

DOCUMENT RESUME

ED 479 756

SO 034 900

AUTHOR Beyer, Sylvia; Rynes, Kristina; Chavez, Michelle; Hay, Kelly; Perrault, Julie

TITLE Why Are So Few Women in Computer Science?

SPONS AGENCY National Science Foundation, Arlington, VA.

PUB DATE 2002-06-00

NOTE 6p.; Paper presented at the Annual Meeting of the American Psychological Association (14th, New Orleans, LA, June 6-9, 2002).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE EDRS Price MF01/PC01 Plus Postage.

DESCRIPTORS Behavioral Science Research; College Freshmen; \*Computer Science; \*Experience; Females; Gender Issues; Higher Education; Males; Questionnaires; \*Sex Differences; \*Sex Stereotypes; \*Student Attitudes

IDENTIFIERS \*Confidence; Gender Gap; Students as Subjects

ABSTRACT

A study examined gender differences in stereotypes, experience, and confidence for computer science (CS) first-year students. Questionnaires were distributed to freshmen students (n=241: 161 females, 80 males) in a required university seminar course. Overall, participants possessed very stereotypical attitudes of CS majors. Findings showed that men reported having more experience with computers than did women, and they also enjoyed working with computers more than did women. (Contains 27 references, 1 table, and 1 figure.) (Author/BT)

Reproductions supplied by EDRS are the best that can be made  
from the original document.

# Why Are So Few Women in Computer Science?

Sylvia Beyer  
Kristina Rynes  
Michelle Chavez  
Kelly Hay  
Julie Perrault

ED 479 756

SO 034 900

PERMISSION TO REPRODUCE AND  
DISSEMINATE THIS MATERIAL HAS  
BEEN GRANTED BY

*S. Beyer*

TO THE EDUCATIONAL RESOURCES  
INFORMATION CENTER (ERIC)

BEST COPY AVAILABLE

2

U.S. DEPARTMENT OF EDUCATION  
Office of Educational Research and Improvement  
EDUCATIONAL RESOURCES INFORMATION  
CENTER (ERIC)

- This document has been reproduced as received from the person or organization originating it.
- Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

# Why are There so Few Women in Computer Science?<sup>1</sup>

Sylvia Beyer<sup>23</sup>, Kristina Rynes,  
Michelle Chavez, Kelly Hay,  
& Julie Perrault

University of Wisconsin-Parkside

## Abstract

We examined gender differences in stereotypes, experience and confidence in Computer Science (CS) in first-year students. Overall, participants possessed very stereotypical attitudes about CS majors. Men reported having more experience with computers and reported more computer confidence than did women. Men also enjoyed working with computers more than did women.

This nation faces a serious shortage of computer scientists. From 1986 to 1996, the number of men majoring in Computer Science (CS) dropped by 33%, whereas the number of women dropped by 55% (calculated from data in U.S. Department of Education, 2000). This shortage of computer scientists provides a major impetus for increasing the representation of women in CS.

Two reasons for the small number of women in CS are negative attitudes towards the field and low confidence. Beyer (1990, 1998, 1999b, 2002; Beyer & Bowden, 1997; Beyer, Chavez, & Rynes, 2002; Beyer, Riesselmann, & Warren, 2002) has repeatedly found that females have inaccurately low confidence in masculine domains, including mathematics, chemistry, and CS.

CS is stereotyped as even more male-dominated than the traditional male bastions of chemistry and

mathematics (Beyer, 1999a). Both males and females *incorrectly* believe that males in CS have higher GPAs than females (Beyer, 1999a). Furthermore, those women who do succeed in CS are often viewed as "exceptional", leaving the stereotype that women do not belong in CS intact (Henwood, 1999/2000).

The stereotypes about CS majors are unflattering. They are perceived to be intelligent but deficient in interpersonal skills (Beyer, 1999a; Beyer, Chavez, & Rynes, 2002). This has been termed the "computer nerd syndrome" or "geek mythology" (Margolis & Fisher, 1997; Rasmussen & Hapnes, 1991). These perceptions of CS majors conflict more with the gender roles of females than of males, because women tend to have a stronger interpersonal orientation than men (Cross & Madson, 1997; Markus & Kitayama, 1991).

