Public Understand. Sci. **1?** (200?) 01–11

Stereotypes about scientists over time among US adults: 1983 and 2001

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Prior research demonstrates that students and some teachers often depict scientists as socially inept workaholic males; however, scholars rarely examine representative samples of adults. How the US general public stereotypes scientists may influence accepting science expertise because its practitioners can appear so eccentric. By expressing negative stereotypes, "typical adults" also can discourage youthful interests in science. This study analyzes general public interview data using identical questions from the 1983 and 2001 National Science Foundation Surveys of Public Understanding of Science and Technology, probability samples of 3219 adults. Despite many positive changes over nearly 20 years, and strong approval of a child's potential science career, sizable minorities of adults continued to negatively stereotype scientists. Women were more positive than men but had considered a science career less often. Images of scientists also were affected by age, educational variables, parental status, and a religiosity measure.

Keywords: gender and science, public understanding of science, representations of science, science attitudes and perceptions, science education, social representations

1. Introduction

Scientists, educators, executives, and journalists often discuss the "condition of science," including why students appear unprepared for college science or avoid science concentrations (Burris, 2006; Gates, 2005; Lemonick et al., 2006). A related concern is gender composition among scientists: although more US women now enter life and health sciences, their participation in some physical sciences or engineering remains lower (e.g., Fox, 2000). For example, the percentage female among physicians rose from 16 to 32 percent between 1983 and 2005, among biologists from 41 to 49 percent, and among chemists from 23 to 35 percent, compared with only 18 to 24 percent among geoscientists or from 6 to 10 percent among engineers (US Bureau of the Census, 2000: Table 669; 2007: Table 602).

A prominent reason cited for such gender disparities is that girls and women perceive "science culture" as largely and inhospitably male (Eisenhart and Finkel, 1998; Etzkowitz et al., 1992; Harding, 1991). Further evidence of sex typing occurs in many studies in which

 ISSN 0963-6625 DOI: 10.1177/0963662508098576

students, and pre service or in service science educators, draw or describe scientists as stereotypically masculine (e.g., Bianchini et al., 2000; Finson, 2002; Schibeci, 2006).

Stereotypes are cognitive schema or prototypes; clusters of perceived personal traits applied to social groupings, e.g., occupational categories. It can be cognitively efficient to describe groups using labels; however, stereotyping exaggerates group differences and underestimates within-group variability (DeLamater and Myers, 2007). Although stereotypes can be positive ("scientists are smart") or negative ("few scientists are happily married," Fraser, 1981), some older studies (Brush, 1979; Hagerty, 1964) found that the *psychological distances* students perceived between themselves and traits imputed to scientists are important.

This study examines how two representative samples of US adults nearly 20 years apart stereotyped scientists, and appraised a science career for their children or themselves. Compared with student or teacher samples, stereotypes among the general public are under explored. Because the aggregated findings largely refer to "one-shot studies," social stereotypes about scientists have not been compared over time or with concomitant changes, e.g., gender occupational composition. Yet, modified scientist images among adults may contribute to a climate affecting science attitudes and policy among other adults and youth.

Furthermore, at least superficially, politicians are sensitive to citizen concerns; thus public science funding can depend in part on images about scientists. For example, adults stereotyping scientists as impractical may distrust their expertise in policy recommendations. Beliefs that science can be dangerous or even fraudulent can make greater government oversight of science appear essential (e.g., Funk, 2003; LaFollette, 1992).

Because of concerns about sex stereotyping in science, and changes in the status of women between 1983 and 2001, I focus on *net* changes in how gender and time affected scientist images. However, because other factors such as educational achievement also changed over this period, it is imperative to institute statistical controls to see whether changes in stereotypes are simply spurious artifacts of changes in correlated variables such as more exposure to science classes in recent years (see Schneider et al., 2007).

Stereotypes about scientists

Stereotype items are common in attitude measures (e.g., 20 percent of the TOSRA is either stereotypes about scientists or science careers, Fraser, 1981). Although scientists are typecast as clever or diligent, and surveys indicate that science careers are prestigious (Harris Interactive, 2007; National Science Board, 2008), scientists are also described as socially inept or even dangerous (Barman, 1999; Bianchini et al., 2000; Finson, 2002; Fort and Varney, 1989). Images of scientists not only portray them as male, but also often depict science *careers* as uninviting.

