

JE Jerry A. Jacobs

The Sex-Segregation of Fields of Study

Trends during the College Years

The field of study chosen by students represents an important part of the college experience. The organization of courses of study into "majors" or "fields of concentration" has been termed "the dominant feature of undergraduate education today" [41, p. 28]. The vast majority of colleges and universities require students to select a primary field of study. The extent of requirements for majors varies but is generally substantial: 30-40 percent of the total course load is typical of bachelor of arts programs and 40-50 percent is typical of bachelor of science programs [41, pp. 32-33].

The field of study constitutes a social as well as an intellectual environment for the student. College majors facilitate frequent contact between students having similar interests, shaping patterns of acquaintance and friendship [25]. Some evidence suggests important differences in the social dimensions of instruction between majors [33]. Other studies indicate that within colleges there is substantial variation between majors in the effort devoted to instruction [60, 53] and in the quality of instruction provided [32]. Political attitudes and grades also vary systematically across college majors [11].

Finally, and perhaps most importantly, college majors influence later-life occupations and earnings. Bielby has linked the field of study chosen by women in college to subsequent employment in female-

dominated occupations [17]. Census Bureau reports indicate that salaries of humanities graduates average 60 percent of those earned by engineering graduates [44 (1982), p. 187; see also 10, 11].

One should not overstate the connection between choice of major and subsequent careers. There is a great degree of instability in the choice of a major: the connection between the field of study and a subsequent job is often indirect for many specialties, and the first job after schooling by no means determines one's entire career. Overall, only 55 percent of a national sample reported a direct connection between the major they pursued in college and the subsequent employment they obtained [44 (1982), p. 186]. Nonetheless, a notable relationship between field of study and subsequent career options is indisputable, especially in certain fields. In short, both the college experience and subsequent opportunities are demonstrably related to the field of study.

The choice of majors by undergraduates has been extensively studied. Prominent among the findings in this literature is the important effect of gender on the choice of major [12, 21, 42, 49, 50; 55, 57]. In some specializations, such as agricultural science, engineering, and physics, male students have predominated. Language, literature and nursing are among the fields in which women predominate. Over one-third of women bachelor degree recipients in 1970 received their degrees in one specialty: teaching. By 1980 this proportion remained nearly 20 percent, despite the weak state of the market for teachers. Gender directly affects the choice of major and also mediates the influence of other determinants of major choice [12, 21].

This article examines the influence of college on the choice of major. About one half of the students change their field of study at some point in their undergraduate years [11, 21, 41]. This mobility allows for substantial effects of the college environment on the distribution of students into specialized areas of study. College has the potential to dramatically increase or dramatically decrease the degree to which men and women specialize in different areas of study. The terms "college" and "college experience" are used here to refer to all four year institutions of higher education.

The three main hypotheses this article examines are (1) the sex-role reinforcement hypothesis, (2) the liberalization hypothesis, and (3) the external trends hypothesis. The first hypothesis predicts that the effect of college will be to intensify sex-role attitudes and behaviors brought to college by entering freshmen, while the liberalization hypothesis predicts that the main effect of college will be the decline in sex-role

The comments of Paul Allison, Fred Block, Michelle Fine, Douglas Massey, Brendan Mullan, and Sam Preston on an earlier draft of this article are greatly appreciated. The research presented here was funded by a faculty research grant from the University of Pennsylvania.

Jerry A. Jacobs is assistant professor of sociology at the University of Pennsylvania.

stereotyping. In short, one hypothesis predicts an increase in the degree of sex-segregation of college majors during the college years, whereas the other hypothesis predicts a decline. The external trend hypothesis suggests that the extent and direction of change will vary over time in response to social trends in the non-college environment.

The sex-role reinforcement hypothesis refers to the implications of a theory most cogently presented by Rosabeth Moss Kanter [39, 40]. Kanter's research has highlighted the importance of proportions in social life. The minority status of women in corporate management, Kanter has maintained, produces a range of pressures and constraints on women's behavior. The problems women face rise as the proportions of women diminish, with token women in the most visible yet most vulnerable position.

A number of specific behavioral consequences of minority status and tokenism have been considered, including systematically distorted perceptions by the dominant group and self-limiting adaptive behavior, such as reduced performance, by the subordinate group. One equally important implication of Kanter's analysis has not been examined. A consequence one may deduce from the pressures placed on minority individuals is the increased likelihood of exit from the position [35, 39, p. 207].

Attrition is a predictable consequence of excessive pressures placed on minorities. In addition to various adaptive strategies designed to assist conformity for the minority, the safety valve offered by exit should be explored as a possible consequence of minority status. In certain situations, the overall costs and benefits perceived by an individual may make exit the rational choice. Further, attrition of minorities may help to account for the inconsistent empirical findings of research designed to test Kanter's hypothesis [2, 52]. The selective attrition from minority positions may skew the characteristics of the survivors so as to confound the prediction of Kanter's theory. This may be especially true for studies of women's performance in minority positions, including research on women's educational performance in male-dominated fields [2].

A number of studies have examined the relative scarcity of women in mathematics and the physical sciences [19, 26, 27, 58]. Other studies have specifically examined the issue of attrition of women from mathematics, science, and other male-dominated fields [14, 24, 47]. Kanter's theory, although developed during research in a corporate setting, provides a theoretical context for these results. The scarcity of women

in certain majors itself constitutes an obstacle to opportunity and is associated with a number of behavioral consequences impeding women's performance and persistence in these settings. Some evidence suggests parallel consequences for men in female-dominated settings [37, 51, cf 40].

This perspective implies that there are net flows of women from male-dominated fields to sex-neutral or female-dominated fields. If men also tend to leave female-dominated specialties, the overall tendency is toward increased sex-segregation over time. Upon graduation women college students would be more segregated by specialty from their male peers than they were in their freshman year.

