1990

Factors that influence the career aspirations of mathematically precocious females

Janey L. Montgomery
Iowa State University

Order Number 9035104

Factors that influence the career aspirations of mathematically precocious females

Montgomery, Janey L., Ph.D.

Iowa State University, 1990

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

Factors that influence the career aspirations

of mathematically precocious females

by

Janey L. Montgomery

A Dissertation Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Department: Professional Studies in Education
Major: Education (Curriculum and Instructional Technology)

Approved

Signature was redacted for privacy.

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1990

TABLE OF CONTENTS

Page

Page

CHAPTER I. AN INTRODUCTION TO STUDY

> ... the cause of woman has at length triumphed, ... Woman's long struggle for complete intellectual freedom is almost ended, and certain victory is already in sight. (Mozans, 1913/1974, p. 101).

Need for Study

At the beginning of the 20th century the anticipation of women achieving full equality was overly optimistic (Steinkamp & Maehr, 1984). In the last several decades, advances made by women have been impressive; yet, women remain underrepresented in mathematical and scientific careers. For example, in the research annual, Advances in Motivation and Achievement: Women in Science, Steinkamp and Maehr (1984) suggest "America can no longer afford the luxury of inefficient use of the scientific talent and education of women" (p. xii). As a result, an interest in the career development of women, especially women with exceptional mathematical talent, has emerged.

Concern for intellectually capable women can be traced to the early 1920s. Terman (1925) identified individuals of extraordinary gifts and studied the development of their potential. Gifted women in the Terman sample achieved less in terms of education and vocational attainment than did their gifted male peers (Terman & Oden, 1947; Oden, 1968). These results are not surprising as many people assumed that the women's career choices were heavily influenced by the values, social expectations, and historical factors of that day. Oden (1968) suggests:

> Not only are the opportunities for achievement in a career outside the home limited by the cultural pattern and socioeconomic biases in our society, but job success, in the

> minds of most women, is likely to interfere with marriage success. (p. 29)

As more women enter the work force and combine marriage and careers, public opinion is becoming more supportive of dual career and family roles. In 1986, women constituted 51.4% of the work force (U. S. Bureau of Census, 1988, p. 365). Yet men continued to outnumber women in positions of eminence and leadership in mathematics, medicine, engineering, and the sciences (Farmer, 1976; Maccoby & Jacklin, 1974; Rossi & Calderwood, 1973) and the "disparity between potential and achievement is considerably less for men than it is for women" (Fox & Zimmerman, 1985, p. 219).

This issue of matching potential with achievement is important to both education and psychology. Beginning in the 1960s, equal educational opportunity for all students regardless of race, sex, and/or national origin has been advocated throughout the educational arena from preschool through post-secondary education. The educational community responded by developing intervention strategies to enhance diversity and provide access to educational and career options. Yet, despite two decades of research and educational/support services for women, only a small percent of women entered mathematics/science areas. The number of all degrees conferred to women engineering students in undergraduate and graduate school increased from .4% in 1960 to 12.5% in 1985. Yet, only 7.6% of all persons receiving doctor's degrees in engineering in 1985 were females. In contrast, the number of medical degrees conferred to women increased from 8.4% in 1960 to 30.4% in 1985. In dentistry, the D. D. S. or D. M. D. degrees conferred to women increased from .9% in

1970 to 20.7% in 1985 (U. S. Bureau of Census, 1988, p. 151). Thus, percentage gains are encouraging. Nonetheless, there are still relatively few women in these career fields.

The concern for the "lack of participation of women in the higher levels of mathematics (e.g., Ernest, 1976) implies a focus on intellectually able girls, rather than girls of average ability" (Benbow, 1988). Most of the top level scientists in the United States graduate from a few academically difficult colleges, and average students usually do not major in sciences at these institutions (Davis, 1965; Green, 1989; Werts, 1967).

In addition to the small number of women selecting mathematical, scientific, engineering, and medical careers, the proportion of young adults is rapidly declining in America (Mumford & Gustafson, 1988). Thus, "substantially greater investments should be made in developing young adults who appear capable of making major contributions" (p. 39) in order to meet the technological needs of the future. The declining pool of Ph.D. candidates, especially in sciences and engineering, is a national concern (National Science Board, 1987). Therefore, it is important to society, especially to educators and psychologists, to understand more about the career development of mathematically precocious females for societal as well as individual reasons.

Theoretical Background for Study

The theoretical basis of this study includes gender differences in mathematics, the development of potential, and career decision-making theory. Each of these areas contribute to the understanding of the problem to be investigated and the significance of the study.

Gender differences in mathematics

In a review of studies on gender differences in mathematical ability and achievement prior to the mid 1970s, Fennema (1974) reported varied results with some studies favoring males, others favoring females, and many showing no significant differences between males and females in achievement. Males appeared to have more advanced mathematical abilities, however. Typically, for average-ability students, gender differences in mathematics achievement are not usually significant any longer (Feingold, 1988; Freeman, 1984; Jacklin, 1989; Kimball, 1989). Yet, among the most highly talented or precocious youth in mathematics, significant sex differences in mathematical reasoning ability have consistently favored the males, are large, and have been stable since 1972 (Benbow, 1988; Benbow & Stanley, 1980; 1981; 1982; 1983a; 1984; Feingold, 1988; Fox, 1976; Fox et al. 1980; 1983; Keating, 1974).

In the mid-1970s, there was national concern about the impact of these differences on women's career options (Datta, 1985). Research studies, funded by the National Institute of Education and reported in an edited volume (Chipman, Brush & Wilson, 1985), examined a number of variables related to the career achievements of women and mathematics. These variables included: participation in mathematics (Chipman & Thomas, 1985; Armstrong, 1985; Chipman & Wilson, 1985; Lantz, 1985) self-perceptions, task perceptions, and socializing influences (Eccles et al. 1985), sex-role stereotyping on women's attitudes (Boswell, 1985), and school, classroom, and home influences (Stallings, 1985; Fox, Brody & Tobin, 1980). In the last decade, research findings on these variables have changed our understanding of how these variables influence female achievement.

Although factors such as "math anxiety" and lack of enrollment by women in math courses were initially identified as barriers to women's participation in math careers, a decade later Holden (1987) reports:

> ... it appears that "math anxiety," the much touted explanation for girls' lower achievement in the 1970s, is no longer much in evidence. (p. 660)

As for enrollment of women in mathematics courses, Datta (1985) suggests that "currently the number of women well-prepared in mathematics has exceeded the number actually entering mathematically related careers" (p. ix).

