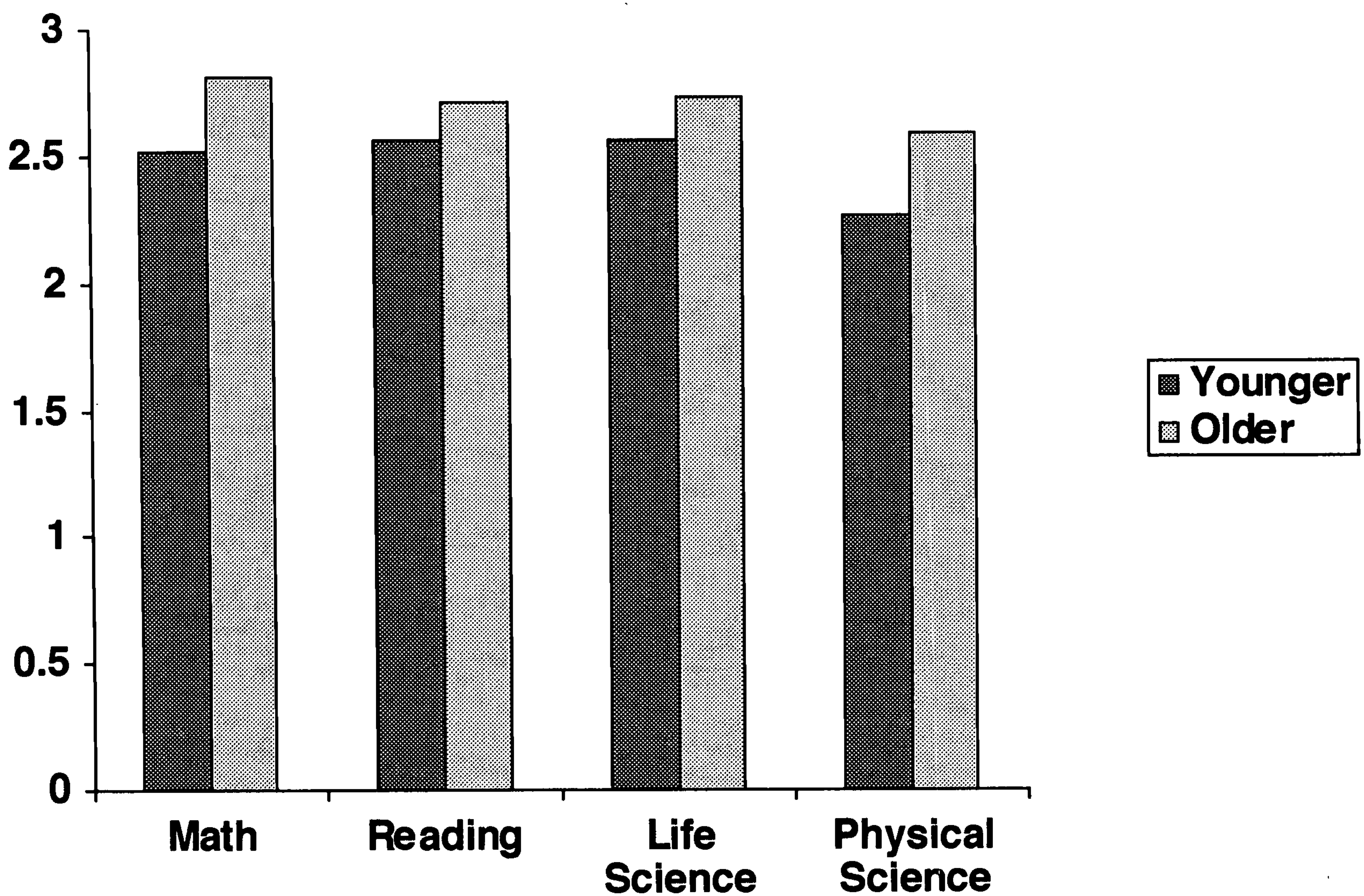


Figure 26. Mean reported liking by K-6 grade students as a function of subject matter and grade level. (Within subject matters, all grade level differences are significant.)

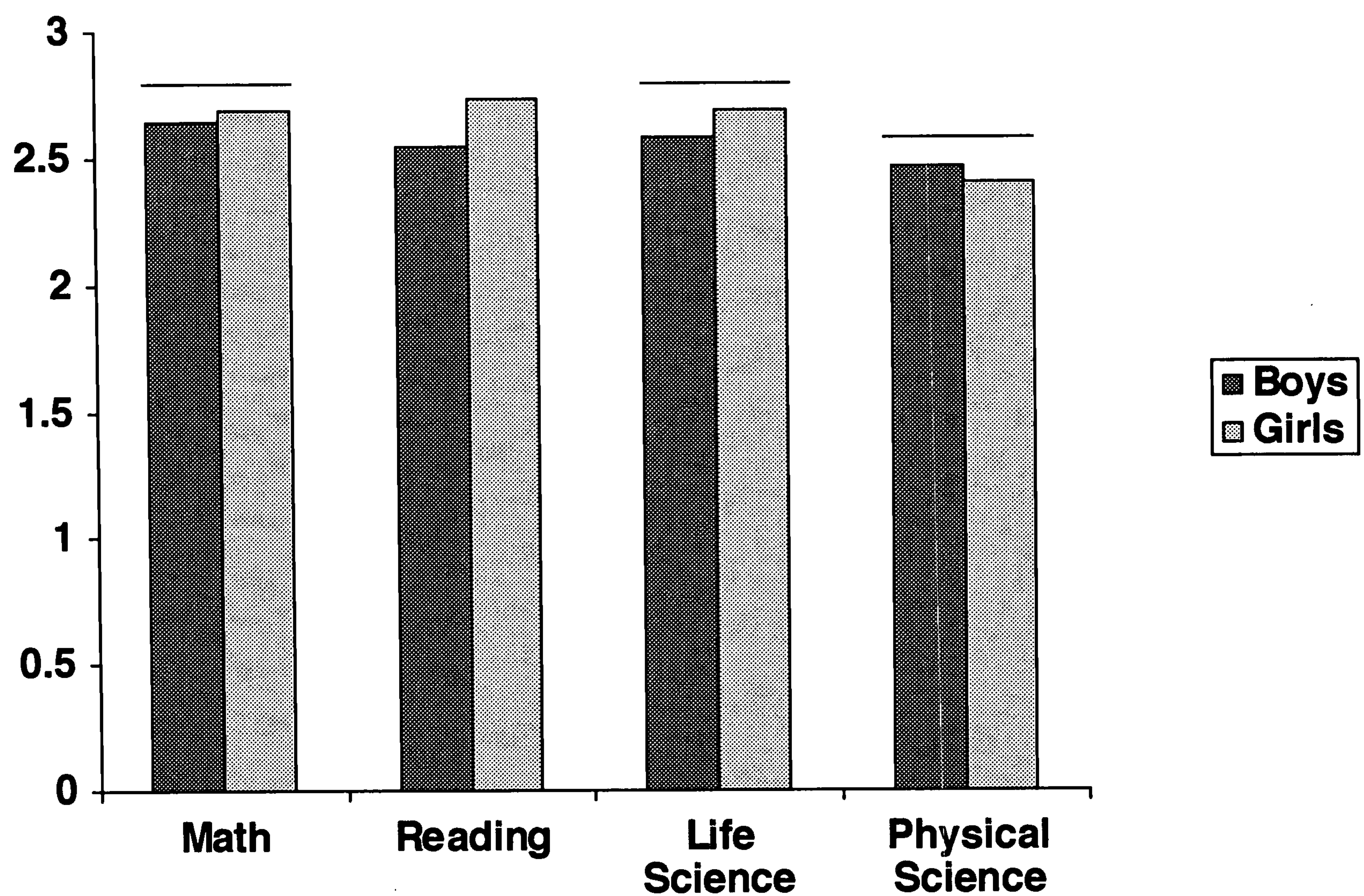


Figure 27. Mean reported liking by K-6 grade students as a function of subject matter and gender. (Within subject matters, bars with common overlines are not significantly different.)

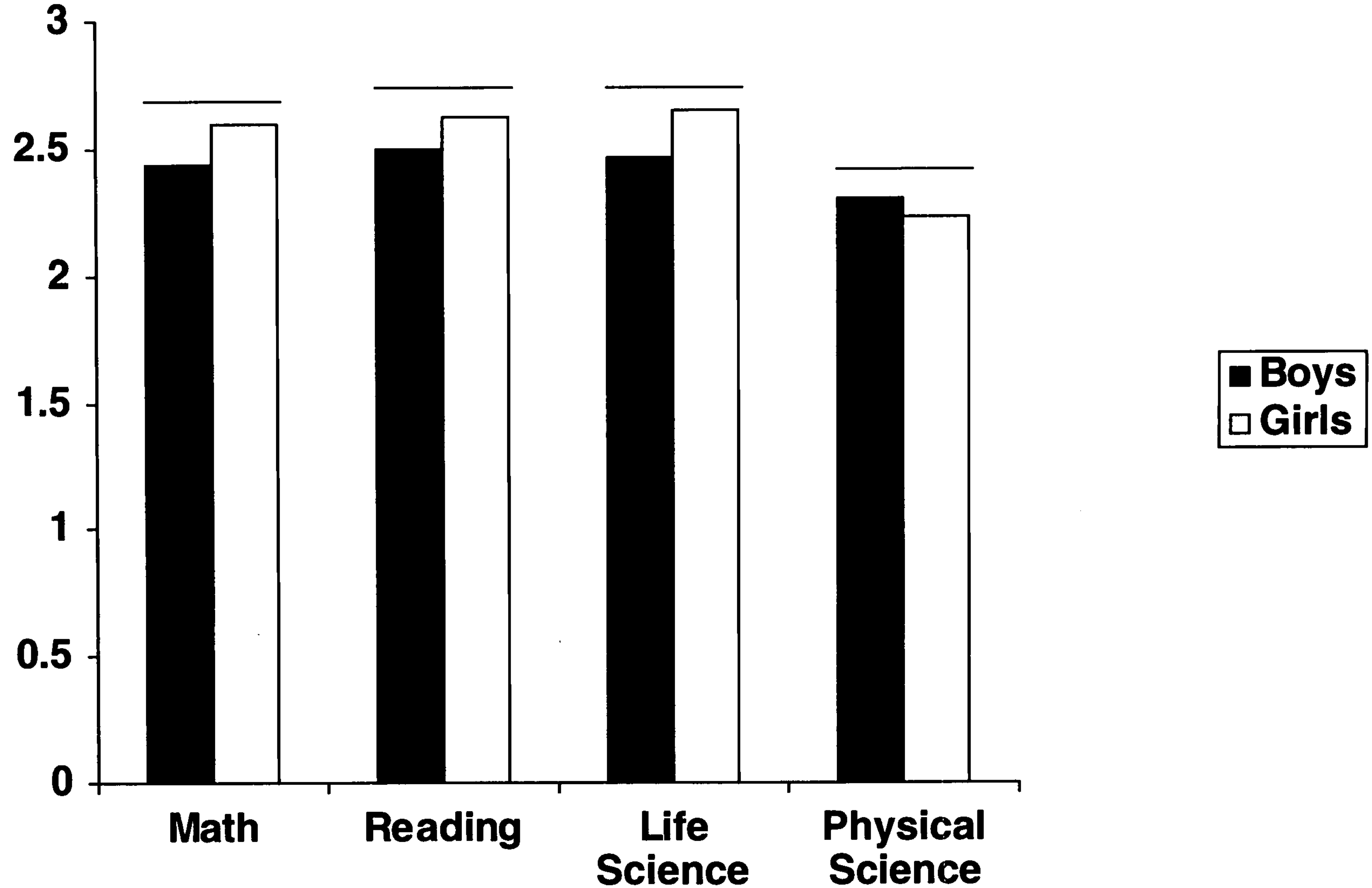


Figure 28. K-3 grade students' liking by gender. (Within subject matters, bars with common overlines are not significantly different.)

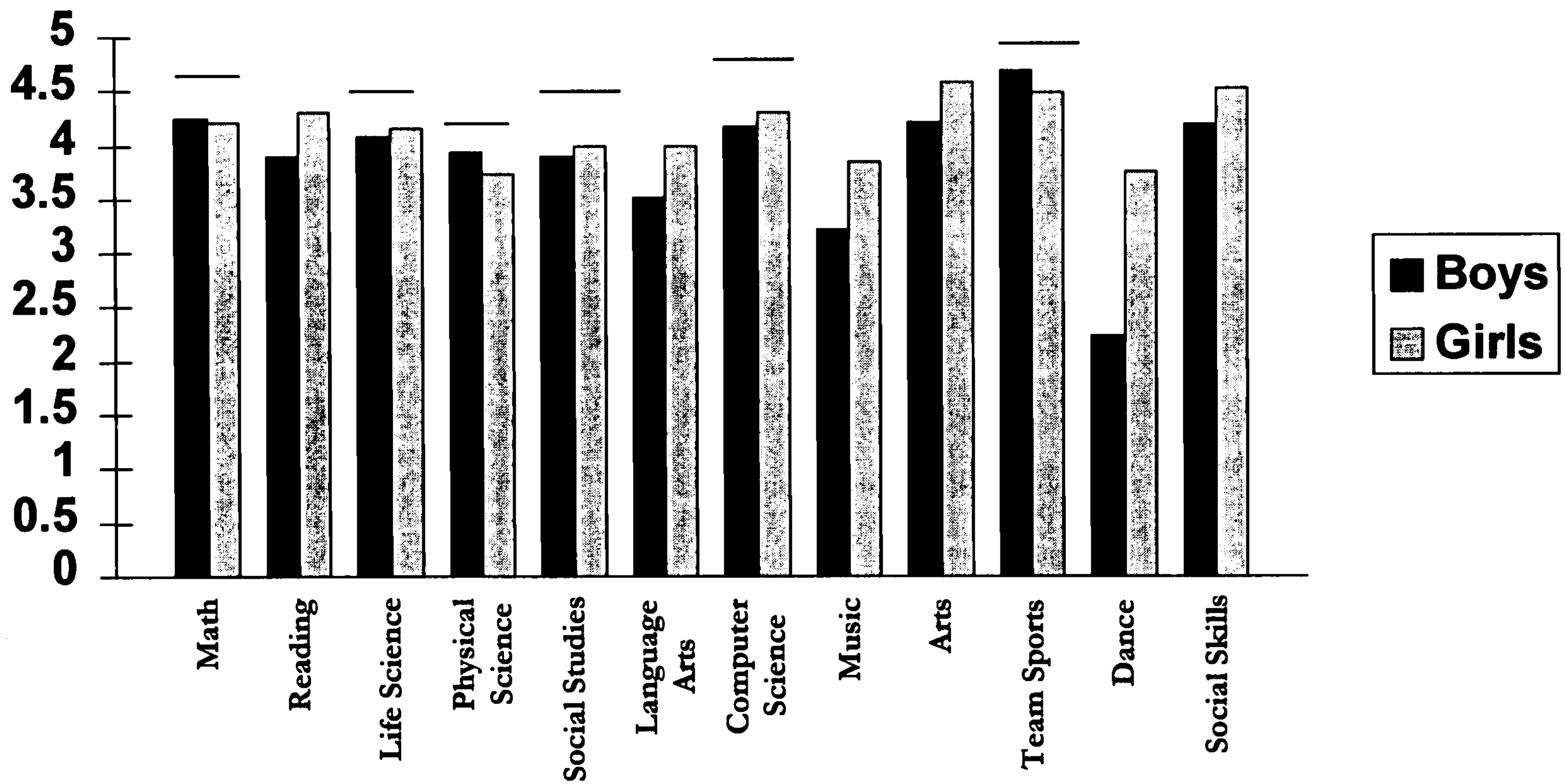


Figure 29. Fourth-sixth grade students' mean report of liking subject matter as a function of gender. (Within subject matters, bars with overlines are not significantly different.)

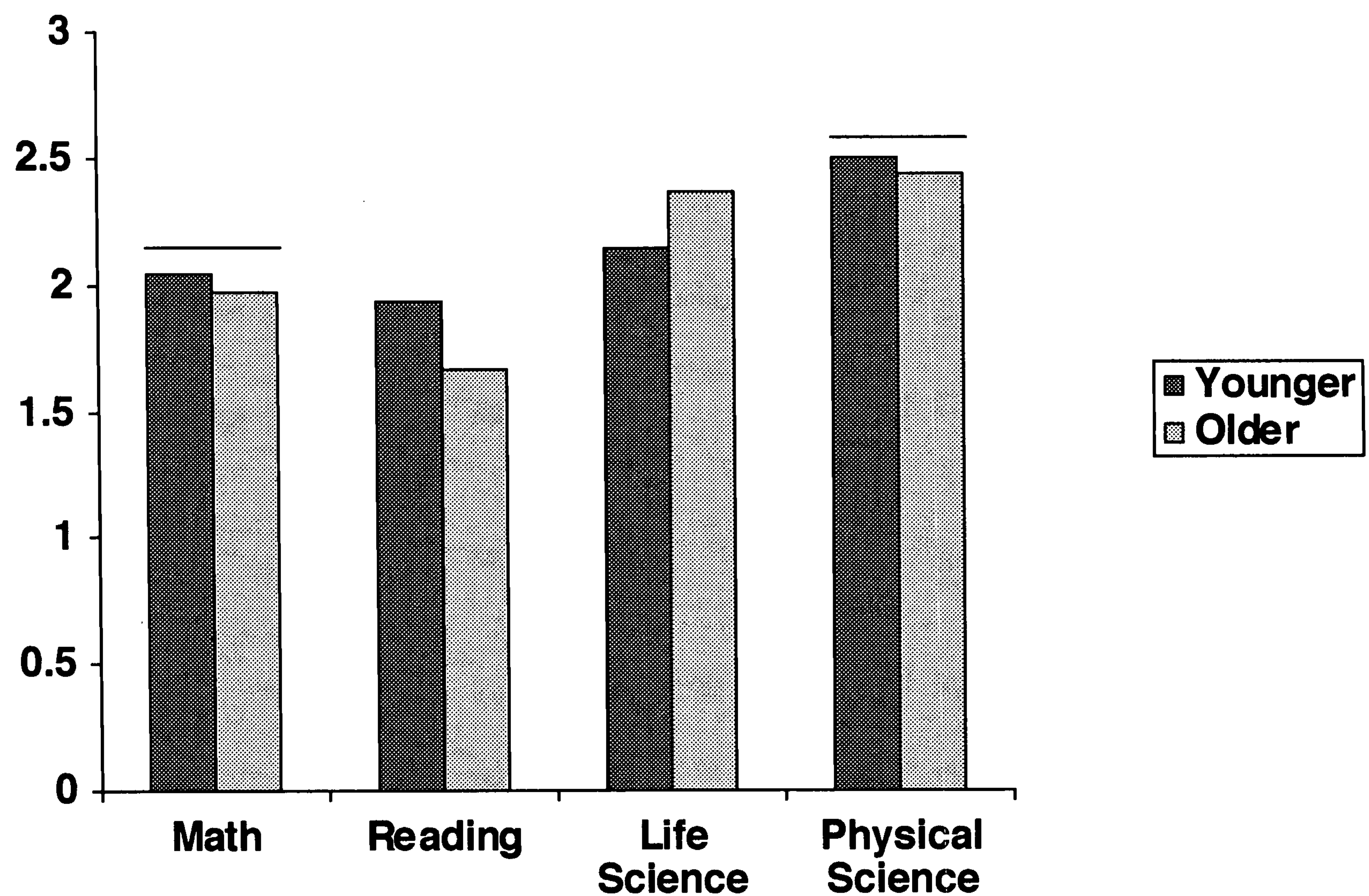


Figure 30. K-6 grade students' perception of male-domination across career areas as a function of grade level. (Within subject matters, bars with common overlines are not significantly different.)

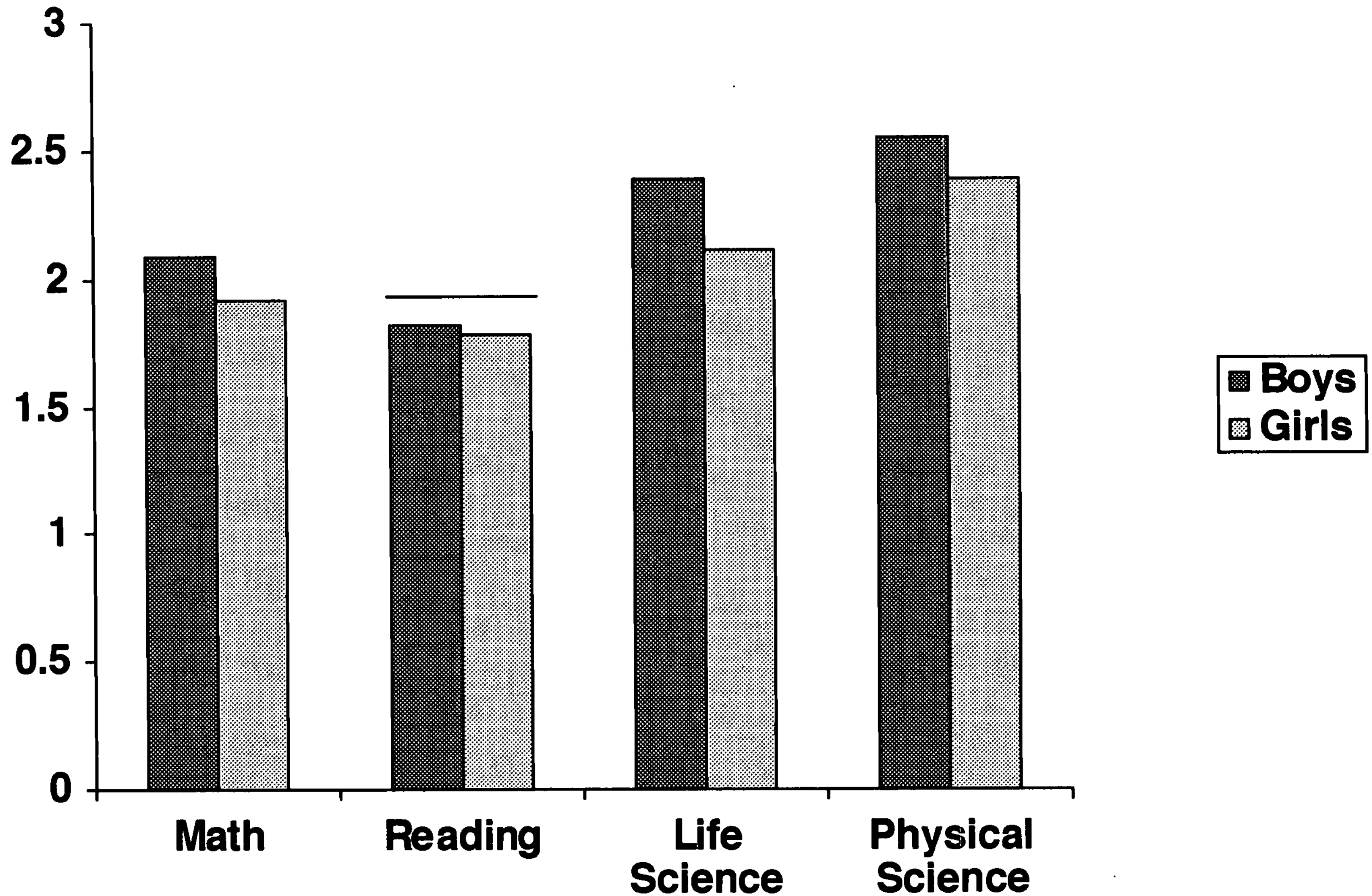


Figure 31. K-6 grade students' mean perception of male-domination across career areas as a function of sex. (Within subject matters, bars with common overlines are not significantly different.)