The liberalization hypothesis sees college as introducing a variety of new ideas to young men and women. College exposes students to other students with different backgrounds, assumptions, and values. College also exposes students to unfamiliar courses of instruction and new fields of study. The consequence of these broadening social and intellectual experiences may be a growing tolerance for diversity of attitudes and behavior.

Several studies have concluded that the college experience has a liberalizing effect on a range of student attitudes and behaviors [18, 60]. Astin finds generally liberalizing effects of college, but finds sex-roles a notable exception to this pattern [11]. The differences between Astin's analysis and the present study are discussed in the third portion of the results section. One might therefore expect the college years to break down the stereotypes and prejudices about sex-appropriate roles freshmen bring to college. If this tendency were dominant, the net effect of college would be to reduce the degree of sex-segregation of college majors.

The final hypothesis suggests that the changes experienced during the college years may be the result of influences outside the identifiable college environment. Both initial hypotheses assume the salience of factors internal to the college environment; yet students may be as readily susceptible to outside influences as to those in the immediate college environment. In addition, colleges themselves are influenced by social trends. As a result, the college experience itself and the changes experienced during the college years may vary substantially over time.

The effect of college is examined with data spanning the 1970s and also with a large-scale study of the class of 1961. The availability of

this series of data allows for a test of the hypothesis that the effect of the college experience was constant over the last ten to twenty years. If the effect of college changed significantly in size or direction over this period, then we will conclude that external influences directly or indirectly affect the salience of the effect of the college experience.

It should be noted that each of the hypotheses on the effect of college runs counter to a good deal of the literature on the determinants of educational and occupational aspirations. This literature has emphasized the importance of socio-economic class and psychological orientation as determinants of educational and occupational choice [43, 1, 28, 34]. Although the bulk of this literature has focused on the level to which young individuals aspire, rather than on the sex-type of the college major or the occupation aspired to, recent work focusing on the sex-type of choices has continued to emphasize socio-economic and especially psychological factors in choice [22, 30, 31, 38, 46, 48, 54, 55, 56, 59, 61]. This literature focuses on individual attributes and assumes the stability of effects of early-life socialization and psychological orientation on the educational and career choices of individuals. In contrast, the present analysis focuses on institutional effects and temporal change. The assumption is that the college milieu has a potentially decisive influence on young people's behavior. Socialization and attendant psychological orientation is posited to interact with a specific social context to produce a range of outcomes. One can interpret significant effects of the college experience as estimates of the potential bias in psychological studies that ignore institutional context and temporal change in studying the attitudes, aspirations, and choices of young adults.

Data and Methods

Students enter college with intentions or plans to major in certain fields. We measured the degree of divergence in plans of young men and women entering college. By measuring the degree of segregation again at the conclusion of the college years, we determined whether the level of segregation increased or declined in the intervening period. Duncan's index of dissimilarity (D), frequently used in studies of segregation, was employed to measure the level of segregation for the initial and final choice of majors [23]. Thus a comparison of entry and exit levels of segregation by sex in the choice of college majors provided an indication of the effect of college on the sex-segregation of majors.

One might object to the examination of freshmen's intended majors on the grounds that these intentions may well be little more than wild guesses. The evidence on mobility between majors, cited above, indicates that there is a great deal of switching before settling in on a major. Yet if this switching simply represented random changes, there would be no net change in the proportion of students enrolled in different majors, a finding that would contradict the hypotheses outlined above. The hypotheses under consideration can be tested even if there is a degree of random movement reflecting randomness in freshman responses.

Data on freshman intended majors have been gathered yearly by the American Council on Education Cooperative Institutional Research Program. The annual survey is extremely large; over two hundred fifty thousand students in over five hundred colleges and universities are surveyed. The sample results are weighted to be representative of the national freshman class, and the data also provides a highly reliable description of the characteristics of this class. Details of the sampling frame and other survey information are presented in the annual reports of freshman norms [4-9, 20] and other ACE publications [13].

The CIRP data are the source of the entry or origin data for this study. Two different terminal or destination groups provide appropriate comparisons: (1) all degree recipients, and (2) the same students four or more years later. This article presents analyses of both types of data.

Data on degrees received by field of specialization are published annually by the National Center for Educational Statistics [44]. They are based on complete or virtually complete reports by all colleges and universities in the United States and are comprehensive and comparable over time. The clear advantage of employing these data is that they offer the definitive evidence on the distribution of majors for students receiving degrees. They are uniquely suited for this purpose.

A further advantage of these data is the ability to analyze trends over time. The NCES data on degrees received constitute an annual series dating from 1948 [36]. The CIRP data also represent an annual series, dating from 1966. As indicated above, one important issue regarding college effects is the degree of consistency of these effects over time. These data provide a unique opportunity for the analysis of the effect of colleges on students' choices of majors over a period of years.

CIRP data are divided into college and university data. They were combined to produce overall four year institution figures and were weighted to reflect the relative size of enrollments in these institutional categories, as reported in national enrollment figures [44]. Data for

freshman classes of 1966 to 1976 were analyzed, and compared with graduating classes of 1970 to 1980.

In addition to these data, the results of four longitudinal surveys were examined. The problem with comparing freshman intentions with degrees received is that some freshmen do not complete college, others do not do so in four years, and some who do receive degrees in a given year began college much earlier or transferred from two-year colleges. In short, the population receiving degrees is not the same group as the freshmen who started four years earlier. Thus some of the differences between entry and exit may be due to differences in attrition and different characteristics of students transferring to colleges. Consequently, the present investigation also examines longitudinal studies of students. By following up the same students four years after college entry, these data avoid the potential problems of divergent populations, which the degree data present. Longitudinal data help to measure the extent of the biases in the degree-recipient data.