The major goal of the present research is to discover the barriers that discourage undergraduate women from taking courses in CS. To this end we examine gender differences in attitudes and confidence in CS in first-year students.

## Method

We distributed questionnaires to 241 first-year students (161 females, 80 males) in a required University Seminar course. Participants were paid. Participants filled out questionnaires assessing demographic and family background information; ability and preparation in quantitative areas; educational goals and interests (Farmer, Wardrop, Anderson, & Risinger, 1995; Lips, 1992); experience with and attitudes towards computers (Lips, 1992); stereotypes and knowledge about CS; confidence (Nickell & Pinto, 1986); interpersonal relations (Cross, Bacon, & Morris, 2000; Cutrona & Russell, 1984); family orientation (Ethington & Wolfle, 1988); personality attributes (e.g., self-esteem [Rosenberg, 1965], gender roles [Bem, 1974], and the Big 5 [John & Robins, 1993]); stress (Cohen, Kamarck, & Mermelstein, 1983); financial and family issues; and attitudes towards any CS courses and instructors they had had.

## Results

2 (gender) x 2 (semester group: students surveyed in fall versus spring 2001) analyses of variance (ANOVAs) were calculated. Gender did not interact with the semester group variable, so only the results for gender will be presented. Selected means and standard deviations can be found in Table 1.

<sup>1</sup> Poster presented at the annual meeting of the American Psychological Society in New Orleans, June 2002.

<sup>2</sup> To whom correspondence should be addressed at Department of Psychology, University of Wisconsin-Parkside, Kenosha, WI 53141. e-mail: beyer@uwp.edu

<sup>3</sup> This research was supported by a grant from the National Science Foundation (EIA-0089957) to the first author.



TABLE 1: Means and Standard Deviations for Selected Dependent Variables.

|                           | Females  |         | Males    |         |
|---------------------------|----------|---------|----------|---------|
|                           | Mean     | (SD)    | Mean     | (SD)    |
| High school GPA           | 3.21**   | (.51)   | 3.00**   | (.58)   |
| Educational aspirations   | 2.34*    | (1.24)  | 2.00*    | (1.14)  |
| Computer enjoyment        | 4.00**   | (1.50)  | 4.59**   | (1.42)  |
| Interest in CS            | 4.95**** | (1.63)  | 3.91**** | (1.95)  |
| Computer scientist salary | \$48355* | (18149) | \$54294* | (23092) |
| Difficulty of CS careers  | 3.53*    | (1.13)  | 3.85*    | (1.06)  |
| Perceived ability in CS   | 3.35**** | (1.55)  | 4.81**** | (1.85)  |

NOTE: \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ , \*\*\*\* $p < .0001$

#### *Demographic Variables*

There was no significant gender difference in age,  $F(1, 236) < 1$ . The average age of our participants was 20. Male and female students were remarkably similar in terms of demographic variables including age, race, number of siblings, year in college, marital status, number of children, prevalence of disabilities, socioeconomic status while growing up, and parental level of education. However, women had attended significantly more semesters at this university than men had,  $F(1, 209) = 5.32, p < .05$ .

#### *Ability and Preparation in Quantitative Areas*

Women reported higher high school GPAs than men did,  $F(1, 225) = 8.25, p < .01$ .

#### *Educational Goals and Interests*

Women had significantly higher educational aspirations than did men,  $F(1, 232) = 4.24, p < .05$ . Men were significantly more likely to plan to take more math and science courses than were women,  $F(1, 236) = 11.70, p < .01$ . In terms of selecting a career, women rated intrinsic satisfaction,  $F(1, 233) = 12.72, p < .0001$ , and interactions with people to be significantly more important than did men,  $F(1, 232) = 7.05, p < .01$ . Interestingly, career concerns were less salient for men than for women,  $F(1, 236) = 11.44, p < .001$ .

#### *Previous Experience with and Attitude towards Computers*

More women (85.4%) than men (73.7%) reported owning a computer,  $F(1, 231) = 5.03, p < .05$ . There was no gender difference regarding the age at first computer use,  $F(1, 232) < 1$ .