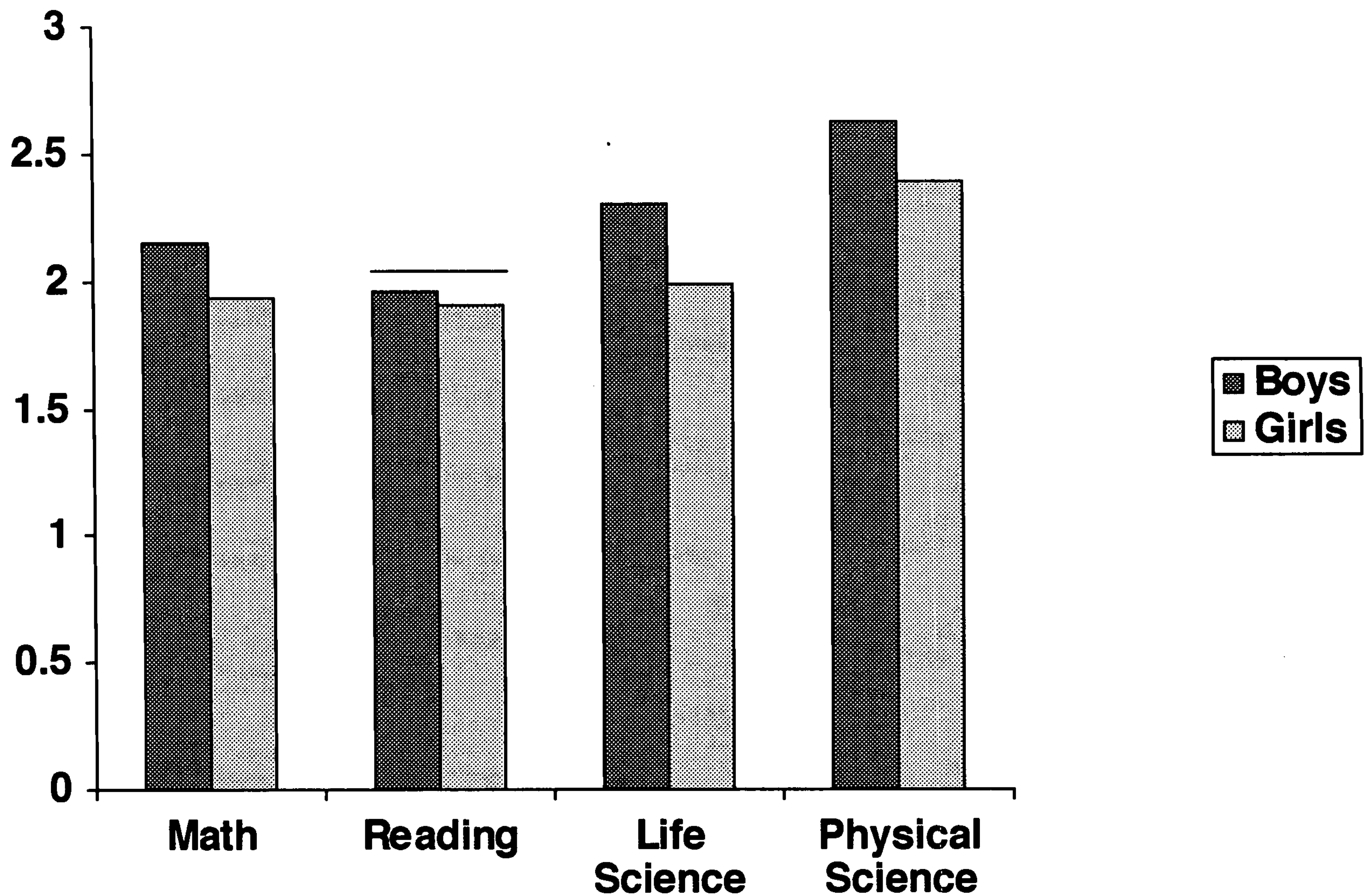


Figure 32. K-3 grade students' perception of male-domination across career areas as a function of sex. (Within subject matters, bars with common overlines are not significantly different.)

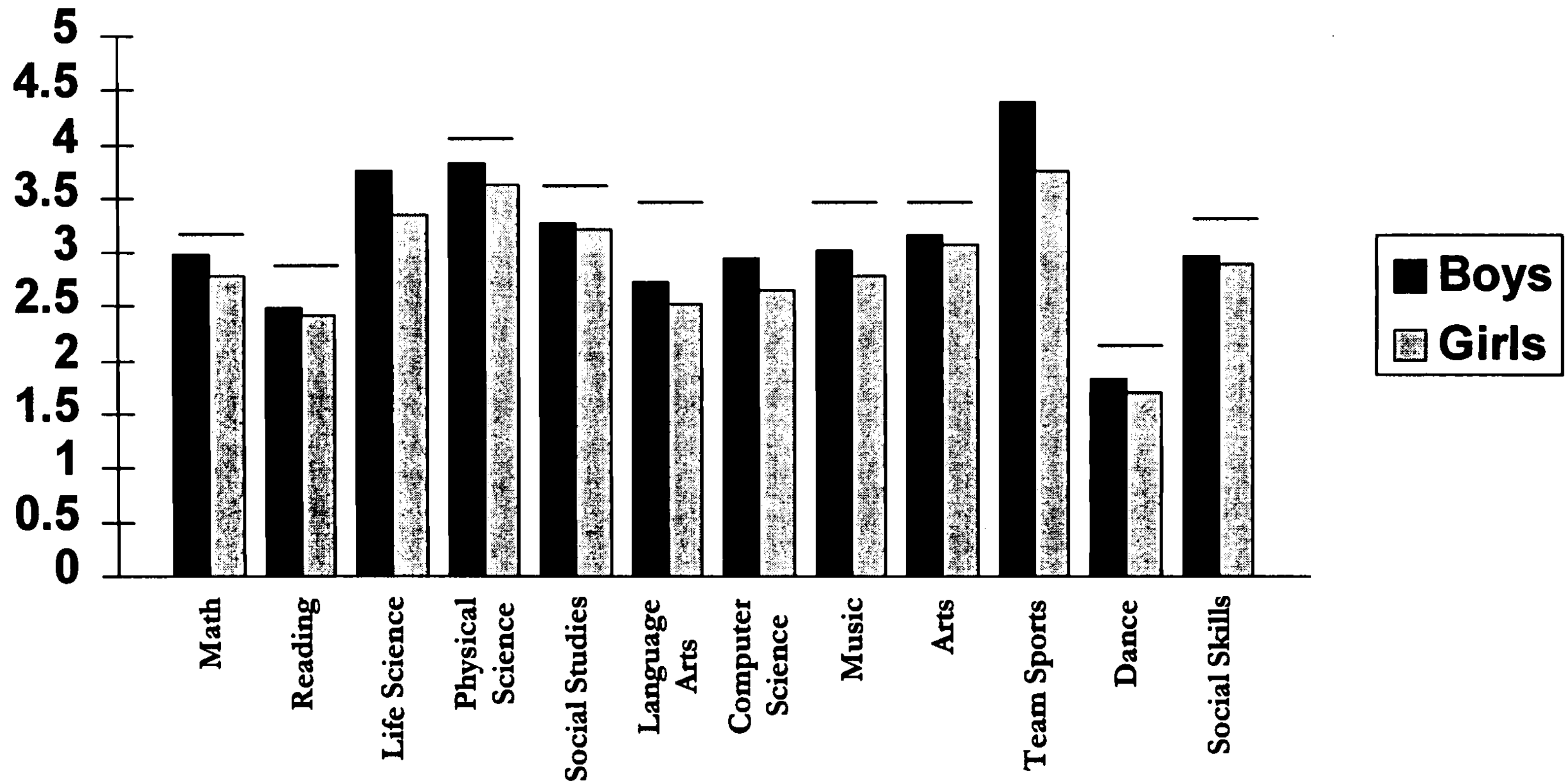


Figure 33. Fourth-sixth grade students' mean perceptions of male-domination across career areas as a function of gender. (Within subject areas, bars with overlines are not significantly different.)

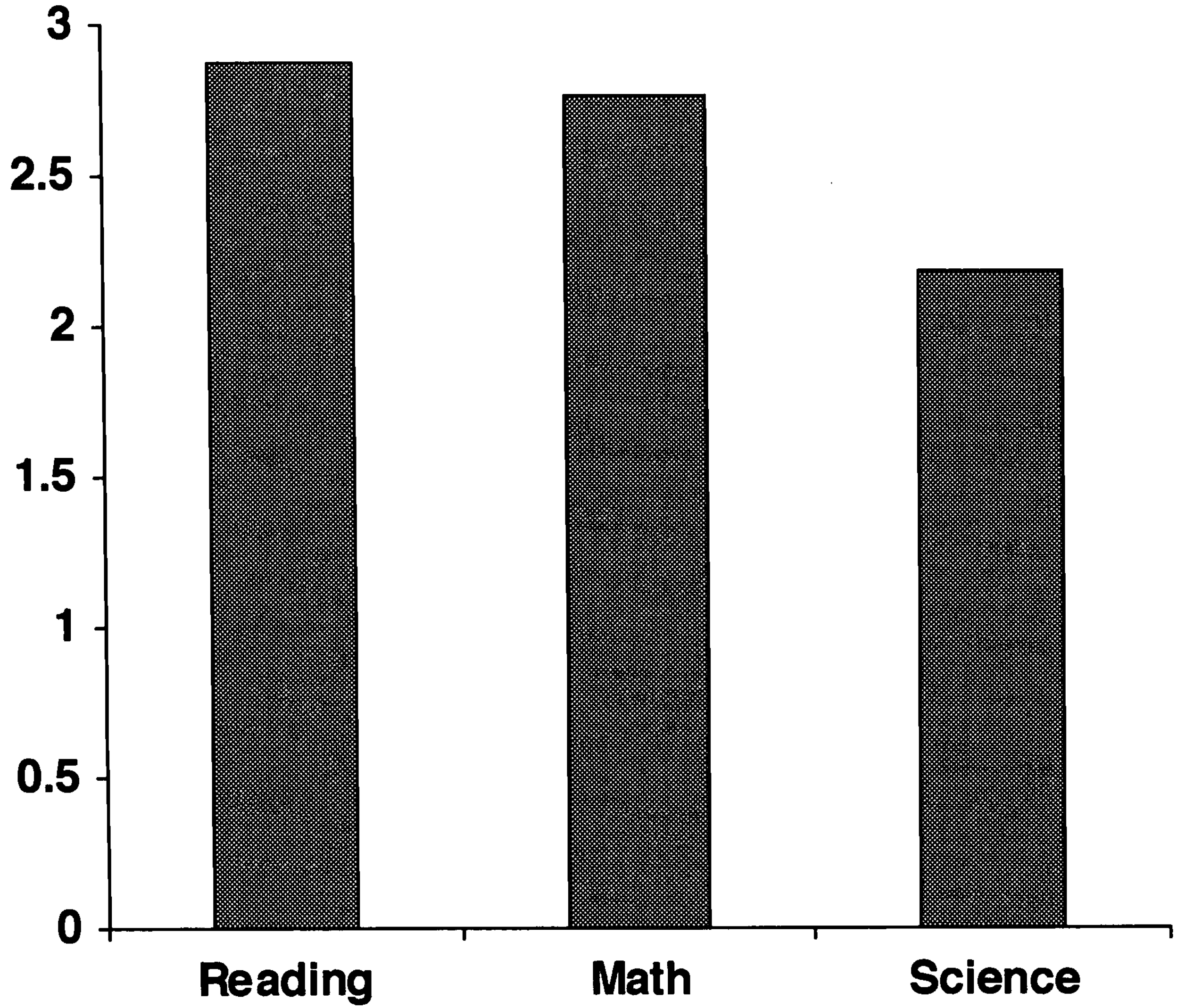


Figure 34. Parents' mean reported use as a function of subject matter. (All subject matter differences are significant.)

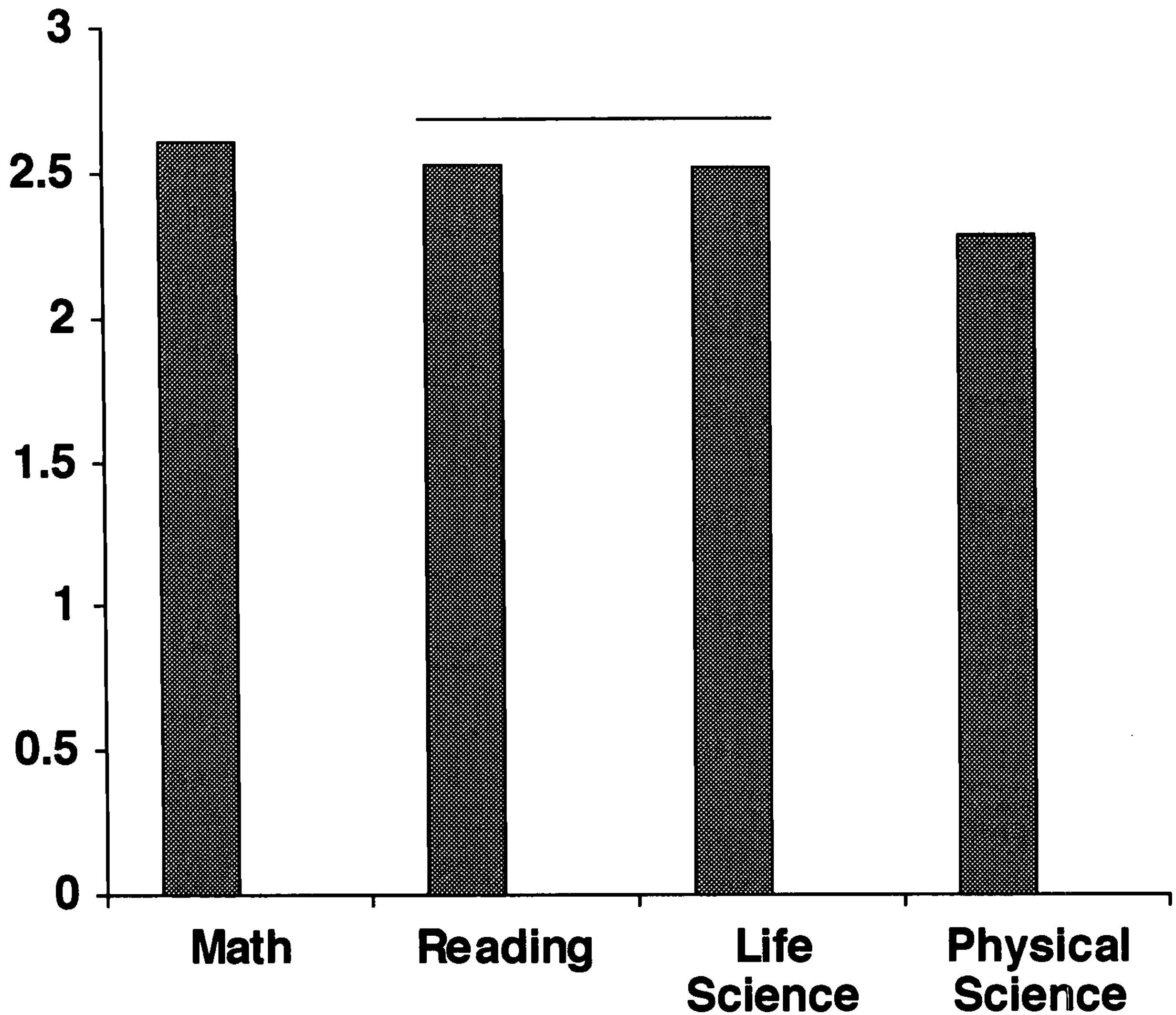


Figure 35. Mean self-rated ability of K-6 grade students as a function of subject matter. (Bars with common overlines are not significantly different.)

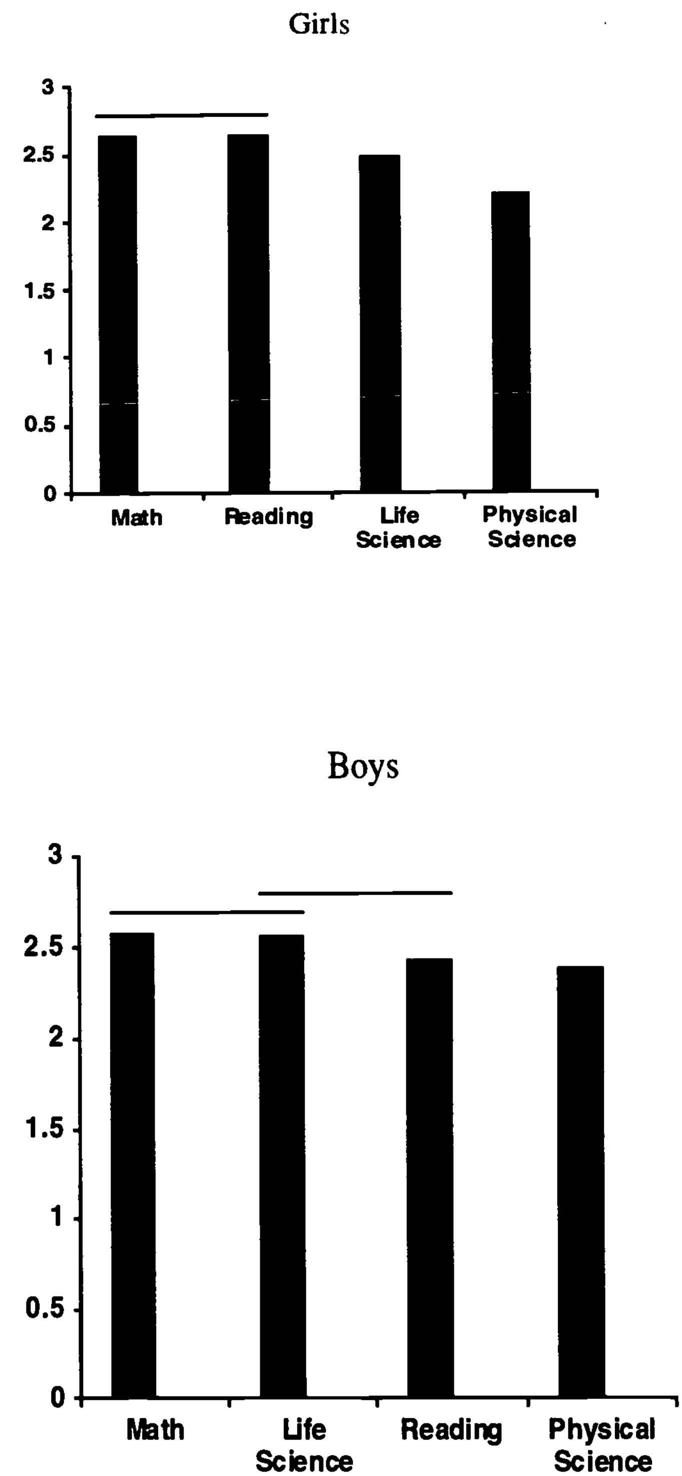


Figure 36. Mean self-rated ability of K-6 grade students as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

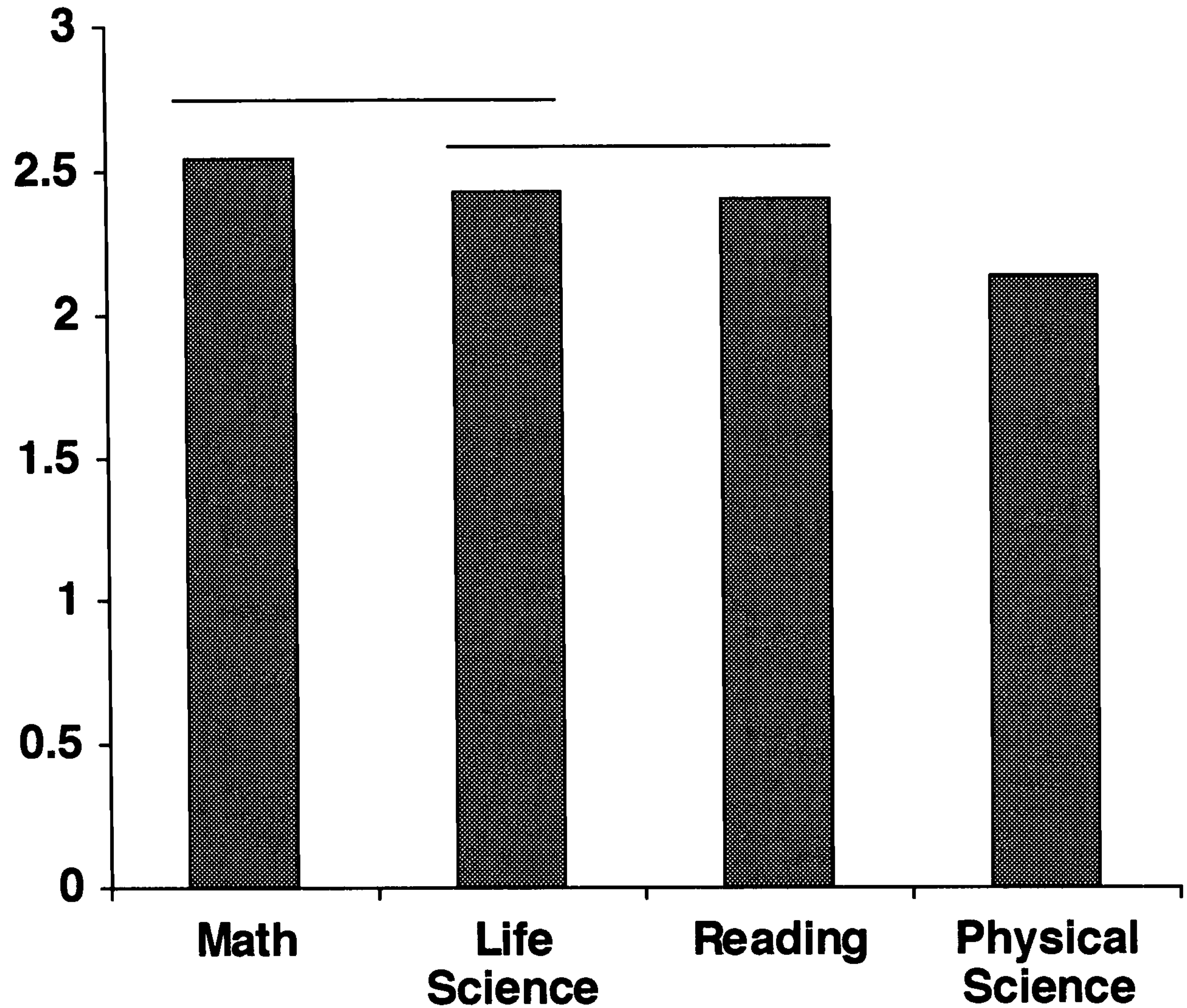


Figure 37. Mean self-rated ability of K-3 grade students as a function of subject matter. (Bars with common overlines are not significantly different.)