The first major national longitudinal study of college students was conducted by Davis for the National Opinion Research Center on the class of 1961 [21]. CIRP researchers have also followed up students for four years after college entry. The data on the 1967-71 cohort and the 1978-82 cohort are examined here [15, 29]. Finally, the National Longitudinal Survey of the High School Class of 1972 included a four-year follow-up in 1976 [45]. These four studies are all large national samples of students with high response rates for follow-up interviews. In each case freshmen year data (plans of high school seniors in the case of the NLS data) are compared with the students' actual majors four years later. The two types of data serve to crosscheck the reliability of each one.

The data for degrees conferred were collapsed into the same broad categories presented in the CIRP publications. Collapsing these detailed majors into broad categories results in some loss of precision. Men and women appear less segregated when major categories are the units of analysis than when detailed categories are employed. Analysis of degree data, conducted to estimate the degree of segregation lost by the reliance on data on aggregated majors, indicates that the major field of study categories available for the CIRP data captures the great majority of segregation between men and women. In 1970 and in 1980, the major categories employed in the CIRP data captured over 80 percent of the sex-segregation measured by the most detailed categories available [36].

It should be noted that the consequences of the aggregated meas-

urement is the attenuation of the revealed effects. By hiding a degree of the true level of segregation, the measures reduce the degree to which the college experience can influence sex-segregation. Rather than undermining the validity of the findings, the aggregation of the data on field of study produces relatively conservative estimates of the effect of college. But because the degree of imprecision introduced is quite modest, the results represent only a relatively minor attenuation of the effects under consideration.

The preprofessional category needs a special word of attention. A number of entering students, predominantly men, indicate that their intended major is law, dentistry, or medicine. Few of these students are able to major in these areas as undergraduates, because few colleges and universities offer bachelor's degrees in these areas. Consequently the preprofessional category loses virtually all of its members by graduation. These students presumably flow into academic fields which lead into the respective professional schools. This category therefore presents two problems. First, after 1973 the CIRP freshman intentions data no longer include "preprofessional" as a separate category, causing the problem of incomparability over time. Second, there is the question whether the preprofessional category should be considered a legitimate intended major, since it cannot be actualized in most settings.

The problem of comparability is addressed by adjusting the pre-1973 results to account for the change in categories. The preprofessional category is removed in the adjusted figures, to enable analysis of trends over time. Substantively, I would argue that the change from self-described preprofessional to an academic major is one of the effects of college which is of interest. In a sense, the change from preprofessional to an academic major is one of the earliest effects of college. The data which remove this effect, I suggest, represent a conservative estimate of the effects of college on students. Thus both unadjusted as well as adjusted figures are presented. Individuals not reporting intended majors are excluded from the analysis.

Results

Aggregate Patterns

Table 1 compares the indices of segregation for freshmen and degree recipients for graduating classes 1970 through 1980. Both the unadjusted indices of segregation as well as the adjusted scores, which account for the change in the classification of the preprofessional category, are presented. The comparisons reveal a striking uniformity. In

TABLE 1
Comparisons of Sex-Segregation for Freshman Intended Majors and Degree Recipients, 1970-80

Class	Segregation of Intended Majors		Segregation of Degree Recipients	Net Change	Net Adjusted Change	Freshman Cohort Comparison Adjusted**
	Unadjusted	Adjusted*				
	D	D	D	D	D	D
1966-70	48.7	46.8	44.1	-4.6	-2.7	-0.8
1967-71	48.3	47.2	44.8	-3.5	-2.4	-3.0
1968-72	48.1	46.9	43.2	-4.9	-3.7	-1.8
1969-73	48.9	47.2	40.1	-8.8	-7.1	-5.5
1970-74	47.5	46.0	39.7	-7.8	-6.3	-10.1
1971-75	46.1	44.2	38.5	-7.6	-5.7	-10.9
1972-76	45.3	45.1	36.3	-9.0	-8.8	-10.8
1973-77	43.4		37.8	-5.6		
1974-78	37.4		34.1	-3.3		
1975-79	35.2		34.3	-0.9		
1976-80	34.5		34.0	-0.5		

*Removes preprofessional category, which is not employed in series after 1973.
**Compares freshmen with those entering four years earlier. For example, 1970 freshman segregation was 47.5; 1966 freshman segregation was 48.7. Thus there was a decline of 0.8 points in this period for incoming freshmen.

all years, degree recipients were less segregated by sex in the distribution of majors than were freshman class students four years earlier. This conclusion is consistent across the ten years studied and for both the adjusted and unadjusted segregation scores. The data on aggregated patterns of change in segregation appear to offer support for the liberalization hypothesis. The net effect of college is a decline in the sex-segregation of majors. These results are inconsistent with a sex-role reinforcement hypothesis.

Table 1 also reveals an interesting pattern of change over time. The effect of college is quite modest for the graduating classes from 1970 to 1972. The decline in sex-segregation during the college years is greatest for the classes of 1973 to 1977, with the three most recent classes exhibiting a sharp diminution of this effect. Sex-segregation in college majors declines throughout the 1970s, which is evident in Table 1 [see also 16, 36, 42, 57]. The college experience appears to have accelerated this trend during the middle 1970s.

This pattern suggests that the mid-1970s were periods of heightened influence of college on students. The liberal atmosphere on many college campuses and the society-wide reevaluation of sex-role attitudes may have created a particularly malleable cohort during this period. As Astin has pointed out, the effects of college in part reflect the college environment and in part reflect change in the society occurring at the

time [11]. Thus the external influences hypothesis finds support in these results.

