3 Gender, sex and science

The strong effect of culturally defined gender roles persists in science and other traditionally male professions through the social meanings attached to gender. Rather than a fluid perspective of human attributes that can be held by members of either sex, behavioral characteristics are frequently presumed to be innate and immutably 'masculine' or 'feminine' in the same way as one's biology.

The thesis that science is masculine, with 'masculine' understood as a cultural rather than as a biological term, ties issues of women in science to broader questions of gender roles and how they are culturally defined and transmitted from birth (Ruskai, 1990; Hyde, 1994). As Howell (private communication) points out, 'Sex, which is concrete and universal, specifies no role whatsoever.' Rather, it is cultural prescriptions and proscriptions, delineating which behaviors are appropriate to one sex and not the other, that creates the 'psychological meaning' of what it is to be male and female.

Thus gender as a concept was created to understand 'the social quality of distinctions between the sexes . . . for the explicit purpose of creating a space in which socially mediated differences can be explored apart from biological differences' (Hare-Mustin and Maracek, 1988). However, the concepts of sex and gender become easily entwined and socialization becomes confused with biology. Taking this a step further, '. . . it would be illogical to say that being male or female would, in itself, make someone a good or bad scientist. Yet this kind of statement is often made.' (Howell, private communication). Negative stereotypes persist. The images of the role of women in science may be slightly more positive, but they have not been radically reshaped.

As the role of women has shifted to meet both society's needs and their own, some mothers and fathers relate to their daughters

differently than in the past. They convey possibilities and expectations that transcend traditional role designations. Many of the young women whom we have interviewed over the course of the past decade not only report that it was their father who encouraged them to attain the Ph.D. in a science discipline, but credit their male advisors for sensitivity to gender inequities and their strategic assistance in helping them move forward. Individuals who encourage an interest in science need not belong to a particular sex or be a member of the family. What is essential is either a broad, flexible and encompassing vision of gender that incorporates non-traditional occupations or, paradoxically, a definition of gender in which it is viewed as irrelevant to vocational choice. The following discussion illustrates how far we are from this goal.

GENDERED CHOICES

The gender roles that children internalize influence which sex will choose to do science as well as who will have the best chances for scientific success. Blatant discrimination may be a thing of the past, but culturally generated gender beliefs play a significant role in leading children toward or away from an interest in science. Perhaps the most effective covert barrier to women is the simplistic idea that science is men's work and that women cannot make good researchers. The erroneous view of biological sex and gender as one and the same has led to the association of the male with the scientific role in western culture: science, like the Church, has been viewed as a 'world without women' (Noble, 1992). In most of this book we explore the conditions faced by women already in science. In this chapter we discuss the forces that work to divert females away from scientific careers from the earliest years of childhood through adolescence.

Differences between boys and girls appear at an early age as part of the social creation of the 'self'. As classically formulated by philosopher George Herbert Mead (1934), the child learns to 'take the role of the other' in play and other social relations. The self is thus constituted through a reflexive interplay of mirroring events. In the

words of classical sociologist Charles Horton Cooley, the self is a 'looking glass self.' Much of our fate thus depends upon what other people think of us and how we respond to them. Children are influenced by the appraisals of others and respond according to those appraisals. If the information received is restrictive, whether based on race, sex or any other variable, there will be loss of human potential. Too frequently experiences for females are constricted through a process in which gender differences are recast into gender stereotypes.

Messages from those close to the child are especially influential in initially shaping a self-concept. As the influence of the child's family decreases, peers, authority figures, and culture as interpreted through the media, perpetuate the transmission of ideals of masculinity and femininity (Ortmeyer, 1988). The curiosity of infants and young children creates for them energy and excitement as they interact and are drawn to novelty in their environment.

However, if experiences are foreclosed and the child's world becomes constrained by what is seen to be appropriate to that sex, the child not only tends to abandon socially unacceptable interests, but comes to fearfully avoid that which is unfamiliar (Schachtel, 1959). Such a self-limiting process is exemplified in the historically high proportion of girls who lose interest in how the natural world works. When socialization impedes the individual's fulfillment of his or her potentiality, society as well as the individual loses.