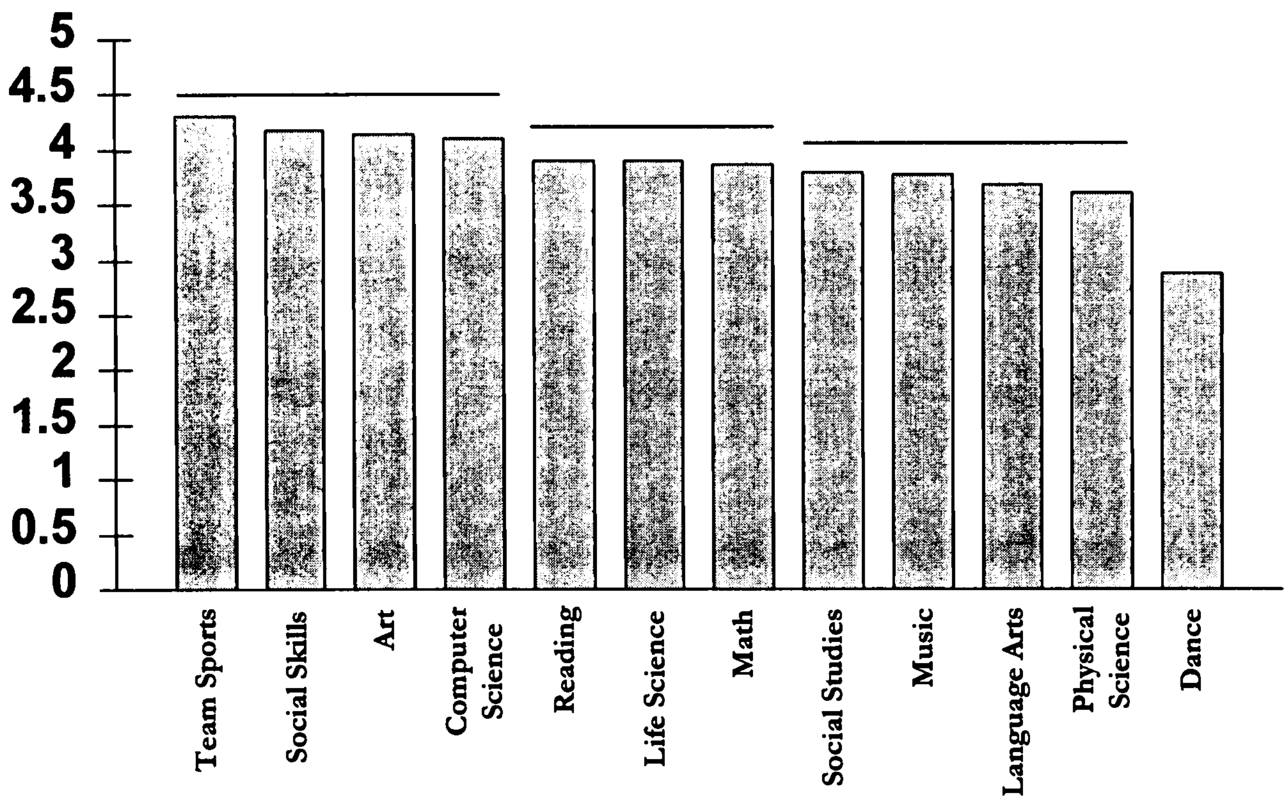
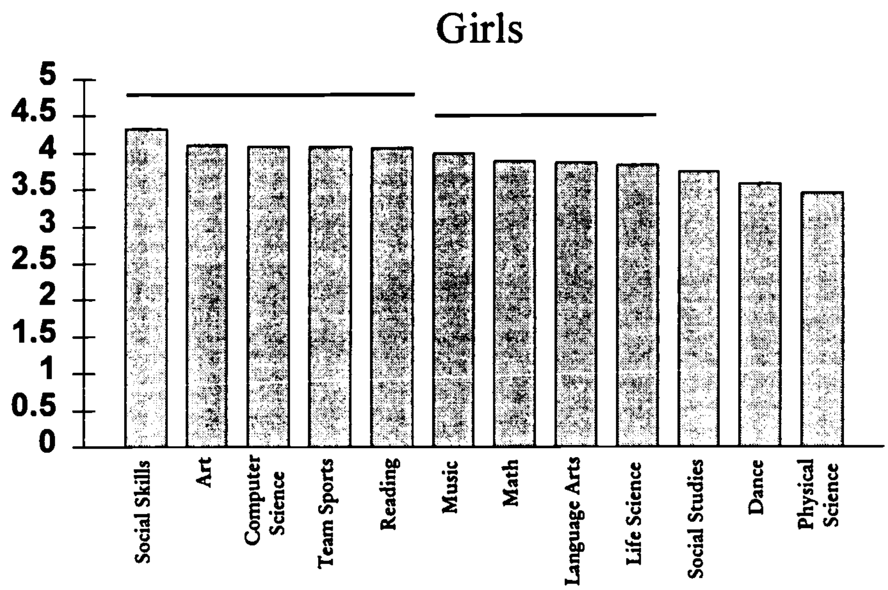


Figure 38. Fourth-sixth grade students; mean self-rated ability as a function of subject matter. (Bars with overlines are not significantly different.)



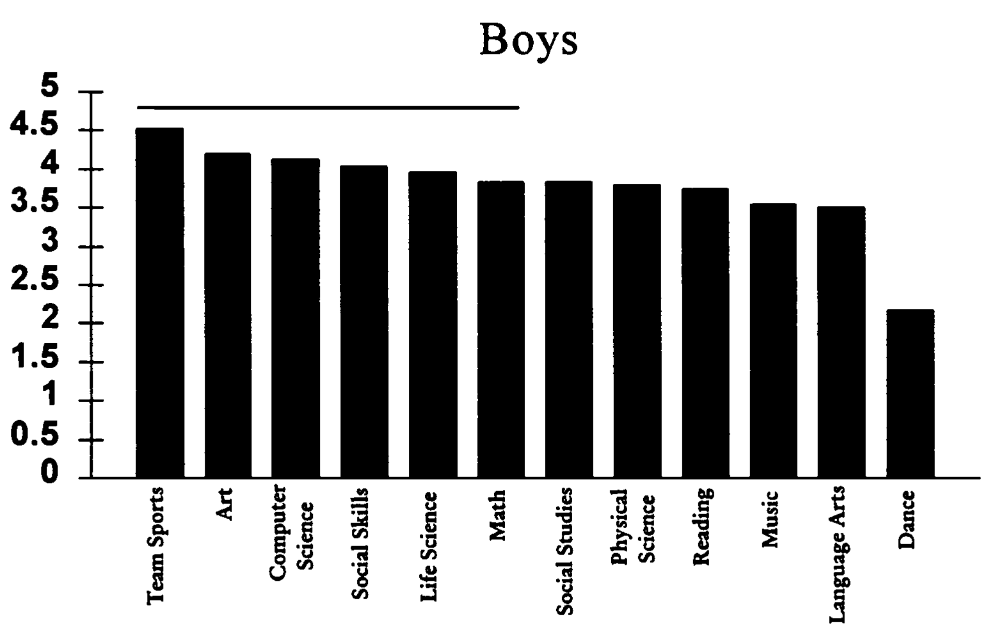


Figure 39. Fourth-sixth grade students' mean self-rated ability as a function of subject matter and gender. (Bars with overlines are not significantly different.)

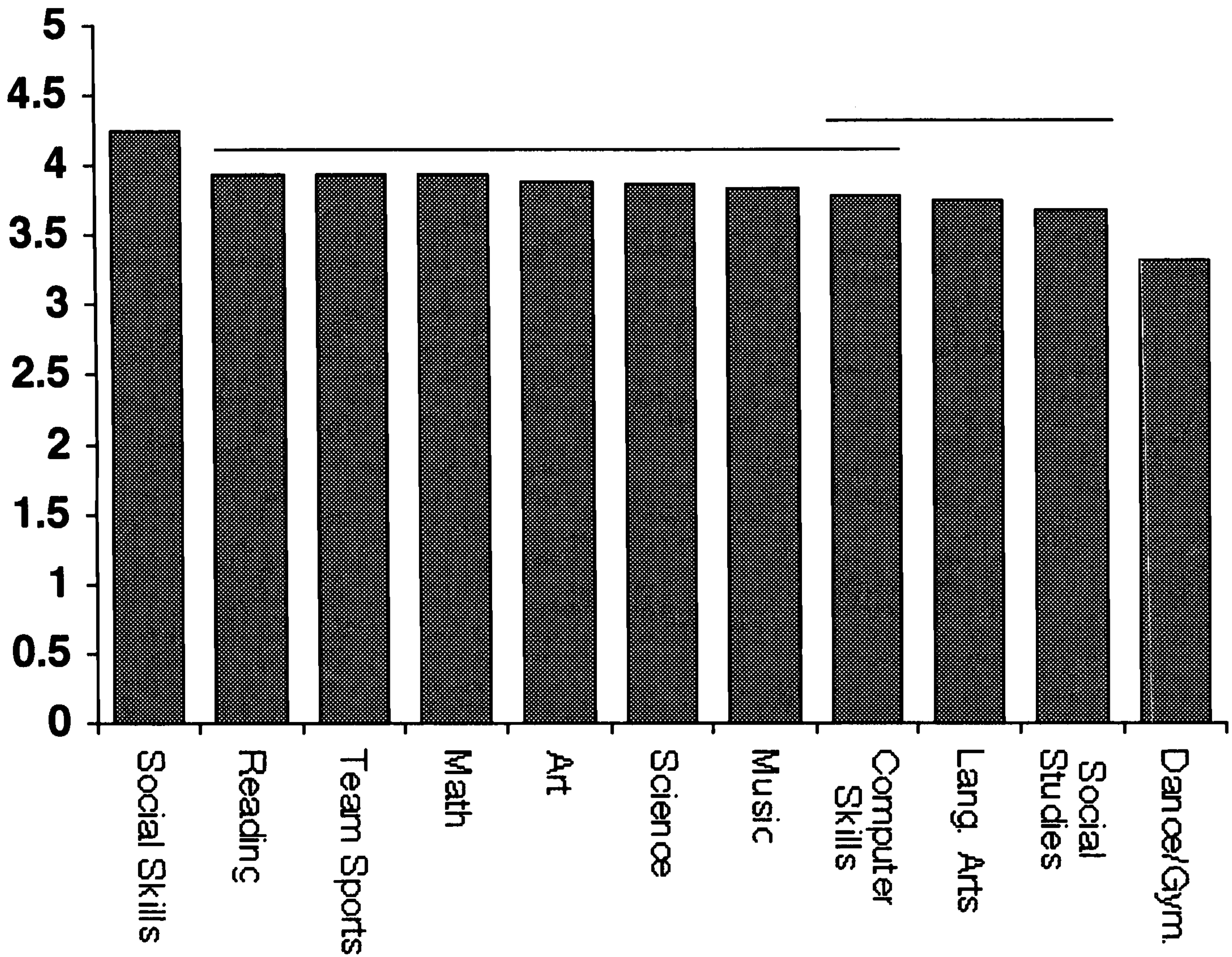
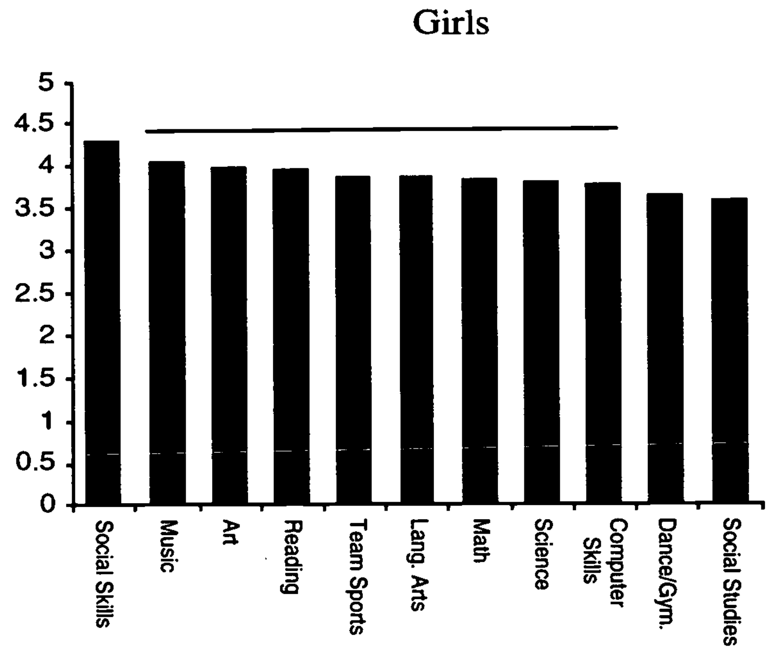


Figure 40. Parents' mean rating of 4-6 grade students' ability as a function of subject matter. (Bars with common overlines are not significantly different.)



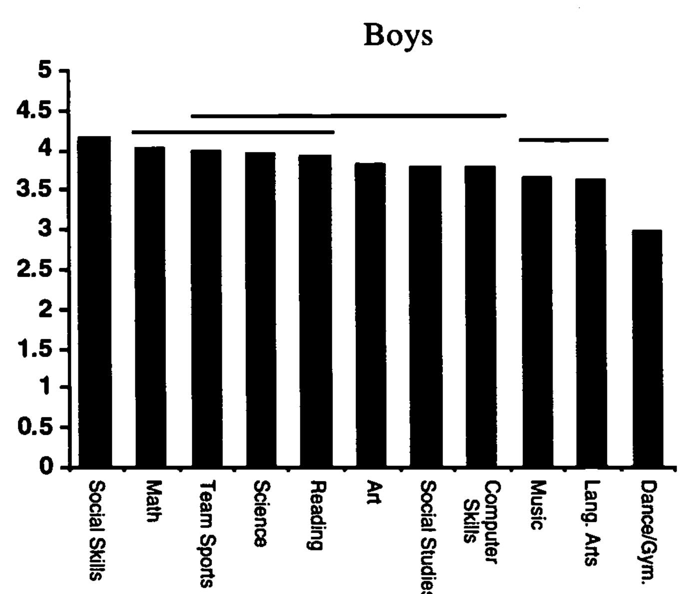


Figure 41. Parents' mean rating of 4-6 grade students' ability as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

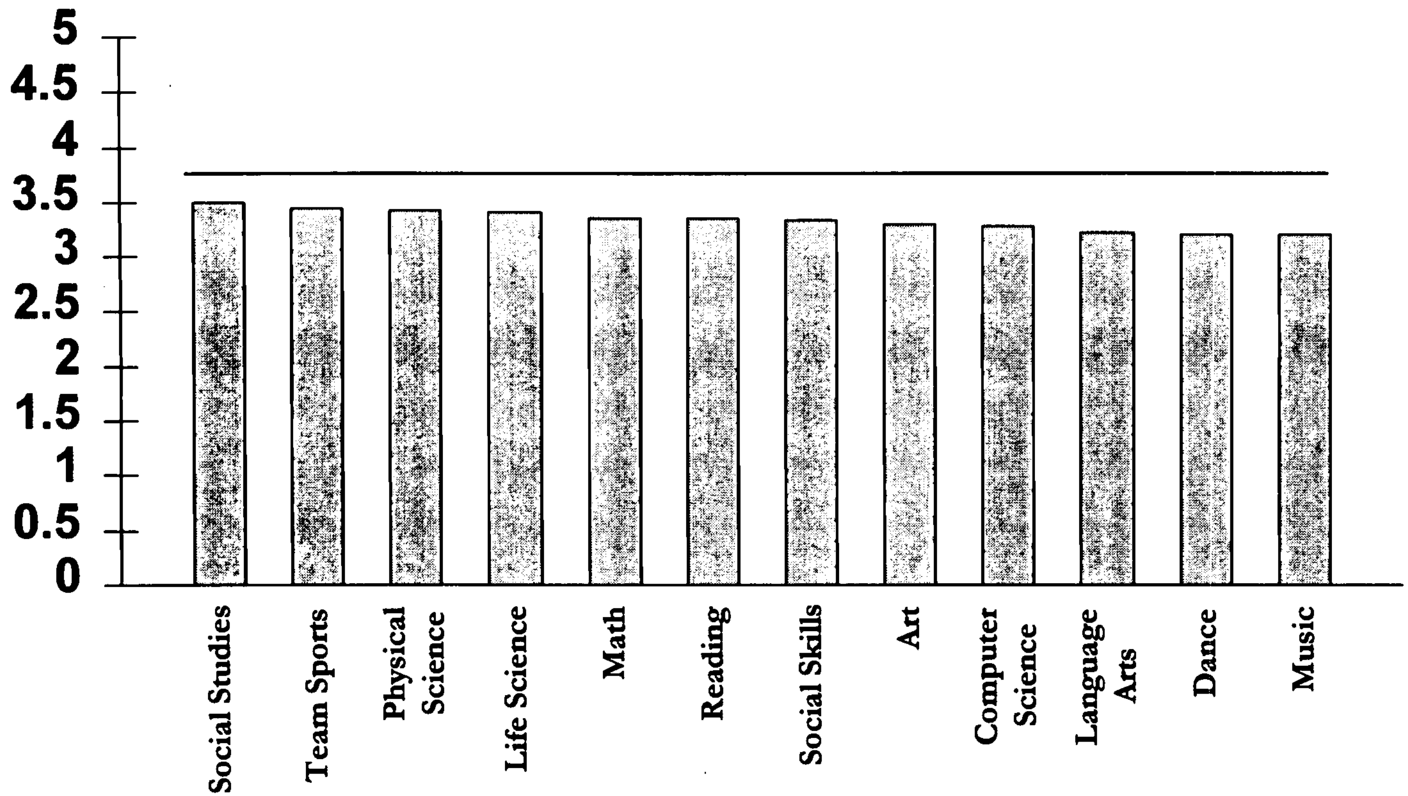
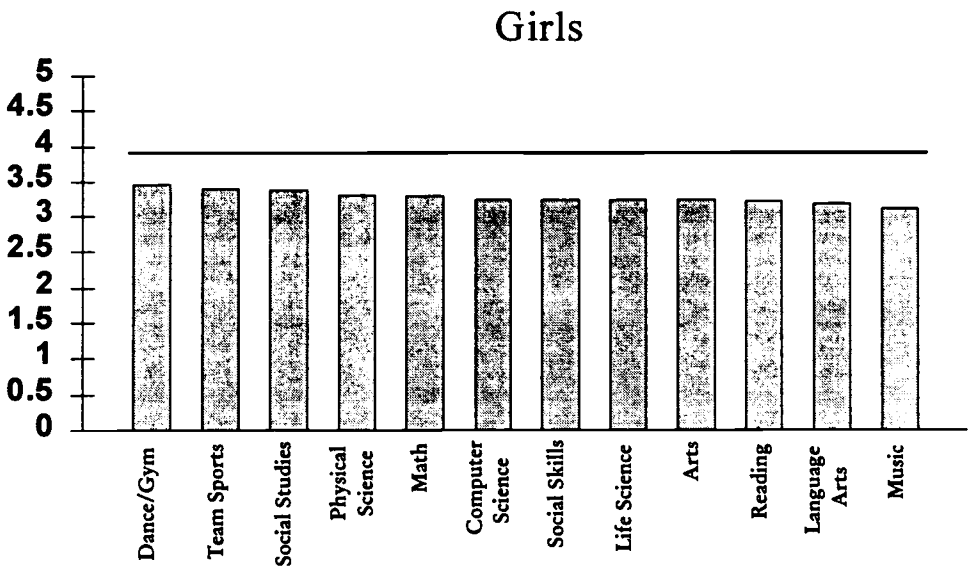


Figure 42. Fourth-sixth grade students' mean reported effort as a function of subject matter. (Bars with overlines are not significantly different.)



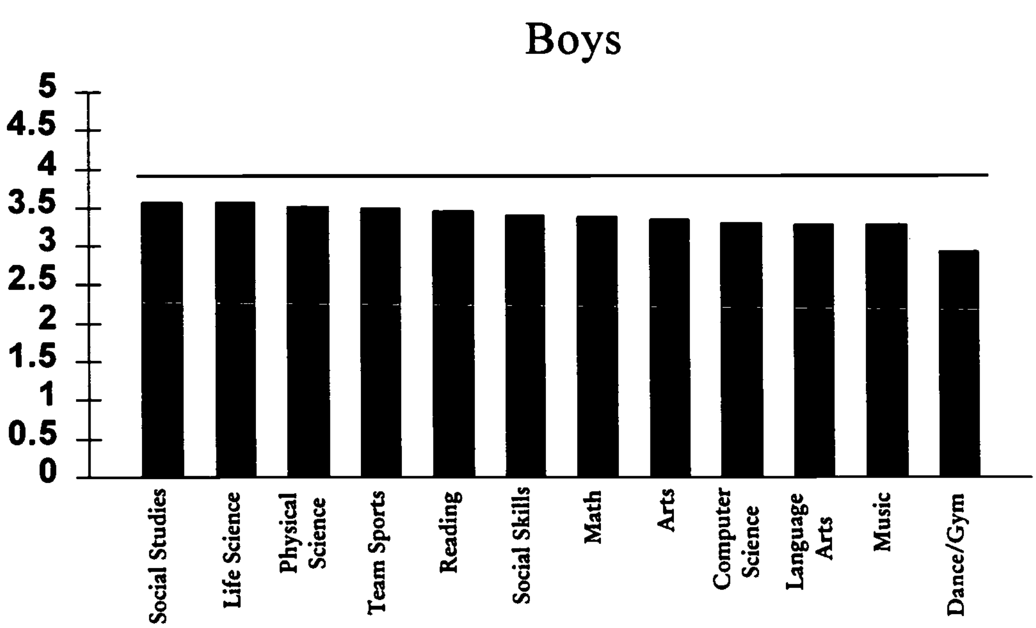


Figure 43. Fourth-sixth grade students' mean reported effort as a function of subject matter and gender. (Bars with overlines are not significantly different.)

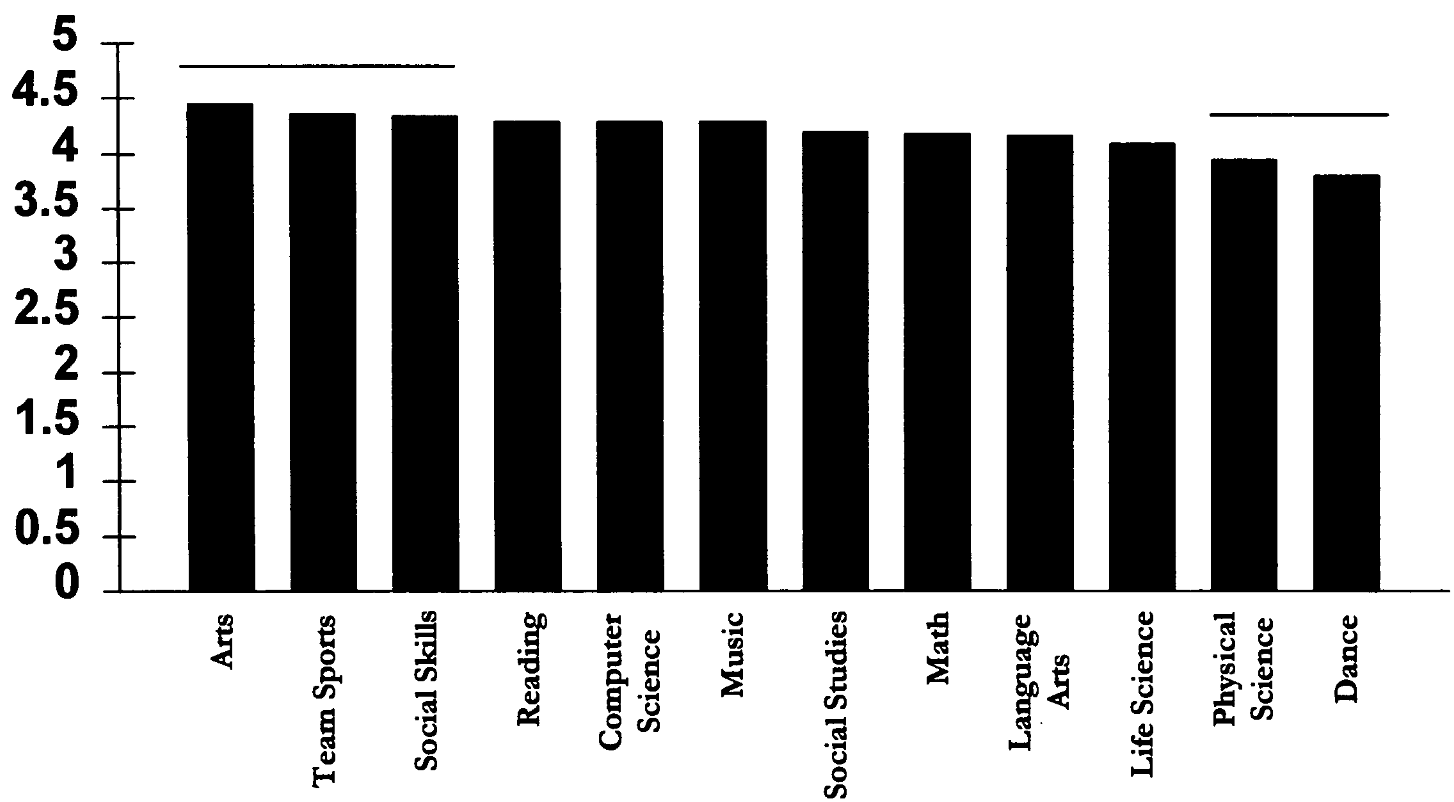


Figure 44. K-6 grade students' mean expected grade as a function of subject matter. (Bars with overlines are not significantly different.)