One way to shed light on the question of external effects is to compare an "experience" effect with a "period" effect. One can compare the difference between cohorts of freshmen at four-year intervals with the change experienced by college students during the same four years. We can ask whether the same declines in sex-segregation are experienced by these two groups. If so, it can be argued that the changes are not the result of the college experience per se but rather the result of a society-wide reevaluation of sex-roles.

The last column of Table 1 compares levels of sex-segregation for four cohorts of freshmen at four-year intervals. The change revealed by this comparison indicates that the rate of change is due to changes in social trends, not to changes caused by the college environment. Changes of college students appear to be quite similar to changes between cohorts of freshmen. In other words, the college effect closely resembles the period effect. For both groups, the rate of change accelerates from the early 1970s through 1976. The declines in sex-segregation were greater for college students from 1970 to 1973, and the changes were larger for incoming freshmen from 1974 to 1976.

The rate of change for college students changes over time, and these changes are broadly in step with changes among incoming freshmen. These data can be viewed as evidence that changes in social attitudes regarding sex-roles affected both high school students who were to enter college and college students to similar degrees during this period. The extent of change in the college years varies over this period, and the variation appears to follow the same pattern for those outside the college environment (among prospective college students).

Table 2 reports comparisons of freshmen and four-year follow-up data for NORC, CIRP, and NLS longitudinal data. As noted earlier, these data allow for a comparison of origin and destination distribution effects for the same individuals, avoiding the potential problem of apparent change resulting from different populations. The NORC data on the class of 1961, the CIRP data on the class of 1967, and the NLS data on the class of 1976 all show a slight decline in the degree of sex-segregation over the period of college enrollment. These data parallel the pattern found in the CIRP freshman-intentions and NCES degree-recipient data. Combined, these two sets of analyses provide compelling evidence that the effect of college throughout the 1960s and most of the 1970s was to increase the level of integration in the socialities pursued by men and women undergraduates. This evidence

TABLE 2
Comparisons of Freshman Levels of Segregation with Follow-up Sample, Four Years Later

Study	Years	N of Cases	Sample Persistence		Freshman Segregation <i>D</i>	Follow-up Segregation <i>D</i>	Change
			Rate %	N of Categories			
NORC	1957-61	33,982	100*	8	50.4	48.5	-1.9
ACE	1967-71	34,346	59	16	48.3	42.8	-5.5
NLS	1972-76	5,503	89**	21	40.0	36.3	-3.7
ACE	1978-82	2,500	?	10	31.7	32.4	+0.7

*Freshman data were gathered retrospectively.
**The sample size refers to the population attending college; the persistence rate was obtained for the whole sample.

is consistent with the sex-role liberalization hypothesis. Although a pattern of liberalization is quite general, sharp changes in the extent of liberalization suggest that external trends in sex-role attitudes rather than college per se may be responsible for these changes.

The 1982 CIRP follow-up of the class of 1978 indicates a slight increase in the level of segregation. This may be due in part to the very high degree of aggregation of these data. The 1982 data were available for ten major subject areas, whereas other data analyzed were grouped into sixteen or twenty categories. This small positive effect, on closer inspection, actually differs only slightly from the small negative effects obtained with the degree-recipient data for the late 1970s. It is reasonably consistent with the CIRP-NCES comparisons presented in Table 1, which indicate that the net effect of college has moderated in recent years.

Flows Between Majors

In the previous section the overall pattern of change during the college period was examined. The aggregate changes are generally inconsistent with the sex-role reinforcement hypothesis and seem broadly consistent with the external effects hypothesis. This section presents a more detailed examination of these hypotheses. I will examine the net flows between majors for three graduating classes and determine whether the patterns of change in individual majors are predicted by any of the hypotheses.

Tables 3, 4, and 5 present the distribution of freshmen and degree recipients for the graduating classes of 1970, 1975, and 1980. The percent of all men found in each major for freshmen and degree recipients is presented next to comparable percentages for women. The change in the percent of men and women in each major, as well as the contri-

TABLE 3
Net Flows Between Majors, Freshman vs. Degree Recipients, Class of 1970

Major	Freshman		Degree Recipients		Change for Men	Change for Women	Change in <i>D</i>
	Men	Women	Men	Women			
Agriculture	3.1	0.2	2.4	0.1	-0.7	-0.1	-0.3
Biology	4.7	3.5	6.0	3.0	+1.3	-0.5	+0.9
Business	16.0	6.9	21.3	2.7	+5.3	-4.2	+4.8
Education	4.5	18.5	9.2	36.4	+4.7	+17.9	+6.6
Engineering	17.3	0.3	9.8	0.1	-7.5	-0.2	-3.7
English	2.4	8.1	4.1	11.1	+1.7	+3.0	+0.7
Health Sciences	2.4	8.1	1.1	5.0	-0.2	-3.9	-1.9
History	1.3	8.9	1.1	5.9	+2.2	-0.7	+1.4
Humanities	8.8	6.6	11.0	5.9	+0.5	-3.2	-1.9
Fine Arts	2.7	8.6	3.2	5.4	-2.0	-4.6	-1.3
Mathematics	6.3	10.7	4.3	6.1	-1.8	-2.5	+0.4
Physical Sciences	5.6	5.5	3.8	3.0	-1.9	-0.6	-0.1
Preprofessional	6.0	1.5	4.1	0.9	-12.6	-2.5	-5.0
Social Sciences	12.7	2.6	0.1	0.1	+9.9	+2.9	-3.5
Other technical	5.4	12.4	15.3	15.3	-1.3	-0.5	-0.4
Other nontechnical	2.7	0.6	1.4	0.1	+2.4	-0.3	-1.3
	0.5	5.1	2.9	4.8			
	100.0	100.0	100.0	100.0	0.0	0.0	-4.6
	<i>D</i> = 48.7		<i>D</i> = 44.1				

tribution of the change to the index of dissimilarity, constitutes the three figures at the right of each table.

