

Cultural Influences on the Science Career Choices of Women¹

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ABSTRACT. Intensive interviews of 35 Ohio State University women graduate students revealed cultural differences influencing the selection of academic majors and careers by American and international women in the sciences and the humanities. Poor or inadequate mathematics and science teaching, pressures to conform to gender-role expectations, and students' social concerns were some of the reasons humanities students selected their courses and majors. Asian and African women usually reported strong familial and societal pressures for selecting scientific careers, while Europeans and some Americans were motivated by personal interest in the subject matter of their disciplines. The findings of this study contribute to the understanding of women's level of participation in science courses, majors, and careers, and may enhance educators' efforts to improve science education for women.

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INTRODUCTION

Women comprise the majority of undergraduate students in U.S. colleges and universities today, but they represent only a small and declining proportion of science or mathematics majors (Green 1989). Although women with B.S. degrees enter graduate school in the same proportion as men, they stop at the M.S. degree or drop out of Ph.D. programs in the natural sciences and engineering at much higher rates than do men (Widnall 1988). Women also make up a significant proportion of the U.S. labor force (45% in 1984), but they are grossly underrepresented in scientific and other mathematically-based occupations. For instance, in 1983 only 3% of all engineers were women (Crowley and Lane 1986). Many explanations for this uneven gender distribution emphasize women's supposed intellectual inferiority in math-related cognitive abilities and a natural, genetic basis for this purported deficiency (Benbow and Stanley 1980, 1983). Although such studies have been shown to be seriously flawed and misleading (Bellisari 1989, Hyde 1981), they have received much publicity. Their unjustified conclusions may help to divert women from majors in mathematics and science disciplines as well as from careers in mathematical and scientific fields.

One serious problem with using supposed innate deficiencies to explain the relative absence of women in the sciences is the failure to adequately address the obvious alternative to inherent cognitive deficits in women, namely potential social and cultural factors that influence the participation of women in science and mathematics courses and their selection of academic majors and careers. Basow (1986) has suggested that sex-typed activities and experiences beginning in early childhood and continuing throughout the life span not only reflect cultural expectations of appropriate male and female behavior, but also influence the development of differential cognitive abilities, skills, and performance. Other studies have already supplied evidence that obstacles to the participation of women exist in teacher-female student interactions (Widnall 1988) and the classroom climate for women (Hall and Sandler 1982), parental beliefs about the abilities of daughters (Eccles and Jacobs 1986),

and female gender role expectations (Fox, Tobin, and Brody 1979), among others.

A comparison of math achievement by Chinese, Japanese, and American children found that, although average scores of American children were only slightly lower than those of Chinese and Japanese children in kindergarten and first grade, the average score of the highest U.S. fifth-grade classroom was below that of all Japanese and all but one Chinese classrooms (Stevenson, Lee, and Stigler 1986). This disparity, attributed by the authors in part to differences in time spent in school and in doing homework and to differences in parental beliefs regarding mathematical ability, demonstrates clearly that math achievement varies more by culture than by gender. Other studies have shown that academic achievement of females is equal to that of males. For instance, Senk and Usiskin (1983) found that American high school girls were as capable as boys of learning to write geometry proofs involving complex mathematical reasoning, despite the higher level of knowledge demonstrated by boys at the start of the geometry course.

Although mathematics performance by U.S. college women was equal to that of men, women dropped out of math programs at a much higher rate. In 1985, women earned 46% of all B.A. and B.S. degrees in mathematics, but only 35% of M.A. and M.S. degrees and 17% of the Ph.D.s (National Research Council 1989). A longitudinal study of top Illinois high school students showed that, although the women were equal to the men in college academic performance and graduate educational aspirations, their self-estimates of intelligence declined sharply during the second year of college, and they were more likely than men to lower their career ambitions before graduation (Arnold and Denny 1985). Many parents and teachers are unaware of the environmental forces that discourage and/or exclude women from challenging, rewarding, and prestigious scientific disciplines. Unfortunately, the general notion that women cannot succeed in these demanding careers still prevails.

MATERIALS AND METHODS

Thirty-five women graduate students at The Ohio State University were given interviews designed to identify socio-cultural factors influencing their selection of academic majors and careers. International students from Asia,

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Africa, and Europe, and their U.S. counterparts of Asian-American, African-American, and European-American ethnic background were interviewed (Table 1). The women either volunteered for interviews when they learned of this project in an anthropology class or were invited to participate on the basis of recommendations by other volunteers. For the sake of comparison, students were selected from the most diverse of graduate programs, 17 representing the sciences (physics, architecture, engineering, computer science, microbiology, physiology, statistics, and natural resources), and 18 representing the humanities (modern languages, folklore, literature, music, theater, art, dance, Black Studies, and history).

