Sex Differences in SAT® Scores

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College Board Report No. 88-9
ETS RR No. 88-58

College Entrance Examination Board, New York, 1988

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ABSTRACT

After adjusting for differences in background, women's average SAT-verbal scores were found to be higher than, or nearly equal to, men's. Although women's average SAT-mathematical scores after adjustment are still lower than men's, they are 25 points higher when adjusted for background. This report's analysis establishes that the background differences between men and women are significantly related to verbal and mathematical score differences.

The research looked at samples of students in the high school classes of 1975, 1980, and 1985 who had taken the SAT. Without controlling for background variables, the average SAT scores in these samples were:

		Verbal	*Mathematical*
• In 1975:	Women	441	461
	Men	441	501
• In 1980:	Women	428	448
	Men	439	499
• In 1985:	Women	436	457
	Men	448	510

Demographic Variables

The authors had predicted that several demographic trends in the SAT population would be related to trends in both SAT-verbal and SAT-mathematical average scores. The background variables considered by the research were:

- Ethnic group: American Indian, Asian American, black, Mexican American, Puerto Rican, white, and other
- Socioeducational status: the only variable available was self-reported family income
- Basic academic high school curriculum: those who have at least four years of English, three years of math, two years of science, and two years of social science, versus those who lack one or more of these basic courses
- Proposed college major: math/science, business, biological sciences, arts, vocational/technical, humanities, social sciences, and other.

Trends in these variables differ among different segments of the SAT population. For example, more women SAT-takers than men are from ethnic minorities, but the proportion of minority group members among both women and men grew over the decade 1975–1985. The proportion of low-socioeducational status women grew during the decade, while the number of academically underprepared women (that is, women who lack the basic curriculum defined above) declined. Still, the plurality of women in the SAT population comes from less well-prepared, less-privileged categories.

When adjusted for the background variables, the average SAT scores are:

		Verbal	*Mathematical*
• In 1975:	Women	447	474
	Men	435	488
• In 1980:	Women	437	459
	Men	435	486
• In 1985:	Women	438	459
	Men	440	489

Trend Differences Remain

Even with the adjustments, however, the trend in differences between female and male average SAT scores remain. The adjustments raised the trend line for the difference in the means by nearly 10 points verbal and 25 points mathematical in each year studied, but they did not change the downward direction of the trend. In the hypothetical demographically adjusted group of men and women, women's average verbal score was estimated at 13 points above the men's in 1975; by 1985, women's average verbal score was estimated at 2 points *below* men's.

The major findings of this study suggest that no more than a small part of the verbal and mathematical trend is due to demographic changes in the population of test takers. It becomes more likely that at least the SAT-verbal trend is due to a change in the way women and men are being educated.

In fact, trends from studies of other verbal tests support this conclusion. This includes tests of verbal reasoning, vocabulary, reading, and English composition at ages ranging from fourth grade to graduate school, and in a number of different testing programs, and both self-selected groups and scientific surveys. No matter what the overall level of performance, women's average verbal scores have been declining relative to men's.

The results of this study are also consistent with those of women's mathematical abilities relative to men's. However, there have been fewer studies of the higher-level mathematical abilities measured by the SAT. Further research on gender differences in mathematical skills is suggested.

INTRODUCTION

For many years researchers have observed substantial differences in young men's and young women's average mathematical reasoning scores, although differences usually do not appear until adolescence. In the College Board's Scholastic Aptitude Test (SAT) population, the average mathematical score difference has been about one-half of one standard deviation (SD). For most of the years since the SAT was introduced, in contrast, the women's average SAT-verbal score was slightly higher than men's. For the past 20 years a very slow decline in women's SAT-verbal scores has been observed. The decline has been about 1 point, or 0.01 SD, per year. By 1973 the average woman scored just below the average man on the SAT-verbal test; by 1980 the women's average score was 12 points below men's. Although this difference is only about 0.11 SD and therefore of slight practical importance, both the test sponsors and the general public are concerned: if the trend continues, the current slight average difference in men's and women's scores could eventually become substantial.

Of all the possible reasons for the decline of women's SAT-verbal scores, the most substantive reason seemed to be that the population of women choosing to take the SAT has been changing. Both for the SAT and for other college and graduate school tests, the relative proportion of women taking the tests has been growing. For a number of verbal tests in addition to the SAT—Preliminary Scholastic Aptitude Test/ National Merit Scholarship Qualifying Test (PSAT/ NMSQT), American College Testing Program (ACT), Graduate Record Examinations (GRE), Graduate Management Admission Test (GMAT), and English Composition Achievement Test (ECT) of the College Board—the relative performance of women compared with that of men has also been declining. On the SAT the correlation between the annual mean verbal score differences by gender and the proportion of women taking the test for the last 20 years was a substantial .85 to .90 (Burton 1987).

Our study was proposed to explore the association of demographic differences between men and women and differences in their SAT scores, and to determine whether changes in these demographic variables over time are related to SAT score trends. Samples of SAT-takers from 1975, 1980, and 1985 were drawn. The background variables chosen for study were gender, ethnic group, family socioeducational status, high school course preparation, and proposed college major. The results are based on multiple linear regression, in which variables were entered separately and in various combinations to allow some speculations about the effects of individual adjustment variables.

METHODS

Basic Analysis Sample

Data from 1975, 1980, and 1985 for college-bound seniors were stratified by presence of SAT score, ethnicity, and gender; spaced samples with a random start were drawn. The goal was to draw samples of about 2,000 persons with SAT scores for each ethnic group by gender cell. Table 1 shows sampling fractions (held constant over years) and resulting numbers for each cell.

After initial analyses it was determined that those whose best language is not English should be analyzed separately, since that characteristic varies both by gender and by ethnic group (see Table 2). For this study the students whose best language was not English were excluded because of inadequate sample sizes.

Characteristics of Women Taking the SAT

Women in the SAT population have a slightly lower mean than men do in many characteristics associated with higher scores—enrollment in an academic program, number of years taken in mathematics and science, degree aspirations, parental education, attendance at private schools, and family income. The areas where women in the SAT population have a slightly

Table 1. Sampling Fractions and Numbers for Basic Analysis Sample

Ethnic Group	Sampling Fraction	Men (N)			Sampling Fraction	Women (N)		
		1975	1980	1985		1975	1980	1985
American Indian	1	1,052	1,984	1,864	1	1,127	2,184	2,242
Asian American	1/5	1,604	2,760	4,050	1/5	1,574	2,744	3,959
Black	1/11	2,167	2,784	2,518	1/17	2,100	2,721	2,497
Mexican American	1/3	1,818	2,292	2,703	1/3	1,689	2,432	3,047
Puerto Rican (mainland U.S.A.)	1	2,408	4,188	4,506	1	2,481	4,980	5,331
White	1/150	2,239	2,299	2,168	1/162	2,151	2,317	2,183
Other	1/4	1,799	2,525	2,353	1/4	1,612	2,264	2,431
No response	1/50	2,330	1,323	1,499	1/50	1,906	1,084	1,259

Table 2. Percentage of Class of 1985 College-Bound Seniors Reporting that English Is Not Their Best Language

Ethnic Group	*Men*	*Women*
American Indian	4.2	3.2
Asian American	28.2	24.9
Black	3.9	3.2
Mexican American	7.8	6.8
Puerto Rican (mainland U.S.A.)	9.9	8.8
White	1.9	1.4
Other	23.2	19.3

Source: Ramist and Arbeiter 1986, Table 3.

higher mean than men do are noteworthy. On average they have higher grades and take more foreign language courses. Fewer women speak English as a second language. Fewer women worked at part-time jobs during high school, and those who did worked fewer hours. (See Ramist and Arbeiter 1982, 1983, 1986; Arbeiter 1984.)

Because the men and women who take the SAT differ in so many ways, it is difficult to compare them. The purpose of this study was to identify variables that could adjust some of these differences. The adjusted data would attempt to answer hypothetical questions. For example, if the men and women taking the SAT had equal course work in high school, what would their SAT scores be? Such adjustment must be interpreted carefully. First, the variables are not measured perfectly. Test-takers may refuse to respond, may misunderstand, may respond dishonestly, or may fail to update information if they take the test more than once.

Second, the variables are usually only proxies for what one really wants to measure. The Student Descriptive Questionnaire (SDQ) identifies those students who have taken, or plan to take, for example, three years of high school mathematics; what one really wants to know is whether they have taken rigorous college preparatory courses in algebra, geometry, and precalculus. The questionnaire reports what the student knows, and will report, of family income and parental education; what one wants is a measure of how willing and able the family is to provide the time, place, and rewards for study, as well as books, newspapers, travel, conversation, and attention.

Third, the adjustments are only estimates of reality. For example, men tend to take more mathematics courses than women do. What the average SAT-mathematical scores would be if women did take equal amounts can be estimated by simply increasing the contribution to the average of those women who take three or four years of math. But there is no reason to believe that if more women were to take higher-level mathematics, they would be just like the women who now do so. This last point—the hypothetical nature of any adjustment—is important because the causes that lie behind the observed data are unclear. Would women get better math scores if they took more math? Or, do women stop taking math courses because their mathematical ability is lower than men's? Either could be true; in fact, both could be true at the same time.

The fourth, and most important, problem with such a study is that all the measured variables and unmeasured causes are likely to be interrelated to some degree. Adjustments in the weights assigned to the number of math courses taken may distort other variables—both those that seem related (science courses) and those that seem logically unrelated (native language or grade average).

Choosing Variables

Because the study concerns changes in men's and women's SAT scores over time, gender and year are the first two necessary variables. The next variable, almost equally necessary, is ethnic group. One major group of hypotheses about men's and women's score differences has to do with men's and women's supposedly different socialization patterns. These range from the hypothesis that men's more active childhood leads to better spatial perception, to the assumption that women are rewarded for playing stupid in school. If socialization is important, it is surely prudent to separate the analyses of such different communities as blacks, Asian Americans, and Puerto Ricans, particularly when time trends are concerned. Over this 10-year period of the study, for example, the number of Asian American test-takers has more than doubled, mostly through immigration; during the same period the number of American Indians has almost doubled, although immigration can have nothing to do with it.