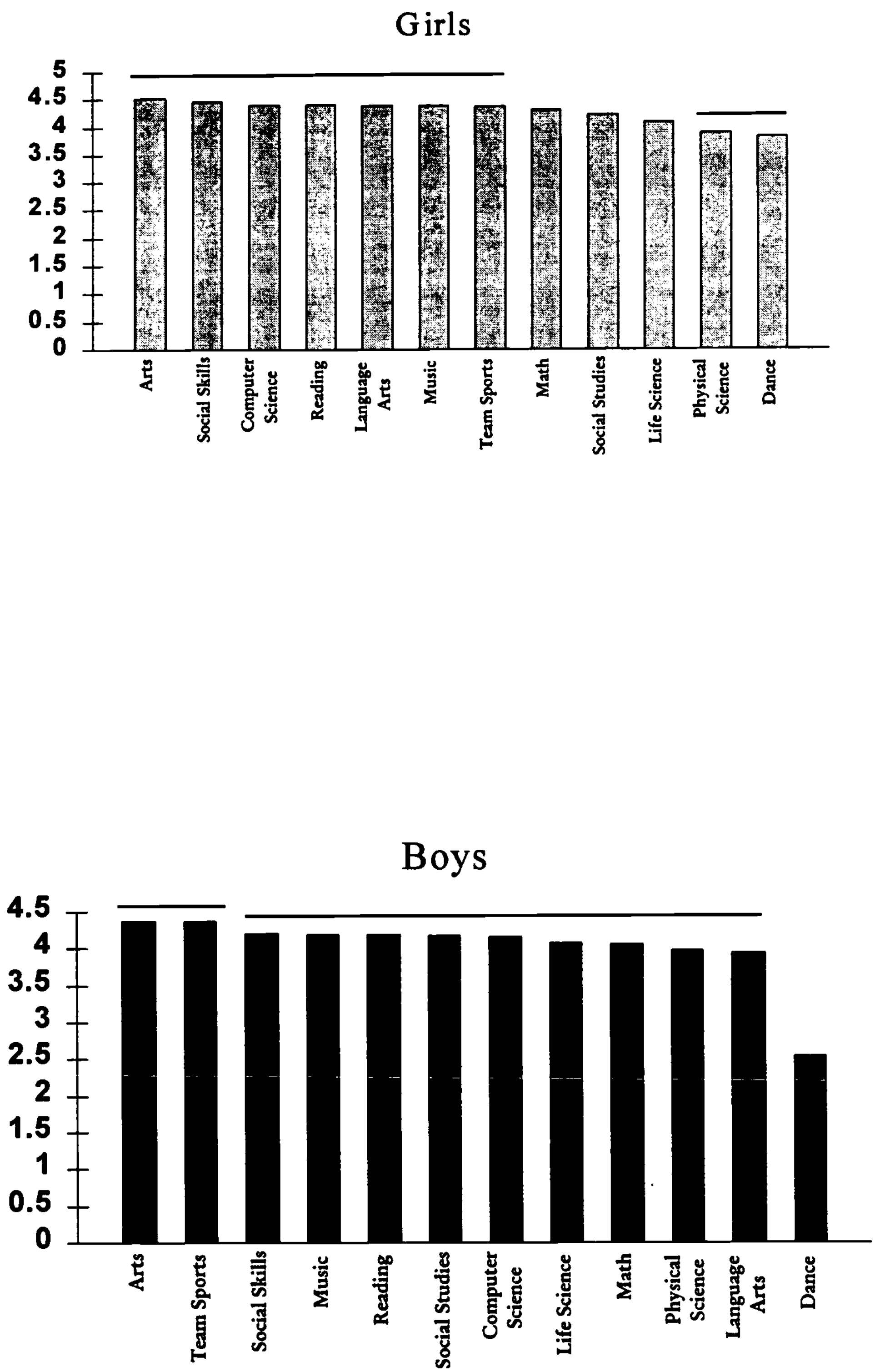


Figure 45. Fourth-sixth grade students' mean expected grade as a function of subject matter and gender. (Bars with overlines are not significantly different.)

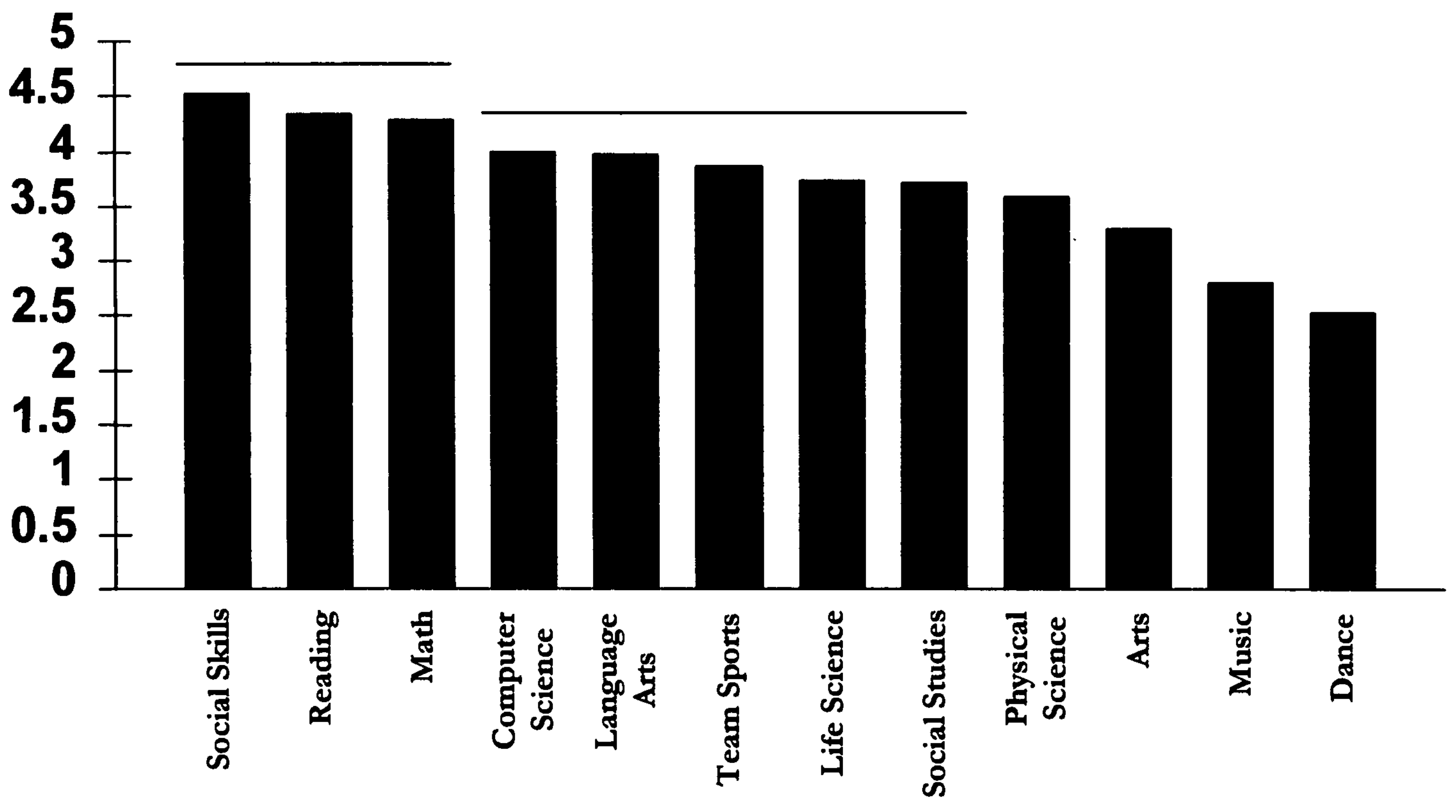
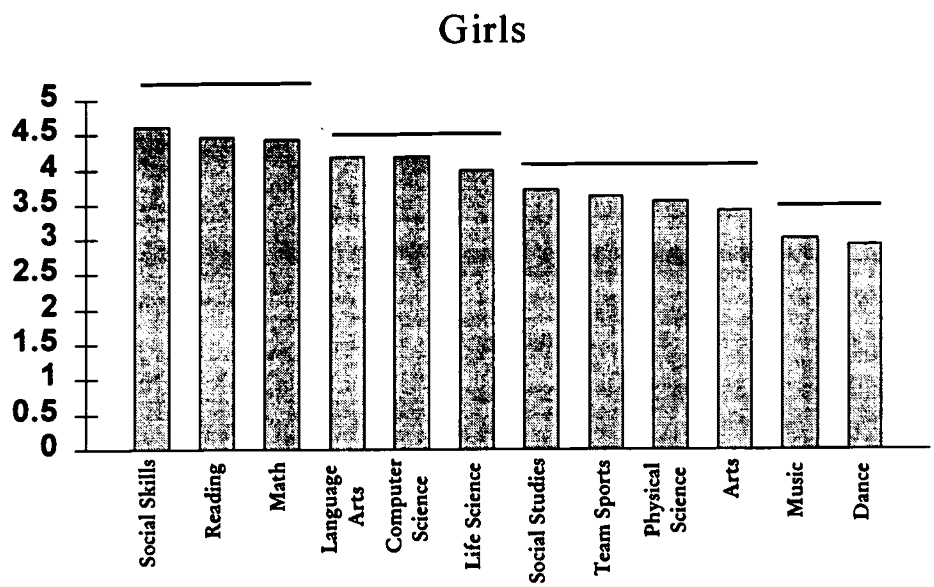


Figure 46. K-6 grade students' mean perception of the importance of subject matter. (Bars with overlines are not significantly different.)



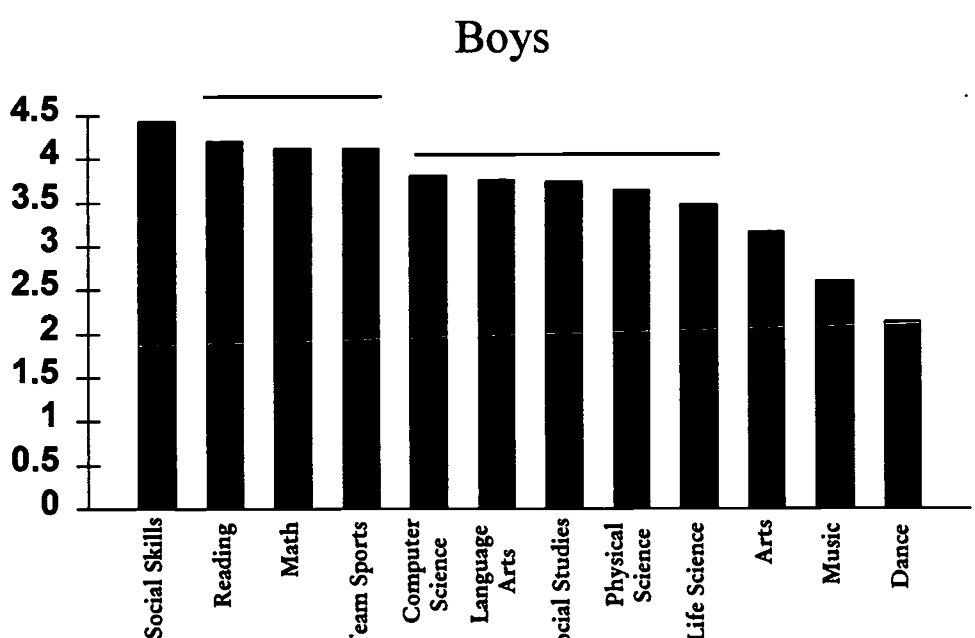


Figure 47. Fourth-sixth grade students' mean perceived importance of subject matter as a function of gender. (Bars with overlines are not significantly different.)

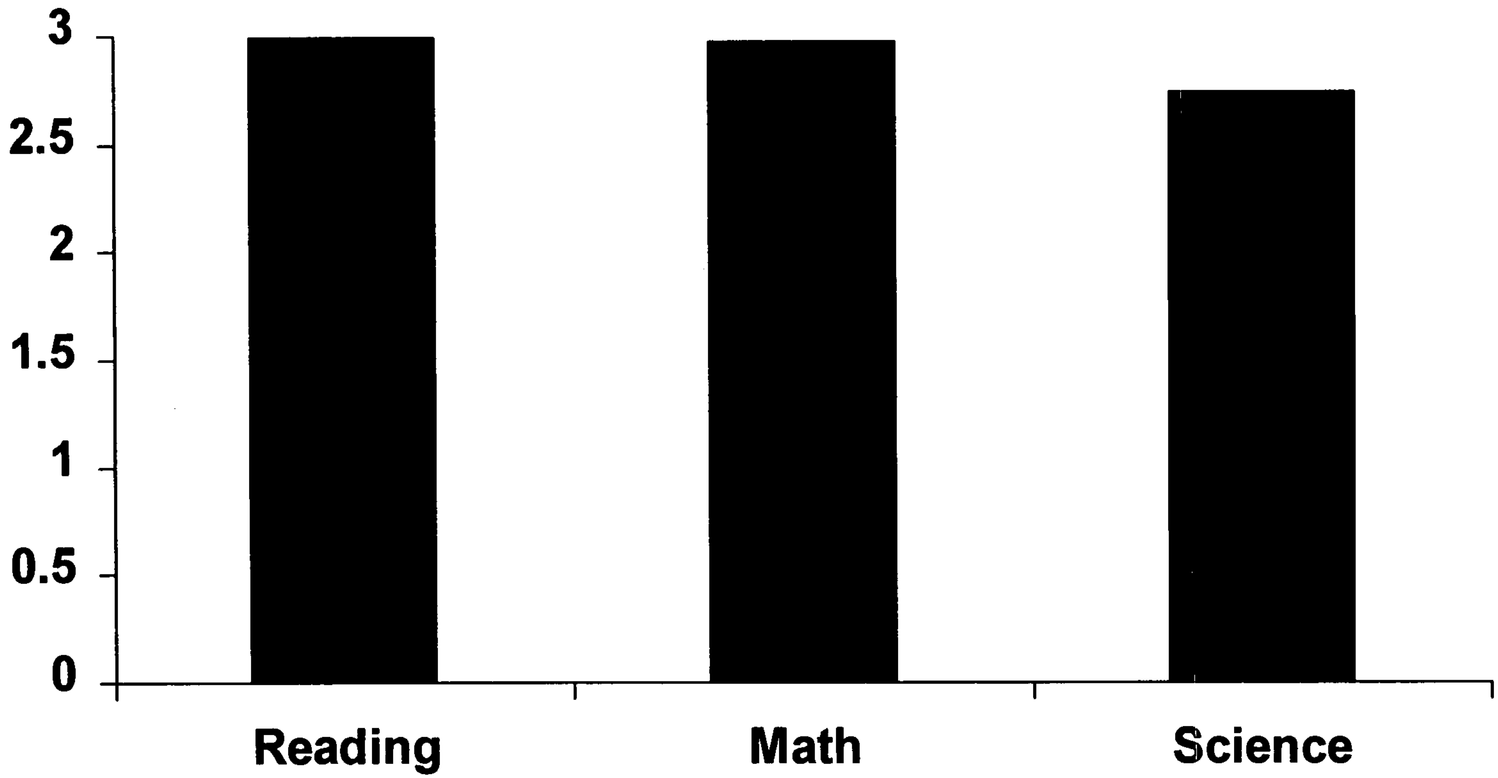
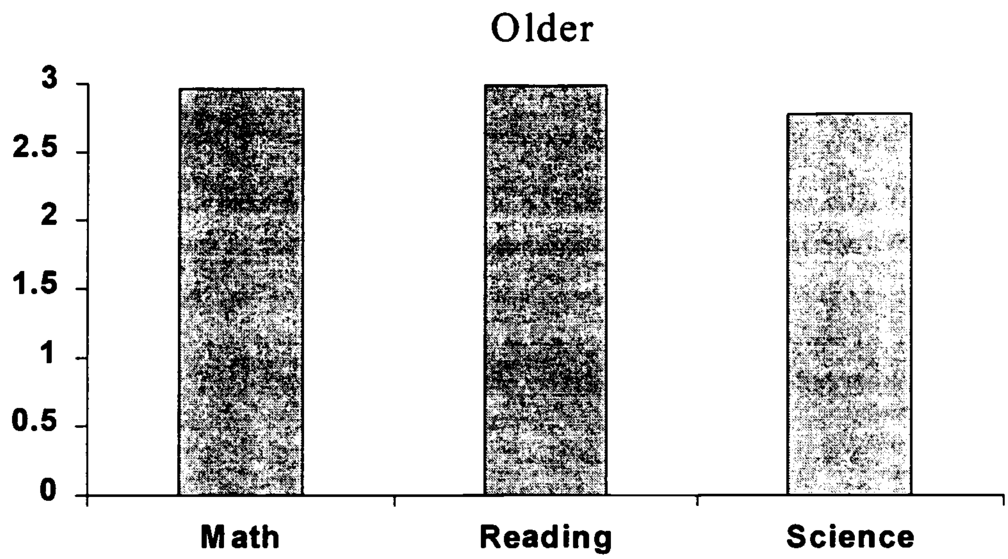


Figure 48. Parents' mean rating of the importance of subject matter for K-6 grade students as a function of subject matter. (Bars with common overlines are not significantly different.)



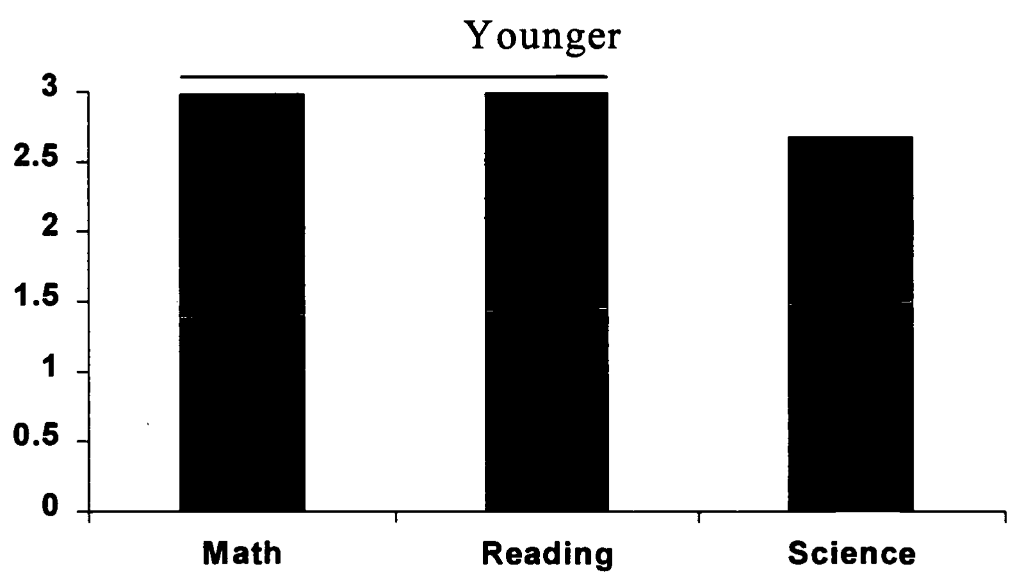
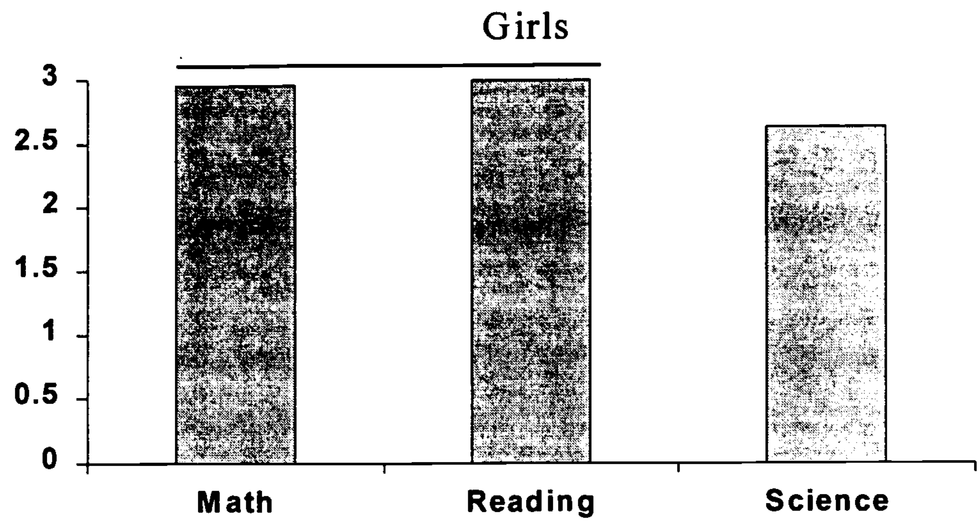


Figure 49. Parents' mean rating of the importance of the subject matter for K-6 grade students as a function of grade level. (Bars with common overlines are not significantly different.)



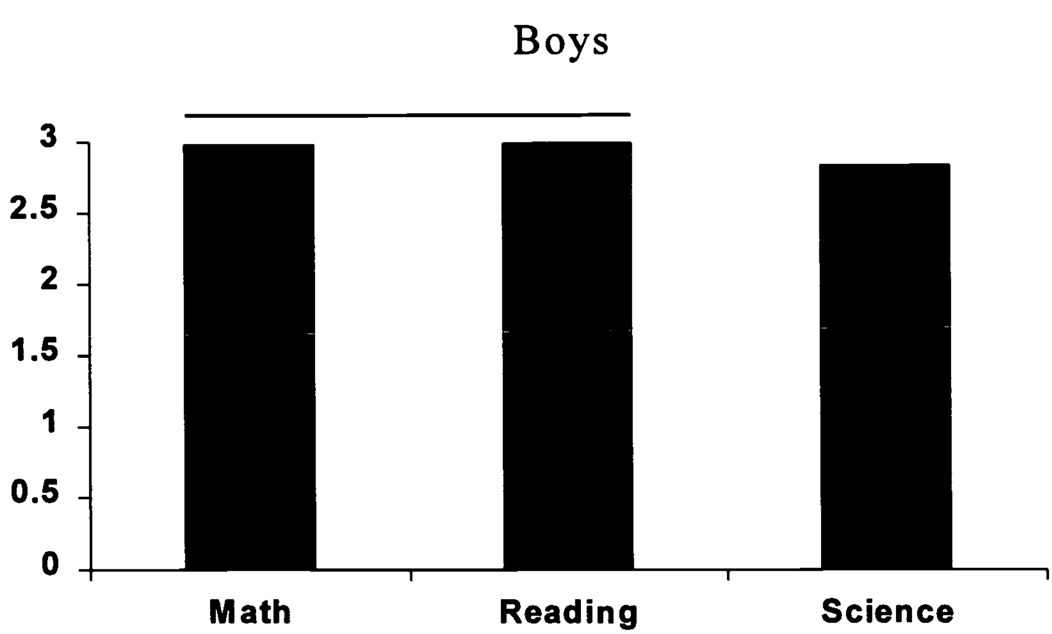


Figure 50. Parents' mean rating of the importance of the subject matter for K-6 grade students as a function of gender. (Bars with common overlines are not significantly different.)