A word about how flows affect segregation measures is in order, because certain changes have slightly counterintuitive effects. Both the change in size and the change in sex-composition of a major influence the contribution it makes to overall segregation. Clearly if a major grows in size and becomes more dominated by one sex, its contribution to sex-segregation increases. Similarly, if a major grows in size and moves toward more balanced representation of the sexes, its contribution to sex-segregation declines.

However, a major can decline in size and become more dominated by one group and still contribute to an overall decline in sex-segregation. The example of engineering should help to clarify this paradox. A large fraction of men indicate they intend to major in engineering; only about half of them manage to obtain degrees in this area. Women leave engineering as well, but the exodus of men is so much larger in absolute numbers that the net effect of this attrition is a decline in sex-segregation. Engineering becomes more male-dominated by the senior year. In 1970, for example, 17.3 percent of men and 0.3 percent of women reported intentions to major in engi-

TABLE 4
Net Flows Between Majors, Freshmen vs. Degree Recipients, Class of 1975

Major	Men 1966 %	Women 1966 %	Men 1970 %	Women 1970 %	Change for Men	Change for Women	Change in <i>D</i>
Agriculture	3.5	0.3	3.0	0.6	-0.5	+0.3	-0.4
Biology	5.5	3.6	6.9	4.1	+1.4	+0.5	+0.4
Business	15.2	6.6	22.2	5.2	+7.0	-1.4	+4.2
Education	4.7	17.9	8.8	29.3	+4.1	+11.4	+3.6
Engineering	12.6	0.4	9.1	0.2	-3.5	-0.2	-1.7
English	1.5	4.2	2.8	5.9	+1.3	+1.7	+0.2
Health Sciences	2.4	13.8	2.2	9.1	-0.2	-4.7	-2.2
History	7.0	4.0	6.2	2.6	-0.8	-1.6	+0.3
Humanities	2.7	5.3	3.6	5.5	+0.9	+0.2	-0.4
Fine Arts	7.9	11.7	4.4	6.4	-3.5	-5.3	-0.9
Mathematics	3.6	3.9	2.1	1.8	-1.5	-1.9	0.0
Physical Sciences	4.4	1.1	3.4	0.9	-1.0	-0.2	-0.4
Preprofessional	15.8	4.8	0.1	0.1	-15.7	-4.8	-5.4
Social Sciences	6.7	14.3	18.7	19.3	+12.0	+5.0	-3.6
Other technical	5.0	2.3	1.4	0.5	-3.6	-1.8	-0.9
Other nontechnical	1.5	5.8	5.1	8.5	+3.6	+2.8	-0.4
	100.0	100.0	100.0	100.0	0.0	0.0	-7.6
	<i>D</i> = 46.1		<i>D</i> = 38.5				

neering; by graduation only 9.8 percent of men and 0.1 percent of women remained. The concentration of men was higher for degree recipients but the exodus of 7.5 percent of all men (vs. 0.2 percent of women) to less male-dominated fields reduced overall sex-segregation. As engineering majors decline as a proportion of the college population, the contribution of this major to sex-segregation also consistently declines.

Inspection of Tables 3, 4, and 5 reveals several majors whose trends fit the predictions of the sex-role reinforcement hypothesis. Business, education, and English fit this pattern for all three years presented. For each field, the change between freshman and senior years increases the contribution to overall sex-segregation. Business represents the single largest male-dominated field, with over one-quarter of men's degrees garnered in this one specialty in 1980. The proportion of men majoring in this field increases during college. Women tended to leave business in the 1970 and 1975 classes, and joined it in small numbers by 1980. In each case, business contributed more to overall sex-segregation by the time the students received their degrees than when they were freshmen.

Education is the largest female-dominated field. Both women and

TABLE 5
Net Flows Between Majors, Freshmen vs. Degree Recipients, Class of 1980

Major	Men 1976 %	Women 1976 %	Men 1980 %	Women 1980 %	Change for Men	Change for Women	Change in <i>D</i>
Agriculture	4.0	1.3	3.4	1.5	-0.6	+0.2	-0.4
Biology	9.3	7.7	5.7	4.3	-3.6	-3.4	-0.1
Business	22.2	12.4	26.2	13.8	+4.0	+1.4	+1.3
Education	5.4	16.9	6.5	19.1	+1.1	+2.2	+0.6
Engineering	15.6	2.2	13.2	1.4	-2.4	-0.8	-0.8
English	0.8	2.0	1.8	3.7	+1.0	+1.7	+0.4
Health Sciences	1.7	13.7	2.4	11.5	+0.7	-2.2	-1.5
History	5.6	3.7	6.2	3.8	+0.6	+0.1	+0.3
Humanities	1.8	3.1	3.2	3.8	+1.4	+0.7	-0.4
Fine Arts	6.2	7.6	4.6	6.2	-1.6	-1.4	+0.1
Mathematics	1.8	1.3	1.4	1.1	-0.4	-0.2	-0.1
Physical Sciences	5.5	1.8	3.8	1.2	-1.7	-0.6	-0.5
Social Sciences	4.3	9.8	13.2	16.8	+8.9	+7.0	-1.0
Other technical	6.2	5.3	2.2	1.0	-4.0	-4.3	+0.1
Other nontechnical	9.6	11.2	6.2	10.8	-3.4	-0.4	+1.5
	100.0	100.0	100.0	100.0	0.0	0.0	-0.5
	<i>D</i> = 34.5		<i>D</i> = 34.0				

men tend to gravitate to education during college. But because a greater proportion of women migrate to education than do men, the overall contribution to sex-segregation rises for this field. This pattern is repeated on a smaller scale in English.