The basic design of the study was stratified by gender, year, and ethnic group. Within these strata, the variables of most interest were socioeducational status and high school academic background, followed by the intended major in college. There were two reasons for that last choice: First, a number of investigators have found the college major to be closely related to test scores (Willingham 1985; Grandy 1987; Pennock-Roman, Rock, and Enright 1988; Koffler, McPeek, and Wild 1988). Second, women have traditionally been encouraged to enter certain fields and they continue to choose different courses and majors from those men choose. Although the causal direction is unclear, different interests tend to be associated with different skills.

The analysis strategy was, first, to try various definitions of the socioeducational status, high school course work, and college major variables for both genders of the 1985 white population, using the SAT-verbal score as the dependent variable; second, to try various combinations of the variables and to test se-

lected interactions on both the SAT-verbal and the SAT-mathematical scores; third, to add ethnic groups to the model; and fourth, to add different years. When ethnic groups were added to the model, the use of sampling weights became crucial because the groups were disproportionately represented in the analysis sample. While in one sense all ethnic groups are equally important in the analysis, an unweighted analysis was undesirable because all the analysis variables, including gender, are distributed differently in the various ethnic groups. Thus, interpretation of all variables would be distorted without population weights.

Ethnic Groups

Although some of the ethnic groups are rare in the SAT population, only two cells in this design fell below 1,000 after language minorities and those with missing data on the analysis variables were removed—American Indian men (N = 720) and American Indian women (N = 734) in 1975. Therefore, small cell sizes are unlikely to be a source of instability in the results.

In addition to the general differences between ethnic groups observed in United States society, there are several additional differences that apply to members of those groups who choose to take the SAT. (Most of the statistics below were taken from the College Board *College-Bound Seniors* reports of 1975, 1980, and 1985.)

- In all ethnic groups but Asian Americans (for whom numbers are approximately equal), more women than men take the SAT.
- Among blacks, the disproportion of women to men is striking—the ratio is three women to two men.
- An extremely high proportion of all Asian American youth take the SAT. In 1985 the number of Asian Americans who took the SAT and reported that they would graduate in 1985 was equal to 70 percent of all Asian American 18-year-olds. The number of white SAT-takers in the same cohort was equal to 30 percent of white 18-year-olds (U.S. Department of Education 1988).
- A relatively low proportion of black and Hispanic youth take the SAT. Part of this is explained by high dropout rates; still, 12 percent of all high school graduates are black and 5 percent are Hispanic (U.S. Department of Education 1988), but only 7 percent of SAT-takers are black and 2.5 percent are Hispanic.
- The proportion of minorities in the SAT population grew between 1975 and 1985 from 14 percent to 20 percent.
- The proportion of blacks in the SAT population grew between 1975 and 1980 but declined somewhat between 1980 and 1985.

Another caution to observe in interpreting ethnic data concerns the students' refusal to respond to the ethnic question on the SAT registration form. Nonresponse was a substantial 22 percent in 1975, declined to 12 percent in 1980, and rose somewhat to 14 percent in 1985. The willingness to respond to ethnic questions is likely to vary by ethnic group over time, depending on the students' beliefs about colleges' discriminatory practices. For example, given the recent publicity about perceived discrimination against Asian Americans in California, one might anticipate an increase in nonresponse for that group. Such trends in nonresponse can be expected to introduce unknown biases in our estimates for ethnic groups. Figure 1 gives trends in ethnic group participation between 1975 and 1985. Note that this figure is based on all SAT-takers regardless of their English-language background or their responses to background questions; that is, these are actual, unselected population values. In all other analyses that follow, participation trends are estimated from a weighted analysis of the study sample described above.

Tables 3 through 5 give estimated participation rates and SAT-verbal and SAT-mathematical means and standard deviations in 1985 by ethnic group and gender. Note that the participation percentages add to 100 percent within gender, so Table 3 does not reflect the overall 52 percent to 48 percent proportion of women to men in the 1985 SAT population. Table 4 shows relatively large verbal differences by gender for American Indians, Hispanics, and other ethnic groups and relatively small gender differences for Asian Americans, blacks, and whites. (The gender-by-ethnic-group interaction for verbal scores did prove to be statistically significant in the presence of all other variables in a supplementary interaction analysis not reported here.)

Table 3. Estimated Distribution of Ethnic Group in 1985 Population by Gender

	American Indian (%)	*Asian American (%)*	*Black (%)*	*Mexican American (%)*	*Puerto Rican (%)*	*White (%)*	*Other (%)*
Women	0.5	3.5	9.0	2.0	0.9	82.4	1.7
Men*	0.5	3.7	6.4	1.9	0.8	84.8	1.8

*Total does not equal 100% because of rounding.

Table 4. Estimated SAT-Verbal Means and Standard Deviations for 1985 Population by Ethnic Group and Gender

	American Indian	*Asian American*	*Black*	*Mexican American*	*Puerto Rican*	*White*	*Other*	*Total*
	391	440	351	384	376	448	405	436
Women	(104)	(118)	(97)	(98)	(106)	(100)	(116)	(111)
	406	449	361	401	397	456	428	448
Men	(106)	(122)	(100)	(102)	(106)	(104)	(115)	(113)
Difference	−15	−9	−10	−17	−21	−8	−23	−12

Note: Figures in parentheses are standard deviations for the adjacent means.

The pattern for mathematical score differences (Table 5) is slightly different. Once again the score differences between Hispanic men and women are relatively large, while those for Asian Americans and blacks are relatively small. Unlike their verbal score difference patterns, American Indian and "other" women and men show relatively small mathematical differences, while white women and men show a relatively large mathematical difference. (Unlike results for the verbal test, the gender-by-ethnic-group interaction for mathematical scores did not prove to be statistically significant in the supplementary analysis in the presence of all other variables.)

Figures 2 and 3 show trends over time in the verbal and mathematical means for white, black, and Asian American men and women. The basic picture for both verbal and mathematical scores is one of modest score increases over this 10-year period, whether the group size is increasing, decreasing, or staying the same (Figure 1). The most striking increases occur for blacks; the worst record is plotted for white women, who experienced a small mean decline in both tests over the decade.

Socioeducational Status

The basic socioeducational variables available for analysis were family income, mother's education, and father's education. In the early analyses various combinations of these variables were tried, but eventually income alone was used. Mother's and father's education would have been preferable in that they are more closely linked to the underlying construct of family support for education, but, unfortunately, these questions were not asked in 1975.

To mitigate the effect of inflation, income was collapsed into three ordered categories within year: lower 25 percent, middle 50 percent, and upper 25 percent. The category boundaries were based on all ethnic groups, unweighted. Weights were not used, so that all ethnic groups would be represented in all three income levels; when population weights are used, the largest group (whites) dominates the category definitions. By defining income within year, we greatly reduce the effects of inflation, but any trends in the income level of the SAT population are obscured. Preliminary analysis indicated that income trends were unlikely to be important.

Tables 6 through 8 display the 1985 observed data for gender-by-socioeducational status (SES) level. Note that the participation percentages add to 100 percent within gender, so Table 6 does not reflect the overall 52 percent to 48 percent ratio of women to men in the 1985 SAT population.

It can be seen that men are slightly underrepresented in the lowest and middle socioeducational status categories and overrepresented in the highest category. The largest verbal score differences between women and men (Table 7) are also observed in the lower socio-

Table 5. Estimated SAT-Mathematical Means and Standard Deviations for 1985 Population by Ethnic Group and Gender

	American Indian	*Asian American*	*Black*	*Mexican American*	*Puerto Rican*	*White*	*Other*	*Total*
	417	501	372	411	390	468	431	457
Women	(103)	(118)	(91)	(101)	(101)	(105)	(112)	(108)
	457	543	403	459	445	520	468	510
Men	(115)	(126)	(108)	(110)	(116)	(114)	(122)	(118)
Difference	−40	−42	−31	−48	−55	−52	−37	−53

Note: Figures in parentheses are standard deviations for the adjacent means.

Table 6. Estimated Distribution of Socioeducational Status in 1985 Population by Gender

	Low (%)	*Middle* (%)	*High* (%)
Women	16	48	36
Men	12	46	42

educational status categories. (However, the gender-by-socioeducational status interaction for verbal scores was not statistically significant in the supplementary analysis in the presence of all adjustment variables.) For the mathematical scores (Table 8), the female-male score differences are consistent across socioeducational levels. When the socioeducational status is taken into account, both mathematical gender score differences and within-cell standard deviations are slightly smaller than in the total population.

Figures 4 through 6 show trends over time for high- and low-socioeducational status men and women in the study sample. Note that the gap in the numbers of men and women has widened over the years at both ends of the socioeducational status scale (Figure 4). There are many more high-socioeducational status students than low, although the categories were defined as the upper and lower 25 percent of the unweighted analysis sample. This shows the effect of the relatively small representation of whites in the unweighted population. Note also that even though there are more women SAT-takers than men, women are slightly *under*represented in the highest socioeducational status category. The number of high- and low-socioeducational status women grew over this decade, but the plurality of women in the SAT population clearly comes from the lowest socioeducational status category. Figures 5 and 6 show time trends of SAT-verbal and SAT-mathematical means for men and women in the highest and lowest socioeducational status categories. Unlike the ethnic group graphs, these reflect the overall population trends—a decline between 1975 and 1980 and recovery since then. Despite some recovery, low-socioeducational status men and women showed a net loss on both tests at the end of the decade; high-socioeducational status women had just regained their earlier level by the end of the decade.

Table 7. Estimated SAT-Verbal Means and Standard Deviations for 1985 Population by Socioeducational Status and Gender

	Low	*Middle*	*High*	*Total*
Women	396 (100)	429 (105)	463 (110)	436 (111)
Men	411 (106)	437 (106)	469 (112)	448 (113)
Difference	−15	−8	−6	−12

Note: Figures in parentheses are standard deviations for the adjacent means.