Another factor, math ability, may influence career aspirations in high mathematic and scientific fields. In an attempt to resolve the importance of math ability, Hollinger (1986) notes:

> Sex differences in math achievements fail to explain why many mathematically talented young women who have chosen to persist in taking upper level mathematics courses and continue to excel on standardized tests of math achievement do not persist in pursuing careers in mathematics. (p. 133)

Moreover, in preparation for careers in science, Albright (1988) found, within a group of highly mathematically talented students, that ability cannot explain why some females choose and then continue to study a science major while most do not. Mathematical ability serves as a floor. Beyond a certain level of ability, other factors become more important in career choice. If other factors tend to contribute to unrealized potential and to the underrepresentation of highly talented women in mathematical and scientific careers, they should be identified.

Thus, a study is needed to search for factors that influence the career decisions of mathematically precocious females. As the 1990s approach, many questions remain. What motivates mathematically precocious females to aspire to mathematical, scientific, engineering, or medical careers versus other careers? How do lifestyle expectations relate to career aspirations? Ultimately, what factors promote the development of potential in mathematically precocious females?

Development of potential

The "development of potential" is often cited in the gifted movement as the goal of educational intervention on behalf of the gifted (Feldman & Goldsmith, 1986). Laycock (1979) also cites societal and individual reasons for attending to the development of potential among the gifted: (1) Society needs their leadership and contributions for survival and for cultural enrichment; and (2) individuals deserve to have the opportunity to develop their talents fully (Laycock, 1979).

There is general agreement that the gifted movement's focus is on children, because precocity among the young is seen as a reliable forerunner for their future direction (Tannenbaum, 1983). A definition of precocity signifies:

> ... rapid learning of ideas or about people, the ability to grasp abstractions quickly and efficiently, and generally to display skills far beyond those expected at the child's age level. (Tannenbaum, 1983, p. 86)

Although precocity focuses on childhood achievements, full potential is rarely realized in childhood. Therefore, interests in gifted children implies a focus on the future. Wallace (1985) suggests:

> The extensive literature on identifying the gifted, on educational programs for the gifted and on advice to teachers and parents of gifted children represents visions of these children's hoped for future as creative adults. (p. 361)

Yet, Gruber (1982) reminds us that gifted children do not necessarily grow up to become creative adults, and creative adults were not necessarily gifted children.

This focus on development of potential makes the transition from childhood precocity to adult creativity a concern of many researchers (Gruber, 1982; Wallace, 1985; Tannenbaum, 1983; Wallach, 1985; Feldman & Goldsmith, 1986). In addition to personal attributes (i.e., high intelligence) that are often also associated with definitions of giftedness (Terman, 1925; Humphreys, 1985), Tannenbaum (1983) has identified four other factors that influence the development of potential: (1) special ability, (2) nonintellective factors (i.e. personal, motivational, self-concept), (3) environmental factors, and (4) chance factors (i.e., birth order, gender, time, and opportunities).

A crucial time in this transition from childhood to adult productivity is late adolescence. At that time gifted adolescents outgrow and leave a network of parents, teachers, and mentors that have supported the gift (Wallace, 1985). They are also faced with the task of making career decisions that will ultimately shape their life. Wallace (1985) suggests:

> Virtually nothing is known about how this process of self-construction develops. What are the contexts that support or inhibit it?... It is necessary to do hard phenomenological work of reconstructing the world of the gifted adolescent from his or her point of view. (p. 382)

Late adolescence is also of great importance to educators. This is the time when gifted youth complete secondary education and initiate plans for college or university work. Important decisions such as selecting a college or university and declaring a major occur during high school years. What factors influence these educational decisions?

Career development theory

Career education, which is an outgrowth of career development theory, emphasizes the importance of career decisions. The origins of career decision-making theory, career choice theory, and achievement motivation are found in social learning theory (Atkinson, 1958, 1978; Bandura, 1978, Krumboltz, Mitchell & Jones, 1976).

Krumboltz and co-authors (1976) advocate a career decision-making theory which emphasizes four categories of factors that influence the nature of career decision: (1) genetic endowment and special abilities, (2) environmental conditions and events, (3) learning experiences, and (4) task approach skills (p. 71). These four factors are similar to those cited by Tannenbaum (1983) and Feldman and Goldsmith (1986) when explaining the development of potential in precocious children.

In contrast to theories that group people by personality types or other factors, Mitchell and Krumboltz (1984) suggest that each individual is unique and creates their own career path. To understand what factors influence or reinforce career decisions among mathematically talented females will therefore require an in-depth study of such individuals, with respect for their unique choices and career paths.

Identification of mathematically precocious females

The Study of Mathematically Precocious Youth (SMPY), initiated under Dr. Julian Stanley's leadership in 1971, is focused on identifying mathematically precocious 12-to 13-year-olds (Keating & Stanley, 1972). Since 1971, several hundred thousand intellectually talented 12- to 13-year-olds have been tested nationwide in SMPY type talent searches (Benbow, 1988).

Mathematical precocity is defined by SMPY as "a high score at an early age on the mathematics section of the College Board's Scholastic Aptitude Test (SAT-M)" (Stanley & Benbow, 1986). SAT-M is a measure of mathematical reasoning ability for twelfth graders. Benbow and Stanley (1981) suggest that this test is an even stronger measure of mathematical reasoning for 7th graders because:

> young students have not had much experience with abstract mathematics and have not been exposed to the content of the test. Thus, they must figure out by themselves how to solve the problems. (p. 170)

In addition to talent identification, the SMPY program provides educational opportunities for its youth and studies these students' development (Benbow, 1988).

In 1980, SMPY began to focus attention on a select group of students, students who are able to score over 700 on the SAT-M before age 13 (700M). Only 5% of college-bound twelfth grade males do that well (Stanley, 1986a). Members of this "700-800 on the SAT-M before Age 13" group represent the top 1 in 10,000 of their agemates--or the top one-hundredth of one percent (Stanley, 1986a).

By the late 1980s, there will be somewhat less than 30 females in the "700-800 on the SAT-M before Age 13 group" who will be in their late adolescence and young adulthood. The career aspirations of such a group of extremely mathematically precocious females are of great interest. They have the potential to achieve highly in mathematics and the sciences. Will they? What career paths do they follow? If a sizeable portion of these girls do not major in mathematics and the sciences, it would be cause for concern.