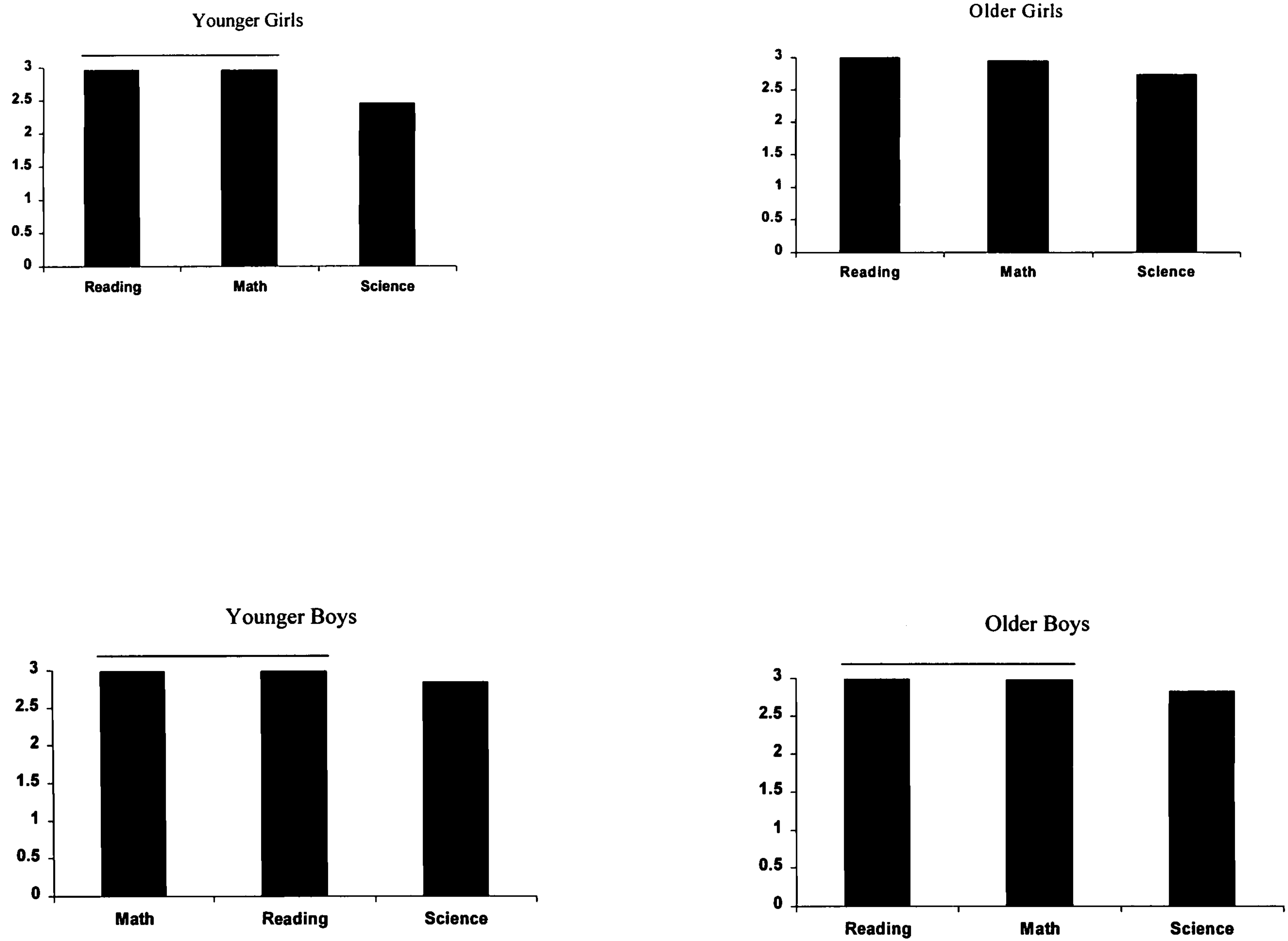


Figure 51. Parents' mean perceived importance of subject matter for K-6 grade students as a function of grade level and gender. (Bars with common overlines are not significantly different.)

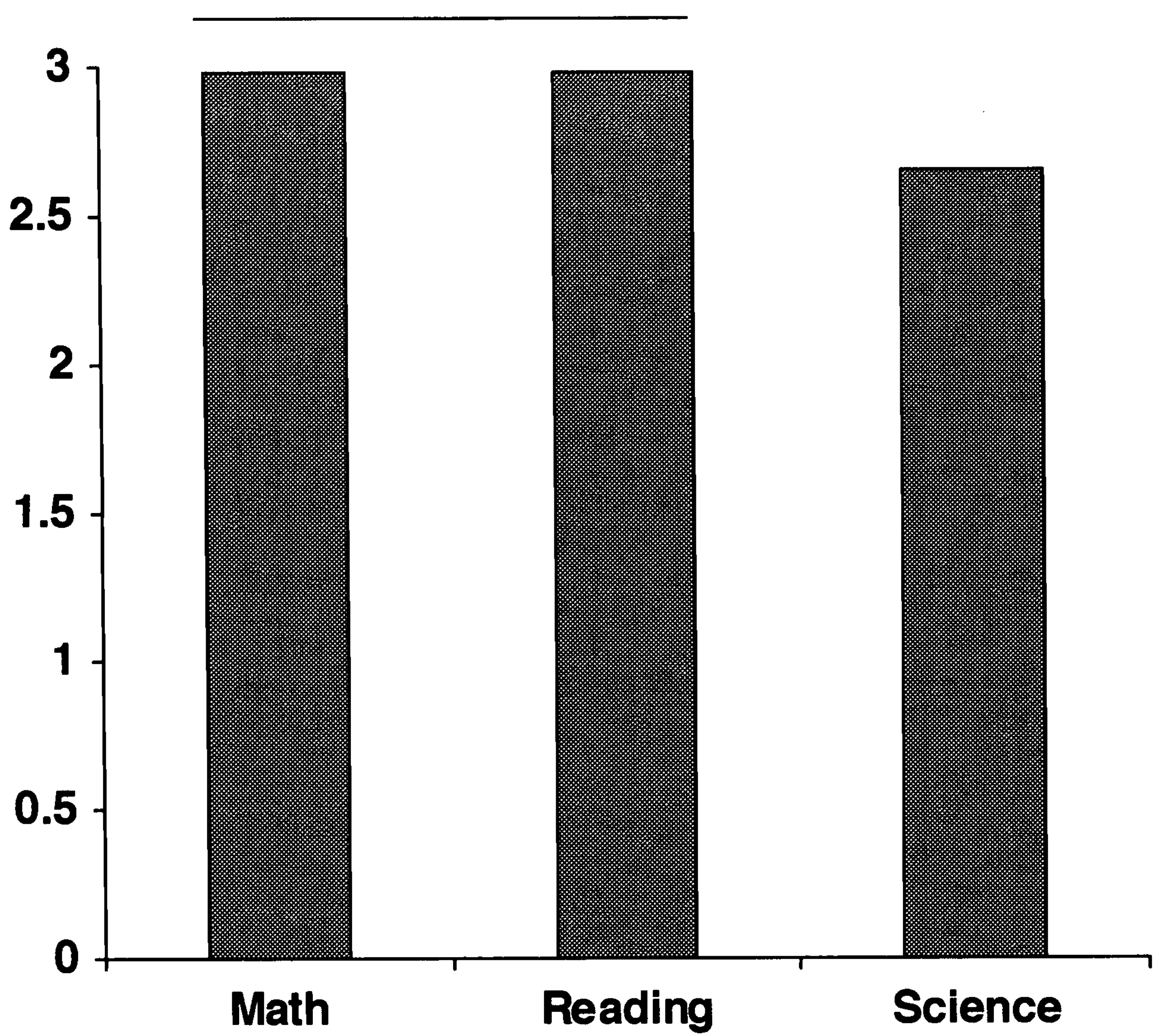
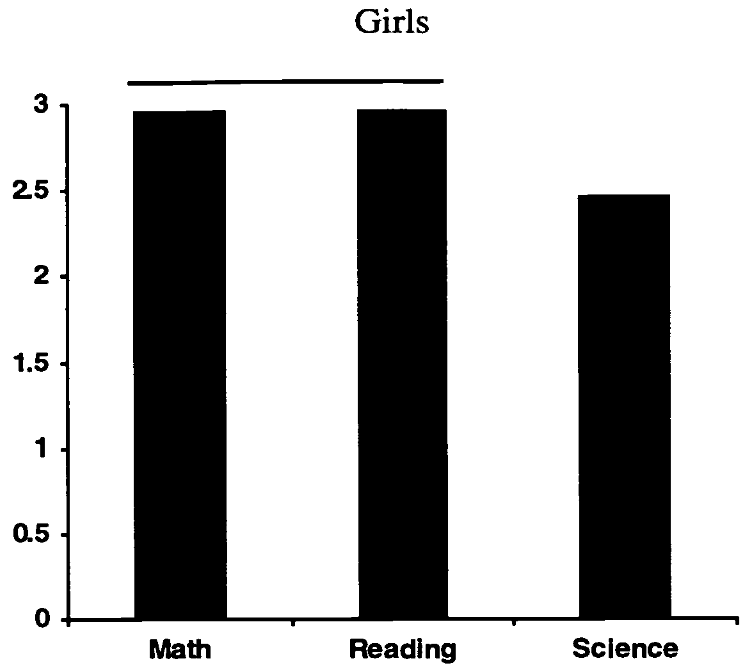


Figure 52. Parents' mean rating of the importance of subject matter for K-3 students. (Bars with common overlines are not significantly different.)



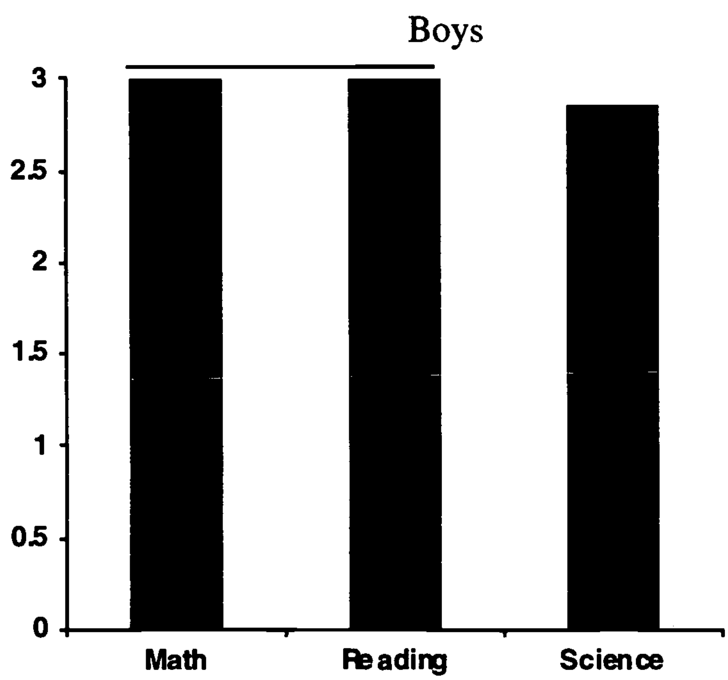


Figure 53. Parents' mean rating of the importance of the subject matter for K-3 grade students as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

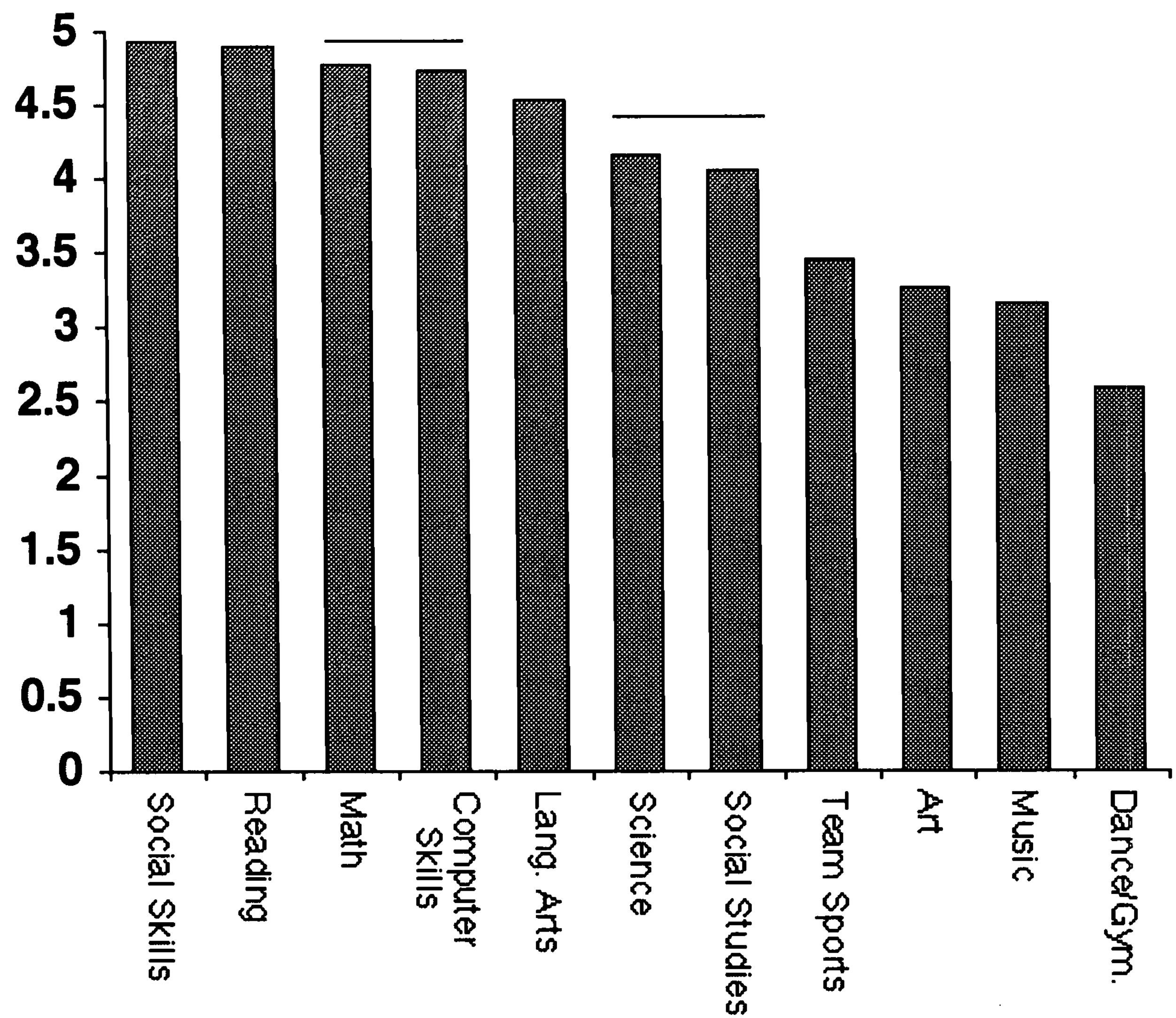
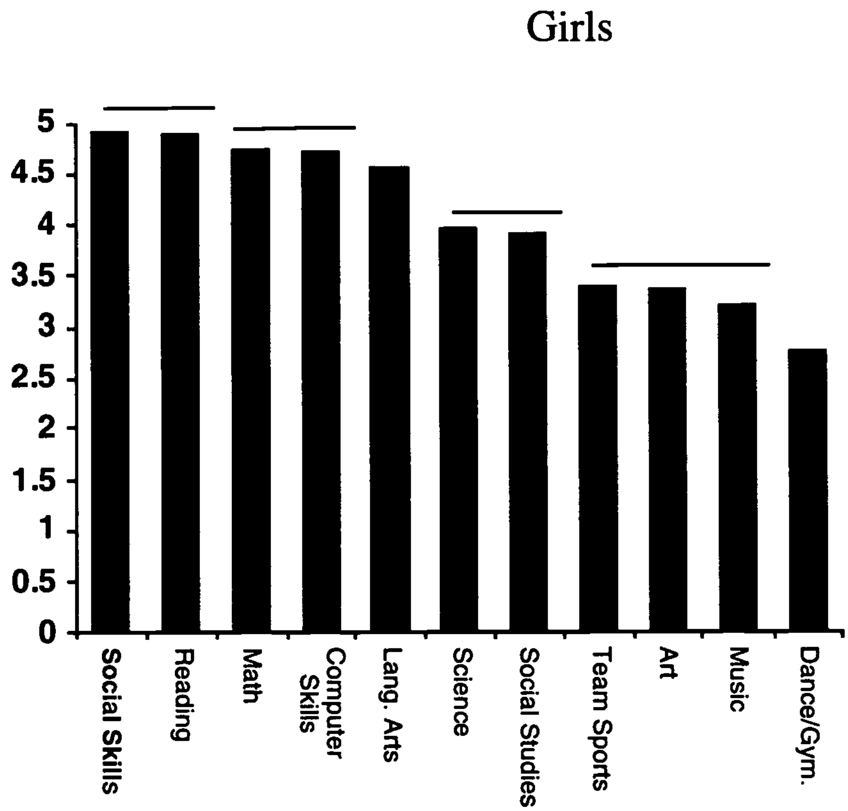


Figure 54. Parents' mean rating of the importance of subject matter for 4-6 grade students. (Bars with common overlines are not significantly different.)



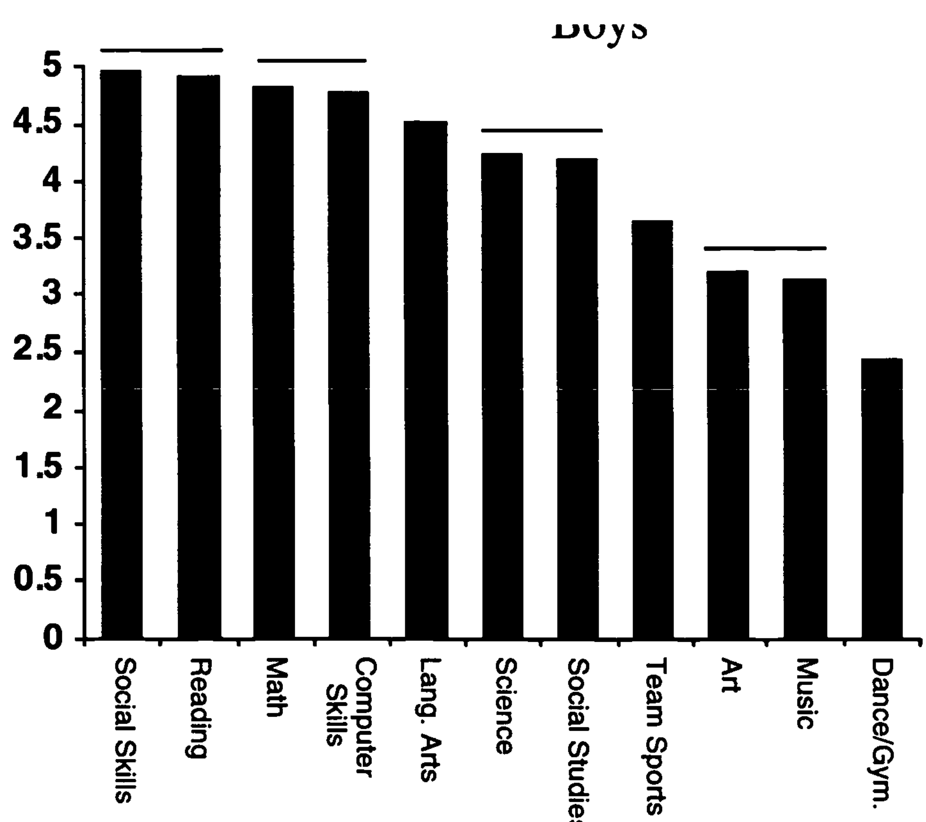


Figure 55. Parents' mean rating of the importance of subject matter for 4-6 grade students as a function of subject matter and gender. (Bars with common overlines are not significantly

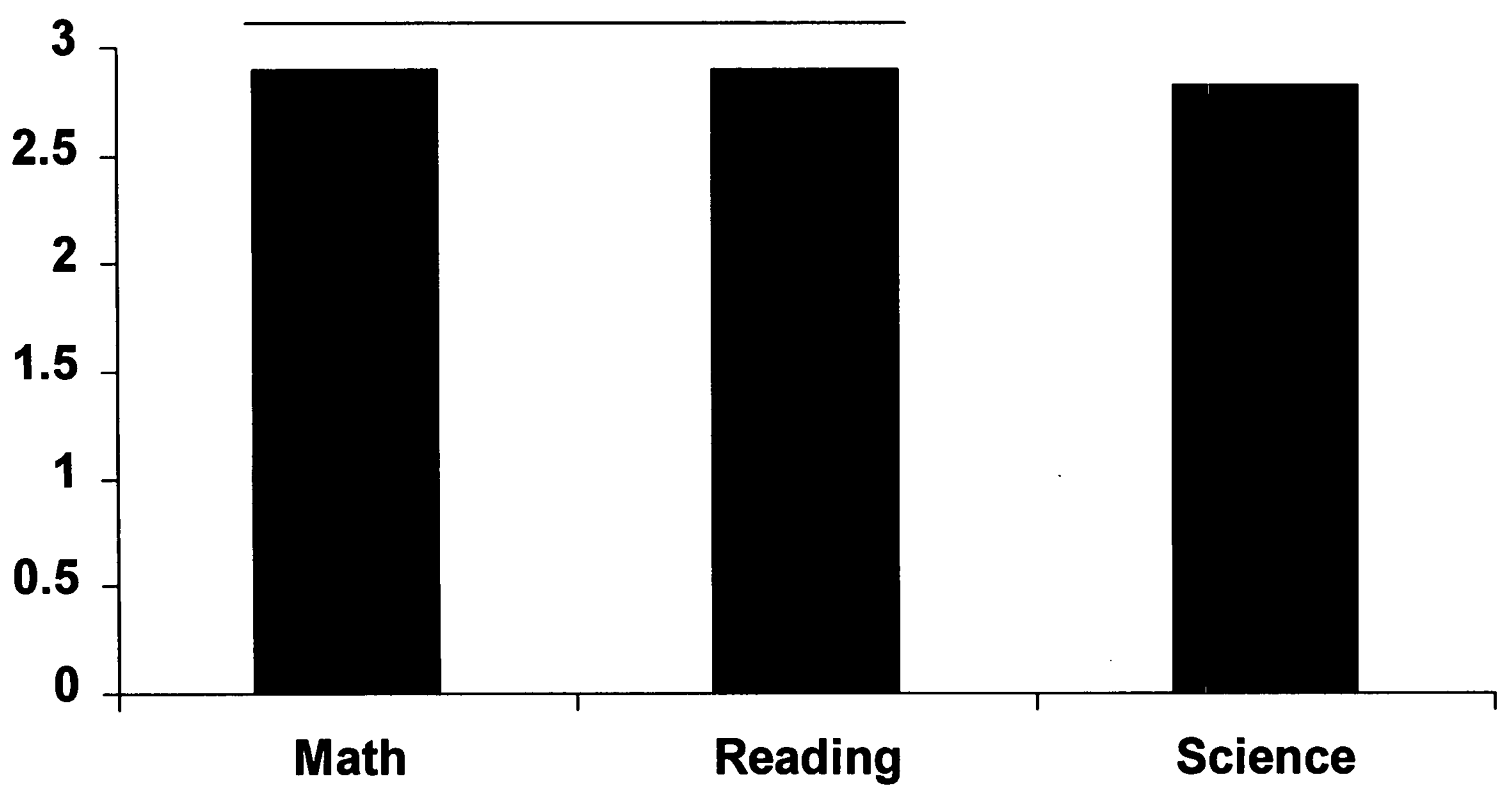
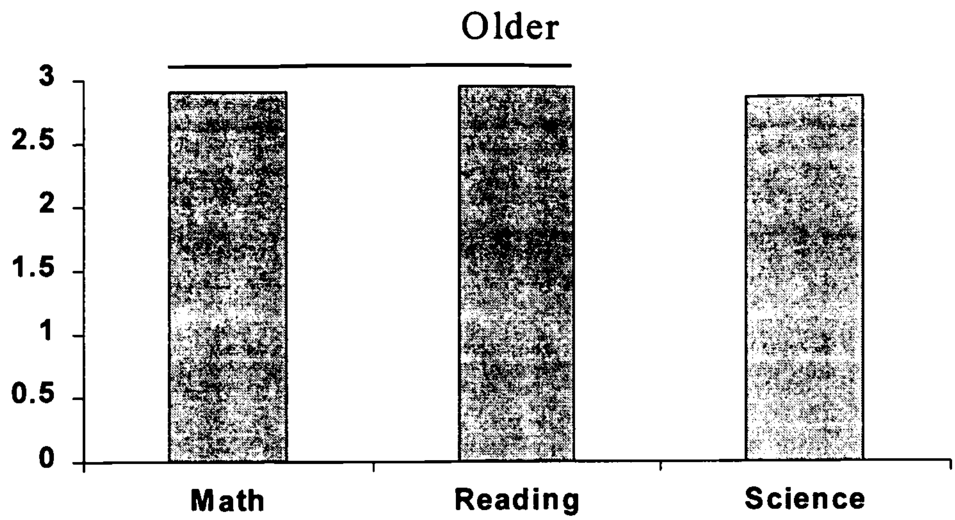


Figure 56. Parents' mean expectation for performance from K-6 grade students as a function of subject matter. (Bars with common overlines are not significantly different.)