VERY YOUNG CHILDREN'S CONCEPT OF THE SCIENTIST

Given the forces that push girls and boys apart, is there an inevitable dichotomy between the female and the male; the female and the scientist? A sample of fifty-three children from Southeastern Montessori School, ages two to six, were interviewed to analyze the emergence of gender differences in the perception of the scientist in early childhood. The middle-class school composition promised the optimal probability for a child's acquaintance with scientists and/or representations of science. A table contained four photographs (from the covers of *Chemical and Engineering News*) of male and female

scientists. The interviewer asked each child to tell her about the pictures: 'Who do you think these people are?' 'What are they doing?' 'How do you feel about them?'

Preliminary data that we have collected suggests that sex-typing persists and appears to become more evident the older the child. For some boys, science was seen as an activity that males, but not females, should take seriously. A typical response was that of a four-year-old boy who said, '. . . only boys should make science.' The strength of the male identification with technology was also indicated by a boy who referred to a picture of a woman at a computer as 'he'. Yet in several instances rigid classifications by sex appeared to be less fixed as some of the children were able to identify both sexes with the role of the scientist. A four-year-old boy recognized a female scientist in the pictures and described her work thus, 'That one looks like a doctor.' 'She's working.' 'Something in a science. She's looking. Doing gravity. Making things fly. Someone who makes things we never saw before. With machines.'

In addition to discerning gender differences among very young children in their image of the scientist, the objective of this investigation was to identify discrepancies between their perception of the role of scientist and the child's view of themself. Boys were more likely to see themselves like the scientist, engaged in 'serious' behavior.

Boys, in general, were more negative in their views of women scientists than girls. Moreover, the older boys in the sample (ages five to six) were increasingly less likely to see girls as possible future scientists. One said, 'My sister Amanda wouldn't like to do this; she's really into Barbie dolls.' When, as part of the survey, the children were asked to draw scientists, more of the girls who drew women scientists did so in their second drawings. This suggests that even where the image of a woman scientist is held, it may be considered 'not quite right' and be presented only after the first, more acceptable picture of the male scientist has been recorded.

These perceptions and self-concepts illustrate the notion of the construction of gender schema (Bem, 1983), a highly selective process

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comprising 'a sprawling network of associations' in which information is taken in and organized according to the sex-differentiated values of the culture. A schema functions as a cognitive structure, serving to anticipate and make sense of new information coming in based on pre-existing perceptions. For instance, boys and girls at age two had 'concepts' of persons by occupation only if they had previous exposure to people holding the particular role. None of the two-year-olds were able to identify 'scientists', but those youngsters whose parents were expecting babies understood the notion of 'doctor' and thus applied this familiar concept based on the white lab coat. In other words, the young child's perceptions are not always dictated by a concrete situation. In this same way, the child learns to link attributes with their own sex or the sex of others. The perception of gender does not depend on the actual situation, but rather on organizing information that makes sense of novelty.

Two-year-olds without expected siblings, and therefore less exposure to doctor visits, were consistent with Piagetian developmental theory. When a child said, 'I don't know this person', it indicated that there were no available mental concepts whatsoever which reflected the attributes in the photograph. Therefore the child could make no interpretation of the photograph.

However, children above the age of three could identify scientific and medical occupational roles and had begun to link occupations with sex based on their knowledge of their family and the outside world. A three-year-old girl said, 'That's a man doctor,' while a three-year-old boy identified another picture as 'a big girl doctor with a cigarette.' A six-year-old boy said, 'My daddy's a builder; my mom's a scientist, but she's a student.' On the other hand, although a three-year-old girl recognized and characterized the activity, she did not attribute the activity to the woman in the photographs, only the man: 'Someone is working hard. He's a scientist because he is doing science stuff.' By age three to six, not only were most children in the sample familiar enough with the concept of the scientist to correctly identify the pictures, but they had begun to generalize sentiments and meanings across

situations, demonstrating how at this early age information is encoded and organized according to cultural definitions of what is masculine and feminine (Bem, 1983).

In responding to the pictures, girls tended to see doctors while boys saw scientists. Showing the power of popular culture on gender images, one six-year-old male associated the images in the pictures taken from *Chemical and Engineering News* with similar images seen on television: 'They're called scientist[s]. I know that because of a cartoon that does [the] same thing he does.' Possibly boys are more frequently exposed to science in the media, games and toys, whereas girls apprehend the physician's role through their own increasing encounters with women doctors. When queried, girls more often identified the scientists as doctors, possibly because more obstetricians and pediatricians are now frequently women, chosen by other women rather than male doctors.