Because the number of 700M females who are approaching young adult years (19-21 years) is small, causal-comparative or correlational studies aimed at the discovery of possible causes of a phenomenon being studied are not appropriate (Borg & Gall, 1983). Yet, there is a sufficient number of girls to warrant an investigation through descriptive research methods. Borg and Gall (1983) suggest that descriptive studies are primarily concerned with finding out "what is" (p. 354). Therefore, this study will seek to discover the career aspirations of mathematically precocious females, as well as identify and describe factors possibly influencing their career decisions.

During the early years of SMPY's efforts, Fox (1973) wondered about the future of these capable students.

> It will be interesting to see to what extent these students [SMPY] will continue to pursue science and mathematics ... and to what extent the values and career interests of these students will change over the coming years. We can now only wait to see how many of these youngsters will become the

creative scientists and mathematicians of the future. (p. 9)

It is now possible to describe what their "future" has become as these 700M females complete high school and pursue their career aspirations through the college years.

Purpose of Study

This study consists of two parts. The first purpose addressed is that of documenting the career aspirations of mathematically precocious females in their late adolescence/young adult years. The career aspirations and the educational choices that are being made at this age as indicated by occupational choice, college selected, college major, and plans for undergraduate and graduate study will be described. Lifestyle expectations at this juncture will be studied, as will be their relationship to career aspiration.

Second, various factors that influence the career aspirations of mathematically precocious females will be identified. A review of literature revealed three sets of factors that are believed to be strong influences on career aspirations. The central focus of this study will be to include descriptions of them. These factors are: 1) personal factors, which include achievement-related personal traits, measured ability, self-perception of ability, attitudes and interests, gender-role orientation, and relationships with peers and significant others; 2) family factors, such as family background, parental expectations and encouragement for career choices, and 3) educational experiences, which include curricular flexibility, math/science coursework, out-of-school activities, guidance activities, and special achievements. The impact of these factors on the career decisions of mathematically precocious females will be explored. Whether such variables can discriminate between those females who aspire to mathematical, scientific, medical, or engineering careers versus other careers will be investigated.

Overview of Methodology

Because the purpose of this study is descriptive, a multiple-case study method and design was deemed appropriate for investigating the career aspirations of mathematically precocious females. Yin (1984) defined the case study design as an empirical inquiry that:

> investigates a contemporary phenomena within its real-life context, when the boundaries between phenomena and context are not clearly evident and in which multiple sources of evidence are used. (p. 23)

The multiple-case study design (Yin, 1984) will be used to develop career aspiration profiles for each mathematically talented female. These profiles will then be used to investigate the patterns and trends of career aspirations among mathematically precocious females.

In this study, several sources of evidence will be used. Information from four questionnaires, collected when the 700M females were in the eighth grade and after high school, is available because the subjects are part of a longitudinal study of individuals participating in SMPY talent searches. Directed by Dr. Camilla P. Benbow (Department of Psychology, Iowa State University) the longitudinal follow-ups:

> help SMPY evaluate the long-term effects of its programs and then refine them further. They also provide information about the development, needs, and characteristics of mathematically precocious youth. Such data are essential for planning appropriate programmatic change, as well as better understanding the nature, nurture and consequences of

> mathematical precocity. (C. P. Benbow, personal communication, November, 1986)

In this study, the four instruments used include: Talent Search Questionnaire, Student Questionnaire, After High School Follow-up (completed by the females), and a Questionnaire for Parents, (completed by the parents).

The Talent Search Questionnaire and the Student Questionnaire were completed by the subjects during the years 1982 through 1984, or when the subjects were in the eighth grade, the year after their identification into the "700-800 on the SAT-M before Age 13" group. The Questionnaire for Parents was completed by the parents of the subjects during the same time span, 1982-1984, shortly after identification. The After High School Follow-up was completed by the subjects in December of their 18th year (1986-88).

An additional source of information for the career aspiration profiles was telephone interviews with each subject. The purpose of the telephone interview was to gain needed information to complete the career aspiration profiles not available from the questionnaires. A second purpose of these interviews involved confirmation of the current career aspiration of the subjects, when SMPY females were 19 to 21 years of age.

Definitions of Terms

1. Career aspiration. Career aspiration refers to a strong desire for high achievement within a career field. The career aspiration is usually expressed in terms of an occupational choice. Yet, a career is viewed as a sequence of positions occupied by a person during the course of a lifetime (Super, 1957; 1976; 1980).

2. Occupational choice. Occupational choice is a stated preference for a specific field, occupation or job title. Educational choices are expressed by college selected, college major or plans for undergraduate or graduate study.

3. Lifestyle expectations. Lifestyle is a "way of life that reflects the attitudes and values of an individual or a group" (American Heritage Dictionary, 1983, p.396). Expectations are expressed in terms of goals or preferences for specific career related concepts such as: salary, geographic location, working conditions, fringe benefits, and integration of career, marriage, and family roles.

4. Gender-role orientation. Gender-role orientation is developed as children use gender as a cognitive organizing principle in order to structure their reality (i.e., Bem's gender schema theory, 1974; 1981; 1983, 1985). "They are likely to organize information about themselves and about the rest of the world according to the definitions of maleness and femaleness that are found in their society" (Matlin, 1987, p. 53).

5. Curriculum offerings. Curriculum offerings refer to the type/location of school, curriculum or specific courses, programs, or summer programs that are available to students, opportunities for acceleration and Advanced Placement courses.

6. Instructional activities. Instructional activities may include both in-school and out-of-school experiences. In-school experiences include actual courses taken in mathematics and sciences, English, and social studies, including Advanced

Placement courses. Out-of-school activities include participation in special courses, competitions, or extracurricular activities that have an academic focus, such as Math Counts or science fairs.

7. Guidance activities. Guidance activities refer to opportunities to talk to school personnel, including school counselors and teachers about career planning decisions.

8. Achievements or special recognitions. Achievements or special recognitions are local, state, national or international awards or prizes in any academic area received by students. Special creative awards or academic recognition, such as National Merit scholarship winner or Presidential Scholar, are included.