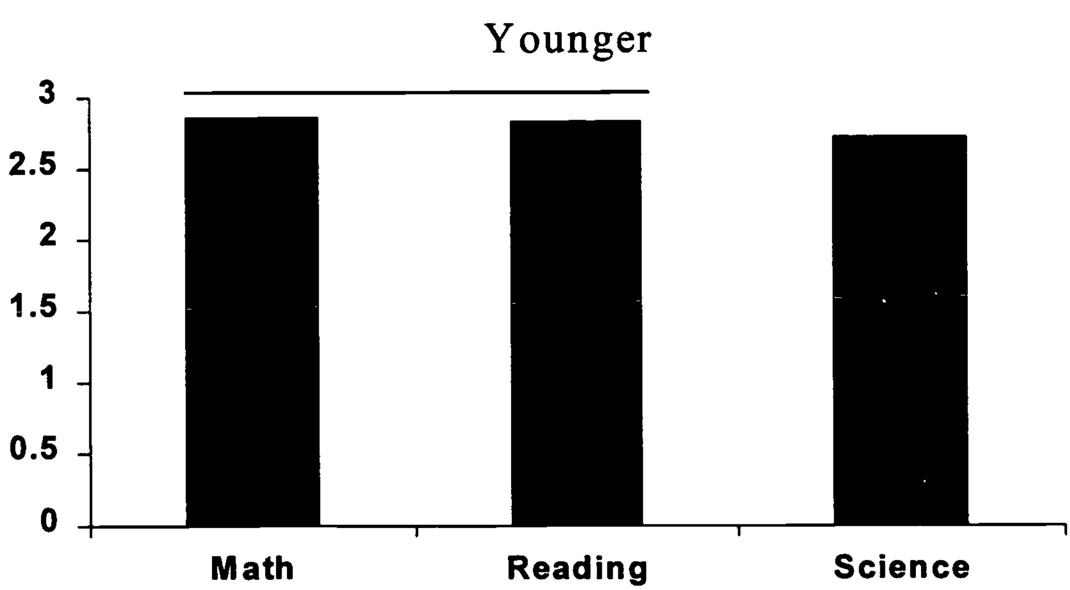


Figure 57. Parents' mean rating of expected performance from K-6 grade students as a function of grade level. (Bars with common overlines are not significantly different.)

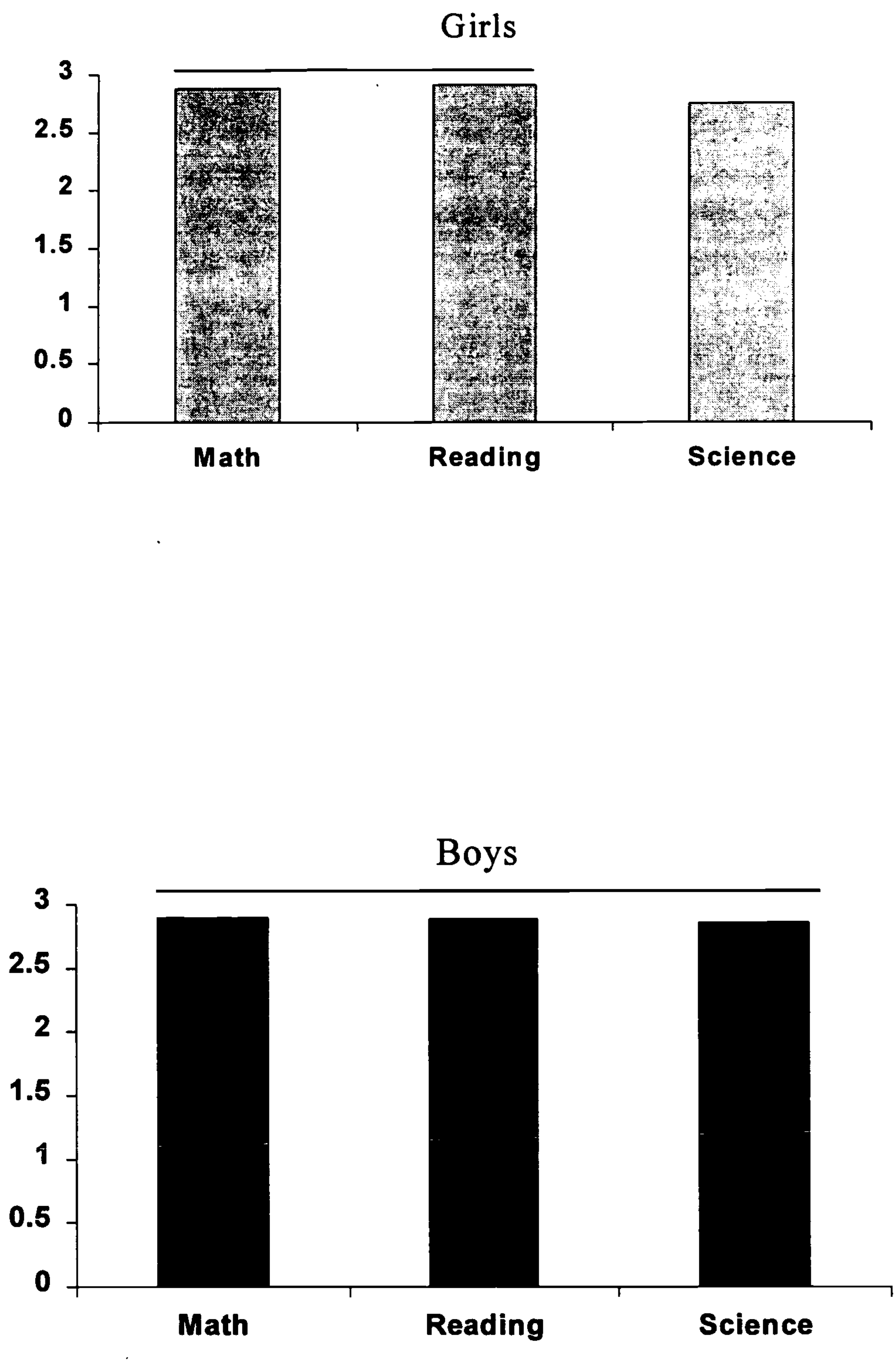


Figure 58. Parents' mean expectation for performance from K-6 grade students as a function of gender. (Bars with common overlines are not significantly different.)

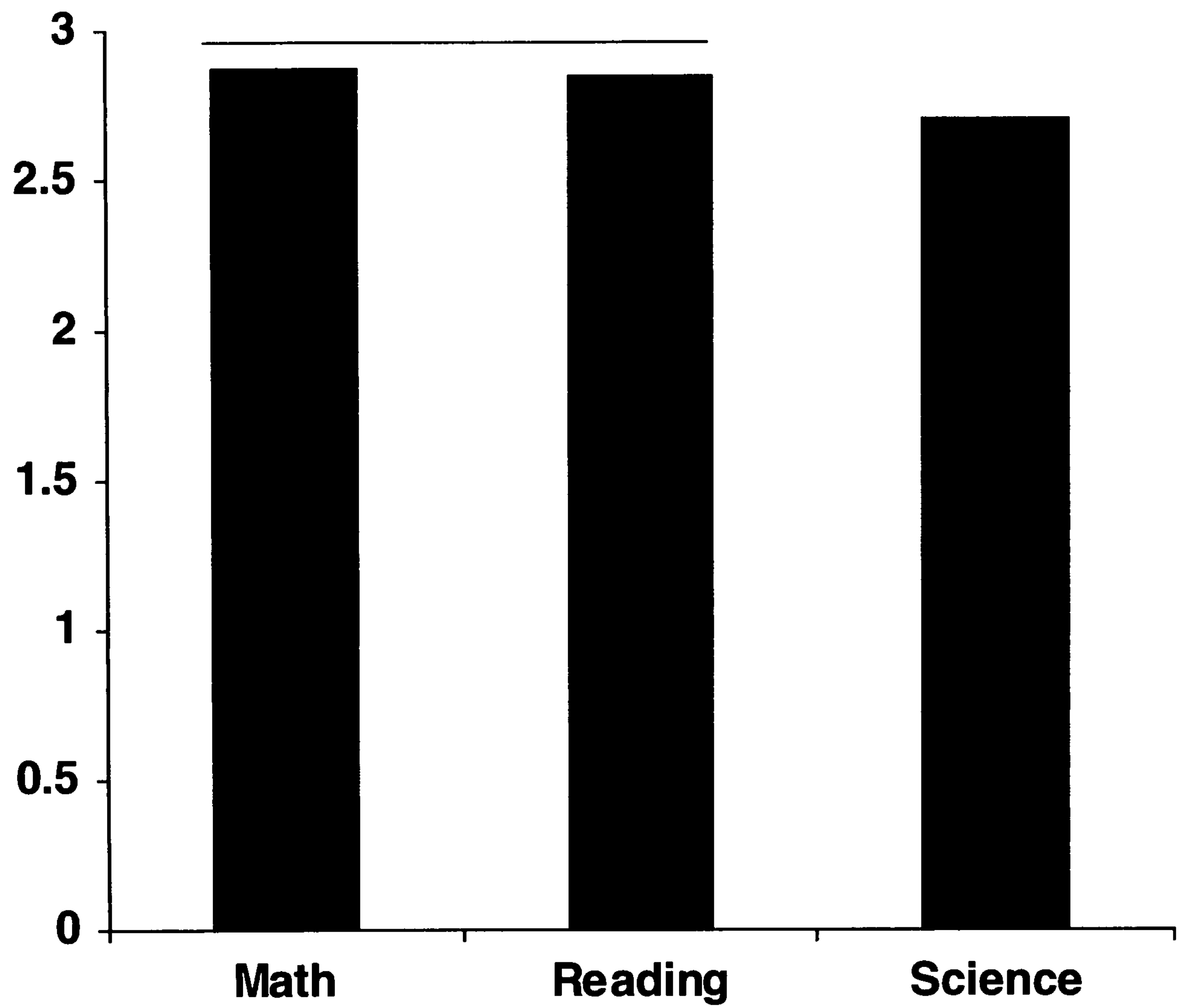


Figure 59. Parents' mean rating of expected performance from K-3 students as a function of subject matter. (Bars with common overlines are not significantly different.)

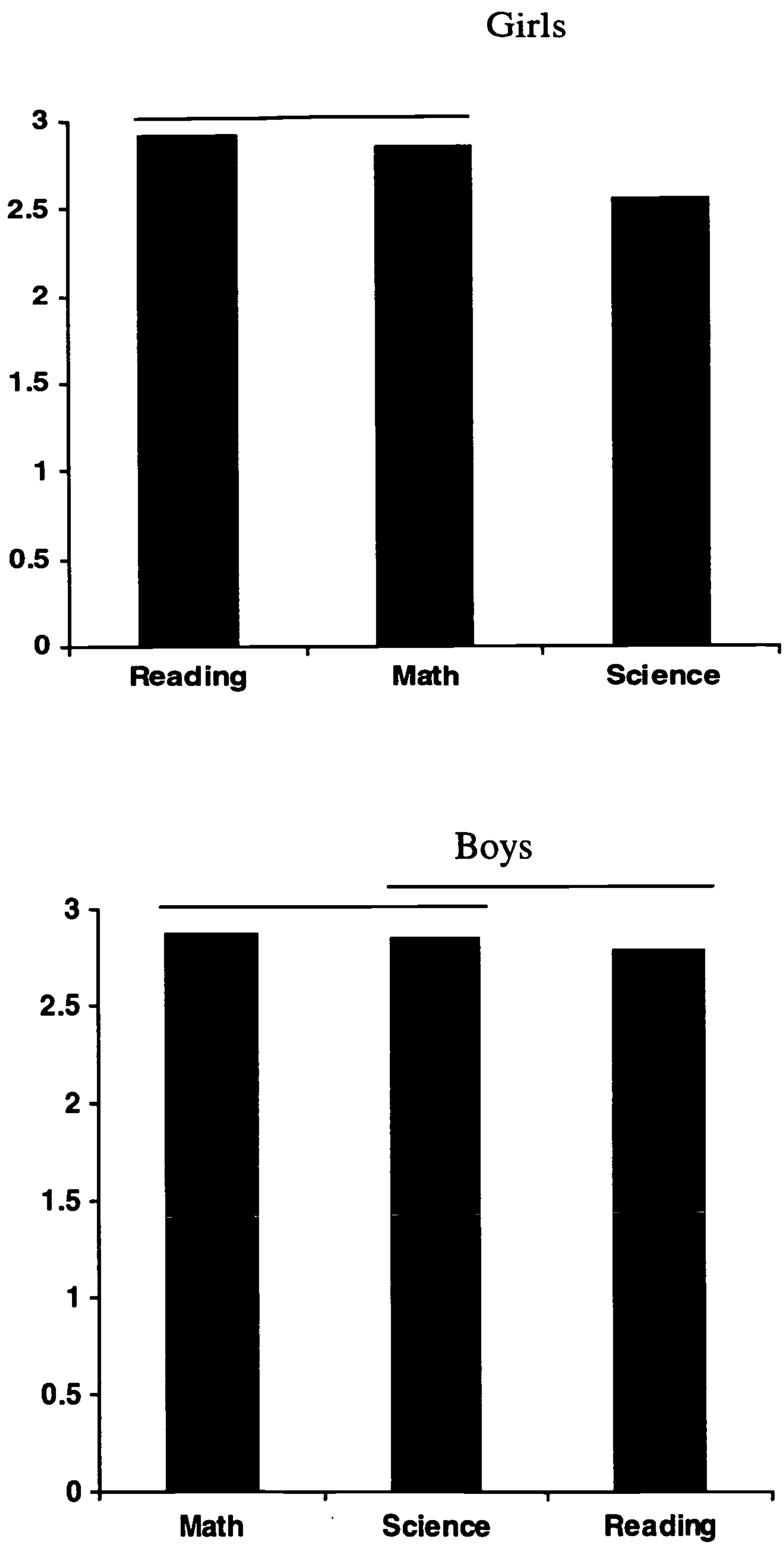


Figure 60. Parents' mean rating of expected performance from K-3 students as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

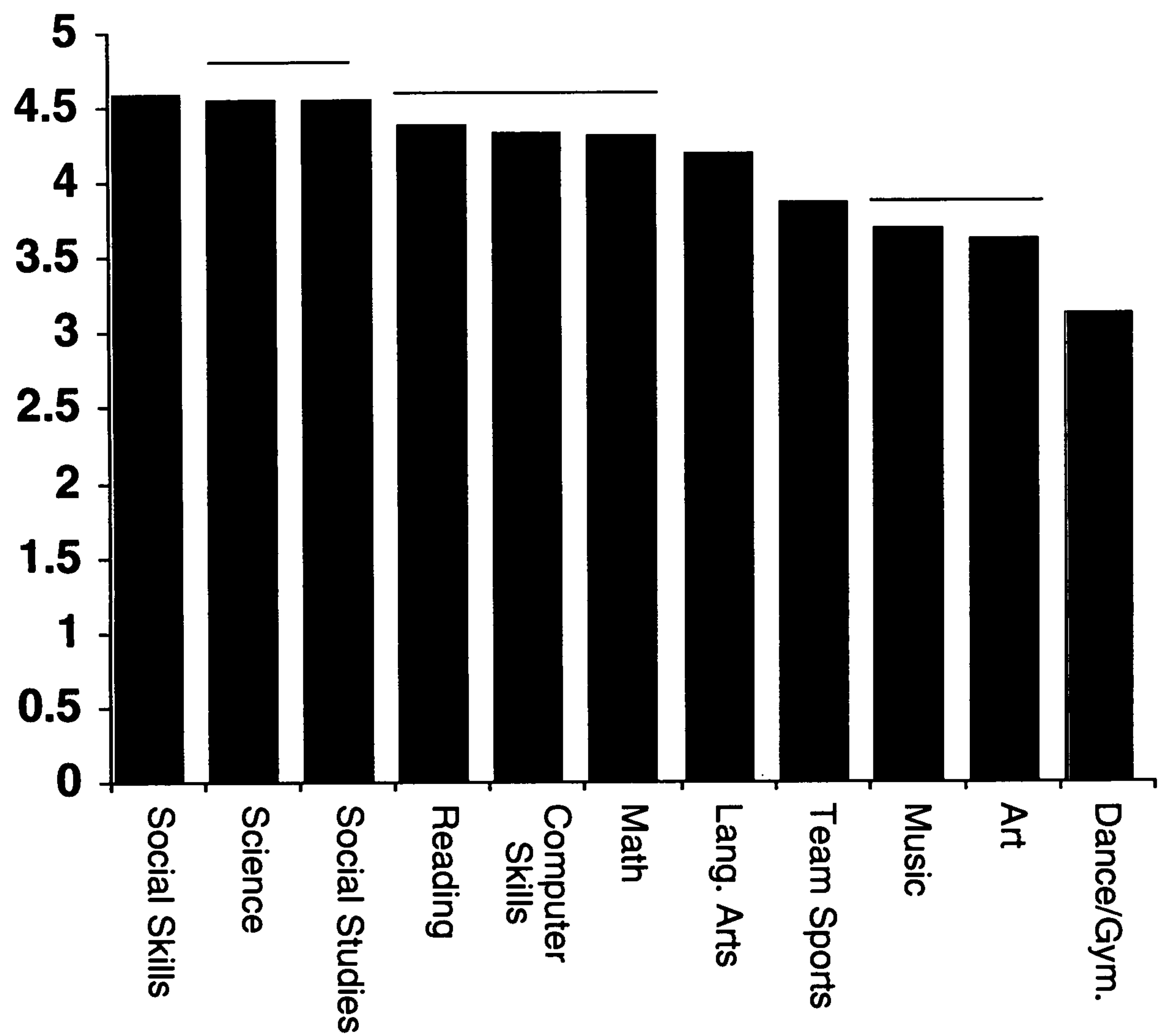


Figure 61. Parents' mean rating of expected performance from 4-6 grade students as a function of subject matter. (Bars with common overlines are not significantly different.)