For example, speaking at the National Bureau of Economic Research, former Harvard President Lawrence Summers "explained" why senior tenured science and engineering female faculty are scarce at major universities. Among the necessary qualities he listed were classic stereotypes portraying scientists as one-dimensional workaholics:

> The most prestigious activities in our society expect of people … near total commitments to their work. They expect a large number of hours in the office, they expect a flexibility of schedules to respond to contingency … and they expect … that the mind is always working on the problems that are in the job. (*Harvard Crimson*, 2005)

Sources of these images are frequently sought in media portrayals, or in verbal and other behaviors science teachers enact (Hagerty, 1964; McDuffie, 2001; Schibeci, 2006). Media and teachers may depict lonely science careers that can seem particularly daunting for young women (Evans, 1996; Ford, 2006; Gerbner, 1987; Gerbner and Linson, 1999; Terzian and Grunzke, 2007). Yet equally probable sources of stereotypes are *other adults* with whom youth interact in their immediate environment—parents and other relatives, neighbors, counselors, health care workers, or pastors.

For example, parents who view sons as more competent in science than daughters can communicate this to their children (Andre et al., 1999). Parents, counselors, principals, friends, and media, as well as teachers, influence career choices (e.g., Hagerty, 1964). And, of course, adults create the media that children use and they train science educators. Thus, it is important to study the "typical adults" who asymmetrically influence youth, other adults, and who transmit stereotypic images of scientists across generations.

Social distance and scientist stereotypes

Some research suggests that students who stereotype scientists more often perceive themselves as dissimilar to and distant from scientists. Even as college freshmen, students who contemplate science careers hold more positive images (Bogart, cited in Beardslee and O'Dowd, 1961) and see their own personalities as more similar to scientists' (Brush, 1979). *In a general population of adults*, other similarities would include higher educational achievement, exposure to science courses, or being male. As US adults increasingly earn higher degrees or elect more science courses, or as more women become scientists, general public images about scientists can also change, again making statistical controls for variables such as degree level important.

Background: gender issues

Scholars have described female scientists in the media as depicted as "superwomen" (e.g., Marie Curie)—or alternatively as victims of career hardships. In other portrayals, fictional female scientists are either absent or relatives of the "lead [male] scientist"; fetching coffee, taking notes, or are scantily clad space adventurers (Flicker, 2003; Gerbner and Linson, 1999; Helford, 2000; LaFollette, 1988). On some new television programs, forensic scientists of both sexes appear "wedded to the job." Terzian and Grunzke (2007) only mention male scientists in their analysis of 1960s films; women were largely concerned about household duties and entertainment. Altogether, media images may exacerbate the lower interest in science shown among females (Eve and Harrold, 1994; Hornig, 1992; Miller, 2007). Despite women's gains in particular science careers during the past 20 years, sex differences in scientist images persist.

Background: changes over time

As noted earlier, assessing *net* gender or time effects among general populations on images about scientists means controlling other changes occurring over the same period that may also correlate with such images. For example, the *number of young children* per household fell over the study period; children's career aspirations are salient, not hypothetical, for parents. Without controlling parental status, apparent changes in the desirability of a child's science career could simply reflect changes in family composition.

Given women's increased education, exposure to science (US Department of Education, 2007), employment, and participation in selected science careers, I control educational and career variables. Because they can see science careers as more personally attainable, well-educated adults may also perceive less distance between themselves and scientists; this may be especially true for younger adults for whom career entrance or changes are highly relevant.

A final important statistical control is inerrant or literal religiosity, which at least some religious denominations contrast with science (e.g., debates about evolution and *Biblical* creation). Women often score higher than men on such religiosity measures (e.g., Eve and Harrold, 1994). Because inerrant religiosity also may have changed over the study period, I control it, too, in time comparisons.

Thus:

(1) Stereotypes about scientists and the desirability of a science career among general public American adults should be more positive in 2001 than in 1983 although
(2) Some positive changes may be due to increased education or greater exposure to science courses among 2001 adults.
(3) Men should hold more positive images than women about scientists and science careers although
(4) Positive *changes* over time may be more pronounced among women, due in part to
(5) Increased science course exposure and employment among women in 2001.