Limitations of Study

1. Self-reporting. The major limitation of the study is the reliance on self-report data. Therefore, it is important to have information from a number of sources. The use of written data from the questionnaires, supplied by both student and parents during early adolescence, can be compared. Many items utilized for analysis are parallel items. The use of questionnaires, completed by the subjects during early adolescence does not require that the subjects recall events or aspects of their behavior at a much earlier age. This is an advantage. The telephone interviews also provide another source to clarify answers and to confirm current career aspirations and expectations of the subjects.

2. Response Effect. Response effect refers to the tendency for respondents to give "inaccurate or incorrect responses" (Borg & Gall, 1983). Several strategies (Weiss, 1975) were used to provide a nonthreatening atmosphere for the telephone interviews including:

1) informing the subjects about the project, 2) assuring the subjects in regard to confidentiality, 3) making an appointment for interviews in advance, 4) forwarding a letter of explanation about the project, and 5) allowing for short and in-depth answers from the subjects (cited in Borg & Gall, 1983).

3. SMPY study. There could also be effects of participating in the SMPY study that are difficult to control. On several occasions during the interviews, the influence of SMPY summer programs on educational and career decisions were discussed, but influence, if any, of their participation in the national longitudinal study upon career choice is difficult to determine.

Significance of Study

Results from this study will aid both psychologists and educators in understanding the factors that influence the career aspirations of mathematically precocious females. The multiple-case study approach (i.e., an in-depth awareness of specific individuals accompanied by a cross-case analysis of the individuals) can reveal patterns or trends in the career development process that affect career aspirations. Knowledge of the factors that influence career aspirations of these mathematically precocious females can lead to consideration of curriculum/educational reform to better meet the needs of gifted females with extreme mathematical ability. Although all of these females have the potential to achieve highly in mathematics and the sciences; many, if not most, will not even embark upon such a career. Hopefully, in the future, a greater number of females with exceptional mathematical talent will pursue such careers where these talents can be utilized and where their potential can be realized.

Explanation of Dissertation Format

An alternate dissertation format, consistent with the ISU Graduate College Thesis Manual (1985), will be used. This alternate format permits inclusion of papers to be submitted to scholarly journals in place of one or more sections. The remaining chapters are explained.

Relevant literature is reviewed in Chapter II. Theories of achievement motivation, career decision-making, models of career choices and achievements, as well as lifestyle expectations, are discussed. Studies on career aspirations and achievement in mathematics and science reveal three sets of factors believed to be strong influences on career decision-making. These three factors: personal factors, family factors, and educational experiences, are reviewed.

Methodology used in the study is described in Chapter III, including an overview of qualitative methodology, multiple-case study method and design, subjects, instrumentation, data collection, and propositions. A brief statement of results, followed by tables which display results from the cross-case analysis are included in Chapter III.

Articles developed for professional journals were included in Chapters IV and V. These articles were developed on each of the two objectives of the study. In Chapter IV the career aspirations of mathematically precocious females are discussed: the career goals, educational choices, and lifestyle expectations of 700M females. The article in Chapter V focuses on the factors influencing career decisions of mathematically precocious females. Both articles report the major findings of the cross-case analysis.

Appendix A includes a list of research questions and corresponding items selected from the four SMPY Talent Search questionnaires. A copy of the interview protocol developed by the researcher is included in Appendix B. In Appendix C, a single-case study, TRUDY, is included as a sample of the types of data that were collected and as an example of a 700M female who verified 18 of 20 propositions predicted from the literature.

Summary

The multiple-case study approach provides both in-depth awareness of the development and characteristics of specific mathematically precocious females and cross-case analysis of several such females to reveal patterns or trends in their career development process that influence career aspirations. Knowledge of factors possibly influencing career aspirations of mathematically precocious females can lead to consideration of curriculum/educational reform to better meet the needs of gifted females with extreme mathematical ability. Thereby, perhaps more females with exceptional mathematical talent will pursue careers where their talents can be fully utilized and where their potential can be realized.

CHAPTER II. REVIEW OF LITERATURE

Introduction

This chapter consists of three parts. It begins with an overview of theories of achievement motivation and career decision-making. Therein, models of career choices and achievements, as well as the influence of lifestyle expectations on career choices are discussed. In the second part, career decision-making of females is discussed. Because studies on career aspirations of gifted females in mathematics and science reveal three sets of factors that relate to their career decisions, each set is reviewed. These are: 1) personal, 2) family, and 3) educational factors. The chapter closes with a summary and research questions.

Part One: Overview of Theories

Achievement motivation

The concept or theory of achievement motivation, as first defined by Atkinson (1958) and McClellan (1951), described how people differ as they strive for certain goals. Atkinson and Raynor (1978) explain:

> The ideas of the theory are based primarily on the results of experiments in which individuals are classified as relatively High and Low in need for achievement (n Achievement) in terms of the frequency of imaginative responses suggesting their concern over performing well in relation to some standard of excellence. These responses appear in stories they have told or written in response to pictures or verbal cues in the standard thematic apperceptive test situation. (p. 11)

Through this method of investigating achievement motivation, the following factors were identified as critical for high achievement motivation:

> ... an internal standard of excellence, independence, persistence, preference for tasks of intermediate difficulty, high academic performance, and clearly defined goals. (Farmer, 1976, p. 12)

A majority of the early achievement motivation studies from the 1950s and 1960s were conducted with male samples. Few studies included male and female subjects or female samples (Alper, 1974). In addition, early testing included pictures and/or verbal cues of men only. Thus, the conception of career motivation became regarded by many researchers as a male-dominated model of achievement (Alper, 1974; Bardwick, 1971; Horner, 1978; Maccoby & Jacklin, 1974).

In the 1970s, researchers began to focus on the achievement motivation of women and revealed some gender differences. Maccoby and Jacklin (1974) reported that these gender differences do not become significant until women reach college.

> During the college years some sex differentiation does occur. At this time, women have less confidence than men in their ability to perform well on a variety of tasks assigned to them; they have less sense of being able to control the events that affect them, and they tend to define themselves more in social terms. (p. 162)

Similarly, Farmer (1976) cited "reduction in academic self-confidence for girls in college" as a factor that differentiates achievement motivation of school age girls.

Young adolescent girls have higher career motivation than boys (Farmer, 1985b). This higher motivation then declines for at least some females. Rooney (1983) found women who perceived their primary role as "homemaker" had significantly lower career motivation than men; whereas, the men and women who continued in the primary role as "student" and "worker" into their young adult years had high career achievement motivation. Farmer (1987) concluded:

> It appears that the transition into adulthood may have diminished women's long range career commitment. Future research should provide further information on the stability of this motivation dimension over time and on influences affecting gender differences. (p. 8)

Thus, the transition into adulthood is cited as a critical time period in achievement motivation of women.