Interviews were made by appointment and were conducted either in the homes of students or in a location near the campus (restaurant, office). Interviews were tape recorded for later transcription. Each participant was interviewed once, with follow-ups made only in two cases of interrupted sessions. Interview questions were open-ended to avoid influencing responses, and were concerned with the following topics, in addition to basic demographic information: motives for selecting specific majors and careers, development of major and career choices, academic and career goals, educational background, family background, personal goals and expectations, and cultural traditions regarding careers for women (interview topics listed in Appendix).

RESULTS

This report focuses only on the responses pertaining to women's motives for selecting science or humanities majors and careers. Findings include variation in social and cultural factors influencing the selection of science or humanities majors as well as in the choices by American *versus* international students.

Reasons for Selecting Science *vs.* Humanities

When the 18 humanities majors were asked to state reasons for their selection of humanities rather than science, four reported a strong dislike of science and mathematics, and five related their choice of a humanities major to poor science and mathematics teaching in their secondary or undergraduate institutions or negative experiences related to math. Three of these women declared that they simply "hated math," and one still remembers being humiliated by her father when she received a poor math grade in elementary school. While civil war interfered with the basic education of one African humanities major, placing her at a disadvantage in later mathematics courses, an American stated that she simply "lacked mathematical ability." Such reports can, of course, be interpreted as rationalizations for avoidance of, or poor performance in, science and mathematics in the first place; but, the events recounted often occurred during the early educational years when they may well have affected young students' attitudes and later selection of courses and majors.

Humanities majors denied that potential income was a motive for their career choices. Instead, they cited personal interests in the intellectual subject matter itself and their goals of expressing social concerns through

TABLE 1

OSU women graduate student participants.

National Origin	Science Students	Humanities Students
Africa		
Nigeria	2	2
South Africa	1	
Somalia		1
Asia		
India	2	1
China (PRC)	1	
Japan		1
Korea		1
Europe		
Iceland	1	
Denmark	1	
Italy	1	
Germany (FRG)		1
United Kingdom		1
France		1
United States		
African-American	2	3
Asian-American	3	3
European-American	3	3
TOTAL	17	18

careers in these fields. Both the British student and the American student of women's history considered this discipline to be an appropriate vehicle for feminist concerns; an African-American history and Black Studies student hoped for better understanding of the social status of her people and, through teaching and research, to help improve social conditions.

Five of the women in science also mentioned the relevance of their discipline to social concerns. An African was studying computer design in order to improve the communication system of her country; a European mechanical engineer was planning to develop equipment enabling orthopedic patients to walk; an American physics student was intending to work in the public sector on political issues related to military defense. But these were usually not the primary motives for their career choices. In contrast to humanities majors, science students reported that occupational opportunities, high incomes, or professional prestige were of primary importance in their career decisions when asked their reasons for selecting science rather than humanities.

For two international women, science and mathematics were virtually unavailable as major choices. Unlike Asian students from China and India, the Japanese and the Korean women reported that strong social sanctions steered men and women to gender-appropriate disciplines in their countries, with mathematics, engineering, economics, medicine, and sociology explicitly reserved

for men, and language, literature, and the arts for women. This gender distinction functioned in secondary and undergraduate educational programs through different academic requirements and emphases for men and women. For Japanese women attending gender-segregated schools, which are now much rarer in Japan than before World War II, science and mathematics training is minimal compared to that for men. The Japanese student interviewed indicated that there were no parental expectations for her to succeed in science and math courses, while her parents stressed achievement for her brother in those areas. She selected a major in linguistics because language studies are "traditional female subjects."

In contrast to humanities majors, ten of whom mentioned female teachers or relatives as role models and motivators and only two of whom referred to fathers or male teachers, eight science majors attributed their sustained interest in science and mathematics to the influence of their male teachers and relatives, and eight others invoked the influence of both parents. Specifically mentioned were fathers, brothers, and one grandfather who discussed scientific subjects with the young women, who included them in science-related activities, and who encouraged or even demanded that they enroll in science courses. One husband and one fiancé were also cited for their positive influences. Of the three science students from India and China, two had scientist or mathematician fathers, and all had mothers with science or mathematics educations and active careers in those fields. These women apparently received a double dose of encouragement, support, and role modeling.

National Origins and Selection of Science

Science students of different national origins exhibited even more striking contrasts in their motives for selecting majors and careers than did the humanities *versus* science groups. African and Asian students gave reasons for selecting scientific academic majors and careers that diverged sharply from those of European and European-American students. African-American and Asian-American women seemed to share some of the reasons for selecting scientific careers that were reported by Africans and Asians, but they were also influenced by their American background.

