

Marriage, Motherhood and Research Performance in Science

Women publish less than men, but marriage and family obligations do not generally account for the gender difference. Married women with children publish as much as their single female colleagues do

by Jonathan R. Cole and Harriet Zuckerman

Studies of scientists' research performance, as gauged by their published productivity, find that women generally publish fewer papers throughout their careers than men matched for age, doctoral institution and field. Various explanations have been proposed to account for this disparity in scientific publication, ranging from systematic gender discrimination to biological differences, as yet undemonstrated, in scientific aptitude.

One frequent explanation holds that women, far more than men, bear the burdens of marriage and child care, and that this fact of social life best accounts for gender differences in scientific publication. Whether or not this is true, the belief that it is so affects women's career opportunities, their decisions and the way they are treated.

We decided (as part of a larger investigation of the careers of American men and women scientists) to test the counterclaim, made in earlier studies, that marriage and motherhood have no effect on women's research performance. We did so by assessing the dynamic relation of family life and women's research throughout their careers—an approach not taken by earlier investigators, who just correlated the number of papers published with current marital and parental status. Our study draws on interviews with 120 scientists: 73 women and 47 men. We wanted to know whether scientists (both male and female) believe marriage and parenthood is incompatible with a scientific career in general, whether this had been the case for them in particular and what quantifiable effects (measured in number of publications) marriage and motherhood have actually had on the research performance of women scientists. Since men traditionally have not had primary responsibility for child

care, we focused almost entirely on women, comparing publication rates for those who are married and those who are single, those who are mothers and those who are childless.

Publication counts are, to be sure, an imperfect indicator of scientists' contributions. Yet such counts are highly correlated with better measures, such as peer evaluation; moreover, the extent to which scientists publish is of major consequence to their careers. We therefore took the extent of publication as a rough but serviceable gauge of research performance. We recognized that women scientists are, in some sense, "survivors." By definition they have passed through the rigors of graduate training, have earned a doctoral degree and are employed in science. We did not seek to examine the impact of cultural expectations on women's chances of running this gauntlet; that would have called for investigating the processes by which women are winnowed out of scientific careers.

We chose subjects for the study by a stratified selection process that took into account gender, professional age, field of expertise and scientific standing. To compare the effects of marriage and motherhood on women who earned degrees in different historical periods, we divided the women into three age groups: those who received their doctorates between 1920 and 1959, before the advent of the women's movement, and during the decades from 1960 through 1969 and from 1970 through 1979, when the movement was getting under way and then becoming widespread. Eighty percent of the women were drawn from mathematics and the physical and biological sciences and the remainder from economics and psychol-