Significantly more men (35%) than women (19%) had experience in computer programming,  $F(1, 235) =$

9.19,  $p < .05$ . Men were significantly more likely to have taken a computer apart,  $F(1, 235) = 26.24, p < .0001$ , and to have installed internal components such as RAM into a computer than were women,  $F(1, 234) = 17.41, p < .0001$ . They also enjoyed working with computers more,  $F(1, 234) = 8.50, p < .01$ , and reported significantly more interest in the Computer Science major than did women,  $F(1, 214) = 17.90, p < .0001$ . Women had less anxiety about the potential harm of computers to humanity than did men,  $F(1, 234) = 9.59, p < .01$ .

#### *Stereotypes and Knowledge about CS*

There were no gender differences in the stereotypes that participants held toward CS majors. Overall participants thought that CS majors are asocial, unathletic, good at math and science, hard-working, and intelligent.

There was no gender difference in knowledge of what CS is,  $F(1, 235) < 1$ . Men estimated the starting salary of a computer scientist significantly more highly than did women,  $F(1, 216) = 4.24, p < .05$ . Both males and females rated the career opportunities of individuals with CS degrees as excellent.

We asked questions regarding CS as a career for parents of young children. Participants indicated that it would be a good career because of high income and the ability to work from home, but simultaneously thought the high level of stress and amount of travel required would be difficult for parents of young children. Participants did not view CS as a field where success and raising a family are incompatible goals. Men thought that careers in CS were more difficult than women thought they were,  $F(1, 234) = 5.16, p < .02$ .

#### *Confidence*

Confidence in computer skills was regressed on gender, mathematics ACT score, and their interaction. A significant interaction between gender and math ACT score was found,  $F(1, 191) = 7.64, p < .006$ . As Figure 1 clearly illustrates, women's confidence in their computer abilities was not affected by their math ACT score. In contrast, men's confidence was greatly affected by their math ACT score, as higher ACT scores yielded higher confidence in computer abilities. Men also reported having more CS ability than women did,  $F(1, 235) = 13.31, p < .0001$ .

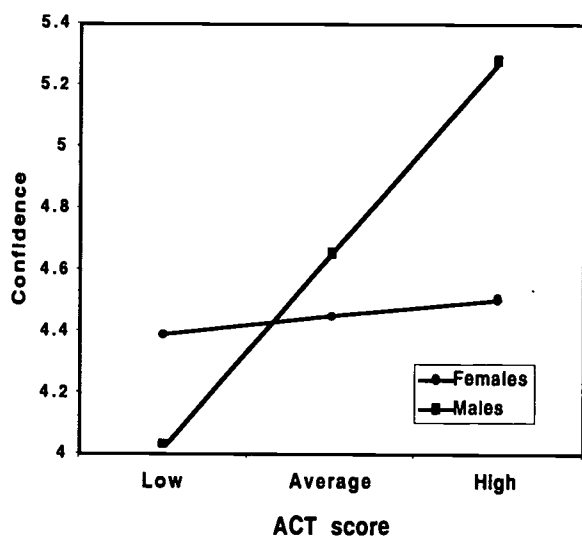


Figure 1: Gender Differences in Confidence by Math ACT Score.

#### Personality Variables

Women scored significantly higher than men in conscientiousness,  $F(1, 232) = 4.18, p < .05$ , and neuroticism,  $F(1, 232) = 10.48, p < .01$ . As expected, men were more often classified as "masculine",  $F(1, 235) = 12.00, p < .001$ , and women as "feminine",  $F(1, 235) = 16.37, p < .0001$ , according to the Bem Sex Role Inventory (Bem, 1974). Women reported more interpersonal attachment,  $F(1, 235) = 17.06, p < .0001$ , and greater family orientation than men,  $F(1, 236) = 7.89, p < .01$ .

#### Stress and Financial Issues

Women reported experiencing significantly more stress than did men,  $F(1, 236) = 5.87, p < .05$ . More women (68.8%) than men (51.3%) were employed at the time of the survey,  $F(1, 235) = 6.96, p < .01$ . However, men reported more work hours than women did,  $F(1, 143) = 4.48, p < .05$ . There were no differences in financial responsibilities,  $F(1, 235) < 1$ , or certainty of having adequate financial support to finish college,  $F(1, 234) < 1$ .