Table 8. Estimated SAT-Mathematical Means and Standard Deviations for 1985 Population by Socioeducational Status and Gender

	Low	*Middle*	*High*	*Total*
Women	416 (105)	451 (105)	485 (106)	457 (108)
Men	467 (117)	500 (116)	535 (115)	510 (118)
Difference	−51	−49	−50	−53

Note: Figures in parentheses are standard deviations for the adjacent means.

Basic High School Courses

For the purposes of this study, a very simple, minimal measure of an academic high school curriculum was chosen. Test-takers were separated by whether or not they had taken all the following basics:

- At least 4 years of high school English
- At least 3 years of high school mathematics
- At least 2 years of high school science
- At least 2 years of high school social studies

This set of basic academic courses was chosen because substantial numbers of even the least-privileged groups of minority women had the minimum preparation level. More detailed analysis of specific course-taking patterns is well worth doing in future studies, although our initial exploratory analyses showed very complex relations among courses in different subjects that appeared to vary by both gender and ethnic group.

Tables 9 through 11 show the 1985 estimated participation rates and SAT-verbal and SAT-mathematical statistics for this variable of academic background for men and women. In 1985 about a quarter (3/12) of the verbal score difference between men and women is associated with basic preparation. Table 10 shows that the score difference between men and women matched on basic prepration is 8 or 9 points compared with the 12-point difference without matching. This is an illustration of what has sometimes been called Simpson's paradox.

Table 9. Estimated Distribution of Basic High School Course Work in 1985 Population by Gender

	Underprepared (%)	*Prepared* (%)
Women	14	86
Men	10	90

Table 10. Estimated SAT-Verbal Means and Standard Deviations for 1985 Population by High School Course Work and Gender

	Underprepared	*Prepared*	*Total Population*
Women	380 (93)	445 (111)	436 (111)
Men	388 (97)	454 (112)	448 (113)
Difference	−8	−9	−12

Note: Figures in parentheses are standard deviations for the adjacent means.

(See Wainer 1986 for another example based on the SAT.)

As with verbal scores, high school course preparation is also associated with female-male mathematical score differences. Unlike the results for verbal scores, most of the effect of matching on mathematical scores in 1985 was for underprepared students (Table 11). However, recall that students were counted as "prepared" with as few as three years of high school mathematics of unspecified content. Requiring more rigorous mathematical preparation for the highest category would probably increase its relationship to the female-male mathematical score difference.

Figures 7 through 9 show trends over time for prepared and underprepared men and women in the SAT population. Figure 7 shows a substantial decline since 1975 in the estimated number of SAT-takers who lack basic academic preparation. The decline is especially marked for women. The proportion of women who are underprepared was more than halved, from 29 percent in 1975 to 14 percent in 1985. Figure 7 also makes it clear that the extra women in the SAT population are underprepared; the numbers of prepared men and women have been nearly equal since 1980.

As the numbers of underprepared students declined, those left in the underprepared category were less and less skilled. Both the verbal and the mathematical skills of underprepared women showed a substantial decline in this decade; the decline for men was much gentler. (See Figures 8 and 9.) Even while the numbers of men and women reporting at least a basic academic preparation in high school increased greatly during the decade, their level of verbal and mathematical skill was not diluted. Overall, the mean SAT scores of prepared students remained nearly constant. Prepared men experienced a slight score increase in both the verbal and the mathematical tests, while the women showed a slight mean decrease.

Table 11. Estimated SAT-Mathematical Means and Standard Deviations for 1985 Population by High School Course Work and Gender

	Underprepared	*Prepared*	*Total*
Women	381 (98)	470 (105)	457 (108)
Men	420 (102)	520 (116)	510 (118)
Difference	−39	−50	−53

Note: Figures in parentheses are standard deviations for the adjacent means.

Proposed College Major

One of the problems in interpreting high school course-taking patterns is that a person's course-taking decisions are likely to be influenced by his or her abilities. That is, a student who is stronger in verbal or mechanical areas may well decide not to go on in mathematics. The same comment applies to the choice of a possible college major. In a causal model, it would be more natural to try to explain the choice of a college major by the SAT-verbal and SAT-mathematical scores than the reverse. However, this variable is based on the choice of a college major at the time the student registers to take the SAT. Although it is probably a poor predictor of any individual's actual major at graduation five or six years later, it is probably a reasonably good indicator of how the student may define his or her own future options. This variable captures female-male differences at least as large as any of the other variables we studied, and it was an effective adjustment variable in the analysis.

A large number of major codes were collapsed into eight categories, which were then entered into the regression equation as dummy variables. The eight categories are the following:

- Mathematics and science, including engineering, computer science, mathematics, and all physical sciences
- Business, including all subjects listed under business and commerce
- Biological sciences and premedicine, preveterinary medicine, and predentistry
- Arts, including art, communications, music, and theater arts
- Vocational/technical, including agriculture, architecture, forestry, all technical health professions (excluding those already defined under biological sciences), home economics, library science, military science, and all trade and vocational subjects
- Humanities, including English, literature, foreign languages, philosophy, and religion
- Social sciences, including education, ethnic studies, geography, psychology, and other disciplines listed under the social science heading
- Other, including undecided

Table 12. Estimated Distribution of Proposed College Majors in 1985 Population by Gender

	Mathematics/ Science (%)	*Business (%)*	*Biological Sciences (%)*	*Arts (%)*	*Vocational/ Technical (%)*	*Humanities (%)*	*Social Sciences (%)*	*Other (%)*
Women	10	20	9	11	18	4	22	5
Men	34	20	9	7	10	2	11	6

Note: Totals do not equal 100% because of rounding.

It was difficult to reduce many majors to just eight categories. In retrospect, gender differences in major categories would probably have been reduced if education had been removed from the social sciences and if engineering and computer science had been separated from the mathematics/science category. Communications probably should have been in the business category (rather than in the arts), as is the practice in the College Board's Admissions Testing Program Summary Reporting Service. Finally, the remaining arts majors should possibly have been merged with the small humanities group.

Tables 12 through 14 show the 1985 estimated participation rates and SAT-verbal and SAT-mathematical statistics for the eight major categories for men and women. Table 12 shows substantial differences in the popularity of various majors for the two sexes. Table 13 shows that in six of the eight categories the female-male verbal difference is reduced or even reversed. In two categories, however, there are very large score differences between men and women. The social sciences difference may largely be caused by the inclusion of the education major, since the students choosing education are mostly women and are mostly low-scoring. The humanities difference may be due to small-sample instability, especially since such a large score difference was not observed in 1980 or in 1975. (The gender-by-major interaction for both verbal and mathematical scores was statistically significant in the supplementary analysis in the presence of all other variables.)

Table 14 shows a reduction in female-male mathematical score differences in all categories. In general, the smaller reductions are observed in those majors that are relatively popular among women. As with ver-

Table 13. Estimated SAT-Verbal Means and Standard Deviations for 1985 Population by Proposed College Major and Gender

	Mathematics/ Science	*Business*	*Biological Sciences*	*Arts*	*Vocational/ Technical*	*Humanities*	*Social Sciences*	*Other*	*Total*
Women	446 (114)	409 (97)	483 (114)	448 (112)	412 (97)	496 (126)	437 (109)	447 (119)	436 (111)
Men	457 (113)	412 (98)	486 (115)	440 (111)	422 (97)	546 (134)	467 (118)	438 (115)	448 (113)
Difference	−11	−3	−3	+8	−10	−50	−30	+9	−12

Note: Figures in parentheses are standard deviations for the adjacent means.

Table 14. Estimated SAT-Mathematical Means and Standard Deviations for 1985 Population by Proposed College and Gender

	Mathematics/ Science	*Business*	*Biological Sciences*	*Arts*	*Vocational/ Technical*	*Humanities*	*Social Sciences*	*Other*	*Total*
Women	504 (117)	438 (101)	511 (107)	447 (106)	435 (98)	476 (103)	446 (104)	489 (113)	457 (108)
Men	544 (119)	479 (110)	549 (109)	468 (110)	482 (107)	519 (118)	498 (117)	489 (112)	510 (118)
Difference	−40	−41	−38	−21	−47	−43	−52	0	−53

Note: Figures in parentheses are standard deviations for the adjacent means.

bal scores, the two categories most different from the total group pattern are arts majors and the other/undecided category.

Figures 10 through 18 show trends over time for selected majors. Figures 10 through 12 show trends for mathematics/science and business. Figures 13 through 15 show trends for humanities and vocational/technical areas. Figures 16 through 18 show trends for social sciences and biological sciences. No graphs were made for arts and other; no clear trends were observed for these two categories. Over this decade the greatest growth was experienced in the mathematics/science and business areas, the two most popular with men (Figure 10). Social sciences became the most popular field with women by 1980 (pulling ahead of vocational/technical majors), and then maintained its lead without further growth through 1985 (Figure 16). Consistent declines were registered in the vocational/technical and humanities fields (Figure 13). Men appeared to concentrate in two popular areas considered vocationally practical—mathematics/science and business—while women were more likely to spread their choices over an array of possible majors. Over this decade, however, although men increasingly expressed an interest in the two "practical" categories of major study, the men who made less-conventional choices were showing more skill in mathematical and verbal areas. Note especially the rising mean scores for men choosing biological and social sciences (Figures 17 and 18). The women's score trends showed no clear pattern.

RESULTS AND DISCUSSION

Regression Analyses

Four variables—ethnic group, socioeducational status, high school course work, and proposed college major—have been defined. Each is related to gender and to SAT scores; presumably, each is also related to the other adjustment variables. Minority groups in the United States, for example, on average have lower income and less academic preparation in high school. Multiple linear regression was used as the primary statistical method to adjust for each variable, first singly and then in various combinations. The method was used to account for some of the complex relationships among the adjustment variables and because it provided a convenient way to compute an adjusted female–male mean score difference for each analysis.*

It is possible to include interactions among the adjustment variables in a multiple linear regression model. This was done in a number of preliminary analyses, but all results reported here are based on models with no interaction terms. When included, the interactions added little to the multiple correlation with SAT scores and did not substantively change the conclusions regarding trends in female–male score differences. Omitting these terms from the final models, on the other hand, greatly simplifies the reporting and interpretation of results.