Young girls then not only learn about doctors in relation to female reproduction, but may experience this specialty as gender-neutral or women-friendly. Certainly it supports Bem's suggestion that gender schematic processing is dependent upon the social context and is a 'learned phenomenon and, hence, neither inevitable or unmodifiable.' Indeed, some boys draw similar androgynous conclusions especially when their mother holds a non-traditional occupational role. Thus, a three-year-old boy said, 'My mom's a doctor. [The person in the picture is] a doctor because he has a thing on his coat.'

Despite the persistence of sex-typing, there were indicators of change. For instance, a four-year-old girl demonstrated a working sense of the disciplinary order and division of labor in science. She said, 'Doctors fix people. A scientist checks things. I only want to be a veterinarian', and a four-year-old boy used clothing, not sex, as the identifying marker: 'Scientists! The clothes look like scientists.' Lastly, a six-year-old boy could identify researchers with a purely operational definition of the scientific method, notably gender-free, 'These are scientists. They're working really hard with experimenting to see if something does it or not. That's figuring out what do.'

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Adults who provide a neutralizing message serve to counteract stereotypical notions of gender pervasive in the larger society. For example, a six-year-old female at Southeastern Montessori School told her interviewer 'I would like to do science. My mom gives me kits sometimes. A scientist is somebody who creates things. I like computers.' Although science was still linked to notions of gender by a number of the youngsters, some shift in traditional gendered associations of the scientific role can be inferred from the responses of others.

GENDER DIFFERENCES IN THE EARLY YEARS

The notion of clear-cut sex differences in the way newborns behave has not been borne out. In repeated studies girls could not be distinguished from boys without seeing physical differences. In those few studies where subtle behavioral differences were discerned, they were deemed moderate at best and were observed to diminish, disappear or be heightened based on the social context. The majority of studies have found that for parents, the sex of a newborn is a 'central organizer, a potent description of who the newborn baby is' (Tronick and Adamson, 1980). From infancy, boys and girls receive divergent messages from adults. Both Block (1984) and Hoffman (1977), in their studies of child-rearing practices, found parents encouraged their sons to actively explore the physical world, emphasized achievement, competition, and self-reliance, and felt it was important they try new things. In contrast, daughters were expected to be 'kind, unselfish, attractive, loving and well mannered [and grew] up in a more structured and directive world than males' (Block, 1984).

With few exceptions, these studies reflect how adult reactions to babies based on presumed sex perpetuate cultural beliefs about masculinity and femininity. Beginning in infancy, adults speak to and touch girls and boys differently. Sex-typed toys are offered by both parents with 'boy toys' providing more active physical manipulation and feedback from the physical world. In general, boys are given more freedom and less supervision, while girls are interrupted more frequently by their parents, particularly fathers.

Researchers alternated between dressing the same baby in pink and calling her Beth or dressing her in blue and calling her Adam. The adults who played with 'her' or 'him' noted that Beth was 'feminine and sweet' and Adam was 'sturdy and vigorous' (Will, Self and Datan, 1976). In a similar study, subjects were shown a videotape of a nine-month-old baby playing with a jack-in-the-box. When the baby was said to be a girl, her response was called fear; when a boy, anger (Condry and Condry, 1976) When a researcher told subjects that her new baby was a girl they responded with coos about 'how sweet she is'. When others were told that the baby was a boy, they said he was 'big and strapping'. In yet another study, parents were given a fourteen-month-old with whom to play. When designated a boy, 'he' was encouraged in active play with typically masculine toys. As a girl, 'she' received more nurturance and cuddling. In each instance, parental attitudes were projected onto the baby, depending upon the sex label, once again demonstrating the thesis of sociologist W.I. Thomas that 'a social situation is real if it is real in its consequences.'

These unconscious parental behaviors create an underlying 'gender awareness' during early childhood in which the world becomes categorized into mutually exclusive classifications (Condry, 1984). Gender roles come to be perceived as 'all or nothing' categories leading to prescriptions that scientists are men and secretaries are women. A female child may therefore believe that she cannot be a scientist even if she would like to because she is of the wrong sex (Kohlberg, 1966). This sex-typing process frequently continues with all authority relationships as the child's social world expands. However, the broadening of experience can sometimes provide the possibility for new influences which serve to enhance a child's self-concept when early familial experiences may have been rigid and stifling.