### Discussion

This research found that first-year students hold

stereotypes regarding CS. Participants described the typical CS major as asocial, unathletic, but intelligent. The stereotypes of CS majors as "nerds", their perceived obsession with machines and lack of interest in people, and associations of technology with masculinity conflict with the gender roles of females (Cross & Madson, 1997; Markus & Kitayama, 1991). Indeed, our first-year undergraduate women were significantly more feminine and less masculine than their male counterparts. Coupled with the stereotypical but inaccurate perception of women's lower ability in CS (Beyer, 1999a), these stereotypes probably conspire to deter first-year women from taking CS classes.

The gender difference in computer confidence is of concern. Importantly, women's low confidence in CS is not due to a lack of quantitative ability. The gender difference in confidence persists even when math ACT score is controlled. It is interesting to note that a similar gender difference in confidence was found for CS students as well (Beyer, Chavez, & Rynes, 2002).

One cause of women's low confidence is their less playful and relaxed attitude towards computers (Rasmussen & Hapnes, 1991). This is exemplified in this study by men's greater likelihood to have taken a computer apart and their reports of greater enjoyment of working with computers. Confidence is also affected by the amount of previous experience with computers (Zubrow, 1987). The fact that our first-year women had less programming experience might negatively affect their confidence.

What is the consequence of low confidence? Positive self-perceptions of ability are intimately tied to aspirations, educational choices, preference for challenging tasks, intrinsic motivation, persistence, and thus have desirable effects on performance (for a review see Beyer, 1995). Indeed, high performance expectations are a better predictor of mathematics participation and of continued high confidence for the future than are grades (Beyer, 1999b; Lantz & Smith, 1981). This suggests that females' low computer confidence has deleterious behavioral consequences. Importantly, low confidence may decrease the likelihood that women will choose to take CS courses. This means that women miss the opportunity to enter into a highly-paid field with excellent career potential.

### References

- Bem, S. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42*, 155-162.
- Beyer, S. (1990). Gender differences in the accuracy

of self-evaluations of performance. *Journal of Personality and Social Psychology*, 59, 960-970.

Beyer S. (1995). Maternal employment and children's academic achievement: Parenting style as mediating variable. *Developmental Review*, 15, 212-253.

Beyer S. (1998). Gender differences in self-perception and negative recall biases. *Sex Roles*, 38, 103-133.

Beyer, S. (1999a). The accuracy of academic gender stereotypes. *Sex Roles*, 40, 787-813.

Beyer, S. (1999b). Gender differences in the accuracy of grade expectancies and evaluations. *Sex Roles*, 41, 279-296.

Beyer, S. (2002). *The effects of gender, dysphoria, and performance feedback on the accuracy of self-evaluations*. Manuscript submitted for publication.

Beyer, S., & Bowden E. M. (1997). Gender differences in self-perceptions: Convergent evidence from three measures of accuracy and bias. *Personality and Social Psychology Bulletin*, 23, 157-172.

Beyer, S., Chavez, M., & Rynes, K. (2002, May). *Gender differences in attitudes toward and confidence in Computer Science*. Paper presented at the annual meeting of the Midwestern Psychological Association, Chicago, IL.

Beyer, S., Riessmann, M., & Warren, T. (2002, June). *Gender differences in the accuracy of self-evaluations on Chemistry, English, and Art questions*. Paper presented at the annual meeting of the American Psychological Society, New Orleans, LA.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 385-396.

Cross, S. E., Bacon, P. L., & Morris, M. L. (2000). The relational-interdependent self-construal and relationships. *Journal of Personality and Social Psychology*, 78, 791-808.

Cross, S. E., & Madson, L. (1997). Elaboration of models of the self: Reply to Baumeister and Sommer (1997) and Martin and Ruble (1997). *Psychological Bulletin*, 122, 51-55.

Cutrona, C. E., & Russell, D. W. (1987). The provisions of social relationships and adaptation to stress. In W. H. Jones & D. Perlman (Eds.), *Advances in personal relationships* (pp. 37-67). Greenwich, CT: JAI Press.