Tables 15 and 16 summarize the adjusted female-male mean verbal and mathematical differences for all combinations of adjustment variables with gender for each of the three years under study. The multiple correlation coefficient (R) is reported for the best combination of variables (for predicting SAT score) in each set of models having the same number of adjustment variables.

The top line of Table 15 shows the unadjusted mean gender difference for verbal scores in each year, which goes from −1 point in 1975 to −12 points in 1985. The second-to-last line gives the final adjusted gender difference. These results show that based on the final adjustment, the women's deficit in SAT-verbal scores can be entirely erased in 1975 and 1980 and almost entirely erased in 1985. In 1975, for example, when all four variables are used, the women's mean verbal score goes from just 1 point below men's to almost 13 points *above* men's, a net adjustment of 14 points. In 1980 a net adjustment of 12 points is made, and in 1985 an adjustment of 9 points. Figure 19 shows that the original downward trend in the unadjusted verbal means is repeated and, in fact, slightly increased in the adjusted means. This is because the net adjustment (last line in Table 15) decreased slightly over time. The result is an adjusted mean loss for women of 15 points from 1975 to 1985.

Turning to Table 16, we see that the most dramatic contrast with the verbal results is the overall size of the unadjusted mean gender differences for mathematical scores. These range from −41 points in 1975 to −53 points in 1985. The trend over years in these unadjusted differences, however, is virtually identical to that for verbal scores—namely, a net mean loss for women of just over 12 points.

The women's mean deficit in mathematical scores is not eliminated in the adjusted differences as was the case for verbal scores. However, the size of the net mathematical adjustment, based on all variables, is approximately twice that of the net verbal adjustment. Thus, in 1975 the mean adjusted mathematical gender difference was 27 points less than the unadjusted difference, while the corresponding net adjustment for the verbal mean difference was 14 points.

Figure 20 (corresponding to Figure 19) shows the trends in mean adjusted and unadjusted mathematical

*When gender is entered as a dummy variable in each model (female = 1, male = −1), 2 times the unstandardized regression weight for gender is the adjusted mean difference between females and males on the dependent variable.

Table 15. Adjusted Mean Verbal Score Differences (Based on Multiple Regression, No Interaction)

Variable	1975		1980		1985	
	Female-Male Difference	*Multiple R**	*Female-Male Difference*	*Multiple R**	*Female-Male Difference*	*Multiple R**
Gender†	−0.74	.004	−10.16	.047	−11.57	.054
Gender, income (socioeducational status)	−0.08		−7.61		−8.39	
Gender, ethnicity	2.30	.290	−7.21	.300	−8.98	.260
Gender, courses (high school course work)	6.23		−5.16		−8.45	
Gender, major (proposed college major)	5.85		−4.45		−9.47	
Gender, income, ethnicity	2.45		−6.09		−7.03	
Gender, income, courses	6.55		−3.13		−5.75	
Gender, income, major	6.31		−1.97		−6.11	
Gender, ethnicity, courses	8.04		−2.81		−6.20	
Gender, ethnicity, major	8.77	.360	−1.35	.380	−5.91	.360
Gender, courses, major	10.99		−1.38		−7.14	
Gender, income, ethnicity, courses	8.08		−1.93		−4.60	
Gender, income, ethnicity, major	8.75		−0.28		−3.98	
Gender, income, courses, major	11.20		0.70		−4.22	
Gender, ethnicity, courses, major	12.94	.400	1.28	.420	−3.91	.390
Gender, income, ethnicity, courses, major	12.85	.410	2.16	.440	−2.25	.410
Change in gender difference (due to adjustment with all variables)	+13.60		+12.30		+9.30	

* Multiple correlation (R) is largest within each set of models having the same number of adjustment variables.

†Unadjusted gender differences (in SAT-V metric) for college-bound seniors with complete data *and* English as best language.

Table 16. Adjusted Mean Mathematical Score Differences (Based on Multiple Regression, No Interaction)

Variable	1975		1980		1985	
	Female-Male Difference	*Multiple R**	*Female-Male Difference*	*Multiple R**	*Female-Male Difference*	*Multiple R**
Gender†	−40.73	.18	−51.03	.22	−52.90	.23
Gender, income (socioeducational status)	−39.95		−48.14		−49.50	
Gender, ethnicity	−37.40		−47.84	.37	−50.00	.35
Gender, courses (high school course work)	−29.10	.36	−44.11		−48.43	
Gender, major (proposed college major)	−23.12		−34.93		−38.81	
Gender, income, ethnicity	−37.21		−46.48		−47.90	
Gender, income, courses	−29.58		−41.86		−45.63	
Gender, income, major	−22.52		−32.07		−35.11	
Gender, ethnicity, courses	−28.06	.44	−41.60		−45.95	
Gender, ethnicity, major	−19.99		−31.65	.46	−34.92	.43
Gender, courses, major	−15.43		−30.88		−35.54	
Gender, income, ethnicity, courses	−27.99		−40.57		−44.24	
Gender, income, ethnicity, major	−19.94		−30.33		−32.79	
Gender, income, major	−15.14		−28.31		−31.74	
Gender, ethnicity, courses, major	−13.42	.50	−28.10	.51	−32.05	.48
Gender, income, ethnicity, courses, major	−13.46	.51	−27.03	.52	−30.28	.50
Change in gender difference (due to adjustment with all variables)	+27.30		+24.00		+22.60	

*Multiple correlation (R) is largest within each set of models having the same number of adjustment variables.

†Unadjusted gender difference (in SAT-M metric) for college-bound seniors with complete data *and* English as best language.

Table 17. Contributions to Adjustment of SAT-Verbal Gender Difference

Variable	*Variable by Itself*			*Variable in the Presence of All Other Variables*		
	1975	*1980*	*1985*	*1975*	*1980*	*1985*
Socioeducational Status	0.7	2.6	3.2	−0.1	0.9	1.7
Ethnic Group	3.0	3.0	2.6	1.6	1.5	2.0
High school course work	7.0	5.0	3.1	4.1	2.4	1.7
Proposed college major	6.6	5.7	2.1	4.8	4.1	2.4

gender differences. As with the verbal scores, the adjusted trend is actually somewhat more extreme than the unadjusted trend, giving an adjusted mean loss for women of 17 points from 1975 to 1985.

In addition to studying the overall adjustments in mean gender differences, the contributions of individual variables to the adjustments may be considered by comparing the unadjusted mean gender difference (first line of Tables 15 and 16) with that resulting from the inclusion of a given adjustment variable. In Table 15, for instance, for 1985 the unadjusted mean verbal gender difference is −11.6 points, while the difference adjusting only for socioeducational status is −8.4 points. Thus the "simple" contribution of socioeducational status to the adjustment is 3.2 points. The left halves of Tables 17 and 18 summarize these contributions (variable by itself) for all adjustment variables and all years, for both verbal and mathematical differences.

Because the adjustment variables are intercorrelated, the simple contribution of each variable reflects, to some extent, the contributions of the other variables as well. One way to take this into account is to assess the contribution of a variable to the adjustment of the mean gender difference when the other variables are already present. In Table 15, for example, for 1985 the mean verbal gender difference adjusting for ethnic group, high school course work, and proposed college major is −3.9 points. When socioeducational status is included in the model, the difference decreases to −2.2 points, giving a "unique" contribution of socioeducational status in the presence of the other variables of 1.7 points. (Note the reduction compared with the simple socioeducational status contribution of 3.2 points in Table 17.) The right halves of Tables 17 and 18 summarize these contributions (variable in the presence of all other variables).

In 1975 proposed college major and high school course work made the largest contributions to the adjustments of both mathematical and verbal mean gender differences; the contribution of the proposed major to the math adjustment was especially great. From 1975 to 1985 there was an increase in the contribution of socioeducational status and a decrease in the contribution of high school course work to the adjustments. There was also a decrease in the contribution of proposed major (the decrease in the unique contribution to math was small), while the contribution of ethnicity to the adjustments remained relatively constant. In 1985 the contribution of proposed major to the adjustment in the mean gender differences for mathematical scores was still the largest of all contributions, while the remaining contributions were of roughly equal magnitude.

Based on the estimated regression weights used to describe SAT scores from the four adjustment variables, plus gender, for each of the three years, it is possible to reconstruct adjusted mean scores for women and men. The differences between these adjusted means equal the adjusted differences plotted in Figures 19 and 20. In addition, adjusted means allow trends for women's and men's mean scores to be considered separately. The marginal frequency distributions for the four adjustment variables in the 1975 sample have been used as the basis for matching women and men for all three years. Thus the adjusted means provide a model-based answer to the hypothetical question of what would happen to mean SAT scores if the women and men taking the test had the same frequency distributions for all the adjustment variables, and if these distri-

Table 18. Contributions to Adjustment of SAT-Mathematical Gender Difference

Variable	*Variable by Itself*			*Variable in the Presence of All Other Variables*		
	1975	*1980*	*1985*	*1975*	*1980*	*1985*
Socioeducational Status	0.8	2.9	3.4	−0.0	1.1	1.8
Ethnic group	3.3	3.2	2.9	1.7	1.3	1.5
High school course work	11.6	6.9	4.5	6.5	3.3	2.5
Proposed college major	17.6	16.1	14.1	14.5	13.5	14.0

butions remained constant at their 1975 values. Wainer (1986) also applies the idea of holding frequencies constant over years in combining group means to compute adjusted trends in SAT means; Wainer warns that results should be interpreted with caution, a warning that applies in the present context as well.

Figure 21 gives unadjusted and adjusted mean SAT-verbal scores for women and men in 1975, 1980, and 1985. The adjusted trend for women shows essentially the same decrease from 1975 to 1980 as does the unadjusted trend, though at a higher overall level. From 1980 to 1985, however, there is virtually no increase in the adjusted women's means. For the adjusted men's means, there is no change from 1975 to 1980 but a small increase from 1980 to 1985, all occurring at a level considerably below that for the unadjusted men's means. Since the most salient increases in observed frequencies from 1980 to 1985 were for the men and women who reported having at least the minimum high school academic preparation, it is tempting to speculate that at least part of the observed score gain was caused by increased academic preparation. While this analysis cannot establish such a causal connection, the hypothesis is well worth pursuing with more appropriate data sources.