2. Methods

Data source

The National Science Foundation *Surveys of Public Understanding of Science and Technology* are the most comprehensive, representative studies available of US general public science knowledge and attitudes. The 1979 to 2006 *total archive* comprises 23,906 interviews in 12 separate studies, each containing several hundred variables. I analyzed 1983 (n = 1645) and 2001 (n = 1574) data; the only years repeating the same questions about scientist images.

Dependent variables

The mean on the standardized "Images Index" was 0; the range was –3.39 to +2.67 standard deviation units (coefficient $\alpha = 0.64$). The index combined weighted loadings from an exploratory factor analysis on five stereotypes: "scientists have few other interests besides their work" (factor loading = 0.74); "scientists don't get as much fun out of life as other people do" (0.69); "are apt to be odd and peculiar people" (0.67); "are not likely to be religious people" (0.57); and "scientific work is dangerous" (0.53). *Higher index scores* signify rejecting negative stereotypes i.e., are *more positive*.

Three questions tapped career desirability, asking whether respondents would be happy, unhappy or not care if (1) a son or (2) a daughter became a scientist, and (3) whether the respondent had personally considered a science career. For analysis, these variables were coded 1 if "happy" (or "considered a science career") and 0 otherwise.

Independent and control variables

Study year, *gender* and *labor force status* were coded as dummy variables (1 = 2001 = male = in labor force). *Age* and the *number of children under age 18* were coded as integers. *Educational variables* included participant's highest degree (high school or less, two-year college, baccalaureate, or advanced degree) and the number of college science courses (to avoid skew introduced by science majors, collapsed into none, one or two, and three or more). A proxy for inerrant religiosity, "we depend too much on science and not enough on faith" was a 5-point Likert item with 5 denoting strong agreement (religious affiliation is unavailable in these data).

3. Results

Overall responses

In 2001, mean Images Index scores were .38 standard deviation units more favorable than in 1983 ($p < .001$). Responses to all five stereotypes became more positive ($p < .001$); the mean 2001 adult agreed with 1.55 stereotypes compared with 2.11 in 1983 ($t = 11.29$, $p < .001$). Yet, even in 2001, 52 percent of US adults agreed scientific work was dangerous, 30 percent agreed scientists were irreligious, 28 percent said scientists had few interests besides work, and 19 percent said scientists get less fun out of life. Although the percent saying scientists were "odd and peculiar" dropped from one-third of 1983 adults, one-quarter still agreed in 2001.

Sixty-seven percent of 1983 adults were "happy" if either a son or daughter became a scientist compared with 80 percent in 2001. The 1983 item about one's *own* science career was asked only to labor force participants: 35 percent of 1983 workers had considered a science-related career compared with 45 percent in 2001 (all comparisons, $p < .001$).

Other changes

To evaluate gender and time effects on scientist images meant controlling other variables that could influence images about scientists and scientific careers. At least some controls (e.g., educational variables) were important because they may tap psychological distance between respondents and career scientists. Initial analyses examine the effects of gender, time, and labor force status (the personal career question was only asked to 1983 workers and employment behavior changed more for women over the study period).

Twenty-six percent of 1983 adults had at least two years of college compared with 43 percent in 2001. Twenty percent of 1983 adults had at least one college science course versus 36 percent in 2001. Women's labor force participation rose from 56 to 63 percent while the mean number of children dropped from 0.9 to 0.6 (all changes, $p < .001$). Final analyses use analysis of covariance and multiple regression to examine how gender and time affected scientist images, controlling degree level, college science exposure, parental and labor force status, age, and the "on faith" question.

Gender, time and labor force status effects combined

Although 2001 adults were more positive about scientists than those in 1983, and (contrary to expectations) women were slightly more positive than men, there was a three-way gender, time and labor force status interaction ($F_{1, 3211} = 11.38$, $p < .001$) on the Images Index. By 2001, all respondent gender–labor force groupings were more positive about scientists, but employed women were the *most* favorable (see Figure 1).