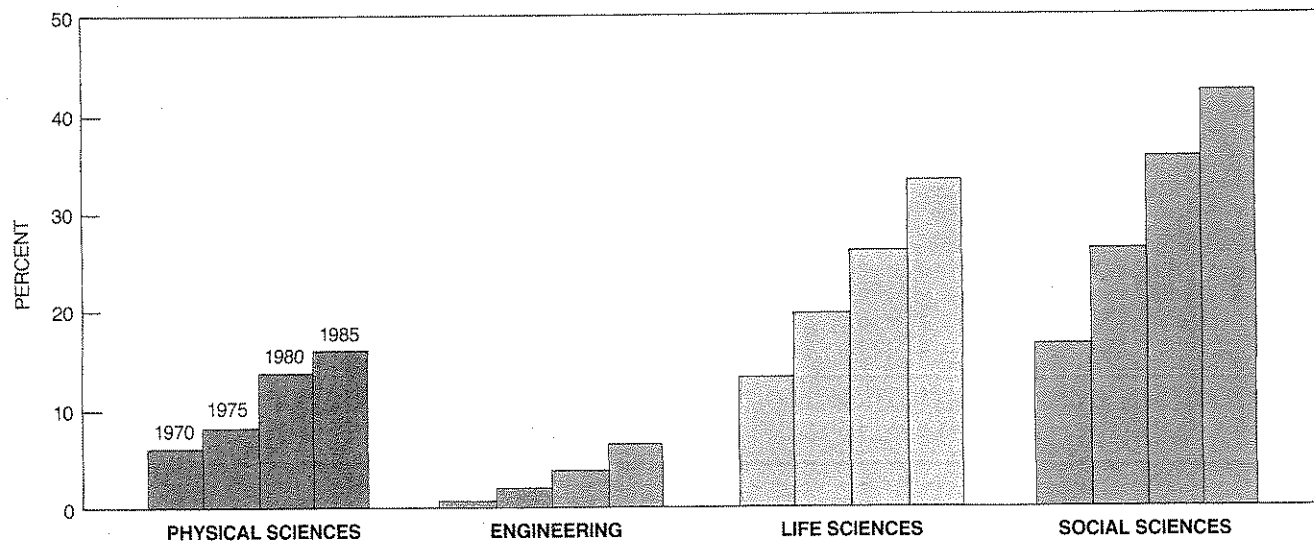
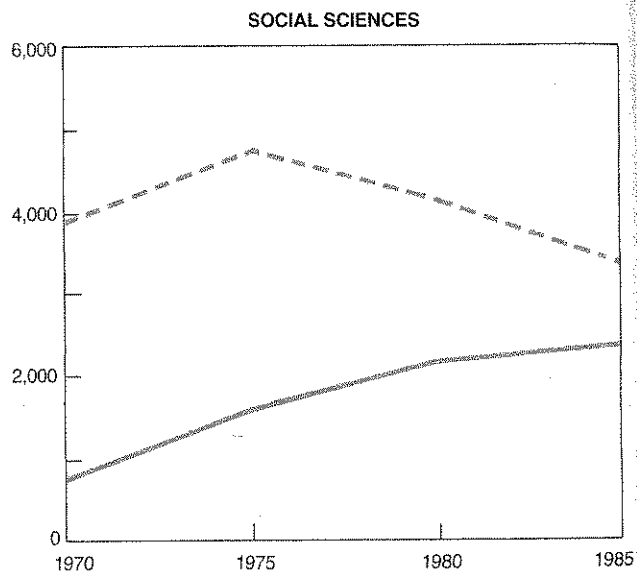
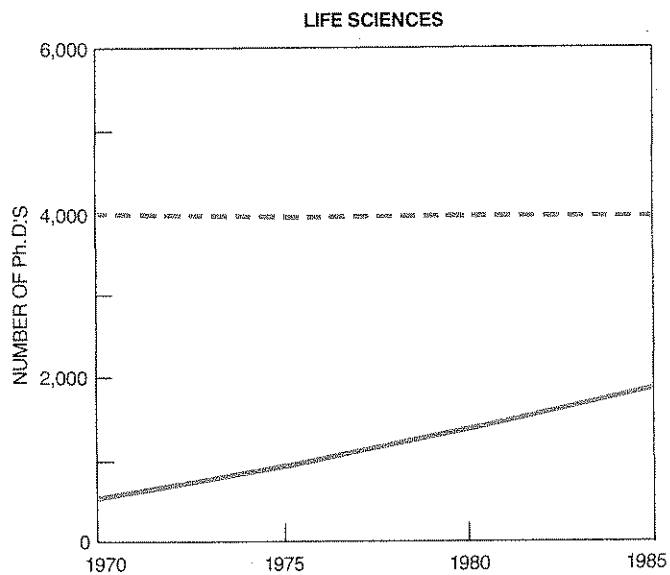
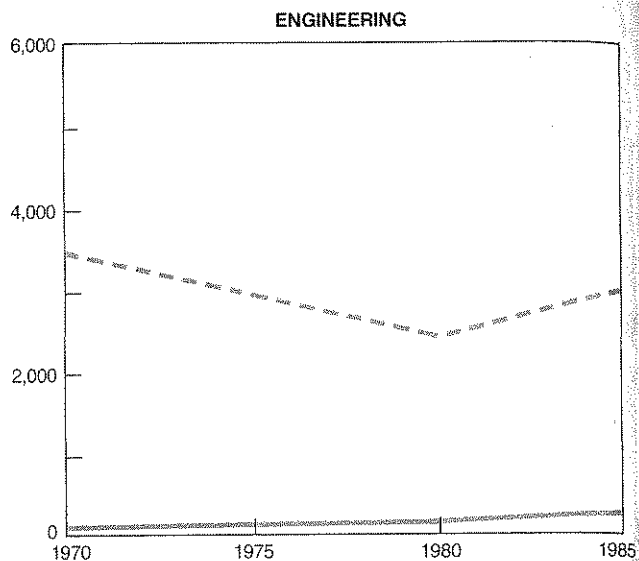
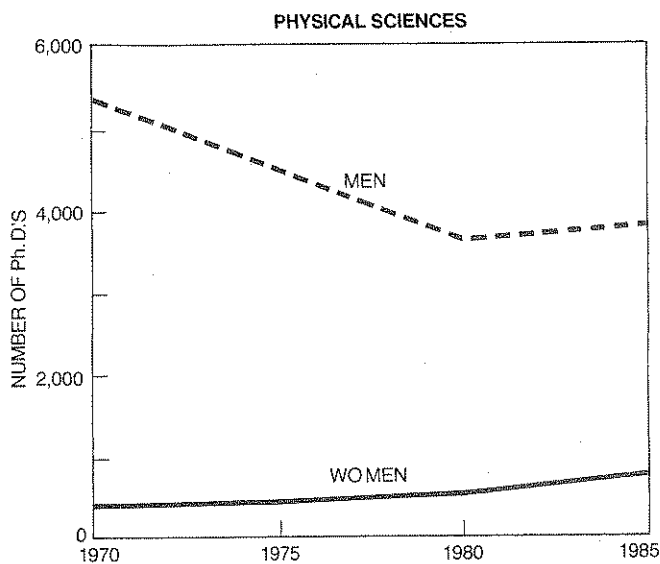
ogy; the same 4:1 ratio was applied in each age group.

Scientists were further divided according to their peer recognition in relation to others of roughly the same professional age. The top tier of scientists (those we designated as "eminent") in the oldest group were members of the National Academy of Sciences or the American Academy of Arts and Sciences or were full professors in departments ranked in the top 10 in each field by national surveys of the quality of doctoral programs. In the intermediate age group, Guggenheim fellows or tenured professors in a top-10 department were classified as eminent. Younger scientists were considered eminent if they had held Guggenheim fellowships or were assistant or associate professors in a top-10 department.