The difference in motivation between adolescent and young adult women may not actually reflect a true decline but rather a change in task demands. Maccoby and Jacklin (1974) hypothesized that for school tasks, which are well defined, boys and girls appear to be equally motivated and intrinsically interested. Thus, achievement motivation between boys and girls is similar during school years. Differences in achievement motivation emerge in college, because no longer are activities structured or well-defined. Maccoby and Jacklin (1974) observe:

> But in the post-school world perhaps it is necessary for the individual to seize more initiative in organizing the sequence of actions and events that lead to achievement, and in this situation it may be that a sense of personal potency does make a difference in the achievements of women as well as of men. (pp. 162-163)

Thus, self-directed, self-initiated and self-organizing skills, which emerge in Wallace's (1985) period of self-construction, are important to achievement motivation after formal schooling is completed. Females may not develop such skills to the same extent as males.

The importance of achievement motivation in gifted females' career decision-making is underscored by Farmer's (1985b) comment that:

> Understanding the factors that influence career and achievement motivation is important because motivation affects achievement (Atkinson, 1978), level of occupation achieved (Sewell & Hauser, 1975), and career satisfaction (Dubin, 1956). (p. 363)

Thus, achievement motivation in the career decision-making process of gifted females warrants investigation.

Career decision-making theory

Several theories of career choice and career decision-making have been identified by recent reviews (Brown & Brooks, 1984; Crites, 1974; Herr & Cramer, 1979; McMahill, 1985; Sanderson & Helliwell, 1978; Srebalus et al., 1982). These theories emphasize various factors contributing to the development of careers, such as: a good match of abilities and interests with occupations (Parsons, 1909), developmental stages, (Ginzberg, Ginzberg, Alexrod, & Herma, 1951), life roles (Super, 1957, 1976, 1980), personality, (Holland, 1966), and psychological need, child rearing practices, and early family experiences (Roe, 1953; 1956). Crites (1974) concluded that each approach to career counseling makes a unique contribution to the ways in which individuals make career decisions.

The origins of career decision-making theory, career choice theory, and achievement motivation are found in social learning theory (Atkinson, 1958, 1978; Krumboltz, Mitchell & Jones, 1976). Social learning theory (e.g., Bandura, 1978), posits that three sets of interacting influences affect learning and related behavior: (a) background variables, such as gender, ethnicity and ability; (b) psychological factors, such as self-concept, attitudes, beliefs, and experiences; and (c) environmental influences in society. According to Bandura (1978):

> In social learning theory, causal processes are conceptualized in terms of reciprocal determinism. Viewed from this perspective, psychological functioning involves a continuous reciprocal interaction between behavioral, cognitive, and environmental influence. (p. 344)

Krumboltz and co-authors (1976), explained how the socialization process in a social learning perspective affects career choices. The theory hypothesizes that an individual is more likely to express a preference for a course of study, an occupation, or field of work:

> 1) ... if that individual has been positively reinforced for engaging in activities s/he has learned are associated with the successful performance of that course, occupation, field of work.
>
> 2) ... if that individual has observed a valued model being reinforced for engaging in activities s/he has learned are associated with the successful performance of that course, occupation, or field of work.
>
> 3) ... if that individual has been consistently positively reinforced by a valued person who models and/or advocates engaging in that course, occupation, or field of work.
>
> 4) ... if that individual has been exposed to positive words and images associated with that course, occupation, field of work, or the activities related to it. (Krumboltz et al., 1976, pp. 76-77).

Career decisions are influenced by an interacting set of variables which include reinforcement received from activities and experiences, genetic endowment, special abilities, environmental conditions, events, learning experiences, and task approach skills (Krumboltz et al., 1976).

In comparison to other theories on the career choice process, Krumboltz's career decision-making theory is consistent with Super's (1980) focus on career choice as a process and a lifetime rather than a one time decision. The development of potential in gifted individuals is also considered a life-long process (e.g., Gruber, 1982; Feldman & Goldsmith, 1986; Tannenbaum, 1983).

Mitchell and Krumboltz (1984) suggest that "each individual has a unique history of learning experiences that results in the chosen career path" (p. 241). To understand what learning experiences differentiate, influence, or reinforce career decisions among highly mathematically talented females will therefore require an in-depth study of such individuals, which is possibly best accomplished by the case study method.

This in-depth study is needed because many of the career development theories are appropriate for describing only the middle class male (Astin, 1984; Eccles, 1985, Farmer, 1985a; 1985b; Rodenstein, Pfleger & Colangelo, 1977). It is difficult to generalize findings to women, because women were dropped from longitudinal studies when they married or left the work force (Wilson, 1981).

This difficulty in generalizing from theories developed for white males becomes apparent when one considers the gender differences in career aspirations and choices. Some studies have favored males (Astin & Myint, 1971; Farmer, 1976; Oden, 1968), while other studies have favored females (Farmer, 1983; Fortner, 1970) or found no gender differences in career aspirations (Card, Steel & Abeles, 1980, Goodale & Hall, 1976).

Researchers have attempted to explain the dynamics of women's career decisions by exploring differences in career aspiration and choices among women (Astin & Myint, 1971), the role of information in decision-making (Laws, 1976), the role of social class and intelligence (Gottfredson, 1981), the role of occupational sex stereotyping (Gottfredson, 1981), and self-efficacy expectations (Hackett & Betz, 1981). Inability of researchers to isolate any one variable suggests that career decisions are complex and results from a number of interacting factors. Nonetheless, they attribute these gender differences to differences in the specific preferences or career decisions made by males and females.

Models of career choices and achievement

Several models attempt to explain the career choices and career achievement of women. Farmer's (1987) multidimensional model includes a broad range of interacting factors. Its three major variables are: 1) background (sex, race, age, math & verbal ability, and social status), 2) environment (school, family, community, economy), and 3) personal (self-concept). These three interacting variables are posited to influence aspiration, mastery, and career motivation.

Eccles's model of achievement differs somewhat from that of Farmer. Eccles (1985) linked choices of women in the area of educational and vocational achievement to two factors: "the individual expectations for success and the importance or value the individual attached to the various options perceived as being available" (p. 264). Thus, for future math performance, the following attitudes and beliefs would be critical mediators: self-concept of ability, the estimates of task difficulty, interpretations of previous achievement experiences, identification with masculine and feminine sex roles; and actual past performance in mathematics (Eccles et al. 1983).

