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Statistical Trends in Women's Participation in Science: Commentary on Valla and Ceci (2011)

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Abstract
Valla and Ceci (2011, this issue) describe the participation of women in science and claim that the increases in quantitative fields (e.g., mathematics, engineering, and physical sciences) are an exception to the statement that "Women's growth in the scientific workforce has been meteoric over the past 40 years" (p. 134). We disagree and present statistics demonstrating a more positive view of the increase of the number of women in quantitative fields.

Keywords
sex/gender, cognition, mathematics, science

Valla and Ceci (2011, this issue), like many analyses of gender differences in cognition, brain activity, or abilities, cite many statistics about women's participation in science. In this commentary, we examine two examples of statements made in the article and demonstrate that a more careful analysis of the data reveals a more positive view of the increase of the number of women in quantitative fields.

1. Valla and Ceci state "Women's growth in the scientific workforce has been meteoric over the past 40 years" (p. 134). But that statement is followed by "However, there is one glaring exception to women's progress in scientific careers. In fields that are highly quantitative, women's success has been far less pronounced" (p. 134).

Women dramatically increased their share of PhDs in all sciences during those years. Table 1 shows percentages of women earning PhDs in various scientific fields in 1970 and 2006. These percentages can be compared in two ways: as a difference (percentage in 2006 minus percentage in 1970) or as a magnitude (percentage in 2006 divided by percentage in 1970). Although the differences in percentages are greater in the nonquantitative fields, the magnitudes of the increases are greater in the quantitative fields. The representation of women in psychology has tripled and has almost quadrupled in other life sciences. However, in mathematics and physical sciences, women's share of PhDs has increased approximately fivefold. The representation of women in engineering in 2006 is over 40 times that in 1970. We argue that this demonstrates more success in the quantitative fields across those years.

Women are also becoming faculty members at a better rate in the quantitative sciences. Valla and Ceci give statistics for women's representation among PhD recipients, among all professors, and among full professors; however, statistics for assistant professors are not given. Any discussion of women's progress in academic science must examine recent hiring. This requires comparing women's representation among PhD recipients versus among assistant professors.

One way to quantify this comparison is to compute utilization by discipline—in this case, the percentage of female assistant professors divided by the percentage of PhDs. A utilization of 1.00 would indicate that women are represented equally among PhD recipients and among assistant professors in the same discipline. A smaller utilization indicates that the proportion of women decreases from PhD to assistant professor. Table 2 shows that utilization in "highly quantitative" disciplines (e.g., mathematics, engineering, and physical sciences) is generally greater than in the life sciences and in most cases at least comparable to the social sciences. A similar,

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Table 1. Changes in Proportion of Women Earning PhDs

Field	1970	2006	Difference	Magnitude
Psychology	*23.5%*	*71.3%*	*47.8%*	*3.0*
Biological, agricultural, health sciences	*13.3%*	*51.8%*	*38.5%*	*3.9*
Mathematics	6.3%	29.6%	23.3%	4.7
Physical sciences	5.5%	29.0%	23.5%	5.3
Engineering	0.5%	20.2%	19.7%	40.4
Overall: science, engineering, and health	9.3%	40.2%	30.9%	4.3

Note. Statistics from Burrelli (2008). Italicized rows correspond to "nonquantitative" fields. Fields appear in order of magnitude of multiplicative increase. The category "Biological, agricultural, health sciences" corresponds to Burrelli's "life sciences." The latter does not include psychology, which is sometimes classified as a life science.

Table 2. Female Faculty at Top 100 Departments in STEM and Other Disciplines in 2007

			Rank			
Discipline	Utilization	PhDs 1996–2005	Assistant	Associate	Full	All
Chemistry	0.65	32.4%	21.2%	19.6%	9.7%	13.7%
Psychology	*0.72*	*67.8%*	*48.5%*	*43.9%*	*29.5%*	*37.3%*
Biological sciences	*0.76*	*46.3%*	*35.0%*	*30.0%*	*17.4%*	*24.4%*
Earth sciences	*0.89*	*31.8%*	*28.2%*	*20.9%*	*11.3%*	*16.5%*
Sociology	*0.92*	*60.8%*	*56.1%*	*45.7%*	*28.2%*	*39.8%*
Mathematics	0.93	28.7%	26.8%	18.4%	7.1%	12.9%
Computer science	0.94	21.2%	20.0%	11.6%	10.3%	13.2%
Political science	*0.95*	*38.9%*	*37.0%*	*29.3%*	*17.6%*	*26.1%*
Chemical engineering	1.02	23.7%	24.2%	17.6%	7.3%	12.6%
Economics	1.02	30.2%	30.8%	20.3%	8.7%	16.3%
Astronomy[a]	1.11	22.7%	25.3%	21.6%	12.3%	15.8%
Civil engineering	1.12	22.0%	24.7%	14.5%	7.1%	13.0%
Physics	1.17	14.3%	16.8%	13.4%	6.1%	9.1%
Electrical engineering	1.26	12.3%	15.5%	12.5%	5.7%	9.5%
Mechanical engineering	2.14	8.4%	18.0%	11.9%	4.4%	8.8%

Note. Statistics from Nelson & Brammer (2010). Italicized rows correspond to "nonquantitative" fields. Utilization is percentage of assistant professors divided by percentage of PhDs and rounded to two significant digits. Disciplines appear in order of utilization.
[a]Indicates top 40 departments only.

though less pronounced, finding appears in the analogous FY 2002 survey (Nelson, 2005, Table 5), so this trend has been in place for a number of years. Thus, in terms of utilization of PhDs in academe, women are much more successful in mathematics, engineering, and physics than in the life sciences (biological sciences and psychology) and fare as well as or better than those in sociology and political science.

2. Valla and Ceci state "There is nowhere close to one-third women occupying math-intensive positions in disciplines such as physics, engineering, computer science, economics, chemistry, and mathematics" (p. 142).

This broad statement does not specify or restrict any level of workforce and is not true for some categories of academic institutions. For example, the representation of women among tenure-track faculty of mathematical sciences departments in 2005 ranged from almost one quarter to one third at four-year institutions (see

Table 3. Percentage and Number of Female Faculty in Mathematics Departments by Type of Institution

Departments	Fall 1995	Fall 2000	Fall 2005
Four-year colleges			
PhD-granting departments			
Tenured faculty	7% (317)	7% (346)	9% (427)
Tenure-track faculty	20% (158)	22% (177)	24% (220)
M.A.-granting departments			
Tenured faculty	15% (501)	19% (608)	21% (532)
Tenure-track faculty	29% (235)	32% (276)	33% (337)
B.A.-granting departments			
Tenured faculty	20% (994)	20% (972)	24% (1,373)
Tenure-track faculty	43% (748)	32% (517)	28% (693)
Two-year colleges			
Full-time permanent faculty	40% (2,999)	49% (3,423)	50% (4,373)

Note. Statistics from Lutzer, Rodi, Kirkman, and Maxwell (2000, 2005). These surveys report the responses of a stratified random sample of two- and four-year institutions.

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Table 3). In mathematical sciences departments at two-year institutions, women were half of the permanent faculty.

In conclusion, any discussion of the lines of research considered in Valla and Ceci (2011)—preferences, abilities, or brain organization—must accurately cite and analyze such empirical findings about women's participation in science.

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