Scientists not meeting those exacting criteria were designated as rank-and-file. They were randomly selected from lists of the faculty and research staff at accredited four-year colleges and universities in the same geographic regions as the eminent scientists. They were also matched to the eminent scientists for professional age and scientific field. Although these scientists were selected systematically, the criteria we applied, the small numbers of subjects and our exclusion of some important groups (such as scientists working in industry) mean this is decidedly not a true random sample of all U.S. scientists.

Our subjects were asked about their research and publication histories and for comments on graphs we prepared that showed the number of papers they had published each year along with important events in their career and personal life.

Both men and women scientists reported having come up against the be-



NUMBER OF Ph.D.'S awarded to women has increased since 1970 in spite of a general decline in the number awarded to men. The curves (*top*) show the annual number of U.S. doctoral degrees

from 1970 through 1985. The percent awarded to women has risen sharply (*bottom*), but it remains low in the physical sciences and engineering. The data are from National Research Council studies.

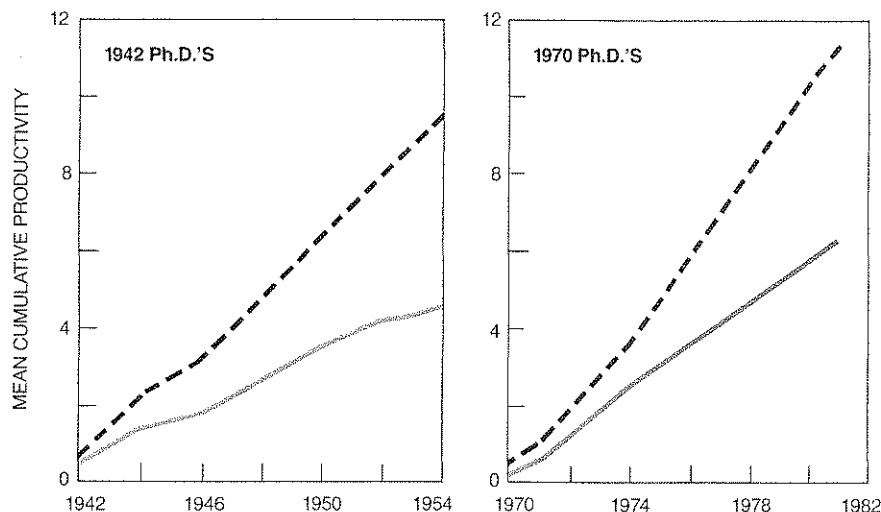
belief that marriage and motherhood cannot be meshed with a demanding scientific career. Not surprisingly, the oldest group of scientists encountered this belief most often. Before (and even shortly after) World War II, the proper priorities for women were widely held to be marriage and motherhood first and science second, and good science was believed to be all-consuming. The notion that women could simultaneously be traditional wives, traditional mothers and productive scientists seemed to be patently absurd.

Such beliefs were articulated by a woman zoologist who recalled that "if one had children and a working husband, it was not part of the psychology to suppose that one's job was anything more than a secondary consideration." Many men and women scientists at the time shared these views. They believed most women could no longer be serious scientists once they were married. A distinguished woman biologist who is now in her seventies said her woman laboratory chief had been appalled that her protégée would marry: "She threw me out of the lab the minute she heard I was going to get married because that was treason against women." For one male chemist, marriage then meant that women scientists were "finished"; a male physicist said, "As soon as women got into domestic life, that was the end of it for all of them."

This climate of opinion meant that women determined to have serious research careers often did not marry. In the words of one biologist now in her seventies, "marrying was not considered the thing to do [for women scientists]. In science, you're dedicated. You go into a shroud, you don't wear normal clothes...you shouldn't get married; you shouldn't have children."

Not all women scientists accepted those views, of course, and some did marry, have children and continue to work. Yet until the end of World War II at the earliest, women scientists were few in number, and fewer than half of them were married. Married women with children were nearly invisible in American science. Such women were viewed as violating the prevailing family norms.

Although social attitudes concerning the roles of wives and mothers have changed significantly, even the youngest women scientists report that many people still consider marriage and motherhood to be incompatible with a scientific career. One young chemist says, "When I got pregnant, I was written off as a serious scientist...by lots of people." When those



MEN SCIENTISTS publish more papers (black curve) than women scientists do (color), and the disparity increases with time. Data from large Ph.D. samples reported in earlier studies by the authors suggest that the disparity has lessened somewhat since the 1940's.

occupying positions of power and authority act in accordance with these beliefs, they severely limit the opportunities and careers available to married women.

To assess the actual impact of marriage and motherhood on women in science we needed answers to four questions: Are married women as a group less productive researchers than single women? Among married women, do those who have children publish fewer papers than those who are childless? Is there a drop in women's published research performance after childbirth? Does the number of children a woman scientist has affect her research performance?

The publication and career histories of eminent scientists provided the first clues that marriage and children do not generally affect scientific productivity. On the average these eminent married women (and eminent women are just as likely to marry and have children as their rank-and-file counterparts) publish slightly more over their careers—not less—than eminent single women: an average of 3.0 papers per year compared with 2.2. Among the eminent married women, those with children publish 2.9 papers annually and childless women publish 3.3. Moreover, during the three-year periods preceding and following the birth of first children the annual published productivity of these women does not fall but actually rises from 1.5 to 2.7 papers. Finally, the rate of publication of these scientists is unrelated to the number of children they have.