A larger set of fields of study do not fit the sex-role reinforcement prediction. A number of male-dominated fields contribute to a decline in sex-segregation. Agriculture is a male-dominated specialty. However, men tend to leave this area and women tend to join it during college (except in 1970), producing a less segregated major by the time degrees are awarded. As shown earlier, engineering is a male-dominated specialty that declines in size when students switch to other fields. Engineering, although it remains highly male-dominated and even experiences an increased concentration of men, nonetheless decreases the overall level of sex-segregation. This pattern is also found in physical science, mathematics (except in 1980), and in "other technical subjects."

Several other disciplines exhibit different patterns which also contradict the expectation of increasing sex-segregation. The health professions, a category which includes nursing and other female-dominated specialties but not medicine, experience a net loss of women during college. This female-dominated specialty consequently becomes less female-dominated as students progress toward their degrees. Fine arts

also follows this pattern of disproportionate loss of women. In the social sciences and humanities, however, men tend to join in disproportionate numbers, reducing the degree to which these areas constitute female-dominated specialties. Finally, certain specialties change over time, with no consistent pattern of attraction or repulsion to the two sexes. In this category fall biology, history, and "other non-technical fields."

The contribution to overall sex-segregation of the net flows from a major has been taken as the test of the competing theories. Another possible approach uses the change in the sex-composition of a particular major as a test of the sex-role reinforcement and liberalization theories. The sex-role reinforcement thesis does not fare better when the sex-composition of majors is taken as the criterion. In 1980 two male-dominated fields declined in the proportion of males (agriculture and mathematics), while four female-dominated fields declined in the proportion of females (education, English, humanities, and the social sciences). This test of the sex-role reinforcement hypothesis produces the same negative conclusions as the previous indicator.

Comparison with Astin and Panos

Alexander Astin, who has headed and helped to initiate the CIRP surveys, has also written a number of excellent articles and books on the effects of college on student attitudes and behaviors. Astin and his colleagues have set high standards both in the collection of data and in their analysis. It is therefore appropriate to reconcile the results presented here with conclusions that Astin and his colleagues have reached in this area.

Astin's conclusion about the effect of college on the sex-segregation of college majors appears to be diametrically opposed to the present findings. In a book with Robert Panos, the following summary of results appears:

Men were much more likely than were women to remain in or be recruited into business, engineering and physical sciences/mathematics majors, whereas women were much more likely to remain in or to be recruited into majors in the arts and humanities and in education. . . . Apparently, initial differences between the sexes in their preferences for various types of occupations become more marked throughout the undergraduate years. [12, p. 104]

Closer analysis reveals more apparent than real differences. There are two reasons Astin and Panos's results and the present findings are not inconsistent. First, regression coefficients do not characterize the overall pattern of flows of men and women between majors. Astin

and Panos's results are based on regression analyses, predicting senior year field of study from a variety of factors, including sex. A regression coefficient does not indicate the overall direction of change, but rather the effect that a given variable has net of other variables. Consequently, if the regression coefficient for being female is negative for a certain major, this indicates that, other things being equal, women are less likely to persist in that field. This coefficient may or may not correspond to the overall, or zero-order relationship. The flows between majors reported here can be thought of as the zero-order relationship between sex and persistence in a field. Second, even when regression results correspond to zero-order relationships, the effect of such flows on overall sex-segregation depends on the growth or decline in the field. As discussed earlier, an increasingly male-dominated field may contribute to a decline in sex-segregation if it is significantly contracting in size.

The case of engineering will serve as an example again. Astin and Panos report that being female reduces the chances of persistence in engineering, net of other factors. But even when engineering becomes increasingly male-dominated, its contribution to overall sex-segregation declines as engineering enrollments sharply contract. Thus Astin and Panos's careful and fruitful analysis of the determinants of major choice do not directly address the question of overall changes in sex-segregation of majors during college. The overall changes occurring during college reduce the segregation between men and women in the major fields they pursue, even though in some male-dominated fields persistence is reduced by being female.

Discussion

The results indicate little support for the sex-role reinforcement hypothesis. Overall the patterns of change in field during college are inconsistent with this hypothesis. Further, even though the analysis of several specific fields reveals several examples that are consistent with the predictions of this theory, a larger number of fields differ from this pattern. Nonetheless, it is important to continue investigations regarding differential attrition, especially for researchers pursuing the Kanter thesis. Differential attrition may account for the inconsistent outcomes of behavioral tests of Kanter's theory.

The direction of change in the college years is consistent with the liberalization hypothesis. This view also fits the changes evident in a preponderance of individual fields and is consistent with the findings

of Bressler and Wendell (1980), which indicate an overall decline in the divergence in occupational plans of women and men during the college years. The reduction in sex-segregation may not be the result of changes in attitudes but may represent students' accommodating themselves to second-choice majors. The sex-role liberalization documented here may be the by-product of the movement of students out of certain high-pressure majors, such as engineering. These data do not directly bear on intentions but rather indicate the overall direction of change.

The main change during the college years is the decline in the proportion of men in male-dominated specialties. Men move in substantial numbers into sex-neutral fields of study. Some female-dominated fields, such as education, attract men, but others, such as nursing, generally do not recruit men during college. If pursuing majors where men do not predominate is viewed as sex-role liberalization, then male undergraduates become more liberal during college.

Women undergraduates join sex-neutral fields, such as the social sciences, during college. Women are beginning to join certain male-dominated majors, such as agriculture and business, but overall, women have tended to leave male-dominated majors. The liberalizing effects of college, with respect to the sex-type of majors, seem more applicable to men than to women undergraduates. More attention needs to be devoted to the problem of attrition of women from male-dominated fields of study.