Neither gender nor work status affected happiness about a son becoming a scientist, but 2001 adults were 13 percent happier ($F_{1, 3211} = 67.70$, $p < .001$) than in 1983. Men were slightly more positive about a daughter's science career than women (75 versus 71 percent, $F_{1, 3211} = 4.92$, $p < .05$), labor force participants were slightly more positive than those not in the labor force (75 versus 70 percent, $F_{1, 3211} = 4.39$, $p < .05$), and 2001 adults were 13 percent more positive ($F_{1, 3211} = 69.22$, $p < .001$) about a daughter's science career than in 1983. Men had considered a

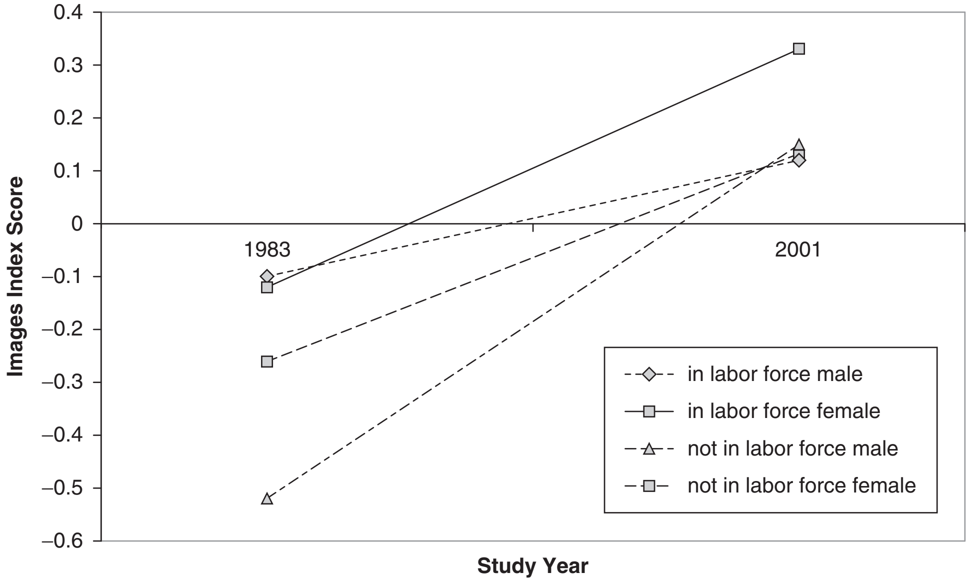

Figure 1. Stereotypes about scientists by time, gender and labor force status.
Note: Higher scores indicate more positive scores.

science career more than women (42 versus 37 percent) and more adults considered a science career in 2001 than in 1983 (45 versus 35 percent; all comparisons, $p < .001$).

What contributed to more positive images about scientists?

The more positive images about scientists and a science career from 1983 to 2001 paralleled increases in female health, biological and chemical scientists; they also were analogous to greater educational achievements between 1983 and 2001, including exposure to college science. Thus I controlled background characteristics in a series of multiple regressions.

Table 1 shows how age, degree level, college science courses, parental and labor force status, religiosity, time, and gender affected stereotypes about scientists and perceptions about a science career for one's child or oneself. All four dependent variables are presented in Table 1 to facilitate comparisons. Once multivariate controls were applied, no interaction effects occurred among gender, time or labor force status (including the Images Index) so these are not presented.

With the exception of the personal science career question, the "on faith" item had the strongest effect on scientist images. *Younger* respondents, the better educated with more science exposure, 2001 adults and women more often rejected negative stereotypes. Time influenced stereotypes about scientists more than gender.

Survey year was the second most important predictor of the Images Index and of adult "happiness" about a child's science career. For each scale change on the "on faith" item toward strongly agree, respondents were 6 percent *less happy* about a child's science career. With controls, 2001 respondents were 11 percent *more* likely to endorse a son or daughter's science career choice than 1983 adults. When compared with bivariate results, survey year had robust net effects. Even when controlling other variables, time effects on the Images Index only dropped from 0.38 standard deviations to 0.33, and time effects on the children's career items only dropped from 13 to 11 percent.