These statistical findings are plainly counterintuitive, and yet they are consistent with earlier cross-sectional

studies. How well do they correspond with the subjective reports of women in the interviews? Do women think marrying and having children really is unrelated to the amount of research they publish and, if they do, how is one to account for that belief?

The publication histories of two older eminent women scientists, one with four children and the other with three, illustrate one general pattern [see illustration on next page]. Such scientists in general published less when they were young and had young children; there is a marked upward trend in the number of papers published after the first decade of their careers. There are also year-to-year fluctuations—peaks and valleys—within the general upward trend. All these women do, to be sure, acknowledge that children take up a great deal of time. They are "a definite time commitment. That means you are doing less with other things"—but not less scientific research. The research continues.

How can it continue? These eminent women emphasize, first, that thinking about science goes on at home as well as at work. It does not end when they close the doors to their laboratories. "When the kids were small...I had ideas when I was washing the dishes and nursing the babies. Scientifically speaking, I did my best work during the period when the kids were coming." Second, if they have a scientist husband (and that is the typical situation), they talk about their research during "so-called off-time." Third, professional obligations other than research are far more limited for younger scientists than they are for older ones. "I spent more time doing

science then than I do now.... The calls on my time [then] were my job and my kids. Now it's so many other things." Fourth, lower rates of publication in the early years are not necessarily attributable to the demands of motherhood but rather are characteristic of the beginning phase of a developing research program. As one physical scientist observed, "In the first years... we were building those enormous instruments. Developing the theory and experiment [took up] a lot of time, so there weren't that many papers." Another, commenting on

the downturns in her own publication graph, said: "You are very busy in the valley."

According to these eminent scientists, marriage and motherhood did not reduce their published productivity. Should one believe their retrospective accounts? Perhaps their perceptions were not correct. After all, inspection of the graphs of older eminent married women with children shows that they indeed were less productive scientifically when they were young and had young children. Did having young children in truth affect

their rate of publication, at least in the short run?

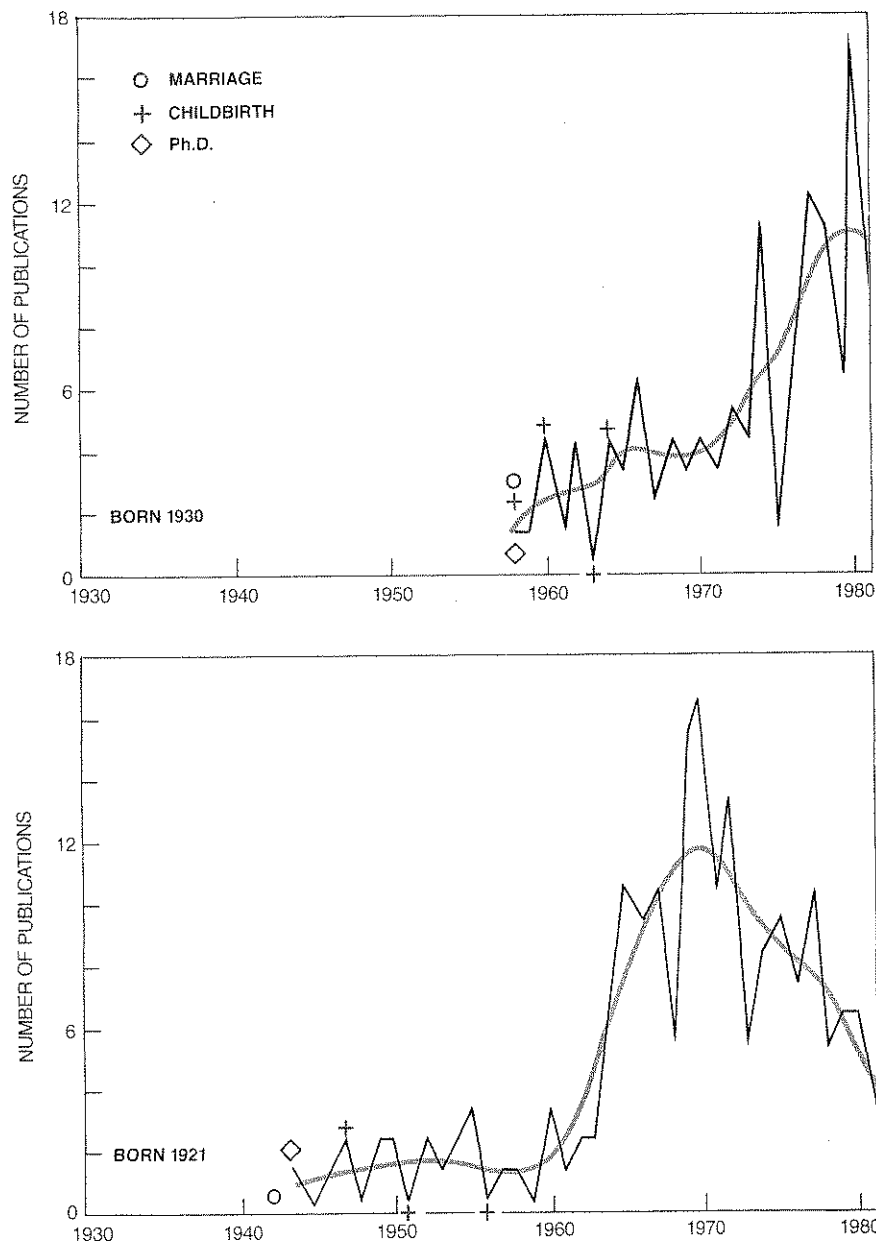
We thought the publication patterns of two groups of scientists who should not be affected by marriage or parenthood—eminent single women and eminent men whose wives took responsibility for looking after children—might further illuminate these first counter-intuitive results. Do the presumably unencumbered scientists publish at a more rapid rate in the early years than women who had young children? The answer appears to be no [see illustration on opposite page]. Single women and married men are just as likely to show a low level of publication in the first decade of their careers. They are also as likely to show oscillations and an overall rising slope of publication with time. The fact that the early publication patterns of these two groups do not differ much from those of married women who have children lends credibility to the married women's observations.