STEREOTYPING OF SCIENCE IN THE PRIMARY SCHOOL YEARS

Among the many forces working against women's participation in science is the masculine image of the scientific role that frequently has

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taken hold by primary school. This is often followed by neglect and/or discouragement of girls from doing mathematics in secondary school in concert with parental (and particularly maternal) perceptions of mathematics as difficult and non-essential for their daughters (Eccles and Jacobs, 1986). Moreover, conformity to stereotypes is frequently, but subtly, encouraged by educators and other authority figures. By puberty, these cumulative cultural messages are reinforced by the powerful need for peer approval and acceptance.

Unless the child is exposed to a wider range of possibilities, they may come to see gender-determined life choices as mutually exclusive and exhaustive. It is notable that both brighter girls and boys have come from family environments which were responsive to all aspects of the child's personality. Optimal performance was reported when children of each sex were encouraged to take the role of the other. Girls were free to actively explore and were 'encouraged to fend for themselves' while boys had received ongoing 'maternal warmth and protection' (Maccoby, 1966). However, once in school, many female children who have had a wholesome beginning in which they were relatively free to explore all aspects of themselves may now experience an erosion of the self based on stereotyped demands of teachers.

Enlightened parents may feel helpless in counteracting ubiquitous sexual stereotyping once their daughter enters school and other social situations outside the home. The recent dismay of dynamic classroom teachers who had allowed their interactions with students to be videotaped underscores the unconscious pull of stereotypical sex-typing behaviors even by educators who thought they were self-aware. As had been found in earlier studies, the teachers observed themselves calling on boys more frequently, providing extended conversation, information and help. On the other hand, because girls were less vocal and more cooperative, teachers were less likely to notice them or reward their talents, appreciating the girls' compliance in large classroom settings which they had to control.

A longitudinal study, over a 25-year period, found that girls were eight times less likely to call out comments, but when they did were

reminded to raise their hands. In contrast, teachers responded to the typically rowdier and more assertive behavior of boys. Thus highly intelligent young girls often give up their own assertiveness and risk-taking behavior in order to earn their teacher's acceptance, fulfilling the social virtues of selflessness and cooperation (Sadker and Sadker, 1994).

By treating boys and girls differently, teachers encouraged 'the exploratory, autonomous, independent mathematical skills associated with males . . .' and discouraged them in females (Birns, 1976). Similarly, teachers gave extra attention to boys who chose to play at more complex tasks, but did not reward girls for the same behavior (Fagot, 1978). In addition, girls received few rewards for highly active behavior, whereas boys gained the attention of their teachers and also the admiration of their peers. While compliance may provide some rewards, it does so at a cost to development. Paradoxically, behaving like the boys can bring with it severe penalties, including adult reprimand and peer ostracism.

Significantly, teacher attention favors those attributes considered as male. Boys frequently succeed in gaining attention by using negative and inappropriate behavior, while less aggressive but more appropriate expressive bids by girls are often ignored (Block, 1984). Thus many teachers unconsciously reward compliance and cooperation from girls, while encouraging or condoning a highly competitive style of interacting for boys. At its most virulent, competitive 'putting others down' can become a pervasive part of personal interactions within the classroom. Not surprisingly, it is these very kinds of behavior on the part of adult male peers that have been identified by female Ph.D. candidates as disturbing and alienating.

Since boys have generally been previously exposed to manipulative toys, such as construction sets and models, they enter science classes with more confidence based on these earlier experiences. Moreover, the teacher's interactions with students influence children's perception of their own ability to do science. Not only are interactions more frequent with boys, but science experiments are often segregated

into all-girl and all-boy groups with the boys receiving more attention, or if in integrated groups, the girls often watch the boys do the experiments (Wellesley College Center, 1992).

A learning environment that emphasizes experimentation, self-motivated exploration and inquiry is often an unfamiliar experience for girls, given 'the more structured, supervised, prescribed and proscribed world of girlhood as compared to boyhood' (Block, 1984). Thus rather than having a lack of interest in science, girls may tend to avoid the lack of structure in science laboratories where their anxiety would be higher than that of boys. In contrast to this kind of early experience, our studies indicate that women Ph.D. candidates frequently identify a particular high school science teacher who was attuned and responsive to their interest and inherent competencies, ultimately assisting in the development of independent exploration.