Ethington, C. A., & Wolfle, L. M. (1988). Women's selection of quantitative undergraduate fields of study: Direct and indirect influences. *American Educational Research Journal*, 25, 157-175.

Farmer, H. S., Wardrop, J. L., Anderson, M. Z., & Risinger, R. (1995). Women's career choices: Focus on science, math, and technology courses. *Journal of Counseling Psychology*, 42, 155-170.

Henwood, F. (1999/2000). Exceptional women? Gender and technology in U.K. higher education. *IEEE Technology and Society Magazine*, 21-27.

John, O. P., & Robins, R. W. (1993). Determinants of interjudge agreement on personality traits: The Big Five domains, observability, evaluativeness, and the unique perspective of the self. *Journal of Personality*, 61, 521-551.

Lantz, A. E., & Smith, G. P. (1981). Factors influencing the choice of nonrequired mathematics courses. *Journal of Educational Psychology*, 73, 825-837.

Lips, H. M. (1992). Gender- and science-related attitudes as predictors of college students' academic choices. *Journal of Vocational Behavior*, 40, 62-81.

Margolis, J., & Fisher, A. (1997). Geek mythology and attracting undergraduate women to computer science. Impacting change through collaboration. *Proceedings of the Joint National Conference of the Women in Engineering Program Advocates Network and the National Association of Minority Engineering Program Administrators*.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98, 224-253.

Nickell, G. S., & Pinto, J. N. (1987). The computer attitude scale. *Computers in Human Behavior*, 2, 301-306.

Rasmussen, B., & Hapnes, T. (1991). Excluding women from the technologies of the future? A case study of the culture of computer science. *Futures*, 23, 1107-1119.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

U.S. Department of Education, National Center for Education Statistics. (2000). *Digest of education statistics, 1999*.

Zubrow, D. (1987). How computing attitudes change during the freshman year. In S. Kiesler & L. Sproull (Eds.), *Computing and change on campus* (pp. 195-211). New York: Cambridge.





# REPRODUCTION RELEASE

(Specific Document)

## I. DOCUMENT IDENTIFICATION:

|  |                             |
|--|-----------------------------|
| Title: Why are There so Few Women in Computer Science?                   |                             |
| Author(s): Sylvia Beyer, Kristina Rynes, Michelle Chavez, Kelly Hay, and |                             |
| Corporate Source: Julie Perrault   | Publication Date: June 2002 |

## II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

The sample sticker shown below will be affixed to all Level 2A documents

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

\_\_\_\_\_ Sample \_\_\_\_\_

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY. HAS BEEN GRANTED BY

\_\_\_\_\_ Sample \_\_\_\_\_

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

\_\_\_\_\_ Sample \_\_\_\_\_

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 1

↓

Level 2A

↓

Level 2B

↓

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) and paper copy.

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.  
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

*I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.*

Sign here, → please

|   |  |                  |
|---|--|------------------|
| Signature:<br>  | Printed Name/Position/Title:<br>Sylvia Beyer Assoc. Prof |                  |
| Organization/Address:<br>Univ. of Wisc.-Parkside, Kenosha, WI 53158 | Telephone:<br>(262) 595-2353                             | FAX:             |
|   | E-Mail Address:<br>beyer@uwp.edu                         | Date:<br>6-16-02 |

(over)

### III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

|                        |
|------------------------|
| Publisher/Distributor: |
| Address:               |
| Price:                 |

### IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

|          |
|----------|
| Name:    |
| Address: |

### V. WHERE TO SEND THIS FORM:

|   |  |
|---|--|
| Send this form to the following ERIC Clearinghouse: | <b>ERIC/CHESS</b><br>2805 E. Tenth Street, #120<br>Bloomington, IN 47408 |
|---|--|

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

#### ERIC Processing and Reference Facility

4483-A Forbes Boulevard  
Lanham, Maryland 20706

Telephone: 301-552-4200

Toll Free: 800-799-3742

FAX: 301-552-4700

e-mail: [ericfac@inet.ed.gov](mailto:ericfac@inet.ed.gov)

WWW: <http://ericfacility.org>