While the effect of college was consistently in the liberalizing direction, the extent of the changes varied from dramatic to minimal. The pattern of change during the college years appears to follow trends of changes among young individuals about to enter college. These findings suggest that the liberalizing pattern during the college years is a reflection of external trends rather than the effect of the college experience per se. It should be noted that the external trends referred to here may not apply to the same degree or in the same way to non-college bound students.

These findings underscore the fruitfulness of studying trends with comparable data over a period of years. Data from any particular year would lead to the support of the liberalization hypothesis, whereas analysis of the time series points more persuasively to the external trends hypothesis. Especially in the volatile area of sex-role norms and behaviors, generalizability across time should not be taken for granted.

The evidence indicates the power of social trends to influence the attitudes and behavior of young individuals. Psychological and soci-

ological investigations that assume constant effects of socialization and psychological orientation are clearly limited due to the degree of change evident in the college years.

The variation between colleges and universities presents a fruitful area for further research. The present study reports average effects across colleges and universities. Interesting possibilities for institutional effects on the size and direction of changes in majors for men and women remain to be explored. Finally, the study of the connection between the sex-segregation of college majors and subsequent graduate study and career patterns might benefit from the longitudinal approach employed in this analysis.

References

1. Alexander, K. L., and B. L. Eckland. "Sex Differences in the Educational Attainment Process." *American Sociological Review*, 39 (1974), 668-82.
2. Alexander, V., and P. A. Thoits. "Token Achievement: An Examination of Kanter's Theory of Proportional Representation." Unpublished Manuscript, Princeton University, Department of Sociology, 1983.
3. American Council on Education, Office of Research. *The American Freshman: National Norms for Fall 1972*. *ACE Research Reports*, Vol. 7, No. 5, 1972.
4. ———. *The American Freshman: National Norms for Fall 1971*. *ACE Research Reports*, Vol. 6, No. 6, 1971.
5. ———. *The American Freshman: National Norms for Fall 1970*. *ACE Research Reports*, Vol. 5, No. 6, 1970.
6. ———. *The American Freshman: National Norms for Fall 1969*. *ACE Research Reports*, Vol. 4, No. 7, 1969.
7. ———. *The American Freshman: National Norms for Fall 1968*. *ACE Research Reports*, Vol. 3, No. 1, 1968.
8. ———. *The American Freshman: National Norms for Fall 1967*. *ACE Research Reports*, Vol. 2, No. 7, 1967.
9. ———. *The American Freshman: National Norms for Fall 1966*. *ACE Research Reports*, Vol. 2, No. 1, 1966.
10. Angle, J., and D. A. Wissman. "Gender, College Major and Earnings." *Sociology of Education*, 54 (1981), 25-33.
11. Astin, A. W. *Four Critical Years*. San Francisco: Jossey-Bass, 1977.
12. Astin, A. W., and R. J. Panos. *The Educational and Vocational Development of American College Students*. Washington, D.C.: American Council on Education, 1969.
13. Astin, A. W., R. J. Panos, and J. A. Creager. *A Program of Longitudinal Research on the Higher Educational System*. *ACE Research Reports*, Vol. 1, No. 1. Washington, D.C.: American Council on Education, 1966.