Eccles (1985) attempted to apply her theory of academic choices to gifted individuals. For the gifted, Eccles considered choice as the outcome of interests. Thus, "by legitimizing the choices of both men and women, we can look at sex differences from a choice perspective rather than a deficit perspective." (p. 265).

In a similar vein, it has been suggested that gender differences in achievement can be traced in part to the narrower range of occupational fields considered by women than men (Farmer, 1987; Farmer & Backer, 1977; Hackett & Betz, 1981; Gottfredson, 1981). Many options are not considered by gifted females because:

> ... the individual is unaware of their existence; others are not considered because the individual has inaccurate information regarding either the option itself or the individual's possibility of achieving the option. (Eccles, 1985, p. 264)

Eccles (1985) also considered that gifted females' choices, such as enrolling in programs and choosing a major or university, are made within the context of a "complex social reality" and are varied and competing. Gifted students are viewed as having "multipotentiality" (Barbe & Renzulli, 1981; Rodenstein, Pfleger, & Colangelo, 1977). Thus, more career choices can be considered by gifted compared to average ability adolescents because of their broad range of interests and abilities.

Consistent with this theorizing, Rodenstein (1980), in a longitudinal study of 638 subjects who were identified as gifted while in high school, investigated the relationship between 1) attitudes and activities in mathematics during high school and 2) the status of a gifted student's occupation attained 5 to 15 years after high school. Regression analysis was used to identify the variables that had the strongest impact on occupational status. For males, it was educational level (number of math classes), while for females, it was familial status.

In summary, the models of Farmer and Eccles are derived from achievement motivation, career decision-making, and social learning theories. These models consider aspiration, mastery, and career motivation as influenced by background, environmental, and personal factors. The choices made by gifted females are influenced by their varied interests and perceived career options. Thus, career decisions are complex and result from a number of interacting factors.

Lifestyle expectations

The career-lifestyle concept is important for gifted students (Rodenstein et al., 1977; Strang, 1958) because the occupational choice becomes a choice of lifestyle (Hoyt & Hebeler, 1974). Lifestyle expectations may be important correlates, along with occupational choice, of females' lower achievement motivation. Lifestyle expectations may explain achievement differences among the gifted Terman women. Although Terman women were extremely able and "well educated," as a group they achieved less in terms of education and vocational attainment than did their gifted male peers (Terman & Oden, 1947, Oden, 1968). Farmer (1987) suggested that "the dual pull of home and work roles for women presents greater challenges for decision-making related to career choice for girls and women" (p. 8).

A critical time when home and work roles are being defined is during the college years. Harmon (1972) found that women who aspired to high level careers in their freshman year often changed their choices to less demanding careers by the time they were college seniors. Card, Steel and Abeles (1980) also found gender differences between potential (at age 14) and achievement (at age 29) among students in Project Talent. The gender differences in career achievement grew larger between the ages of 23 and 29, as a greater proportion of the women in the sample became wives and mothers. Despite the fact that at age 14 females had significantly higher academic ability, better high school grades and their educational expectations during high school did not differ significantly from males, the males at age 29 had significantly more education, greater occupational status, and higher annual incomes. These results based on women in the 1980s are strikingly similar to Oden's (1968) report of the Terman women.

Although such findings are not encouraging, they do not imply that high career achievement of females must be attained at the price of having a family. Helson (1980) and Luchins and Luchins (1980) suggested that high achieving women have successfully combined home and work goals. The lifestyles of Helson's (1980) creative women mathematicians:

> ... expressed strong interest in leisure activities that were primarily intellectual in nature; attending concerts, listening to classical records, going to plays, reading

> classics, and hiking.... The creative women seem to have simplified their lives to a few things about which they cared very much. They spend most of their time in research and homemaking; they spend less time than the comparison subjects in teaching, administration, community activities and politics. (p. 28)

Likewise, Luchins and Luchins'(1980) study of 350 female members of the Association for Women in Mathematics indicated that 43% were married. Over 70% of those who were or had been married had children. Most respondents thought:

> ... that mathematics was a good career for women and that it could be fairly easily combined with marriage and family, especially with the help of an understanding spouse. (p. 9)

This view is consistent with Hawley's (1972) earlier prediction that the attitudes of significant men toward working women are important to career aspiration.

Studies on career aspirations and lifestyles expectations of young females in the 1980's are more optimistic (Yogev, 1983; McBain & Woolsey, 1986), however. Bledsoe (1982) revealed that gifted girls who aspire to traditionally male-dominated professions perceive no feminine identity or role loss as a result of entering such occupations. Cray-Andrews (1983) investigated gifted female adolescents perceptions of career and lifestyle aspirations. Girls who were in 6th, 9th and 12th grade had little difficulty stating their career preferences; favored careers were challenging, diverse and service-related. McBain and Woolsey (1986) found the home/career conflict to be an "outdated concept" for high ability Canadian women, who demonstrated no evidence of attitudinal conflict about life roles or high level career aspirations.

Yet, Benbow and Arjmand (in press) demonstrated that despite high career and lifestyle aspirations, about one-third of mathematically talented females abandon careers in mathematics and science during college. While 50% of SMPY females intended to major in mathematics or science at the beginning of college, only 37% of the females eventually completed such majors. Benbow and Arjmand (in press) also identified that the:

> ... statistically significant gender differences in college major were due primarily to females less than males choosing engineering (25.4% versus 7.6%) computer science (6.9% versus 3.6%) and the physical sciences (10.3% versus 4.3%). (p. 5)

There were no significant differences in the proportion of males and females majoring in biology or in mathematics. The perceptions, attitudes, interests, and experiences of mathematically precocious females toward the physical sciences, computer science, and engineering are apparently somewhat negative. Thus, even though mathematically talented students appear to consider dual careers roles in home and work, yet they do not choose careers in areas such as physical sciences, computer sciences and engineering. Why?

Part Two: Factors Influencing Career Decisions

<u>Personal factors</u>

Several explanations for gender differences in career achievement in mathematics/science relate to personal variables. Such factors, which are reviewed in this section, include: a) achievement-related personal traits, b) measured ability, c) self-perception of ability,

d) attitudes and interests, e) gender-role orientation, and f) personal relationships.