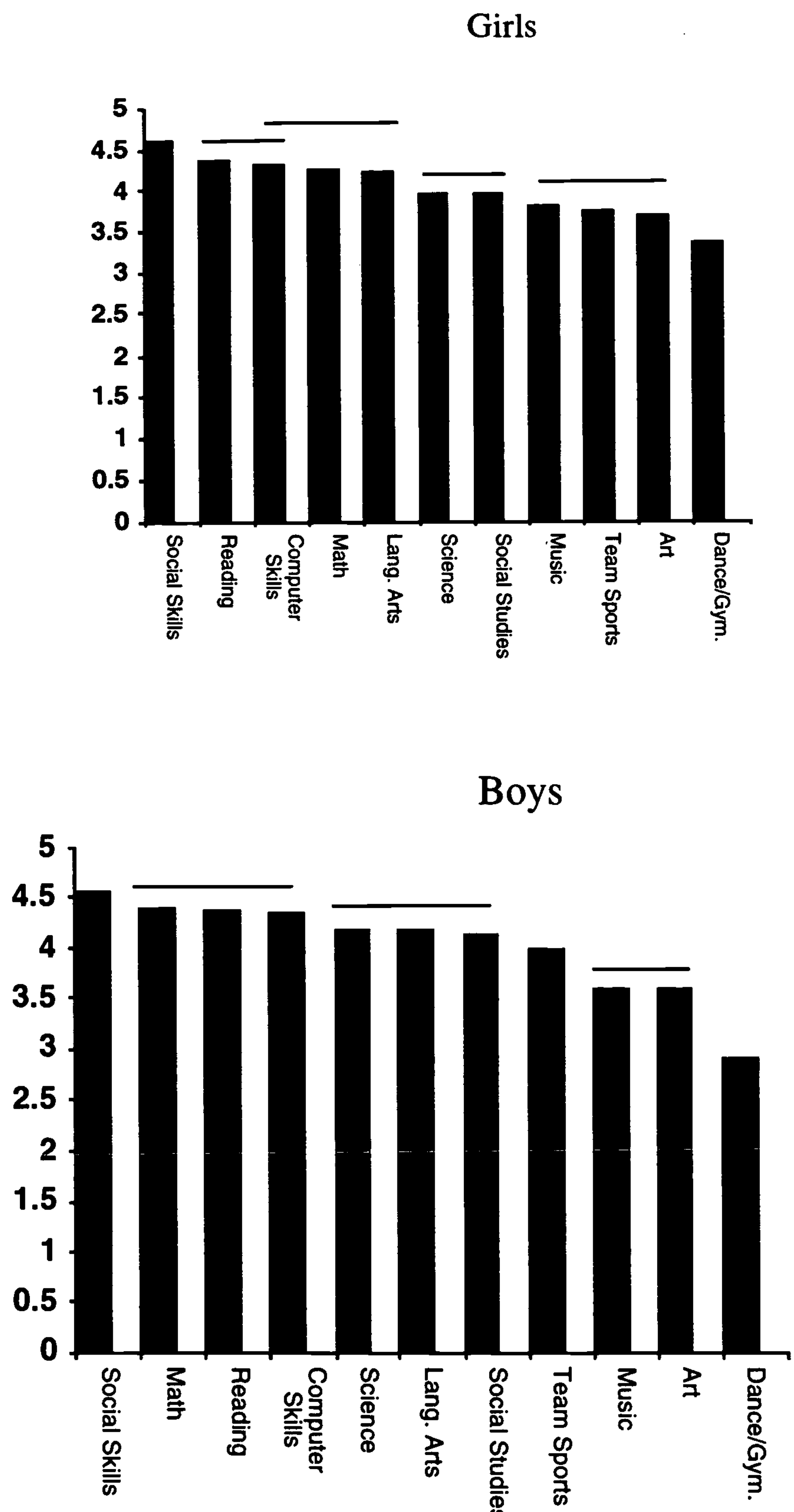


Figure 62. Parents' mean rating of expected performance from 4-6 grade students as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

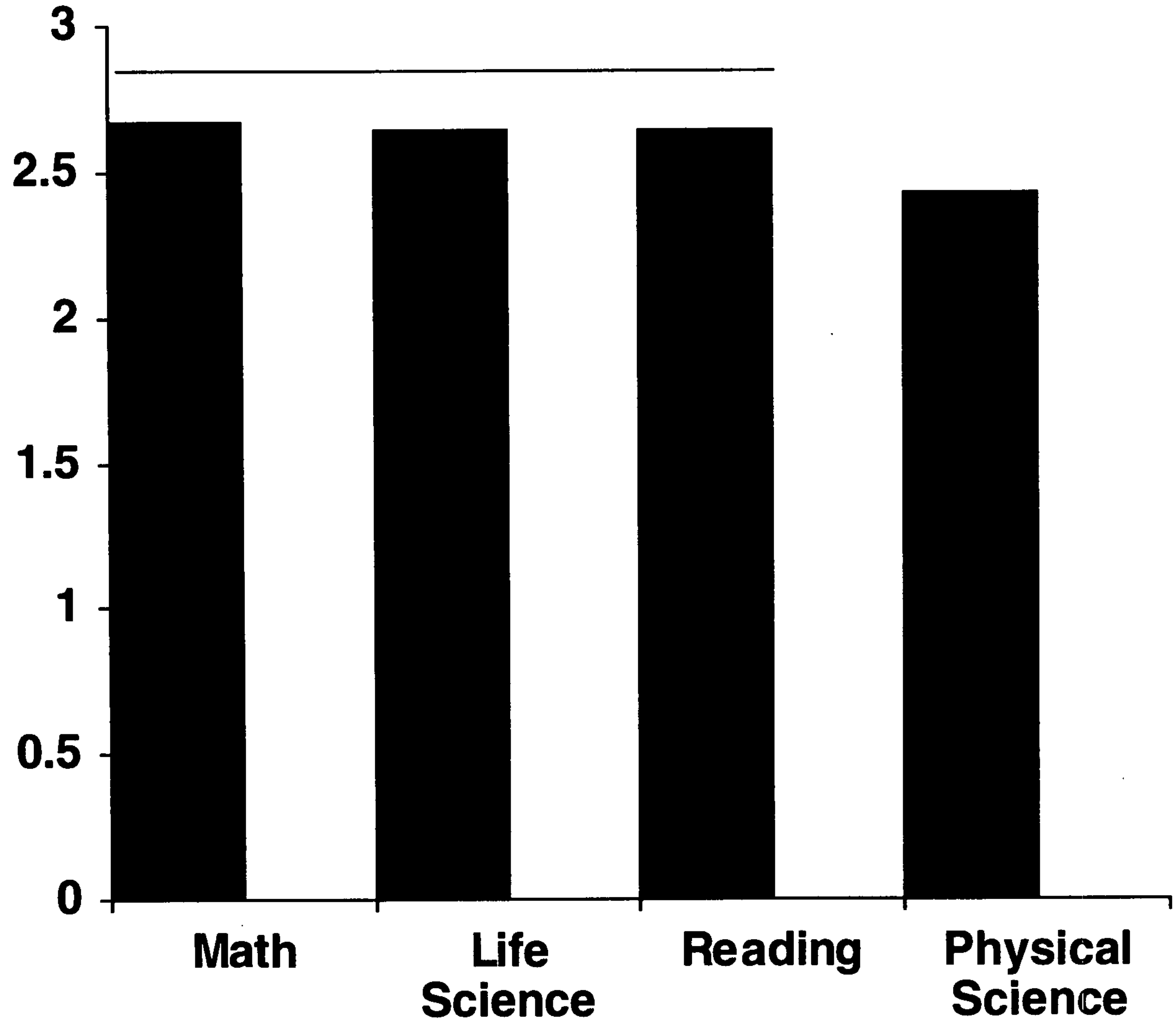
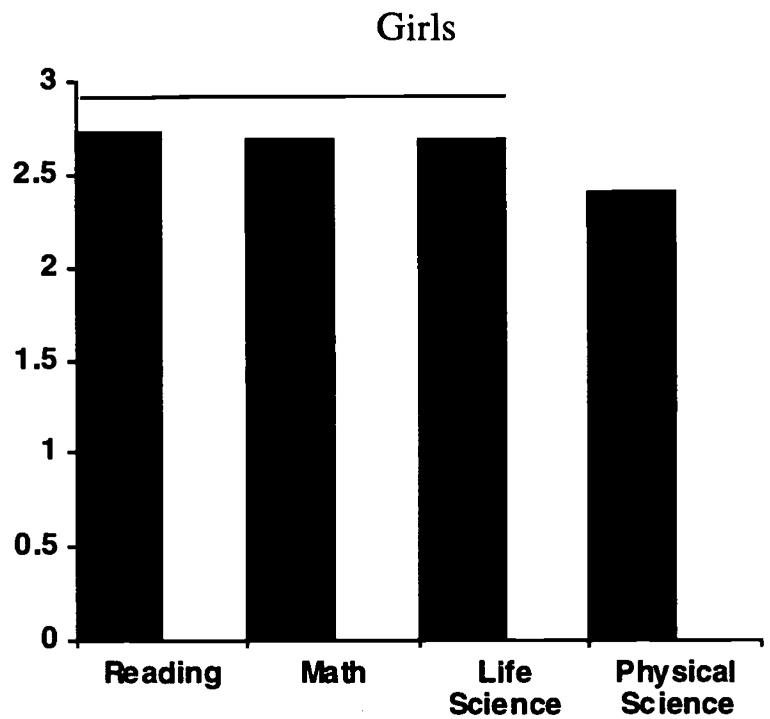


Figure 63. K-6 grade students' liking as a function of subject matter. (Bars with common overlines are not significantly different.)



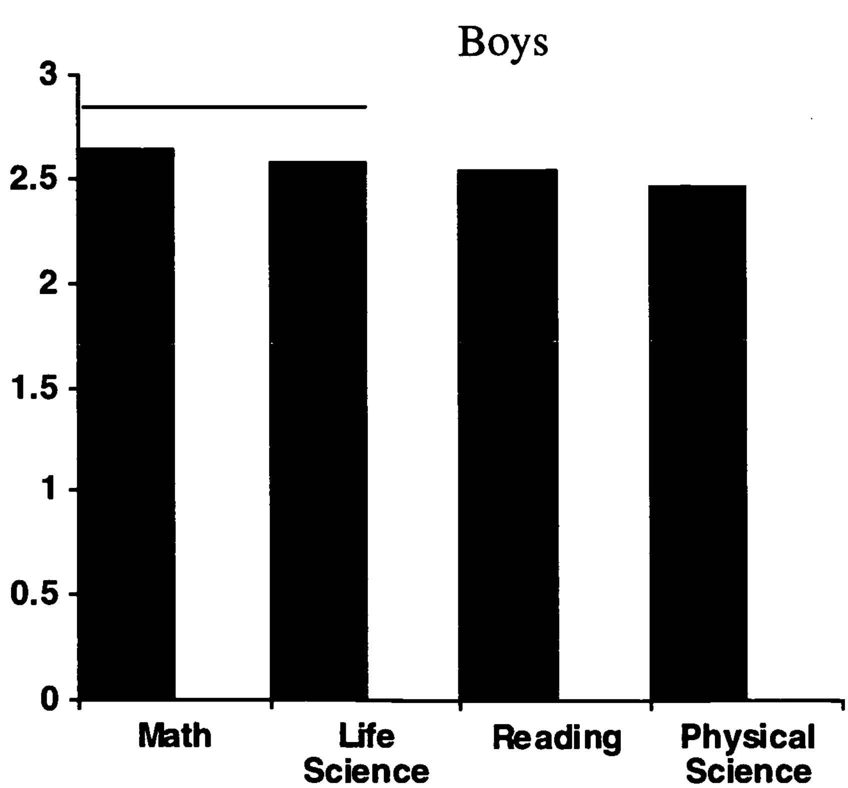


Figure 64. K-6 grade students' liking as a function of subject matter and gender. (Bars with common overlines are not significantly different.)

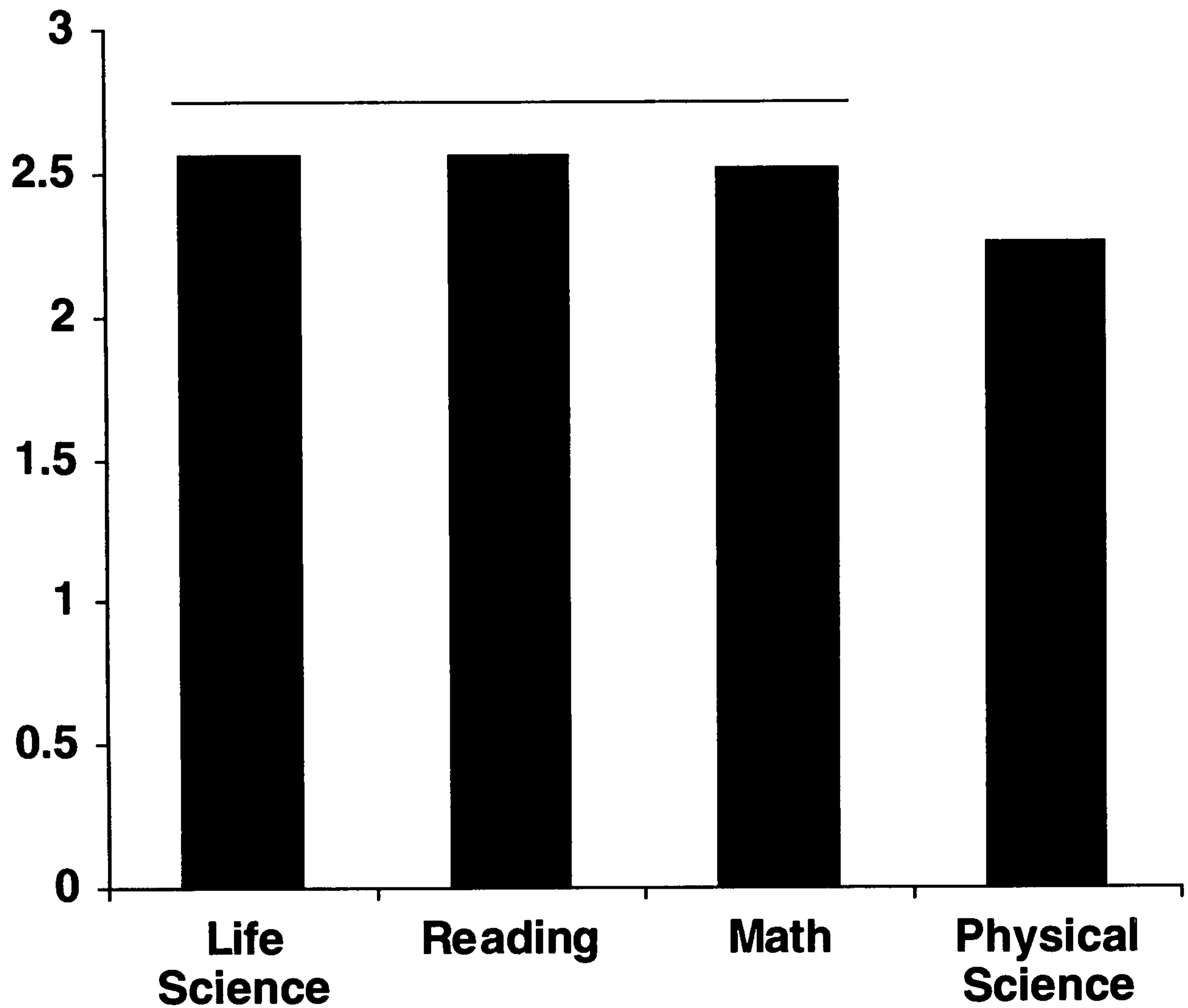


Figure 65. K-3 grade students' liking as a function of subject matter. (Bars with common overlines are not significantly different.)

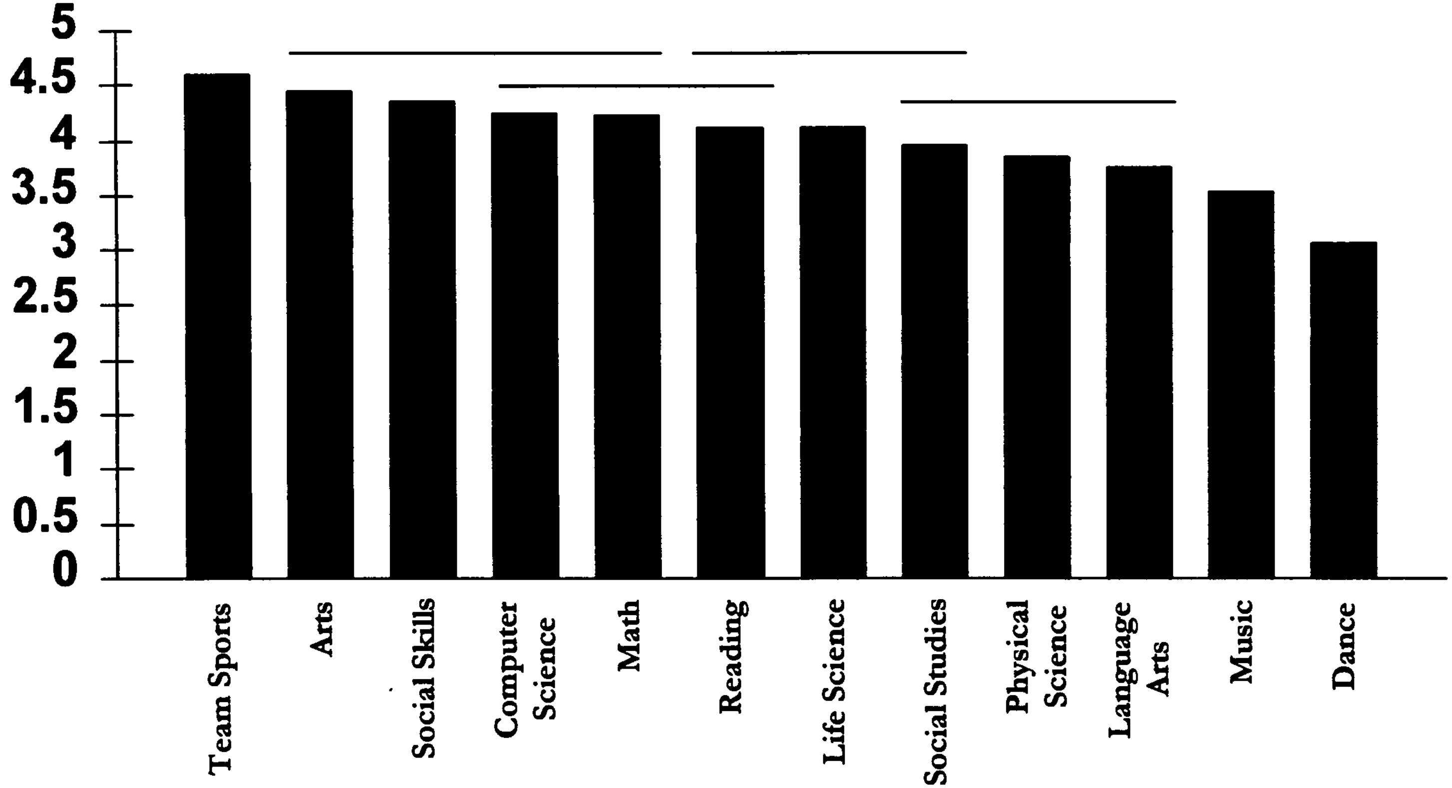
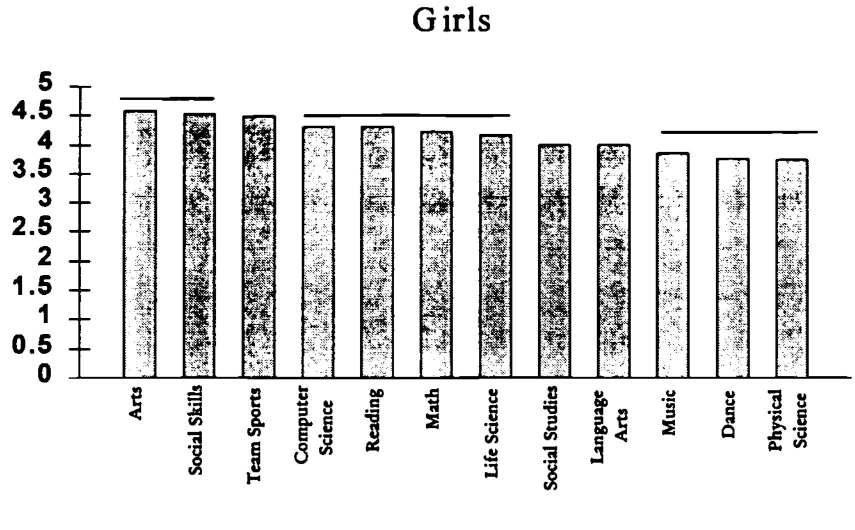


Figure 66. K-6 grade students' mean liking of subject matter. (Bars with overlines are not significantly different.)



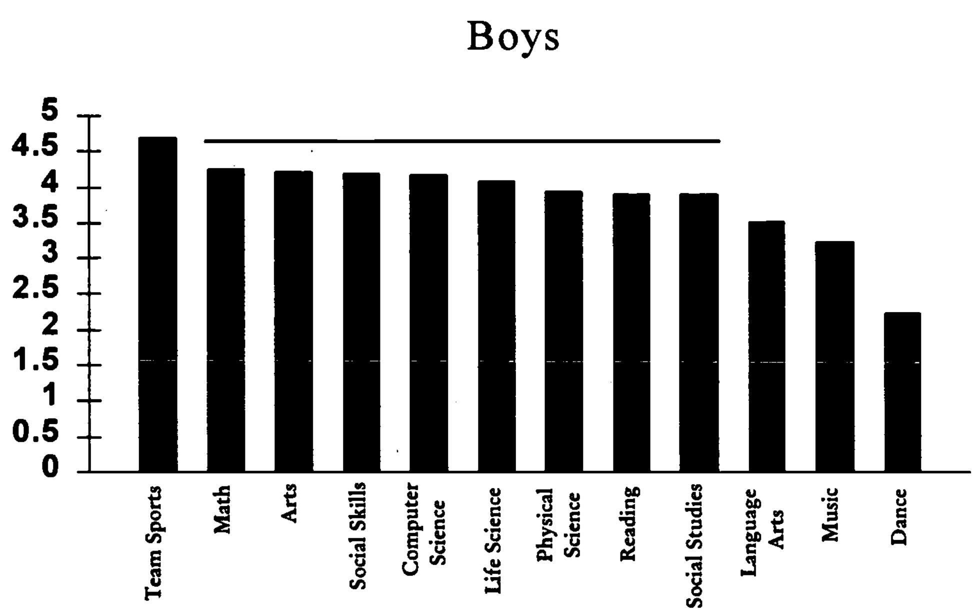


Figure 67. Fourth-sixth grade students' mean report of liking subject matter as a function of gender. (Bars with overlines are not significantly different.)

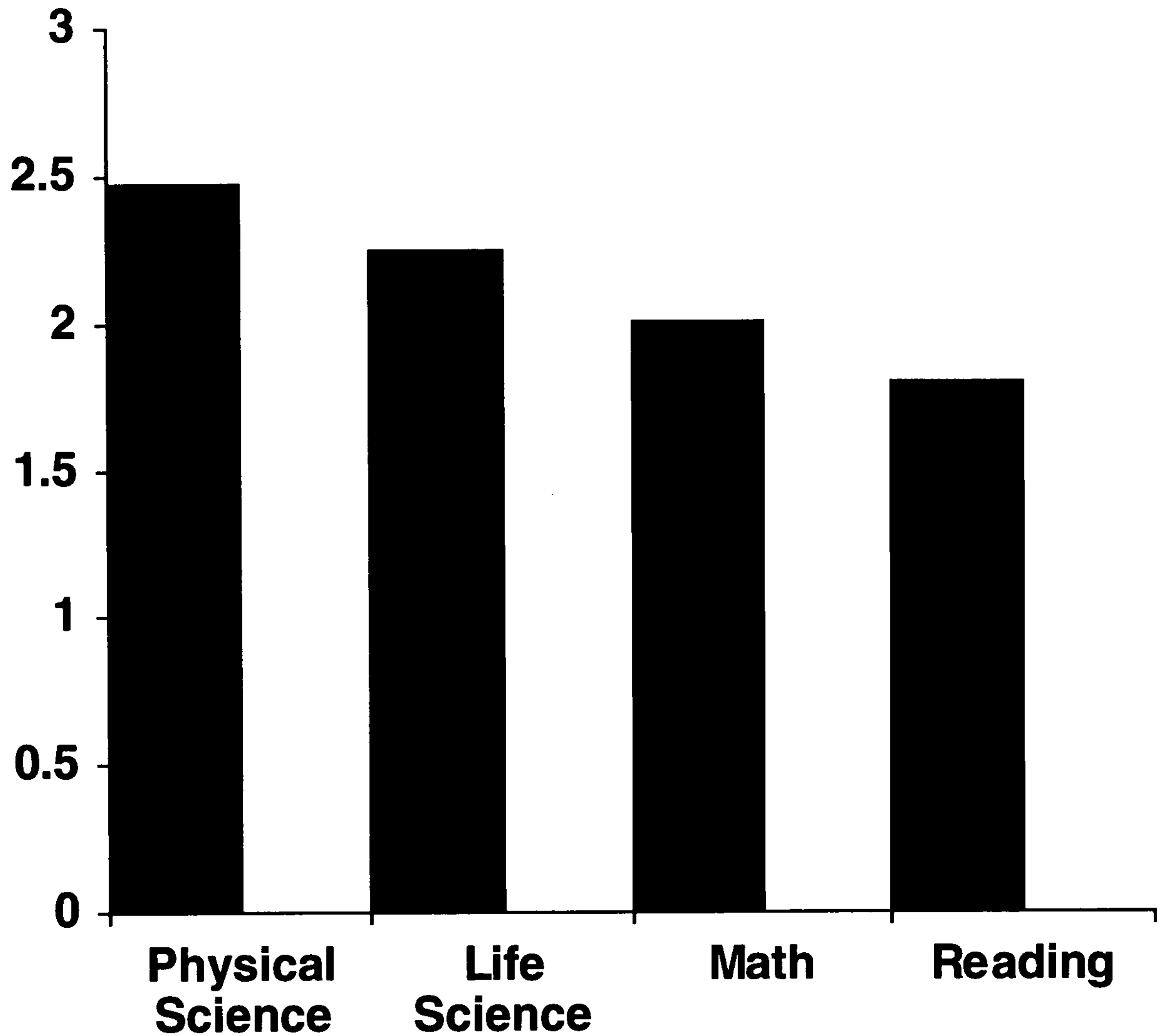
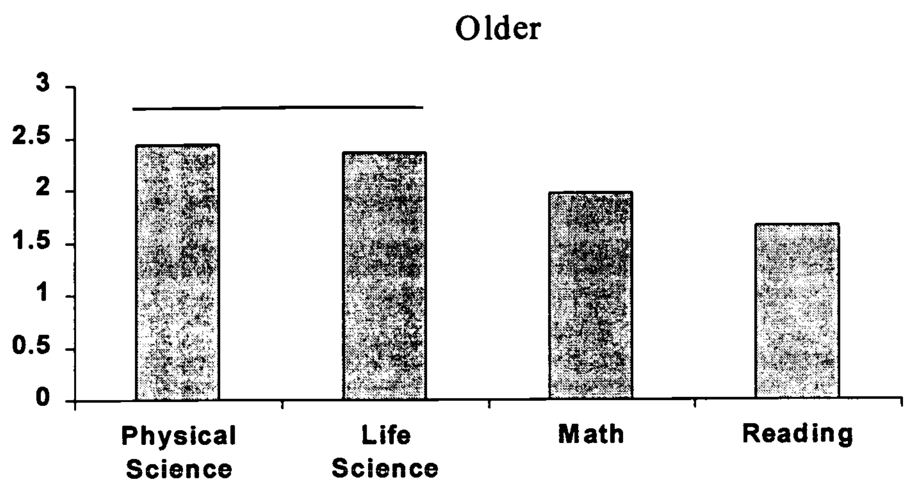


Figure 68. K-6 grade students' perception of male-domination by career area. (All career area differences are significant.)