Another question comes up, however. The eminent older women say that marriage and childbearing did not reduce their scientific productivity. If that is so, why do their publication rates increase as they pass beyond the child-care age—particularly in view of the additional distractions and responsibilities they say come with professional maturity and a higher degree of recognition? Part of the answer is that the opportunities for collaborative research increase as one's career progresses. Beginning scientists do most or all of the benchwork themselves; more established ones often assume major administrative roles and oversee the work that goes on in their laboratories. Their publication records reflect the resulting upsurge in collaborative research.

We should mention that the publication record of some eminent women scientists does not exhibit the typical rising slope with time [see illustration on page 124]. These women too say they think marriage and motherhood had little bearing on their scientific productivity.

Our data seem to indicate, then, that older eminent women with children generally publish as much early in their careers as their unmarried counterparts do. Could we have made a critical error, however, in compiling and interpreting the data? Could it be that women who have children and yet remain scientifically productive are "self-selected," that is, are simply more talented scientists than those who choose to remain childless?

Although strict comparisons of sci-



EMINENT WOMEN SCIENTISTS, during the first three decades of their career, typically show a general upward trend in the number of papers published annually. The publication histories of two married women, one with four children (*top*) and the other with three children (*bottom*), conform to this pattern; they show no lasting negative effects of marriage or children. The jagged black curve indicates the number of papers published in each year; the smooth curve (*light color*) is calculated to indicate the general trend.

entific ability cannot be made, we can compare the publication rates of older eminent scientists who did and did not have children, focusing on the years before motherhood. To this end we matched the two groups of women roughly by their birth dates. The publication rate during the three years before women with children had their first child was compared with "equivalent years" in the life span of women without children. We found similar early histories: approximately 1.3 papers annually for women who subsequently had children and 1.6 for those who did not. In other words, older eminent women who eventually had children published inconsequentially fewer papers initially than women who never had children.

More important, might we be mistaken in concentrating on the histories of eminent women scientists instead of on those who might be more likely to experience the debilitating effects of marriage and motherhood on publication rates? The eminent women, after all, are very successful scientists; if marriage and motherhood had taken a toll in their case, such women would presumably not have been able to achieve the recognition they actually did achieve. Do the publication histories of other women scientists, those we have designated as rank-and-file, testify to the negative impact of marriage and child care?

Rank-and-file men and women scientists do, of course, in general publish less than their eminent colleagues. Within the rank and file in our sample, married women did publish slightly fewer papers than single ones (an average of 1.1 a year compared with 1.7). But married women with children publish no fewer papers than married women without children; both groups average about one paper per year. As in the case of eminent women, their publication rates did not decline after children were born. Rank-and-file women averaged well under one paper per year (.2) in the three-year period prior to the birth of their first child and they averaged just under one paper per year (.8) in the three years following the birth.

Much the same impression is conveyed by these scientists' own testimony: having children did not significantly affect their records of research and publication. As one relatively unproductive behavioral scientist observed, "It didn't occur to me to stop working when I had [a child]. . . . In fact, right after she was born I wrote one paper and started to work on the next one, . . . so if anything, . . . I seemed to