Table 1. Images of scientists: multiple regressions on stereotypes, desirability of a child's science career, and own science career

Dependent (criterion) variable→	Images Index[a]		Happy for son		Happy for daughter		Own science career[b]	
Predictor	B	Beta	B	Beta	B	Beta	B	Beta
Age	–0.01***	–0.11	0.00***	0.09	0.00***	0.08	–0.01***	–0.17
Degree level	0.11***	0.11	–0.01	–0.02	–0.01	–0.02	0.03*	0.06
Number of college science courses	0.17***	0.13	0.05***	0.09	0.05***	0.10	0.19***	0.32
Number children under age 18	0.02	0.02	0.03***	0.07	0.02**	0.06	–0.01	–0.02
Labor force status (in labor force = 1)	–0.05	–0.02	0.04*	0.05	0.05**	0.06	—	—
Rely too much on science, not enough on faith	–0.21***	–0.25	–0.06***	–0.15	–0.06***	–0.15	–0.03**	–0.07
Net gender and time effects								
Gender (male = 1)	–0.16***	–0.08	0.00	0.00	0.01	0.02	0.05*	0.05
Survey year (2001 = 1)	0.33***	0.16	0.11***	0.12	0.11***	0.13	0.05**	0.05
Constant	0.64***		0.70***		0.70***		0.54***	
R	0.44		0.24		0.24		0.43	
R^2	0.20***		0.06***		0.06***		0.18***	
Case base	2865		2865		2865		1918	

[a] Higher scores indicate more positive scores.
[b] Labor force participants only.
* $p < .05$; ** $p < .01$; *** $p < .001$.
Source: All data, the National Science Foundation Surveys of Public Understanding of Science and Technology 1983 and 2001.

Older adults, those electing college science, parents, and workers more often endorsed a child's science career; educational level itself had no effect (probably because exposure to college science, a more proximate predictor, was included in the regression analyses). Gender had no net effects on happiness about a child's science-related career.

Finally, I analyzed considering *one's personal* science career. The explained variance for one's own science career was triple that ($R^2 = 0.18$) explaining happiness about a child of either sex's science career (both $R^2 = 0.06$), perhaps reflecting personal rather than hypothetical career considerations. Not surprisingly, the most important predictor was exposure to college science (Beta = 0.32), followed by age (Beta = –0.17). Younger adults for whom career entrance or change is more salient more often had considered a science career. 2001 adults, the better educated, and males also more often had considered a science career. The "on faith" item *negatively* related to considering a science career.

4. Discussion

United States adults clearly held more positive images about scientists and science careers in 2001 than in 1983. And, although 1983 adults equally endorsed science careers for sons *and* daughters, many more did so, as well as considering their own science career, in 2001. Positive changes over time were net of several educational and other background variables; thus, these net changes were not due to increased educational and science exposure in 2001. Perhaps as Gerbner and Linson (1999) note in their systematic content analyses of television portrayals about scientists, mass media now depict scientists more positively, despite the emergence of "reality" television shows (e.g., "Beauty and the Geek") that capitalize on classic negative stereotypes about scientists and engineers. If so, the spread of satellite and cable television can facilitate transmitting more favorable images to the US general public. "Outsourcing" of many US jobs and continuing job losses through automation also may have made scientific vocations more appealing to US adults than they were 20 years earlier.

Information about gender career distributions, and research on gender and attitudes toward science, all suggested that women would negatively stereotype scientists more than men would, and that men would more positively view science careers for themselves or for their children. However, generally this was not the case: by 2001 gender effects had disappeared when contemplating a child's science career. Furthermore, women more often *rejected* negative scientist stereotypes: employed women described scientists the most positively in 2001. Women's labor force participation, at least by 2001, and women's greater entrance into some science fields over the study period may have made science careers seem more appealing to women than previously.

Even controlling education, time, parental and labor force status, and a religiosity proxy, a five percent gender gap remained when considering one's own science career. More US women than men may have *both* been gerrymandered *and* self-selected out of the high school and college math and science classes required to actually attain a science career. Classic negative stereotypes about scientists, more prevalent in 1983 than in 2001, could have contributed to at least some women earlier finding the supposed isolation and "workaholism" of a science career as discouraging. And, of course, just because images of scientists improved among women by 2001 does not mean as many women as men felt confident about actually *becoming* scientists.

Why, on the Images Index, were women more positive and why did older adults more often endorse a child's science career? Perhaps gender and age intertwine with respecting educational and career achievement. Certainly during the twentieth century, science and technology often dazzled the general public—catapulting people into space, taming bacterial diseases with antibiotics, developing computers, and cloning are vivid examples. Also, both women and seniors more often visit physicians and take medication, and mothers more often interact with their children's teachers. Perhaps greater first hand experiences with applied practitioners using science and technology to teach or improve health helped promote more positive images about scientists.