On a deeper level, these socializing processes may also account for later differences in the cognitive strategies used by girls and boys. In their more highly structured play and learning environments, girls use 'assimilative strategies' for adapting (that is, they tend to fit new information or experiences into their pre-existing cognitive ways of understanding) and are discouraged from engaging in more anxiety-provoking innovative efforts (Block, 1984). In contrast, where boys have been encouraged to explore 'a less predictable world . . . success in inventive ad hoc solutions would be expected to benefit boys' self-confidence' and the freedom to take risks. Along these lines, women graduate students in our studies, comparing themselves to male peers, reported feeling 'less able to take risks.' However, their prior educational successes and continued positive movement through the pipeline appear to reflect the importance of women's programs, as well as past and current mentors who created and continue to provide learning and social experiences free of gender-laden constraints.

Thus, gender differences become significant when masculine and feminine are defined in terms of narrow cultural norms, some of which are peculiar to American society. These norms set up a supposed contradiction between the traditional notion of 'scientific values' and

what are considered feminine characteristics. Once they have identified themselves as males or females, girls and boys then want to adopt the behaviors consistent with their newly discovered status. This process of socialization results in children forming a conception of maleness and femaleness, revolving about such highly visible traits as hair style, dress, and occupation. They then use these gender images to organize their behavior and to cultivate attitudes and actions associated with being a boy or a girl (Kohlberg, 1966)

Although a young girl may have attended the same classes as male peers, by the time a young woman enters high school, she will not have had the same educational experience (Eccles and Jacobs, 1986). The cultural message that has predominated has been that active exploration, the capacity to be competitive, and the opportunity to handle machinery, play with chemistry sets and operate a computer are exclusively male activities. Not only are boys pictured prominently on the packaging of most science and building toys, but even the box of a chemistry set shows a girl looking on while a boy conducts the experiment. An eighth-grader described a dream in which she saw herself working for a scientist who did the experiments while she was left to write the paper. The youngster ended with, 'That's the way it is, right? . . . That's how we'll end up, the girls.' It is not that most girls will have been directly told that they 'can't' do what boys can. Indeed, most will be encouraged to 'fulfill their potential.' Nevertheless, in various ways many receive veiled messages of discouragement and denigration (Orenstein, 1994).

DISCOURAGEMENT OF GIRLS' INTEREST IN SCIENCE DURING ADOLESCENCE

One of the primary tasks of adolescence is the further consolidation of identity. Peers replace adults in importance, and social acceptance has primacy. The cumulative subtle and covert messages regarding expectations and perceptions of females eventually influence the sense of one's place in the world, feelings of self-worth, and possibilities for the future. At a time when peer acceptance is crucial, conformity to stereotypical social roles is heightened. The anticipation of rejection

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by male and female peers in competitive activities may make such activities too threatening for most young women to undertake, particularly if such 'masculine' behavior contradicts the attitudes of the popular culture and the family (Block, 1984; Eccles and Jacobs, 1986). Therefore, adolescence is a logical time for the hidden meanings of gender roles to solidify further and become enacted in school performance and life choices unless the social milieu strongly encourages an inclusive ethos free of assumptions about gender.

By the time young women enter college many are not sufficiently qualified to major in those hard science areas that require a strong mathematical background, having avoided advanced classes in high school. Based on the research available and the fact that girls demonstrate equal mathematical capacity before adolescence, we can regard this 'giving up' of a potential skill as part of the legacy of the days when women's attempts at mastering mathematics met with indifference or overt rejection.

The controversy over differences between males' and females' mathematical skills, in concert with the issue of 'math anxiety', is of particular importance in illustrating how gender-appropriate roles affect later competencies. Nevertheless, an analysis of the results from numerous studies found no differences between males and females of any age in ability to understand mathematical concepts (Hyde, 1994). Gender differences in science achievement do not appear until the eighth grade; thereafter, strong gender differences in career orientation emerge, with half as many girls as boys showing interest in mathematics and science careers (Catsambis, 1994).