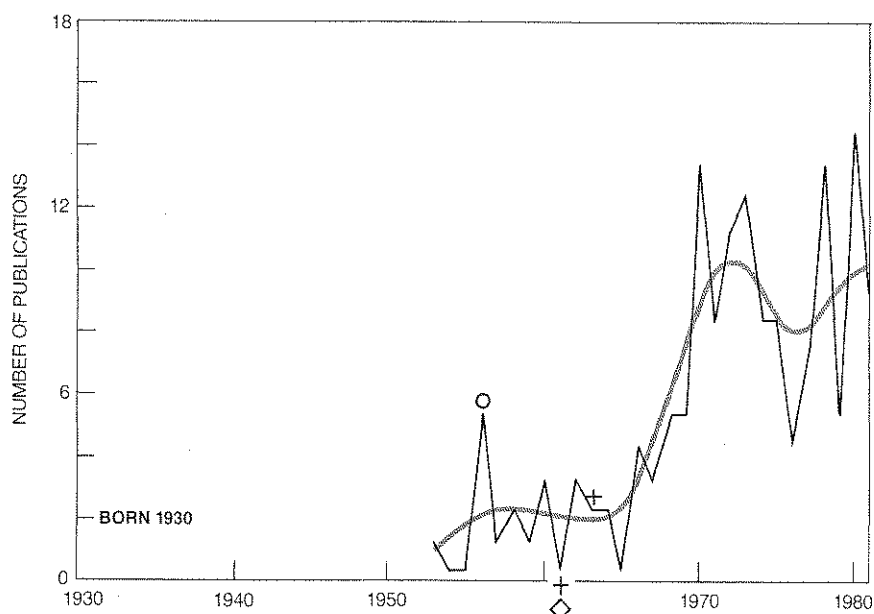
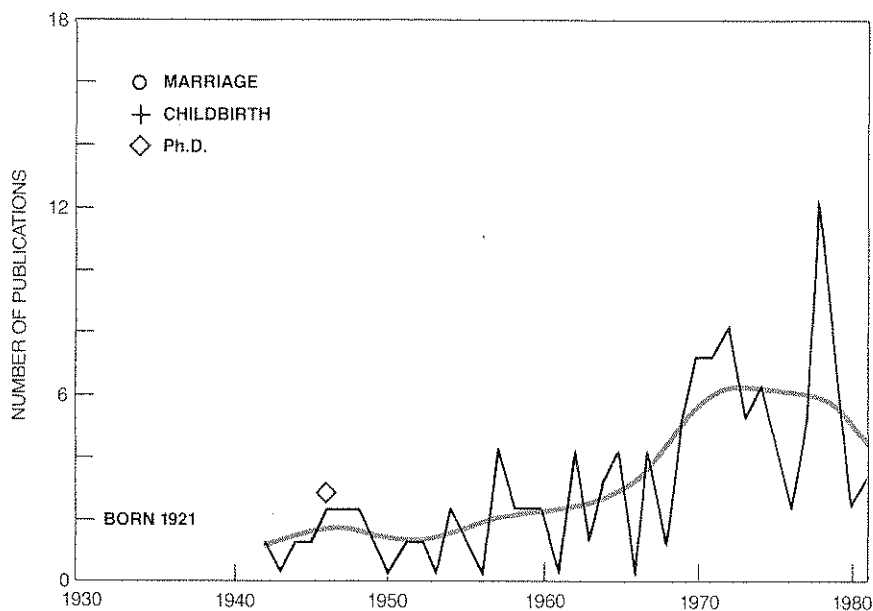
work better (which is to say more efficiently albeit under greater pressure)."

Her account is consistent with accounts of other women, such as a biochemist who asserted that her publication rate was not affected by family obligations. "It's just fortuitous. . . . The kinetics of me as a parent and me as a researcher don't have a direct relationship. . . . One has not interfered with the other." Contrary to expectation, then, such women are no more likely than older eminent ones to say that marriage and family responsibilities account for their rate of publica-

tion, and the statistical data we have in hand bear out what they say.

Would we find a similar pattern in data for younger women? Because marriage and childbearing usually come early in a woman's career, the records for younger scientists should show their effects on published productivity, at least in the short term.

A behavioral scientist who is now a full professor in a high-ranking department, and who had just had a child, suggested that motherhood was unrelated to her pace of publication. "Hav-



LOWER RATES OF PUBLICATION in the early part of a career are characteristic of both married men and single women. The publication profile of a distinguished woman biologist (*top*) who never married shows the same pattern of oscillations and an overall increase as the graphs of women who married and had children. The same pattern can be seen in the profile of an eminent male chemist (*bottom*). He published at a much slower pace when his children were young, although his domestic responsibilities were minimal.

ing a child is draining in many ways, but not in terms of having affected my work, especially when I look at how much I've...done this year. No, it's really movies, social life and things like that [that go]... I feel chronically slow and behind and this year I'm blaming it on the baby, but I realize that has nothing to do with it." In the past it was "too many graduate students...[a] grant reviewing committee, [an] editorship [and now a] baby. So I have always had some kind of baby to blame it on."

Perhaps the limiting case is a woman who has an endowed chair in a major department. She has been married four times and divorced three times, and she has had four children by three different husbands. If marriage and motherhood should bring a scientist's career to a halt, they should have done so here. Yet her published output has risen throughout her complex history. Ironically, the largest dip in her pattern came in 1979, one of the few years

in which she did not get married, have a child or get divorced [see illustration on opposite page]. Asked about her publication pattern, she replied, "Suddenly you're ready to report on three different projects and therefore [the papers] roll off the presses... The ups and downs [have] nothing to do with the rest of my life."

Even so, pregnancy and its aftermath did interfere temporarily with research in the case of three of the 37 women in our sample who had children. A woman biologist told us, "I was one of those women who said I'm so well organized, I'll just drop a child and that will be it—but I didn't realize that hormones could do such a job on a person." Asked to explain why her publication rate declined only temporarily and not by much, she said, "I was lucky because by then I had people in my lab. They were working [and] productive... But I found that for a whole year my mind wasn't functioning."

These longitudinal data indicate that marriage and children are not inimical to the published productivity of women in the aggregate. Although few people would question the fact that marriage and motherhood impose formidable responsibilities, apparently many women scientists can manage a career and family obligations simultaneously. How do they do it? And how, when conflicts arise between home and career, do women scientists deal with them?