What distinguishes Africans and Asians from the other science students is the very strong influence of their social environments, especially their families, upon their career choices. On the other hand, Europeans and European-Americans made their selection largely on the basis of individual choice, personal interest in the subject matter, and emotional satisfaction with solving practical problems. While European and European-American students cited parental support for their choices and also sometimes mentioned teachers, guidance counselors, and peers as influential, Africans and Asians from China and India reported very strong pressures from their families and from their societies to enter science and mathematics fields. Two of the three African women in science were urged to enter medicine in order to please their parents and bring prestige and honor to their families. A Nigerian industrial microbiologist had origi-

nally selected medicine primarily because her parents had been frustrated in their own efforts to enter this field and had strongly encouraged her to fulfill this family goal.

Asian parents also placed great stress upon science and mathematics careers for their daughters, not only because such fields were valued as highly prestigious, but also because they were considered financially rewarding. In some Asian families, subjects in the humanities were disparaged and, as reported by an Indian student of biomedical engineering, children were "brainwashed" to enter science and mathematics fields. Especially when both parents were in science, engineering, or mathematics, the emphasis on these fields as career choices was particularly powerful. Two African students actually would have preferred to major in psychology and English literature but deferred to pressures from teachers and parents to develop science careers. Two Asian women said that they could well have majored in another scientific discipline but remained in their current one for the same reasons.

In addition to these strong family emphases on science and mathematics careers, African and Asian science majors cited national developmental needs and goals as motivating factors for their career choices. All three African science students had selected health-related careers, with two of them originally planning to enter medicine. A Nigerian student pursuing a master's degree in zoology stated her desire to contribute to the developmental efforts of her country through bacteriology in the food sciences or in environmental studies, and to be a "research pioneer" in her field. The black South African physiology major planned to teach her major subject to others in her country. For Asians, national development was an important factor as well. The two students from India were receiving training in scientific fields that were new in their country (biomedical engineering and ceramic engineering), and the Chinese student, whose education was funded through a government scholarship, expected to return to China to teach.

African-American and Asian-American science students also cited strong family influences and support for science careers. One African-American indicated that her parents "demanded" that her secondary school provide her with a strong math and science education. Grandmothers, mothers, and other female relatives were reported to be powerful professional role models for African-American students, one of whom persisted in her choice of a science career in order to become a role model for other African-American students herself.

According to the Asian-American students, the definition of "success" is a career in science or business. Applied and social sciences, on the other hand, are not highly regarded. Much like their Asian counterparts, all three Asian-American science students had scientist or mathematician fathers who strongly supported the choice by their daughters of science and mathematics courses, majors, and careers. For one Asian-American student, support also came from a sister in the form of tuition payments, establishing a family investment in this science student and, according to her, an obligation on her own

part to eventually assist this sister to study art in Europe.

While African-American and Asian-American women appeared to be influenced by family and community and by values favoring science and math careers, much like their African and Asian counterparts, they also seemed to respond to influences related specifically to their American environment in emphasizing individualistic goals and personal preferences over family concerns and community needs. For one thing, most of the Asian-American students had at least once considered an academic major in the social sciences or in the humanities, despite their parents' disapproval. One had majored in psychology and changed to industrial engineering, but with an emphasis on human factors. Another had selected statistics, but was in the process of reconsidering her major choice in favor of education. Another apparently "American" influence upon their choices of major was a strong personal attraction to the subject matter under study. African-American and Asian-American math and science students cited the excitement of participating in a high school internship experience and a summer program for gifted mathematics students, the joy of applying mathematical principles in attempts to solve practical problems, the pleasures of the "objective" and "aesthetic" dimensions of science and mathematics, and the "restricted creativeness" of science.

European and European-American scientists did not mention family pressures or financial motives as their reason for selecting specific disciplines. Invariably, they cited personal interest in the particular subject of their study as the primary reason for entering scientific fields. An electrical engineering student mentioned that her favorite subject had always been math, which she considered to be a "clean" subject, and that she "enjoyed playing with things"; a student of architecture liked "to touch what I've thought"; a biomedical engineering student had selected her field in order to prepare for a "career to be happy in." Their motives for selection were apparently based on a strong desire to satisfy personal needs and individual goals.

DISCUSSION

The U.S. is facing a scientific labor crisis. According to the Director of the National Science Foundation, only 15% of U.S. college students major in science and mathematics, and only one-third of them graduate (Erich Bloch, Wright State University lecture, 10 April 1990). From 1985 to 1988, U.S. colleges and universities granted 10% fewer baccalaureate degrees in science and engineering than in the preceding years, while the need for more scientists continues to grow. Although American women now earn 45% of the bachelors degrees and 30% of the Ph.D.s in science and engineering, they receive only 8% of the Ph.D.s in physics, 14% in computer sciences, and 15% in mathematical sciences (Pool 1990). Most American women in science earn Ph.D.s in life sciences (35% of all Ph.D.s) or social sciences (50% of all Ph.D.s). In spite of similar enrollments for undergraduate male and female biological science students in 1984, for example, women were less represented in graduate programs and severely under represented in faculty positions in these fields; they also received lower salaries (Koshland 1988).