Achievement-related personal traits. Individuals who have high achievement motivation are characterized by traits such as perseverance, integration of goals, and self-confidence (Cox, 1926; Galton, 1869; Goertzel & Goertzel, 1962; Goertzel et al., 1978; Gruber, 1982; Roe, 1953). Oden (1968) delineated the characteristics of those men in the Terman sample who were considered high achievers:

> Most important among these traits are perseverance, integration in working toward goals, and self confidence; interest in being a leader, in having friends, and in academic success; and above average ambition, as compared with their friends and colleagues, for excellence in work, for recognition of accomplishments, and for vocational advancement. How these traits are acquired or developed is not fully answered in these data, but they are fundamental to achievement. These are the traits that provide the motivation, the drive, and the implementation of ambition that lead to the realization of potential. (p. 92)

Since high achieving women in the Terman sample were not studied, we do not know the extent to which these findings apply to gifted females. Helson's (1980) work with women mathematicians and the creative personality offer some insights, however. Her profiles of women mathematicians generated two clear findings.

> The first has to do with superior intellectual functioning, and unusual combination of perseverance, adaptiveness and sensitivity to the new and unforeseen. The second has to do with temperament, which in this case appears to be moderate and even subdued, and yet without loss of individuality or spark. (p. 26)

Similarly, Hollinger (1986) reported that mathematically talented female adolescents who aspired to careers in mathematics and science were more likely to demonstrate "strong investigative interests, competencies, occupational preferences and self estimates of investigative abilities" (p. 140). Parker's (1988) investigation of mathematically talented youth indicated that the two most frequent personality types were:

> 1) inquisitive analyzer; reflective, independent, curious; more interested in organizing ideas than situations or people; and
>
> 2) warmly enthusiastic planner of change; imaginative, individualistic; pursues inspiration with impulsive energy; seeks to understand and inspire others. (p. 185).

Thus, studies of women mathematicians, as well as highly talented youth in mathematics, suggest that certain personal traits are conducive to the development of potential. The identified traits are consistent with predictions from theories of achievement motivation.

Measured ability. Another explanation for gender differences in career achievement in mathematics/science is that males have greater mathematical ability than females. Typically, for average ability students, gender differences in mathematics achievement are decreasing and usually not significant (Feingold, 1988; Freeman, 1984; Fennema, 1974; Jacklin, 1989; Kimball, 1989). Yet, among the most highly talented or precocious youth, significant gender differences in mathematical reasoning ability have consistently favored the males, are large, and have been stable since 1972 (Benbow, 1988; Benbow & Stanley, 1980; 1981; 1982; 1983a; 1984; Feingold, 1988; Fox, 1976; Fox et al. 1980; 1983; Keating, 1974).

Mathematical reasoning ability is relevant because it is predictive of math achievement (Benbow, 1983) and is somewhat related to career achievement of the gifted (Benbow & Arjmand, in press). Similarly, women who have high career motivation and who pursue graduate level education often show an exceptional aptitude for mathematics (Astin, 1968, 1974; Astin & Myint, 1971).

While mathematical ability predicts later achievement, in their study of high and low academic achievement among gifted students, Benbow and Arjmand (in press) found amount of mathematical talent of a student does not relate much to achievement after a certain point. For example, low achievers in their sample were nonetheless extremely able. Thus, Benbow and Arjmand (in press) concluded:

> It does not seem likely, therefore, that ability differences between these two groups alone can explain more than a small part of the achievement difference between these two groups. (p. 7)

Similarly, Albright (1988) found that ability cannot explain why some talented females choose and then continue to study a science major while most do not.

Thus, ability appears to serve as a floor; beyond a certain level of ability, other factors become more important to career choice. Measured ability within the highest ability groups does not seem to account for differences in achievement.

Self-perceptions. The individual's perceptions (e.g., confidence, internal locus of control, positive view of ability) are equally important for career achievement in mathematics/science. Covington and Omelich (1981) have argued that self-perception of ability is the most important causal factor in most achievement behaviors. It is generally agreed that females, even mathematically talented females, have less confidence in their mathematical ability than do their male counterparts (Ernest, 1976; Fennema & Sherman, 1977; 1978; Fox 1977; 1982). These gender differences usually appear in adolescence (Benbow, 1988; Eccles et al., 1983; Ernest, 1976; Fox, 1982; Heller & Parsons, 1981; Meece et al., 1982). Benbow (1988) reported:

> Overall, research indicates that females have less confidence in their mathematical ability than do males and that this lower self-concept may relate to females' lower levels of participation and performance in mathematics. (p. 175)

Since participation and performance in mathematics are linked with career aspirations (Chipman & Thomas, 1985; Armstrong, 1985; Chipman & Wilson, 1985; Lantz, 1985), the influence of self-perception of ability warrants investigation.

Lower self-esteem in gifted females than males also has been reported (Bardwick, 1971; 1974; Hollinger, 1983; Wilson, 1981). In her work with gifted high school students, Wilson (1981) explained:

> When students were asked to identify reasons for the discrepancy between ideal and actual job choice, lack of money for education and a lack of talent or intelligence were most commonly chosen by females. The female concern with lack of intelligence and talent was not shared by the male participants. (p. 58)

Similarly, Hollinger (1983) reported self-perception of ability was most effective in discriminating between the math/science and non-math career aspiration groups.

Eccles et al. (1985) reported a fairly consistent pattern of gender differences in self-perceptions of ability:

> Across both years, boys, compared to girls, rated their math ability higher, felt they had to exert less effort to do well in math, and held higher expectancies for future successes in math, even though there had been no difference

> between the past math performances (both standardized test scores and course grades) of these same boys and girls. (p. 100)

For science, DeBoer (1984) concluded that women's lower sense of competence in science could explain their reduced participation in science courses and careers. Yet, in one Canadian study (Lips, 1984), it was found that the major reason for women's avoidance of mathematics and science was not lower self-perception of ability. Rather, it was simply a lack of interest.

In summary, self-perceptions can be as important as measured ability for career achievement. Females have a lower self-confidence and lower perceptions of ability than males, even among the mathematically talented.