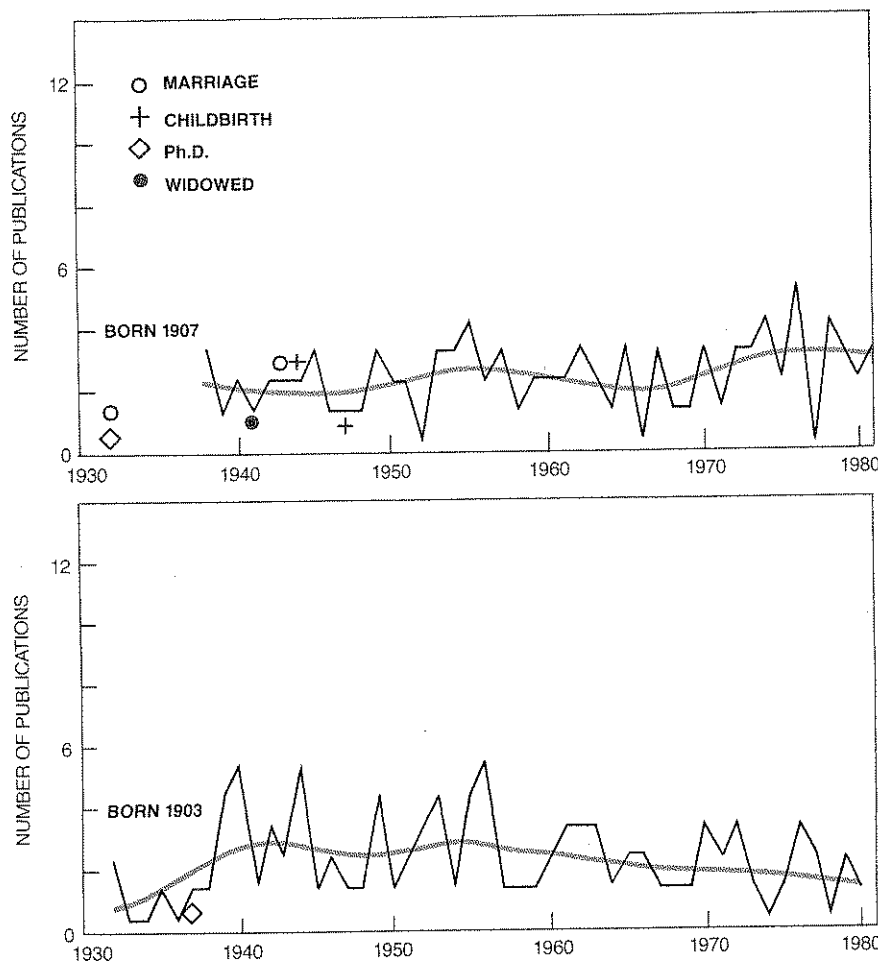
The answer can be found in part in how women scientists manage their "status set," that is, the array of social positions each of them occupies (such as professor, laboratory director, wife, mother and citizen). We focused on three interconnected aspects of status sets: size (the number of positions held simultaneously), congruence (the extent to which various obligations are consistent rather than in conflict) and the timing of the addition and deletion of status obligations.

At the extreme, several women, convinced that marriage is incompatible with scientific work, opted not to marry, in effect limiting their status sets. Yet three-fourths of the women in our sample did marry—a proportion that appears to be typical of women scientists in general now. For the majority of them the fundamental question about marriage was one of timing. As a young economist said, it "would also be a big career disadvantage for me [to get married]. Once I have tenure and am more settled down in a university, it would be a little bit easier."

Two-thirds of these married women had children. Timing their arrival, many women say, helps one to maintain a research career. A renowned physical scientist delayed having her first child for nine years after marrying in order to prove herself as a professional. Many younger women said they were delaying motherhood until they receive tenure. Doubting that she could have a child and maintain the level of performance needed for tenure, a young biochemist noted, "My ideal scenario is to get a tenured position and then have a child or two."

All told, eminent and rank-and-file women had about the same number of children: an average of two, with none exceeding four. Our data show that annual rates of publication are virtually the same for women who have one child and for those with two or more.

There are aspects of marriage and motherhood other than timing that can make for congruent status sets. Close to four-fifths of the married women we interviewed were married



SOME SCIENTISTS publish at a rather constant rate throughout their career. These are profiles for two eminent women: one who married twice and had two children (top) and another who never married (bottom). Although the annual number of publications fluctuates, the mean number in five-year intervals remains much the same for these scientists. This pattern appears as often among married women as among unmarried ones.

to scientists (again, a proportion typical of married women scientists in general). Such "assortative," or selective, mating apparently gives these women (and men too) a variety of benefits, including ready understanding of their professional obligations and way of life. A molecular biologist observed that her husband could hardly be upset when she came home late because "he knew that no matter how well I had planned something, experiments do get delayed. I think that's made it a lot easier." Women scientists married to scientists publish, on the average, 40 percent more than women who are married to men in other occupations. The difference in publication rate may result from self-selection, congruence of values or the flexibility of academic schedules.

Women scientists can also achieve congruence of status obligations by compartmentalizing their lives, but they report that compartmentalizing is not always feasible. In fact, many find it harder to keep their mind off work when they are at home than it is to keep their mind off children when they are at work. Moreover, every woman with children emphasized that she relied on some form of child care or household help—necessary arrangements, but fragile at best. The illness of a spouse, child or housekeeper can throw the entire scheme awry.