Unadjusted and adjusted mean SAT-mathematical scores are shown in Figure 22. The trends for both sets of means are similar to those observed for the verbal scores. As before, the negative trend in the adjusted mean gender differences is interpreted as primarily associated with a substantial decrease in the means for women's scores between 1975 and 1980, followed by a mild increase for men's scores between 1980 and 1985.

Discussion

This analysis establishes that the women who take the SAT are different, on average, from the men and that these background differences are significantly related to SAT score differences. Each of the four adjustment variables studied—ethnic group, income as a proxy for socioeducational status, presence or absence of a set of basic high school courses, and proposed college major—is associated with a significant difference in the size of the female-male score difference, both separately and in the presence of the other variables. In 1980, for example, women's verbal scores adjusted on all four variables together were 2 points above men's. The results suggest that if the women and the men taking the SAT were more alike in background, women's SAT-verbal scores would be higher than, or equal to, men's. Women's SAT-mathematical scores, while still below men's, were raised even more by the adjustments. In 1980 the difference between women's and men's mean mathematical scores was adjusted from −51 to −27, an increase of 24 points.

Contrary to our expectation, however, this analysis did not account for the declining trend of women's SAT scores compared with men's. The adjustments raised the verbal trend line by 10 points and the mathematical trend line by more than 20 points in each year studied, but they did not change the downward direction of the trends. In the hypothetical demographically adjusted group of men and women, for example, women's average verbal score was estimated at 13 points above men's in 1975; by 1985 women's average verbal score was estimated at 2 points below men's. Apparently, then, while the demographic variables we chose to study were indeed related to female-male score differences, these variables could not explain the trends. This may be because the major demographic changes in the SAT population occurred before 1975; it may be because of the conflicting trends in the background variables studied (women's economic position worsened while their academic preparation improved); or it may be that demographic trends were overwhelmed by larger educational or social events.

The adjusted trends, in fact, show slightly steeper declines than do the unadjusted trends, because of a decline in the adjustment produced by both the high school course work variable and the proposed college major variable. Perhaps the growth observed over these 10 years in the number of academic courses reported has not been based on courses of equal academic rigor. Or perhaps the trend away from gender-stereotyped course and major selection has led some young women to devote less time to areas of their greatest interest or ability.

Earlier analyses showed that the SAT-verbal trend is unlikely to be due to changes in the SAT (Burton 1987) or to the effect of individual items (Wendler and Carlton 1987). Our analysis suggests that neither the verbal nor the mathematical trend is initiated by demographic changes in the population of test-takers. It becomes more probable that the SAT trend is the result of a change in the way young women are being educated. That the verbal trend is not confined to the SAT supports this last hypothesis. This trend is echoed in a number of different verbal tests—verbal reasoning, vocabulary, reading, and English composition—for students ranging from fourth grade to graduate school, in a number of different testing programs, and both in self-selected groups, and in scientific surveys (Hyde and Linn 1988; Burton 1987; Mullis 1987). For some tests women's scores are rising, but men's are rising faster (NAEP reading, Mullis 1987); for other tests (the SAT from 1967 to 1980) all scores declined, but women's declined more. No matter what the overall trend, women's average scores have been declining relative to men's.

Both Hyde and Linn (1988) and Feingold (1988) have analyzed data on gender differences from other

testing programs. Feingold, especially, by confining his analysis to norming studies, reports data more representative of the entire high school population than the voluntary and relatively selective SAT population. Hyde and Linn summarize more studies with less control on the selectivity of the samples, but they purposely omit SAT data from their summaries because of the known selectivity of the data. Both studies conclude that the 20-year trend is for gender differences to disappear, and both observe the decline in young women's verbal scores relative to young men's. For the measures and the samples they studied, however, the trend has gone from a moderate female advantage (+0.25 to +0.10 SD) to near parity (+0.10 to 0 SD). The SAT-verbal data, when adjusted for female–male background differences, is quite compatible with these results.

Feingold also reports an increase in young women's mathematical test scores relative to young men's except for "the well-documented gender gap at the upper levels of performance on high school mathematics [which] has remained constant over the last 27 years" (p. 95). This result is not consistent with the 10-point mean mathematical score decline observed in our study.

There may be a number of reasons for this inconsistent finding. The entire SAT-mathematical gender trend observed between 1975 and 1985 may be associated with the addition of the Test of Standard Written English (TSWE) to the SAT administration in the 1974–75 school year. Both the mathematical and the verbal tests were shortened by 15 minutes to allow time for the 30-minute TSWE; at the same time a new, shorter item type known as quantitative comparison was added to the mathematical test. For the five years prior to the addition of the TSWE, the women's SAT-mathematical scores had varied from 41 to 44 points below the men's, averaging −42.6. In the first year the TSWE was introduced (when about half the graduating seniors took the SAT in its new format), the women's average mathematical score declined about 4 points relative to men's (from −42 to −46). In the next year, when virtually all the graduating seniors took the test in its new format, the women's relative scores declined by another 5 points to −51, where they stabilized for four years. Since 1980 the women's relative scores have averaged just under −48. This is just the pattern of results one would expect if the change in the SAT format differentially affected the young women. This result differs from an earlier analysis of the SAT-verbal test (Burton 1987), which concluded that changes in the SAT-verbal scores were unrelated to gender difference trends. If the gender trend observed here is due to changes in the SAT-mathematical format, the results of our study are once again compatible with those of Feingold (1988).

The declining SAT-verbal trend would be easy to explain if it were balanced by a rising SAT-mathematical trend—much as Feingold observed in the study of lower-level math tests—because it could be related to changing course-taking patterns. However, women's scores on the SAT-mathematical test have not risen despite the increase in the number of math and science courses reported by women taking the SAT during the decade between 1975 and 1985. Further study of gender differences in mathematical score trends is clearly called for. Such studies need to take into account more information about high school curriculum, particularly advanced mathematics and science courses. They need to deal directly with the possible effects of less-familiar item formats and with possible speededness. Finally, they need to deal with the higher standard deviations observed for men and, particularly, the greater frequency of very high scores attained by men.

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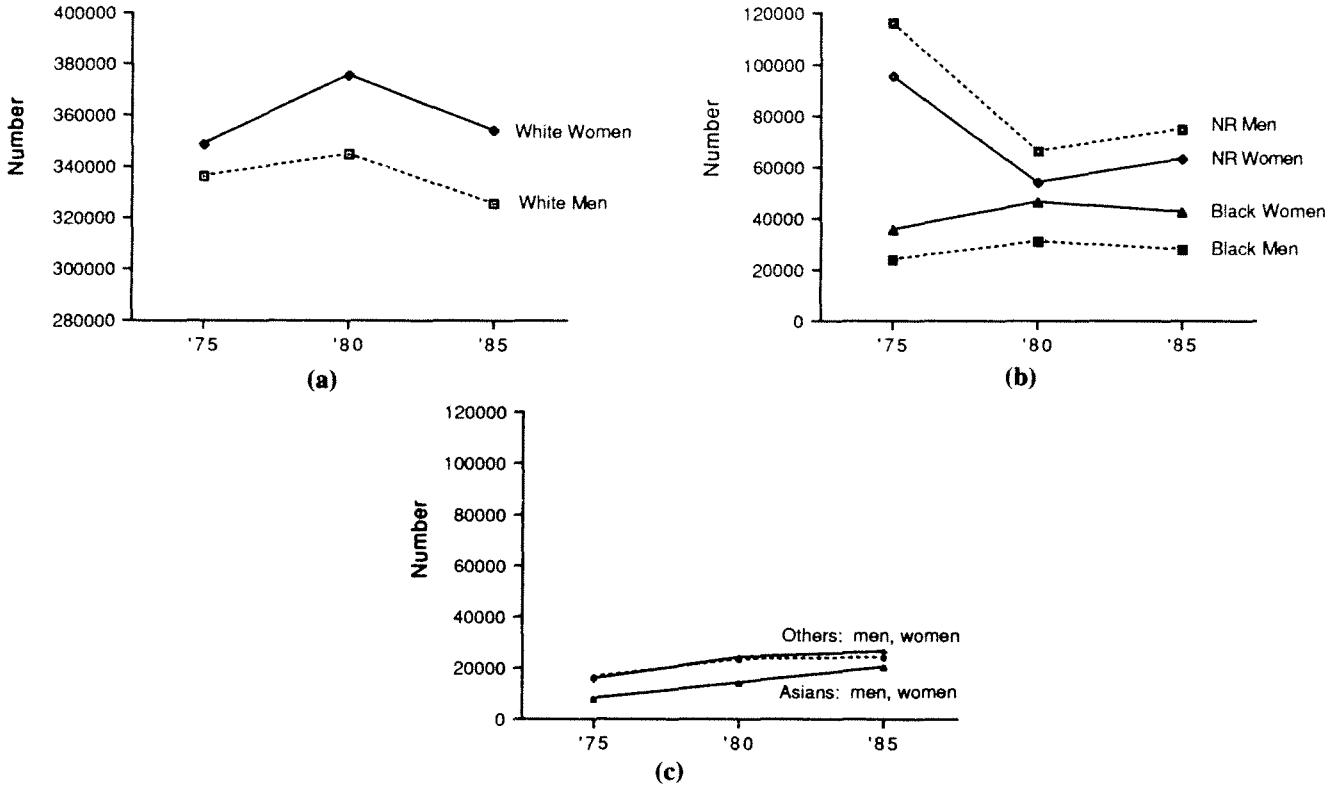

Figure 1. Population Size Trends of Women and Men Taking SAT in Various Ethnic Groups, Including Those Who Did Not Respond (NR).