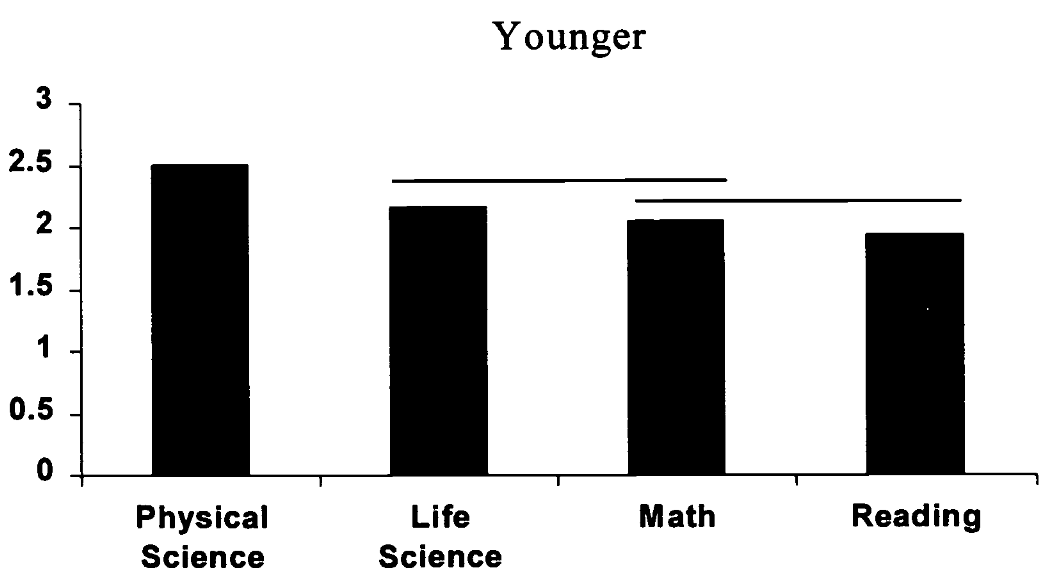


Figure 69. K-6 grade students' mean perception of male-domination across career areas as a function of grade level. (Within subject matters, bars with common overlines are not significantly different.)

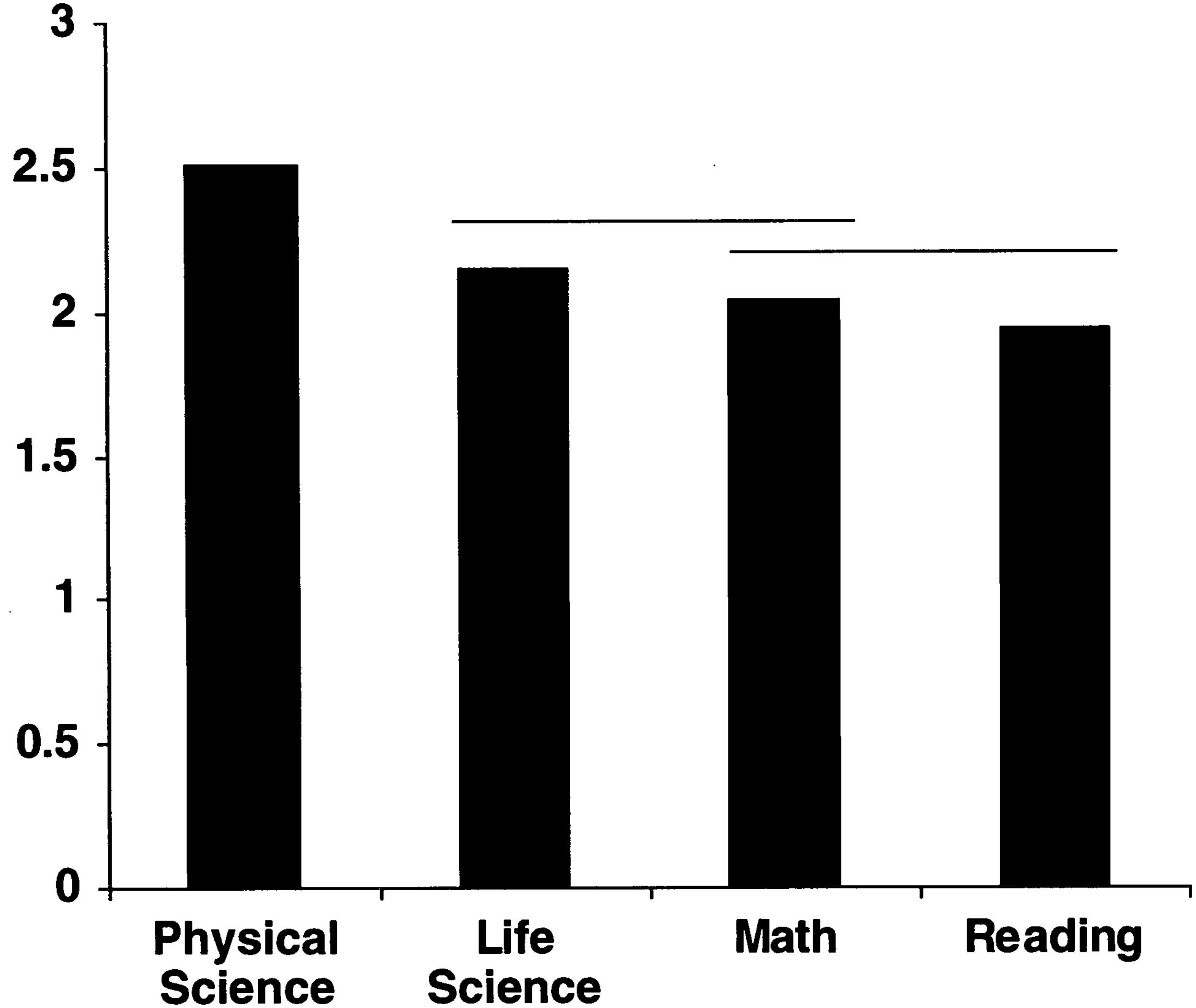


Figure 70. K-3 grade students' perception of the male - domination across career areas. (Bars with common overlines are not significantly different.)

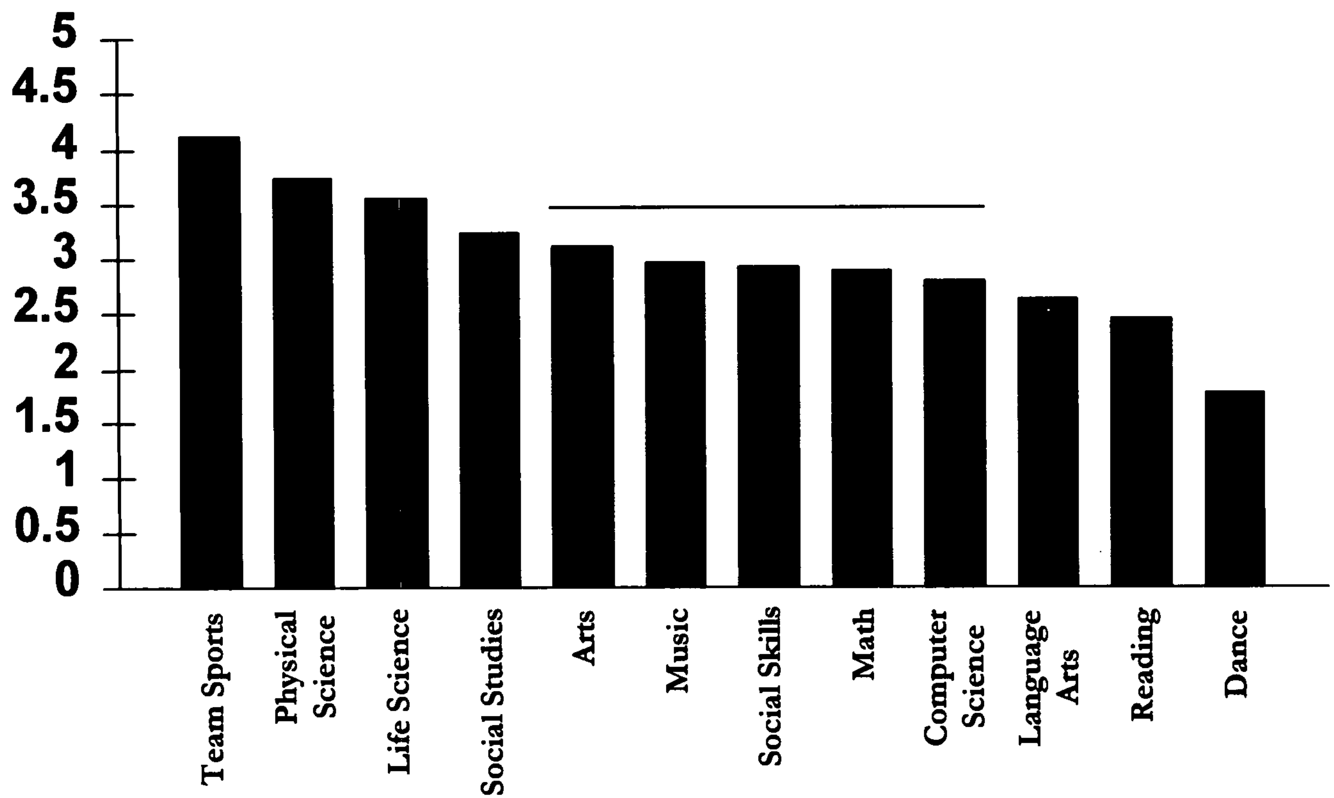


Figure 71. Fourth-sixth grade students' mean perception of male-domination across career areas. (Bars with overlines are not significantly different.)

Appendix 1: Verbal description of correlations between parental and student variables.

Within the entire sample, students' perceived ability in math correlated positively with mothers' perceptions of their child's ability in math, r=.21, and with mothers' perceptions of the importance of math in their child's future, r=.13.
Students' perceived ability in reading correlated positively with fathers' perceptions of their child's reading ability, r=.30, with mothers' perceptions of their child's reading ability, r=.42, and with mothers' perceptions of their own ability in reading, r=.16.
Students' rating of how much they liked reading correlated to their father's report of perceived competency in reading, r=.24, with their mothers' perceptions of their child's ability in reading, r=.31, and with their mothers' perceived importance of reading in their child's future, r=.13.
Students' perceived ability in life science was positively correlated with both their fathers' and mothers' perceptions of their child's science ability, r=.27 and r=.17, respectively. Students' rating of how much they liked life science correlated with their fathers' perceptions of the child's science ability, r=.28, and with their mothers' perception of the importance of science in their child's future, r=.14.
Student's perceived ability in physical science correlated only with their fathers' perceptions of their child's ability in science, r=.36. Students' rating of how much they liked physical science also correlated with their fathers' perceptions of the child's ability in science, r=.32, and with the fathers' rating of the importance of science in their child's future, r=.26. The students' physical science perceptions did not correlate with any of the mothers' ratings.
Younger students' perceived ability in reading correlated positively with their mothers' perception of their child's reading ability, r^*=.47, with mothers' reported use of reading, r=.28, and with mothers' expectation of their child's performance in reading, r=.21. Younger students' rating of how much they liked reading correlated with mothers' perception of their children's ability in reading, r=.33. Finally, younger students' rating of how much they liked physical science correlated with their fathers' expectations of the child's performance in science, r=.48.

Older students' perceived ability in math positively correlated with mothers' and fathers' perceptions of their child's ability in math, r=.39 and r=.40, respectively; and with mothers' perceptions of their own math ability, r=.34, mothers' reported use of math, r=.24, mothers' perception of the importance of math in their child's future, r=.20, and finally, with mothers' expectations of their child's performance in math, r=.23.

Older students' reported liking of math also corresponded to mothers' perceptions of their child's ability in math, r=.35, to mothers' reported use of math, r=.35, and mothers' perception of the importance of math in their child's future, r=.27.

Older students' expected grade in math directly related to fathers' and mothers' perceptions of their child's ability in math, r=.39 and r=.43, respectively. This variable also correlated with mothers' perceptions of their own ability in math, r=.29, and with mothers' expectations of their child's performance in math, r=.30.

Older students' perceived ability in reading positively correlated with fathers' perceptions of their child's reading ability, r=.45, and with three of the mother variables. Students' perceived ability in reading correlated with mothers' perceptions of their child's ability in reading, r=.52, with mothers' perception of the importance of reading in their child's future, r=.27, and with mothers' expectations of their child's performance in reading, r=.22.

Older students' rating of how much they liked reading related to mothers' perceptions of their child's ability in reading, r=.30, and with their mothers' perceived importance of reading in their child's future, r=.23. Students' reported effort in reading negatively correlated to fathers' perceptions of their own reading ability, r=-.27. Finally, students expected grade in reading correlated with mothers' perceptions of their child's ability in reading, r=.44, with mothers' perception of their own ability in reading, r=.32, with mothers' reported use of reading, r=.37, with mothers' perception of the importance of reading in their child's future, r=.20, and with mothers' expectations of their child's performance in reading, r=.24.

Older students' perceived ability in language arts was positively correlated with both fathers' perceptions of their own language arts ability and their reported use of language arts, r=.34 and r=.27, respectively. This variable also directly related to mothers' perception of their child's ability, r=.20, with mothers' reported use of language arts, r=.17, and with mothers' perception of the importance of language arts in their child's future, r=.22. Students' perception of the importance of language arts to their future negatively related to mothers' perceived ability, r=-.17.

Older students' rating of how much they liked language arts correlated with fathers' perceptions of their own language arts ability, r=.27, with their fathers' perception of the importance of language arts in their child's future, r=.38, and with mothers' perceived ability, r=.19. Finally, students expected grade in language arts correlated with fathers' perceived ability, r=.38, with fathers' perception of the importance of language arts in their child's future, r=.36, with mothers' perceptions of their child's ability, r=.29, with mothers' perception of their own ability, r=.26, and with mothers' reported use of language arts, r=.29.

Older student's perceived ability in life science correlated with fathers' and mothers' perceptions of their child's ability in science, r=.45 and r=.31, respectively, as well as with mothers' rating of the importance of science in their child's future, r=.25. Students' rating of how much they liked life science also correlated with fathers' and mothers' perceptions of the child's ability in science, r=.39 and r=.22, respectively.

Older student's perceived ability in physical science correlated with fathers' and mothers' perceptions of their child's ability in science, r=.42 and r=.24, respectively, as well as with mothers' rating of the importance of science in their child's future, r=.27. Students' rating of how much they liked physical science correlated with fathers' perceptions of the child's ability in science, r=.31, and with mothers' rating of the importance of science in their child's future, r=.20. Finally, students expected grade in physical science correlated with fathers' and mothers' perception of their child's ability, r=.38 and r=.25, respectively.

Older students' perceived ability in social studies positively correlated with both mothers' and fathers' perceptions of their child's ability, r=.41 and r=.46, respectively, as well as with father's reported use of social studies, r=.43. Students' reported effort in social studies negatively related to mothers' reported use of social studies, r=-.21. Finally, students expected grade in social studies correlated with mothers' and fathers' perceptions of their child's ability, r=.24 and r=.34, respectively.

Older students' perceived ability in computer science positively correlated with mothers' perceptions of their child's ability, r=.25, and with fathers' perception of the importance of computer science in their child's future, r=.32. Students' rating of how much they liked computer science related to mothers' and fathers' perceptions of their child's ability, r=.30 and r=.28, respectively, as well as with fathers' perceived importance of computer science in their child's future, r=.31.

Older students' reported effort in computer science related to mothers' perceptions of their own ability, r=.18. Finally, students expected grade in computer science correlated with mothers' perceptions of their child's ability, r=.31, and with fathers' perception of their own ability in computer science, r=.29.

Older students' perceived ability in music positively correlated with mothers' perceptions of their child's ability, r=.33, with fathers' reported use of music, r=. 27, and with fathers' perception of the importance of music in their child's future, r=.31. Students' rating of how much they liked music related to mothers' perceptions of their child's ability in music, r=.32. Students expected grade in music correlated with mothers' perceptions of their child's ability in music, r=.31, and with mothers' expectations of their child's performance in music, r=.18.

Older students' perceived ability in art positively correlated with mothers' perceptions of their child's art ability, r=.24. Students' perception of the importance of art to their future related to with mothers' perceptions of their child's ability, r=.18, and with mothers' rating of the importance of art to their child's future, r=.18.

Older students' rating of how much they liked art related to mothers' and fathers' perceptions of their child's ability, r=.27 and r=.28, respectively, as well as with mothers' expectations of their child's performance in art, r=.19. Students' reported effort in art related to mothers' perceptions of their child's ability, r=.20.

Finally, students expected grade in art correlated with fathers' reported use of art, $r=.32$, and with mothers' perception of the importance of art in their child's future, $r=.17$.

Older students' perceived ability in team sports positively correlated with mothers' perceptions of their child's ability, $r=.34$, with mothers' rating of the importance of team sports to their child's future, $r=.34$, and with mothers' expectations of their child's performance in team sports, $r=.25$. Students' perception of the importance of team sports to their future related to with mothers' perceptions of their own ability, $r=.22$, with mothers' reported use of team sports, $r=.24$, and with mothers' rating of the importance of team sports to their child's future, $r=.36$.

Older students' rating of how much they liked team sports related to mothers' perceptions of their child's ability, $r=.36$, as well as with mothers' expectations of their child's performance in team sports, $r=.20$. Finally, students expected grade in team sports correlated with mothers' perceptions of their child's ability, $r=.33$, with mothers' expectations of their child's performance in team sports, $r=.20$, and with mothers' perception of the importance of team sports in their child's future, $r=.21$.

Older students' perceived ability in dance/gymnastics positively correlated with mothers' and fathers' perceptions of their child's ability, $r=.39$ and $r=.37$, respectively, also with mothers' and fathers' expectations of their child's performance in dance/gymnastics, $r=.26$ and $r=.38$, respectively, and mothers' perception of the importance of dance/gymnastics to their child's future, $r=.20$. Students' perception of the importance of dance/gymnastics to their future correlated with mothers' perception of their child's ability, $r=.32$, and with mothers' and fathers' expectations of their child's performance in dance/gymnastics, $r=.27$ and $r=.32$, respectively.

Older students' rating of how much they liked dance/gymnastics related to mothers' and fathers' perceptions of their child's ability, $r=.48$ and $r=.40$, respectively, as well as with mothers' and fathers' expectations of their child's performance in dance/gymnastics, $r=.40$ and $r=.35$, respectively, and mothers' and fathers' perception of the importance of dance/gymnastics to their child's future, $r=.23$ and $r=.38$, respectively. Students' reported effort in dance/gymnastics related to fathers' perceptions of their child's ability, $r=.28$. Finally, students expected grade in dance/gymnastics correlated with mothers' and fathers perceptions of their child's ability, $r=.48$ and $r=.36$, respectively, with mothers' and fathers' expectations of their child's performance in dance/gymnastics, $r=.37$ and $r=.36$, and with mothers' perception of the importance of dance/gymnastics in their child's future, $r=.30$.

Older students' perceived ability in getting along/social skills positively correlated with mothers' and fathers' perceptions of their child's ability, $r=.29$ and r=.33, respectively, and with mothers' perception of their own ability, r=.18. Students' rating of how much they liked getting along/social skills related to mothers' and fathers' perceptions of their child's ability, r=.19 and r=.28, respectively. Finally, students expected grade in getting along/social skills correlated with mothers' and fathers perceptions of their child's ability, r=.22 and r=.27, respectively, with fathers' expectations of their child's performance in getting along/social skills, r=.34, and with fathers' perception of their own ability, r=.32.

Appendix 2: Preliminary multiple regressions between student variables and parent variables.

Because of the possibility that both parents' perceptions of their child's ability in a subject matter as well as their own perceived ability in the area could influence the children's self-perceived ability, we performed a regression analysis of these variables. For the entire sample, mothers' perception of their child's ability in math significantly predicted child's perceived ability, but mother's rating of their own ability in math did not. These variables accounted for only 4% of the variance in child's perceived ability.

Mothers' perception of their child's reading ability significantly predicted children's perceived ability, but mother's rating of their own reading ability did not. These variables accounted for 18% of the variance. In predicting children's perceived life science ability, mothers' perception of their child's science ability was significant, but mother's rating of their own science ability was not. These variables only accounted for 3% of the variance. For physical science, neither mother's perception of their child's ability nor mother's rating of their own ability significantly predicted children's perceived ability in physical science.

In predicting children's perceived abilities from fathers' perceptions, no variables were significant predictors for math. However, fathers' perception of their child's reading ability significantly predicted children's perceived ability but fathers' perception of their own ability did not. These variables accounted for 13% of the variance in children's perceived reading ability. Also, fathers' perception of their child's science ability significantly predicted children's perceived ability in life science and physical science, but fathers' perception of their own ability in science did not. Seven percent of the variance in children's perceived ability in life science and 14% of that in physical science was accounted for by fathers' perceptions in the sciences.

In predicting younger children's perceived math abilities from mothers' perceptions, no variables were significant predictors. Mothers' perceptions of their child's reading ability significantly predicted child's perceived ability, but mother's rating of their own reading ability did not. These variables accounted for 22% of the variance. In predicting younger children's perceived life and physical science ability from mothers' perceptions of their child's science ability, neither of the variables were significant. In predicting children's perceived abilities from fathers' perceptions, no variables were significant predictors for math, reading, or the sciences.

In predicting older students' perceived math abilities, both mothers' perceptions of their child's and their own ability were significant. These variables accounted for 23% of the variance in students' perceived math ability. Mothers' perception of their child's reading ability significantly predicted children's perceived ability, but mothers' rating of their own math ability did not. These variables accounted for 27% of the variance.

Similarly, mothers' perception of their child's science ability significantly predicted children's perceived ability in both life science and physical science, but mothers' rating of their own math ability did not. These variables accounted for 10% of the variance in students' perceived life science ability and 6% in their perceived physical science ability.

In predicting older students' perceived math abilities, fathers' perceptions of their child's ability was significant, but fathers' perception of their own ability was not. These variables accounted for 16% of the variance in students' perceived math ability. Fathers' perception of their child's reading ability significantly predicted children's perceived ability, but fathers' rating of their own math ability did not. These variables accounted for 21% of the variance.

Similarly, in predicting older children's perceived ability in both life science and physical science, fathers' perception of their child's science ability was a significant predictor, but fathers' rating of their own math ability was not. These variables accounted for 20% of the variance in students' perceived life science ability and 18% in their perceived physical science ability.

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Signature: Thomas Andre Position: Professor

Printed Name: Thomas Andre Organization: Iowa State University

Address: N152 Lagomarcino Telephone Number: (515) 294-1754
Dept. of Curriculum & Instruction
Ames, IA 50311

Date:

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