In view of these difficulties, is it possible that women and men scientists manage to continue their research only by neglecting their spouses and children? Our study was not designed to answer that question. This much we do know: The divorce rate for both women and men is unrelated to published productivity.

Married women scientists with children do pay a price to remain scientifically productive. They report having had to eliminate almost everything but work and family, particularly when their children were young. As an eminent psychologist observed, what goes first is "discretionary time. I think I can only work effectively... 50 hours a week.... If I didn't have children, I'd probably read more novels... or go to more movies."

Loss of discretionary time not only affects leisure pursuits but also sometimes has serious consequences for women's research and careers, even if it has no significant effect on their rate of publication. Women scientists who adhere to rigid family schedules say they have lost the flexibility to stay late in the laboratory to work on an interesting problem; they report not feeling part of "the club," not

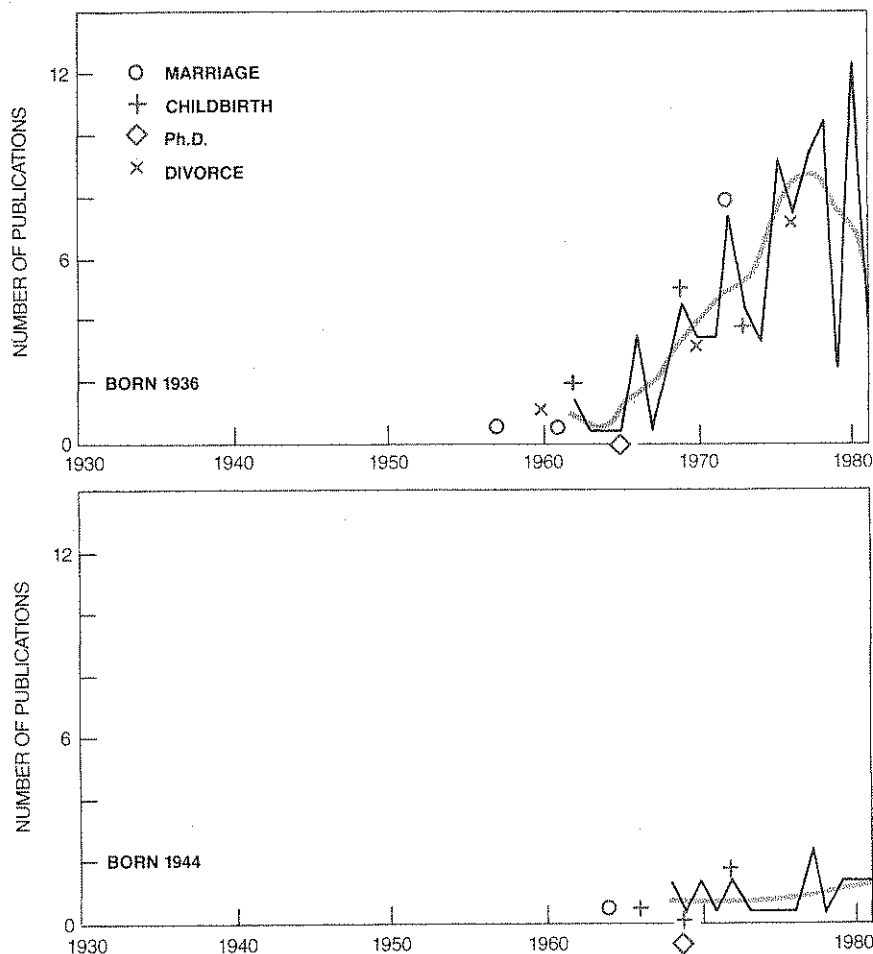
having time for informal discussions with colleagues.

Other investigators have shown that only some 12 percent of women scientists stop work after getting their Ph.D. Surely some of them do so because of the intense conflicts that arise between science and parenthood. One woman who had left a promising research career for an administrative job said in a supplementary interview, "I was only in the lab [for] the hours that the children were in school.... I was working with really bright people who ground out the publications at a rate I couldn't keep up with.... It was too frustrating." A small subset of women, then, find that science and motherhood do not mix and alter their careers to give more time to their families.

Our study shows, however, that for most of these women science and motherhood do mix. Women scientists who marry and have families publish

as many papers per year, on the average, as single women. Managing the simultaneous demands of research careers, marriage and motherhood is not easy; it requires organization and an elaborate set of personal adaptations.

The results of this study should not be interpreted as meaning that marriage and children have no effect on the careers of women scientists. They do, but they generally do not take their toll on women's research performance. How then can the persistent disparity in rate of publication between men and women scientists be explained? Why do men publish substantially more papers over the course of their careers than women with comparable backgrounds? The difference is evidently not explained by marriage and motherhood. It remains a puzzle requiring further comparative inquiry into the research careers of men and women scientists.



PUBLISHED PRODUCTIVITY is not related to family obligations, as is indicated by the publication histories of two women with strikingly different career patterns. One (top) is an eminent behavioral scientist whose productivity rose steadily in spite of the fact that she has been married four times (most recently in 1982) and divorced three times and has four children. The other (bottom) is an associate professor of chemistry and has three children. She attributes her low productivity to constraints other than domestic obligations. Her publication history is typical of many rank-and-file women scientists.