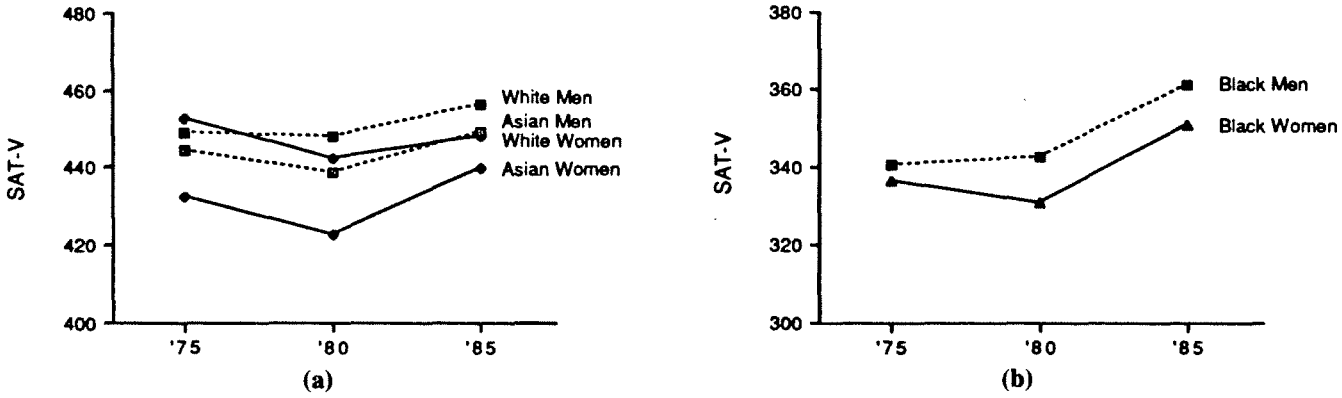

Figure 2. Trends in the SAT-Verbal Means of Women and Men in Various Ethnic Groups.

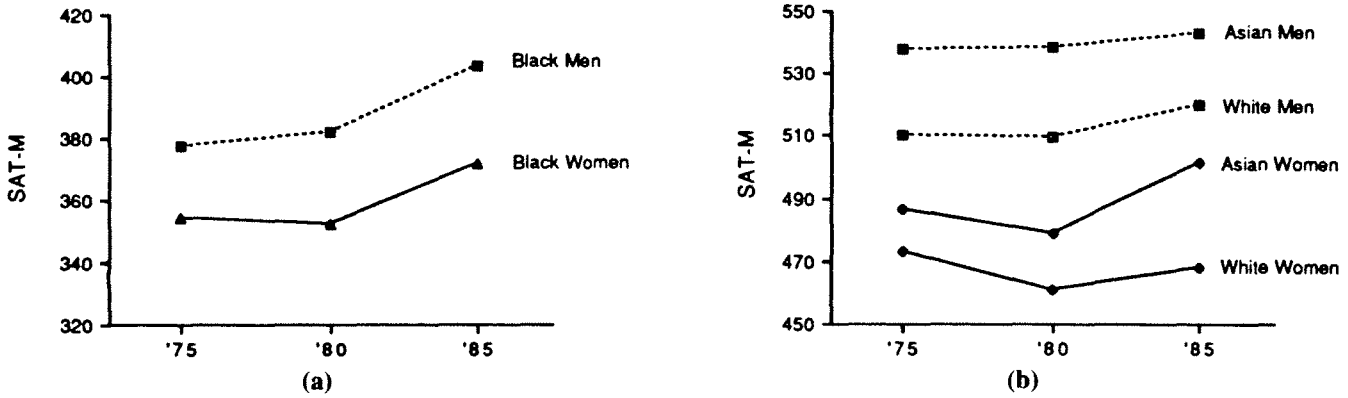

Figure 3. Trends in the SAT-Mathematical Means of Women and Men in Various Ethnic Groups.

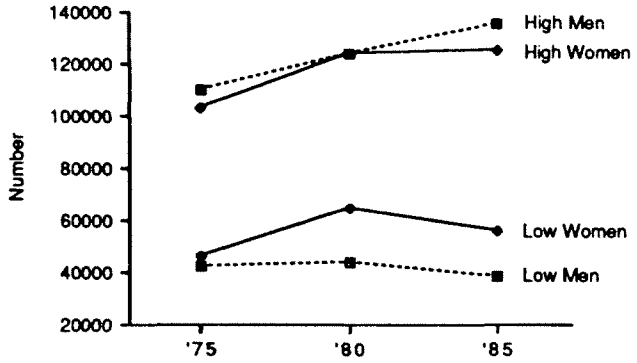

Figure 4. Trends in the Numbers of Women and Men Taking the SAT in High- and Low-Socioeducational Status Categories.

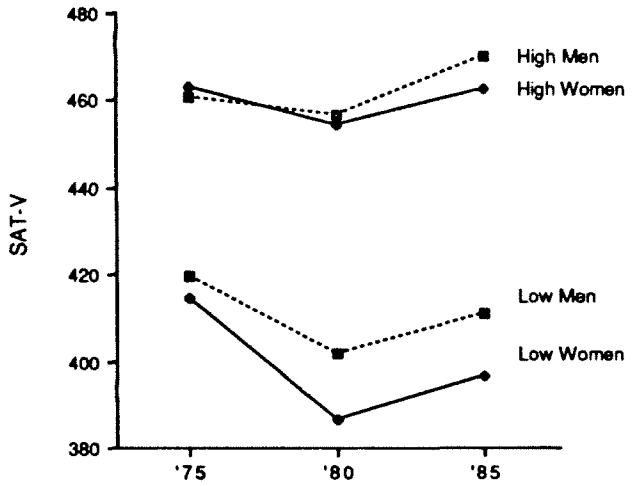

Figure 5. Trends in the SAT-Verbal Means of Women and Men in High- and Low-Socioeducational Status Categories.

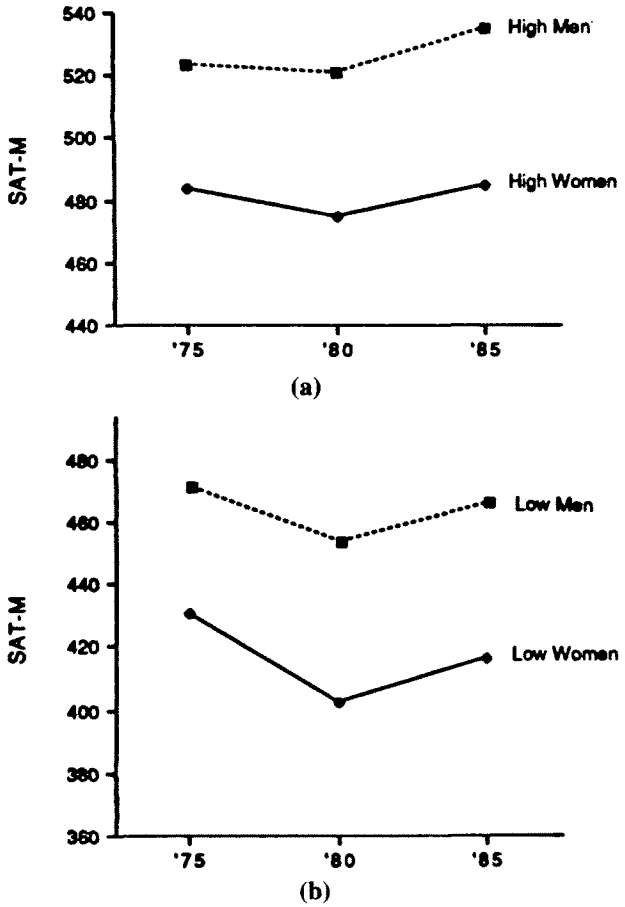

Figure 6. Trends in the SAT-Mathematical Means of Women and Men in High- and Low-Socioeducational Status Categories.

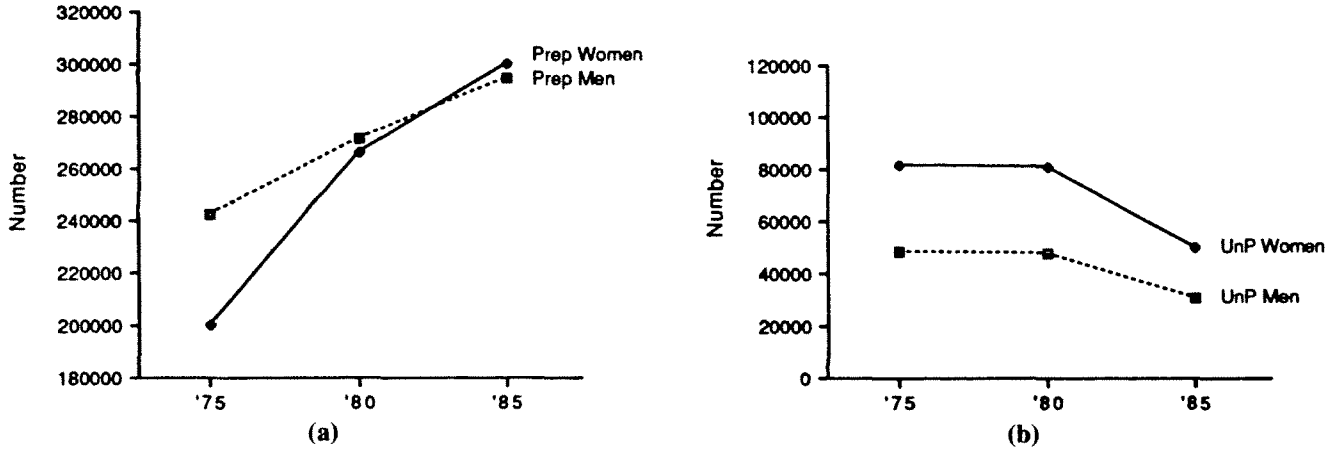

Figure 7. Trends in the Estimated Number of Women and Men Taking the SAT Who Are (Prep) and Are Not (UnP) Taking a Basic Academic Program in High School.