Although this study centered around how gender and time affected images about scientists among representative general public samples of adults, analyses also provided an opportunity to partially revisit Brush's (1979) and Hagerty's (1964) "distance" hypothesis. Between 1983 and 2001, exposure to high school and college science classes rose considerably (US Department of Education, 2007), making science more familiar to Americans. "Average Americans," especially better-educated adults with more exposure to science, may have come to perceive less distance between scientists and themselves, and thus may have come to find both scientists and their careers more attractive.

The "on faith" item was the most salient predictor on three out of four measures of images about scientists; it most strongly affected the "Images Index" and appraising a child's science career. It appears that many American adults continue to see schisms between science and at least some forms of religion. Recall that 30 percent in 2001 agreed that, "scientists are not likely to be religious people." Such a substantial minority presence may help fuel continuing controversies among school boards, parents, and "typical" citizens about religion and science in school curricula, and swell audiences for films such as "Expelled: No Intelligence Allowed."

In statistical analyses not shown, I checked whether the "on faith" item more strongly predicted scientist images in 2001; such a finding could have indicated increased polarization between literalist *Biblical* attitudes and support for science. However, the effects of the inerrancy proxy on assessing a child's science career were identical both years, and its effects on the Images Index slightly more *positive* by 2001. If anything, these results suggest that literal *Biblical* religiosity and images of scientists were slightly more conciliatory among the general public than they were nearly 20 years earlier.

This study does have several limitations: items available for both survey years were *negative* stereotypes about scientists. A series of Likert items with the same valence can be susceptible to acquiescent response set, although including educational predictors may have partially controlled for this. It would have been valuable to see how *positive* stereotypes of scientists also changed over the study period.

As mentioned earlier, considering a *personal* science career was only asked to 1983 labor force participants, then excluding 20 percent of men and 40 percent of women. Furthermore, stereotype measures among the different populations of students, educators and these representative adult samples are not totally parallel. Student studies more often employ *drawings* of scientists; the NSF surveys used verbal stereotypes. It is all the more useful to the study of scientist images that depicting scientists as eccentrics engaged in dangerous practices regularly occurs using *both* kinds of research measurements, thus extending our knowledge all the way from kindergarten to general public adults at all ages.

Some of the most important factors influencing women's participation in science are predictors I cannot control, structural dimensions such as job opportunities or sex discrimination rather than attitudes. Structural variables can help explain why nearly half of 2001 respondents had *considered* a science career, but only six percent *actually held* (including medicine) such a science or technology job. Structural factors may help explain why comparatively few increases occurred over the study period in the numbers of women entering some physical sciences or engineering. For example, a doctor may establish her own self-employed practice, and many women obtaining medical degrees by 2001 have done just that; self-employment is rarely an option open to scientists such as physicists who typically are hired and promoted in academia or private industry.

Between 1983 and 2001, US adults described scientists more favorably and more often endorsed science careers for children of either sex or for themselves. Youth can perceive these more heartening views, and a more positive adult climate may encourage youth to elect more science courses or consider a science career more seriously. But *what* adult Americans become more positive over time, and the role gender played in the change, was not always clear. We need more longitudinal research to see why, despite controlling several other relevant variables, Americans improved their images of scientists. Meanwhile, it would be wise for public figures and media to stop portraying scientists as eccentric, obsessed, lonely workaholics, descriptions hardly calculated to increase personal respect for scientists or interest in science careers.

Acknowledgements

An earlier version of this paper was presented at the annual meetings of the American Sociological Association, August 2006, Montreal, Quebec, Canada. This research was supported by National Science Foundation Grant 0532943 from Science Resources Statistics, although the analyses and interpretation of the findings, of course, are my own. I appreciate assistance and insights from Jon Miller, Alice Robbin, Ryan Wilke, Crissie Grove, Ying Guo, Brandon Vaughn, Brandon Nzekwe, Ray Eve, Martin Bauer, Lynda Carlson, Robert Bell, Jeri Mulrow, and Melissa Pollak.

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