Thus, females appear to have the same aptitude for mathematics as males, but begin to lose interest and take only the minimum requirement in high school. Based on class grades, girls and boys are similar in mathematical and scientific ability until about tenth grade when girls decline to take elective mathematics courses. It is then that sex differences in problem-solving abilities begin to emerge. The question is not that of inherent ability, but one of why girls drop out of mathematics courses in high school and college (Hyde, 1994).

A 2-year longitudinal study of seventh- through ninth-graders, and their mathematics teachers and parents, argued that sex differences in attitudes toward mathematics, as well as achievement, are due to 'math anxiety' (Eccles and Jacobs, 1986). The level of anxiety correlates with the gender-stereotyped beliefs of parents (and particularly mothers) and the values placed on mathematics by the family. Students' attitudes and plans to continue taking mathematics courses were substantially influenced by parental perception that mathematics was difficult and of little value for their daughters. Thus rather than grades and performance having direct bearing on girls' self-confidence in mathematics, beliefs about their competence and desire to pursue interests and goals appeared to be strongly influenced by the parent's response to their daughter's grades. In short, prior performance, even when stellar, was secondary to the response of significant others. While there is a correlation between teachers' attitudes and the student's beliefs, the impact of teachers was not as strong as the influence of the parents.

There is conflicting evidence over whether the support of the school or the family is more significant to the minority of young women who do express an interest in science. Alice Rossi (1965) noted that a young girl with high intelligence and scientific interests must come from a very special family situation and must be a far rarer person than the young boy of high intelligence and scientific interests. On the other hand, if she reaches adolescence with the same intellectual inclination, it is often despite her early family or social experiences rather than because of them. This may reflect why women, when questioned in college about the background of their science interests, frequently point to particularly important teachers they had, often as early as the third or fourth grade, who provided them with new channels of communication and new expectations. In contrast, graduate students in our studies frequently cited both parents, and most often the father, as highly encouraging. Fathers have been found to be particularly supportive of their daughters' mathematical abilities (Eccles and Jacobs, 1986).

The gap in gender differences in standardized testing and achievement has narrowed since the early 1980s (Berryman, 1983; Orenstein, 1994; Hyde 1994). Nevertheless, girls' historically lower mathematics scores are typically attributed to biological characteristics, even a so-called 'math gene.' Yet how can biological differences explain the 50% reduction in this score gap between boys and girls by 1994 and current near-parity? Girls' supposedly lesser 'spatial abilities' have also improved with increasing exposure to spatial tasks. If mathematical skills were biologically determined they would presumably be impervious to such rapid and dramatic shifts.

Another seeming anomaly is the fact that non-Caucasian girls outperform boys in the highest-level mathematics classes in Hawaii (Orenstein, 1994). Since most people construct their perceptions of the world largely in accordance with cultural prescriptions that they take for granted, ethnic variation within the larger structure speaks to the influence of subsets, including family attitudes. During the past few decades there has been increased awareness of the way girls are treated in mathematics and science classes. Indeed, given the coincidence in the timing of the change in testing outcomes, even a modest shift in social attitudes might well be an indirect cause of improved awareness in how teachers relate to girls.

Nevertheless, it has been argued, perhaps most prominently in an article in the journal *Science*, that innate, biological male superiority was the best explanation for sex differences in standardized testing, based on the premise that girls and boys received identical training (Benbow and Stanley, 1980). In contrast to the fathers, mothers' confidence in their daughters' mathematical aptitude declined further in response to the *Science* article. Given the prestige of the journal and its prominence within the scientific community, the influence of the article in adding to pre-existing gender bias in the sciences could be high, but is still unknown.

Benbow and Stanley's paper certainly enabled advocates of 'meritocracy' to draw the conclusion that females are, in fact, 'incompetent' at science and competent at other things. Along these

lines, our own findings indicate that any inference of 'difference', including variation in socialization, opens the floodgates for negative interpretation of what it means to be female. For instance, graduate women's programs, created to mitigate social isolation by building networks, are frequently interpreted as indicating that women have special needs. The possibility of different biological influences does not have to imply that behavior is 'predetermined'. Instead, biological propensities may be 'manifested in behavior in diverse and complex ways, as organisms are shaped by . . . the environment in which they must function' (Block, 1984).