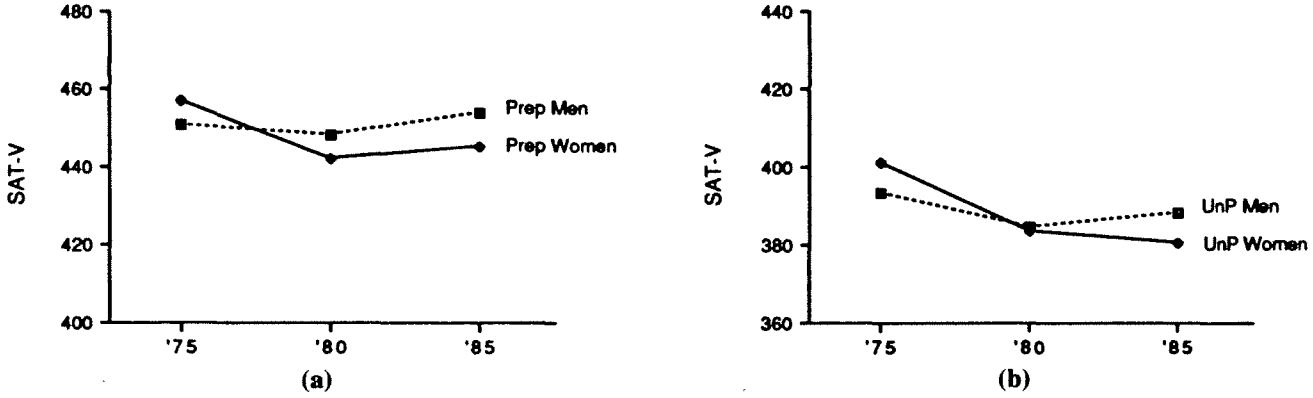

Figure 8. Trends in the SAT-Verbal Means of Women and Men Who Are (Prep) and Are Not (UnP) Taking a Basic Academic Program in High School.

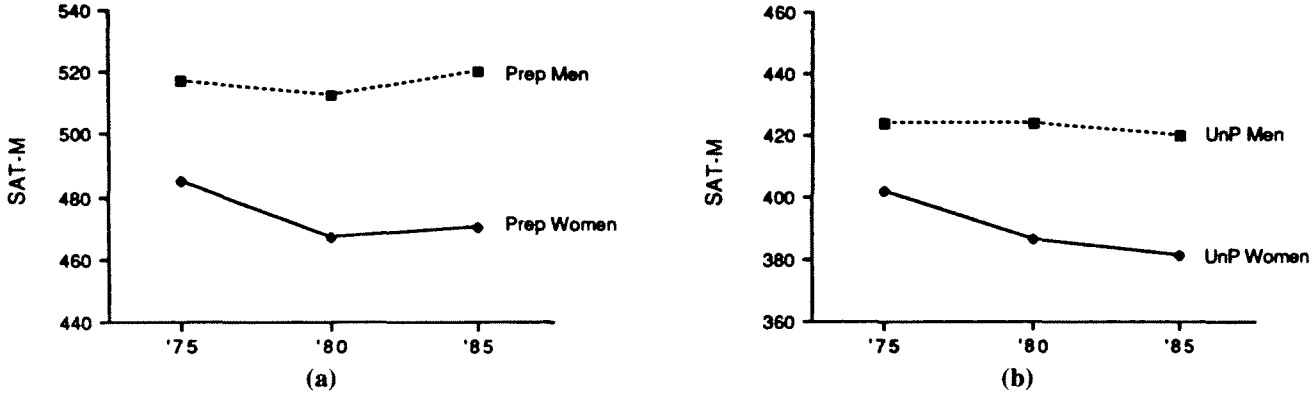

Figure 9. Trends in the SAT-Mathematical Means of Women and Men Who Are (Prep) and Are Not (UnP) Taking a Basic Academic Program in High School.

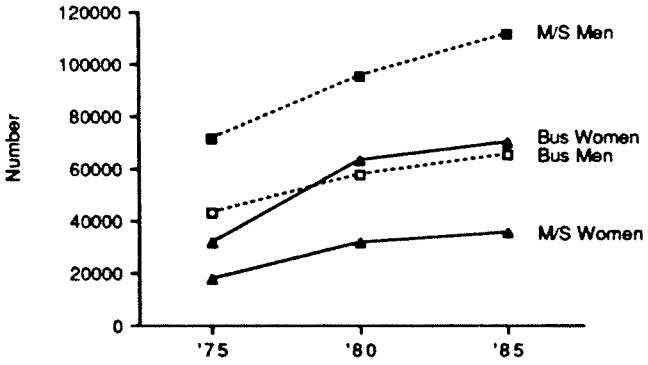

Figure 10. Trends in the Numbers of Women and Men Who Indicated an Interest in Business (Bus) and Math and Science (M/S) College Majors.

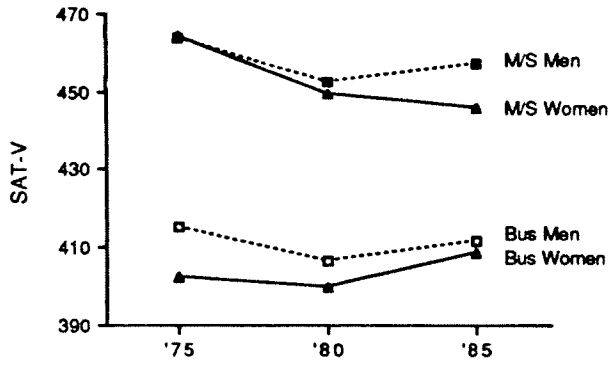

Figure 11. Trends in the SAT-Verbal Means of Women and Men Who Indicated an Interest in Business (Bus) and Math and Science (M/S) College Majors.

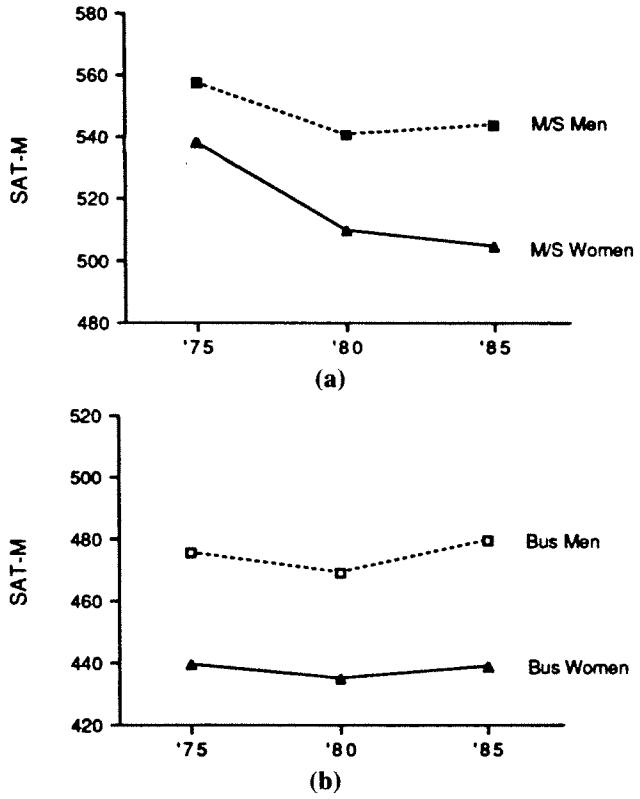

Figure 12. Trends in the SAT-Mathematical Means of Women and Men Who Indicated an Interest in Business (Bus) and Math and Science (M/S) College Majors.

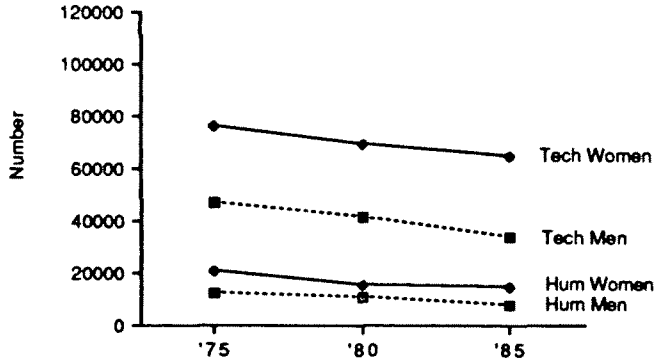

Figure 13. Trends in the Numbers of Women and Men Who Indicated an Interest in Humanities (Hum) and Technical (Tech) College Majors.

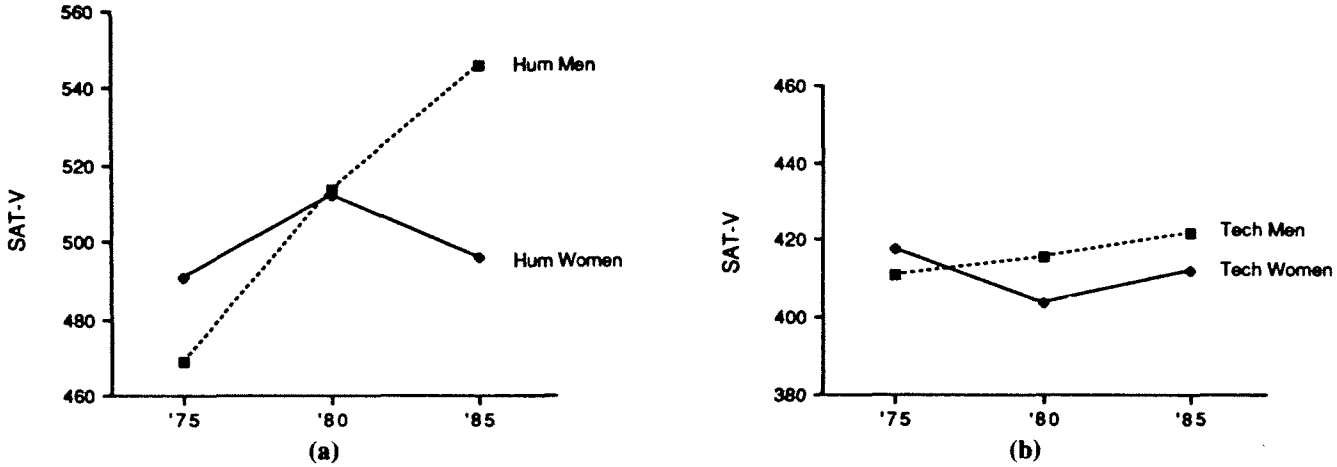

Figure 14. Trends in the SAT-Verbal Means of Women and Men Who Indicated an Interest in Humanities (Hum) and Technical (Tech) College Majors.