Women are not deficient in intellectual potential, nor is their scholastic performance inferior. Only their participation in higher mathematics and science courses is substandard (Linn and Hyde 1989). Identifying some of the motivators and facilitators that operate in other societies may help educators to enhance American women's scientific opportunities. Participation might be improved by a change in attitude toward women's abilities, by very emphatic encouragement and support from parents and teachers, by science and mathematics education for all male and female students, and by effective teaching that includes demonstrations of the social value and practical applications of math and science. In light of the urgent national need for scientists and technicians, the active recruitment of young women into math and science courses at all levels and their retention in the higher ranks of these disciplines will go far toward improving their participation, and ultimately will help to alleviate the scientific shortfall.

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APPENDIX

*Interview topics and questions: OSU women graduate students.
(Suggested follow-up topics in parentheses.)*

APPENDIX (continued)

TOPIC: Career Goals

1. What are your academic/career goals?
 - a. Where do you plan to work?
(U.S., home country, other)
2. Why did you choose (science/humanities) over other fields?
(potential income, prestige, job opportunities, inherent properties of subject matter, teacher influence, other)
3. How did your career goals develop, how did you arrive at your choice?
(experiences, role models, influences: closest friends, classmates, boyfriends, others of own age, parents, siblings, other relative, teachers and counselors)
 - a. What did teachers and counselors tell you?
 - b. What are the academic and social interests of your closest friends?
 - c. How do you feel about your choice of major/career? (confident, worried about success, not concerned)
4. How appropriate is your career choice for women in your society?
 - a. How are women accepted in this field?
 - b. Is math/science appropriate for women?
 - c. How do others you know feel about your choice?
(your relatives, your relatives' friends, your own friends, employers, coworkers, government planners, other socioeconomic classes)
5. Are there more men or women in your chosen career field? Why?
(field is inherently masculine, more attractive to men than to women, men are more capable)

TOPIC: Family Background

1. Describe your family structure.
(parents, siblings' number, ages, sex, education, occupation, own birth order, other relatives)
 - a. What is your parents' educational and occupational history
(occupation during critical points in own educational stages)?
 - b. What is your family's socioeconomic class rank?
 - c. What is your family's social orientation?
(traditional-conservative/progressive-modern)
2. How did your family influence your choice of major or career?
(father, mother, other relatives, siblings; encourage/discourage, financial support)
3. With whom in your family do you identify most closely?
Why?

TOPIC: Educational Background

1. Describe the structure of the school system in your country.
(years in each level, points of transition-exams, private *vs.* public schools—number and ease of entry, coed and single sex schools)
 - a. Now tell about your own educational background.
(list above, plus math and science courses taken, achievement in each, degree of choice regarding courses taken)
 - b. What courses do most students take?
 - c. Are there people who help you decide on courses, majors?
 - d. What place do sports have in the educational system? Dating/parties/other social activities?

2. In your country, what fields/areas are viewed as male domains?
Female domains?
(science, math, engineering, art, teaching, medicine, others)
3. How did your teachers/advisors/counselors/mentors influence your choice of major/career?
(role model, sex of teacher, quality of teaching or counselling)
4. Who was your favorite/most admired/most influential teacher/counselor/advisor? Why?
 - a. Who was your least favorite/admired? Why?
5. What was the best thing about your pre-university training? The worst?

TOPIC: Here and Now

1. How do you compare yourself with the typical American female student?
2. How do you compare yourself with the typical women in your own society?
(traditional woman, others of your own generation)
3. How many women are in your department?
(American, international)
 - a. Is there evidence of differential treatment of men and women in the university or your department?
(specific examples)
 - b. How do you feel about that?
4. Why do you think so few women enter math and science related fields in your country? In the U.S.?
5. Do you have a role model/mentor/advisor?
 - a. What sex?
 - b. Is this person helpful?
6. What was your first American math course and your grade in this course?

TOPIC: Strategies

1. What are your family goals?
(marriage, significant other, children, timing re:career)
2. How do you plan to combine career and family responsibilities?
 - a. How will you deal with marital/housework responsibilities?
(won't do, husband expected to help, do all alone, hire servants)
 - b. How will you deal with children?
(limit number, delay, space, adopt)
 - c. With child care responsibilities?
(servants, other family members, husband help)
 - d. How do you plan to accommodate your husband's career demands?
(defer to his career, give up own career, work only part-time)
 - e. How have other women in your society dealt with these issues?
3. What are your family's expectations regarding your career/family goals and responsibilities?