Our concern is how socialization, based on stereotyped sexual division, appears to restrict the possibilities for girls and women and has a destructive impact on the sense of self for both sexes. The consequences of female socialization have a concomitant deleterious effect for young males as well, in the demand that they 'maintain the image of the aggressive, detached, active male' (Gould, 1978).

Neurological differences between right and left side brain development, or distinctive identifications and attachment between mother and daughter, have provided insight into the more verbal, relational and nurturing characteristics of females (Chodorow, 1978; Miller, 1976; Gilligan and Brown, 1990). However, qualities of maleness and femaleness are not rigid and impermeable. Boys and men have rich capacities for empathy, nurturance and attunement in relationships just as girls and women have aggressive, active, and competitive capacities.

Considering gender along lines of difference or non-difference presents numerous paradoxes with which women in the scientific community currently struggle. As mentioned above, when differences are acknowledged, as in graduate women's programs, females are negatively construed as the same (in some way needy or deficient) and not viewed as individuals. Thus, by focusing on difference, this approach minimizes similarities between males and females while obfuscating institutional sexism. On the other hand, adherence to a no-difference model 'makes man the referent . . . women must aspire to be

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as good as men' (Hare-Mustin and Maracek, 1988). For women scientists in less hospitable milieus, the no-difference model creates another paradox in which women must be either 'better than' or 'just like' men in order to prove they are equal.

FORECLOSING WOMEN'S CHOICE TO DO SCIENCE

By adolescence, gender socialization has affected career plans. The achievement orientation of the scientist depends on competitive success. Yet for females, competitive success is often accompanied by great emotional costs based on family attitudes and their early experiences in the classroom.

In many ways, women are unable to choose to do science; society has already chosen who will do science through its construction of gender roles. There is considerable evidence of the relationship between the adolescents' notions of gender-appropriateness and recruitment to scientific careers (Eiduson and Beckman, 1973; NSF, 1988). The image of the scientist as eccentric, non-conformist, and lacking in emotional capacity suggests that the potential recruit must have certain types of personality characteristics and live a particular lifestyle.

If the caricature of the scientific personality and lifestyle does not mesh with the student's interests, beliefs, and values, she or he is unlikely to become committed to being a scientist. For women, the requirements of a college major or pre-college mathematical preparation are not the only factors when making a career choice (Barnett, 1978). Rather, women avoid majors in science and engineering, in part, because they are socially ascribed as 'men's jobs.' Other studies corroborate these findings (Gerson, 1985; Berryman, 1983).

An early study by anthropologist Margaret Mead and Rhoda Metraux (1957), conducted during the 1950s, identified a negative image of the scientist among high school students in the U.S. and found that girls, especially, viewed a scientific career as an inappropriate form of work for themselves. Girls rejected science as being concerned with things

rather than people. Moreover, they viewed science as a highly demanding career that would take them away from their future husbands and children, an issue which continues to trouble and impede women scientists today.

More recently, in Norway, strong clashes were found between girls' values and priorities and their perception of what it means to be a scientist (Sjoberg, 1988). Indeed, a series of U.S. studies, from the 1950s through the 1980s, showed that both boys and girls identify the typical scientist as a man (LaFollette, 1988). On the other hand, a study of elementary and middle school children in Taiwan found that although older students were more influenced by stereotypical images representing scientists as men, female students were three times more likely than male students to draw female scientists (She, 1995).

A study of the image of the scientist among older primary school students in Ireland found that girls, but not boys, drew pictures of female scientists, suggesting that even if the boys did not see science as an appropriate career for women, some girls, at least, could envision the possibility (O Maoldomhnaigh and Hunt, 1988).

Given these disparate and possibly contradictory findings across cultures, what is not yet known is which aspects of gender remain fixed and which are more flexible and amenable to change as individuals mature, particularly as they pertain to the image of the scientist.

American girls' performance in mathematics and science is still negatively affected by traditional gender beliefs. In other countries, particularly in Asia, boys and girls perform equally on mathematics tests. David Dunn of the University of Texas at Dallas notes, 'We tend, both in our family lives and in grade school and high school, to counsel girls away from math and science.'

By the time young women attend high school and college, they are frequently viewed as inappropriate persons to become scientists and engineers. Girls are often given the impression that they will face '. . . intolerable obstacles, conflicts and handicaps' (Moulton, 1972), an understanding that all too accurately reflects the traditional organization of science.