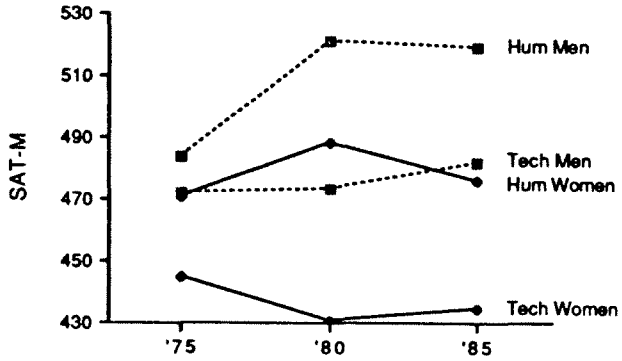

Figure 15. Trends in the SAT-Mathematical Means of Women and Men Who Indicated an Interest in Humanities (Hum) and Technical (Tech) College Majors.

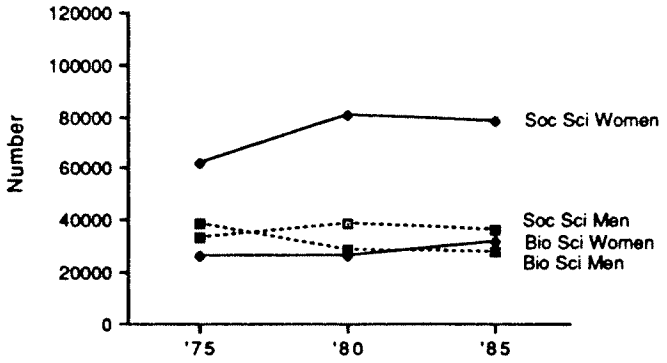

Figure 16. Trends in the Numbers of Women and Men Who Indicated an Interest in Biological Science (Bio Sci) and Social Science (Soc Sci) College Majors.

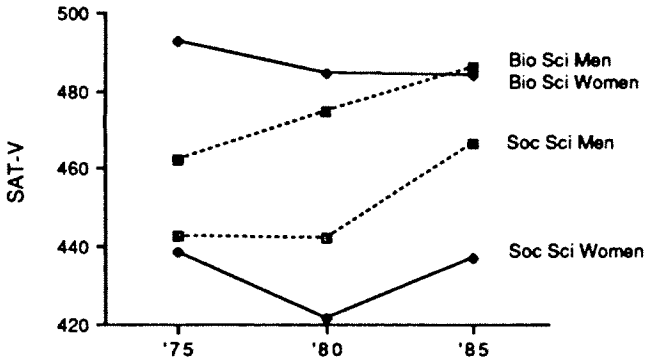

Figure 17. Trends in the SAT-Verbal Means of Women and Men Who Indicated an Interest in Biological Science (Bio Sci) and Social Science (Soc Sci) College Majors.

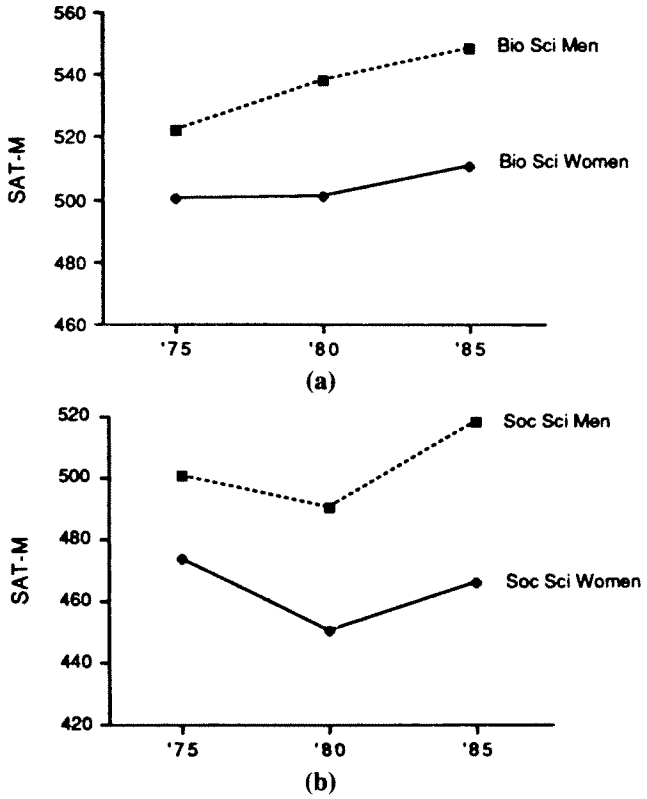

Figure 18. Trends in the SAT-Mathematical Means of Women and Men Who Indicated an Interest in Biological Science (Bio Sci) and Social Science (Soc Sci) College Majors.

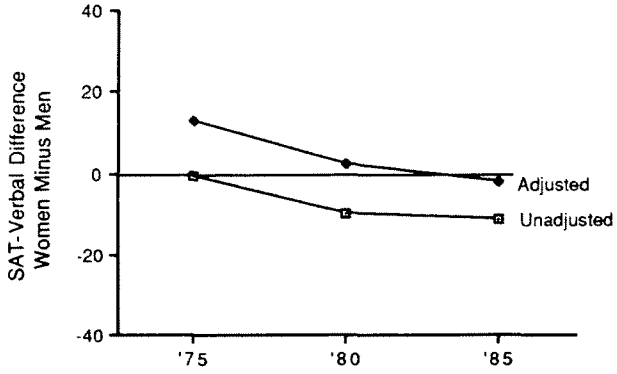

Figure 19. Trends in Adjusted and Unadjusted Verbal Differences.

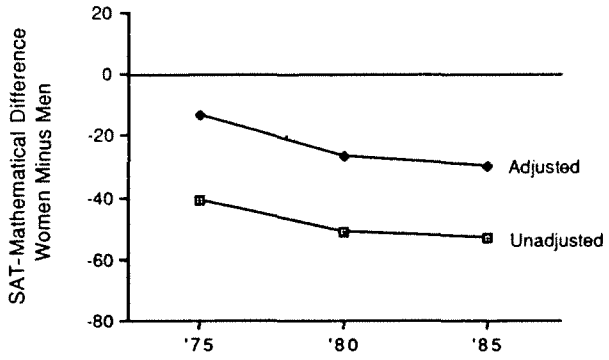

Figure 20. Trends in Adjusted and Unadjusted Mathematical Differences.

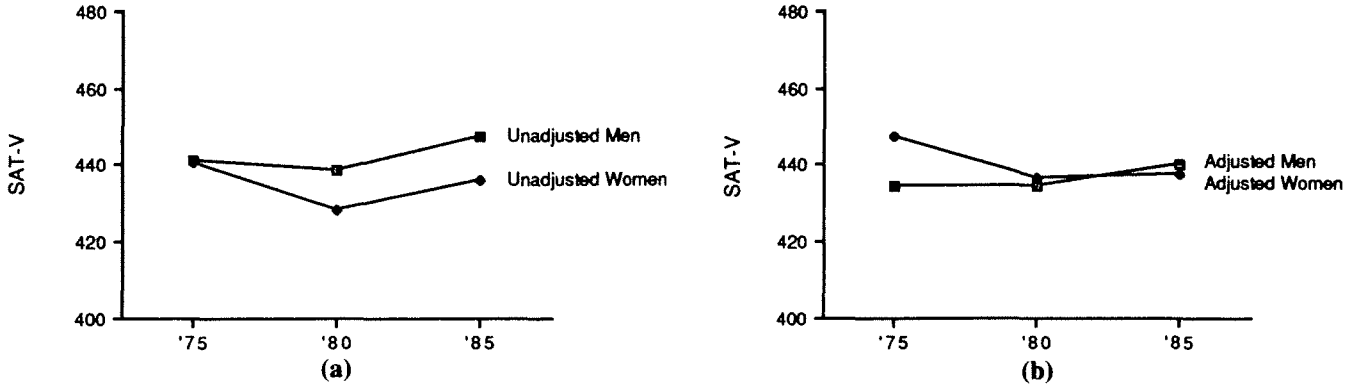

Figure 21. Trends in Adjusted and Unadjusted Verbal Means. (Adjustments based on yearly gender effects and 1975 frequencies.)

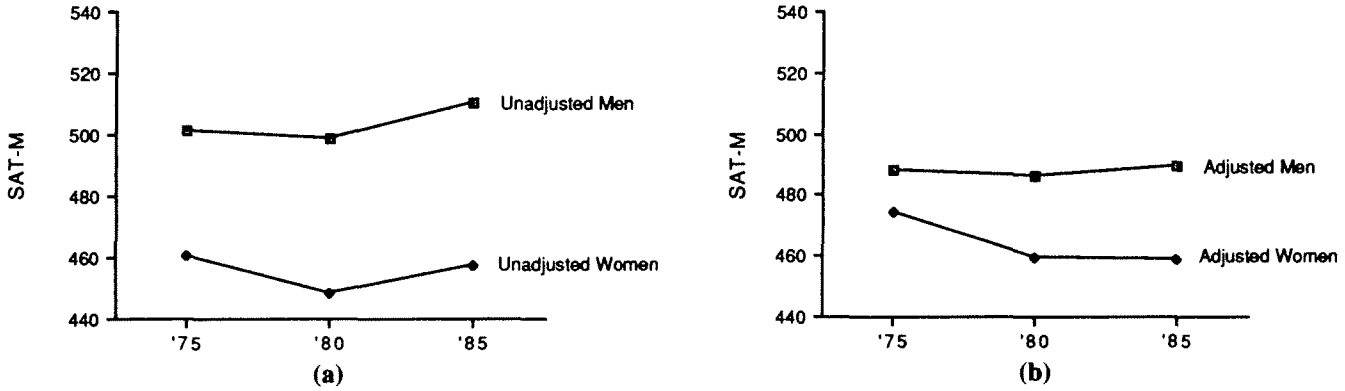

Figure 22. Trends in Adjusted and Unadjusted Mathematical Means. (Adjustments based on yearly gender effects and 1975 frequencies.)