14. Baruch, G. K., and J. Nagy. *Females and Males in the Potential Scientist Pool: A Study of the Early College Years*. Hanover, New Hampshire: Dartmouth College, 1977.
15. Bayer, A., J. Royer, and R. Webb. "Four Years After College Entry." *ACE Research Reports*, Vol. 8, No. 1, 1973.
16. Beller, A. H. "Higher Education Fields of Study and Professional Employment: Trends in Sex Segregation during the 1970s." Unpublished Manuscript, University of Illinois at Urbana-Champaign, 1984.
17. Bielby, D. D. V. "Career Sex-Atypicality and Career Involvement of College Educated Women: Baseline Evidence from the 1960s." *Sociology of Education*, 51 (1978), 7-28.
18. Bressler, M., and P. Wendell. "The Sex Composition of Selective Colleges and Gender Differences in Career Aspirations." *Journal of Higher Education*, 51 (1980), 651-66.
19. Brush, L. R. *Encouraging Girls in Mathematics: The Problem and the Solution*. Cambridge, Mass: ABT Books, 1980.
20. Cooperative Institutional Research Program. *The American Freshman: National Norms for Fall 1973-1979*. American Council on Education: University of California at Los Angeles, 1974-80.
21. Davis, J. A. *Undergraduate Career Decisions*. Chicago: Aldine, 1965.
22. Diamond, E. E. "Occupational Interests: Male-Female or High-Level Low-Level Dichotomy?" *Journal of Vocational Behavior*, 1 (1971), 305-15.
23. Duncan, O. D., and B. Duncan. "A Methodological Analysis of Segregation Indexes." *American Sociological Review*, 20 (1955), 210-17.
24. El-Khawas, E. H. "Sex Differences in Academic Development during College." in C. Leland, ed., *Men and Women Learning Together: A Study of College Students in the Late 1970s*. Providence, R. I.: Brown University, 1980.
25. Feldman, K., and T. Newcomb. *The Impact of College on Students*. San Francisco: Jossey Bass, 1969.
26. Finn, J. D., L. Dulberg, and J. Reis. "Sex Differences in Educational Attainment: A Cross-National Perspective." *Harvard Educational Review* (1980).
27. Fox, L. H., E. Fennema, and J. Sherman. *Women and Mathematics: Research Perspectives for Change*. Washington, D.C.: National Institute of Education, 1977.
28. Garrison, H. "Gender Differences in the Career Aspirations of Recent Cohorts of High School Seniors." *Social Problems*, 27 (1979), 170-83.
29. Green, K., A. Astin, W. Korn, and P. McNamara. *The American College Student, 1982: National Norms for 1978 and 1980 College Freshmen*. American Council on Education: University of California at Los Angeles, 1983.
30. Haber, S. "Cognitive Support for the Career Choices of College Women." *Sex Roles*, 6 (1980), 129-38.
31. Harren, V., R. Kass, H. Tinsley, and J. Mooreland. "Influences of Gender, Sex Role Attitudes, and Cognitive Complexity on Gender Dominant Career Choices." *Journal of Counseling Psychology*, 26 (1979), 227-34.
32. Hartnett, R. T., and J. A. Centra. "The Effects of Academic Departments on Student Learning." *Journal of Higher Education*, 48 (1979), 491-507.
33. Hearn, J. C., and S. Olzak. "The Role of College Major Departments in the Reproduction of Sexual Inequality." *Sociology of Education*, 54 (1981), 195-205.
34. Hout, M., and W. R. Morgan. "Race and Sex Variations in the Causes of the Expected Attainments of High School Seniors." *American Journal of Sociology*, 81 (1976), 364-94.
35. Jacobs, J. A. *The Sex-Segregation of Occupations and Women's Career Patterns*. Ph.D. Diss., Department of Sociology, Harvard University, 1983.
36. ———. "Sex Segregation in American Higher Education." In *Women and Work: An Annual Review*, edited by L. Larwood, A. H. Stromberg, and B. A. Gutek, pp. 191-214. Beverly Hills: Sage, 1985.
37. Jacobs, J. A., and B. Powell. "Gender Differences in the Evaluation of Prestige." *Sociological Quarterly*, 25 (1984), 173-90.
38. Janda, L. H., K. E. O'Grady, and C. F. Capps. "Fear of Success in Males and Females in Sex-Linked Occupations." *Sex Roles*, 4 (1978), 43-50.
39. Kanter, R. M. *Men and Women of the Corporation*. New York: Basic Books, 1977.
40. ———. "Some Effects of Proportion on Group Life: Skewed Sex Ratios and Responses to Token Women." *American Journal of Sociology*, 82 (1977), 965-90.
41. Levine, A. *Handbook on Undergraduate Curriculum*. San Francisco: Jossey-Bass, 1978.
42. Lyson, T. A. "The Changing Sex Composition of College Curricula: A Shift Share Approach." *American Educational Research Journal*, 18 (1981), 503-11.
43. Marini, M. M. "Sex Differences in the Determination of Adolescent Aspirations: A Review of Research." *Sex Roles*, 4 (1978), 723-53.
44. National Center for Educational Statistics. *Digest of Educational Statistics*. Washington, D.C.: U.S. Government Printing Office, 1971-82.
45. ———. *National Longitudinal Study of the High School Class of 1972: Tabular Summary of the Third Follow-Up Questionnaire Data*. Washington, D.C.: U.S. Government Printing Office.
46. O'Donnell, J. A., and D. G. Anderson. "Factors Influencing Choice of Major and Career of Capable Women." *Vocational Guidance Quarterly*, 26 (1978), 214-21.
47. Ott, M. D. "Retention of Men and Women Engineering Students." *Research in Higher Education*, 9 (1978), 137-50.
48. Parsons, J. E., I. Frieze, and D. N. Ruble. "Intrapsychic Factors Influencing Career Aspirations in College Women." *Sex Roles*, 4 (1978), 337-47.
49. Peng, S. S., and J. Jaffe. "Women Who Enter Male-Dominated Fields of Study in Higher Education." *American Educational Research Journal*, 16 (1979), 289-93.
50. Polachek, S. "Sex Differences in College Majors." *Industrial and Labor Relations Review*, 31 (1978), 498-508.
51. Powell, B., and J. A. Jacobs. "The Prestige Gap: Differential Evaluation of Male and Female Workers." *Work and Occupations*, 11 (1984), 283-308.

52. Spangler, E., M. A. Gordon, and R. M. Pipkin. "Token Women: An Empirical Test of Kanter's Hypothesis." *American Journal of Sociology*, 84 (1978), 160-70.
53. Stark, J. S., and B. R. Morstain. "Educational Orientations of Faculty in Liberal Arts Colleges: An Analysis of Disciplinary Differences." *Journal of Higher Education*, 49 (1978) 420-37.
54. Stockton, N., J. Berry, J. Shepson, and P. Utz. "Sex Role Innovative Major Choice Among College Students." *Journal of Vocational Behavior*, 16 (1980), 360-67.
55. Strange, C. C., and J. S. Rea. "Career Choice Considerations and Sex Role Self-Concept of Male and Female Undergraduates in Nontraditional Majors." *Journal of Vocational Behavior*, 23 (1972), 177-201.
56. Tangri, S. "Determinants of Occupational Role Innovation Among College Women." *Journal of Social Issues*, 28 (1972), 177-201.
57. Thomas, G. E. "Race and Sex Group Equity in Higher Education: Institutional and Major Field Enrollment Statuses." *American Educational Research Journal*, 17 (1980), 171-81.
58. Tobias, S., and C. Weissbrod. "Anxiety and Mathematics: An Update." *Harvard Educational Review*, 50 (1980), 63-70.
59. Trigg, L. J., and D. Perlman. "Social Influences on Women's Pursuit of a Non-Traditional Career." *Psychology of Women Quarterly*, 1 (1976), 138-50.
60. Trow, M., ed. *Aspects of American Higher Education*. New York: McGraw Hill, 1977.
61. Yanico, B., S. Hardin, and K. McLaughlin. "Androgyny and Traditional vs. Non-traditional Major Choice Among College Freshmen." *Journal of Vocational Behavior*, 12 (1978), 261-69.