Attitudes and interests. Gender differences in career achievement in mathematics/sciences also may be attributable to gender differences in personal interests. Females have a lower liking for or more negative attitudes toward mathematics than do males (Fennema & Sherman, 1977; Fox, 1976). Benbow (1988) concluded:

> The general evidence seems to indicate that females do have somewhat more negative attitudes toward mathematics than do males. Furthermore, it is probable that these attitudes are correlated with variables related to mathematical performance. (p. 175)

Yet, among mathematically talented students, Benbow and Stanley (1980; 1983d) found no gender differences in attitudes toward mathematics; nor did attitudes correlate with mathematical achievement (Benbow, 1988).

Interest may, in part, be related to the perceived usefulness of mathematics toward future career goals. Some researchers suggest gender differences emerge because boys perceive the study of mathematics as relevant to their future careers more often than do girls (Armstrong, 1985; Brody & Fox 1980; Fennema & Sherman, 1977; Haven, 1972; Lantz, 1985). Benbow (1988) reported that no gender differences or predictive value has been found among mathematically talented for this variable.

Eccles, Adler, and Meece (1984) suggested, however, that gender differences may be explained by measures of subjective task value:

> If, as our data suggest, males and females attach different values to various achievement tasks, then it seems likely that this sex difference is the more important influence on sex differences in achievement-related choices, such as course and career selection. (p. 41)

Using measures of subjective task value, Eccles and co-authors (1984) reported that females rated mathematics as less important and English as more important than did males. Females expressed a stronger interest in continuing to take English courses than did males. Moreover, Ethington and Wolfle's (1986) found attitudes toward math to be more negatively influenced by verbal abilities for women than for men:

> Higher mathematical ability and more positive attitudes toward mathematics led to greater increases in mathematics achievement for men than women. Similarly, higher verbal ability led to greater exposure to mathematics for men than for women. (p. 73)

With SMPY students, Arjmand, Benbow, and Lorenz (1988) found that there was no relationship between sex and attitude toward and rated importance of quantitative subjects. Such relationships were found, however in verbal areas. Arjmand and co-authors (1988) concluded: "... females believe verbal subjects to be more important for future careers than did the males" (p. 12).

Attitude toward science is an important factor influencing career choice in science (Astin & Myint, 1971; Baker, 1981; Benbow & Arjmand, in press; Lips, 1984). Baker (1981) concluded the spatial ability and attitude toward science influence choice of careers for both males and females, however:

> For women, the attitudinal factor is more important than the cognitive factor, although how these two may be related is unclear. Nevertheless, once women are in science it is not possible to distinguish them from men on the basis of attitude or spatial ability. They are however very different from men who are not in science on these two variables. (pp. 6-7)

Among high ability students, Benbow and Arjmand (in press) investigated attitudinal differences between high academic achievers (HAAs) and low academic achievers (LAAs) in mathematics and science. They reported:

> Before talent search participation, there were essentially no differences between high HAAs and LAAs in their attitude toward mathematics for either males or females. By the end of high school differences began to emerge, especially for girls and in science. Variables studied were liking for mathematics, biology, chemistry, and physics and consideration of a career in these areas .... Overall, attitude toward science was a more important correlate of high achievement in mathematics and science than was attitude totward mathematics. (pp. 7-8)

Thus, attitudes and interests in subjects such as mathematics, English, and/or sciences influence career decisions. Research is needed, however, to explore the role that interests and attitudes play in the career aspirations of mathematically precocious females.

<u>Gender-role orientation</u>. Gender differences in career achievement in mathematics/sciences may be related to gender-role orientation of individuals. Gender-role orientation is developed as children begin to

view gender as a cognitive organizing principle for structuring their reality (e.g., Bem's gender schema theory, 1974, 1981, 1983, 1985). Matlin (1987) suggested children:

> ... are likely to organize information about themselves and about the rest of the world according to the definitions of maleness and femaleness that are found in their society. (p. 53)

Therefore, perceptions of careers as "feminine" or "masculine" may impact on career decisions, especially during late adolescence.

Maccoby and Jacklin (1974) suggested that lack of flexibility in gender roles can be negatively related to intellectual development and performance of both males and females; cross sex-typing may confer an intellectual advantage. For mathematically talented females, this ability to "cross sex-type" would be especially important. Mathematics is often linked with "masculine" characteristics.

Meece and co-authors (1982) suggested females and males sex-type mathematics as a masculine discipline, thereby making females less motivated to achieve in mathematics (Fennema & Sherman, 1977; Hollinger, 1983; Sherman, 1983). Hollinger (1983) noted that high ability females in mathematics may avoid math/science careers because such careers are perceived as stereotypically masculine, with little emphasis on interpersonal, artistic, or creative skills. Sherman (1983) argued that women avoid math/science careers because of gender-role orientation. Raymond and Benbow (1986) found that mathematics was not significantly sex-typed and that sex-typing had no relation to further mathematical study. With these varied results, Benbow (1988) concluded:

> It appears then that if mathematics is sex-typed, directly or indirectly, it is considered masculine. The relationship

> of sex-typing to mathematical performance is unclear. (p. 176)

Gender-role orientation may impact career achievement through its influence on achievement motivation. Lesser, Krawitz, and Packard (1963) found that adding females to the pictures and/or verbal cues (e.g., she, her) differentiated responses by male and females. Males and underachieving females demonstrated higher achievement aspirations when males were presented in the pictures or verbal cues (e.g., he, him). Yet, high achieving females demonstrated higher achievement aspirations only when females were presented in the pictures. This suggests that for underachieving females, the "girls' usually lower n Ach [achievement] scores may not reflect their own motivations but rather their concepts (which they share with men) concerning the usual characteristics of women and girls" (Maccoby & Jacklin, 1974, p. 137). Lesser and co-authors (1963) concluded that "achieving girls perceive intellectual achievement goals as a relevant part of their own female role" (p. 63). This suggests that gender-role orientation may influence achievement motivation differently for achieving versus underachieving females.

Helson's (1980) work with creative women mathematicians indicated that these women identified with their fathers more than the comparison group. Helson explained:

> Although the women mathematicians as a whole came disproportionately from families of girls, the creatives, unless they came from very large families, were particularly likely not to have brothers. A number of the women mathematicians seem to have been adopted as the "son" of an intellectual father. (pp. 28-29)

Thus, their identification with fathers may have promoted cross sex-typing and thereby influenced the choices of these creative women mathematicians. Similarly, Hawley (1972) found that the opinions of significant men were influential in career decisions made by females. Females who were math/science majors and were preparing for careers in male-dominated areas expressed a view of femininity that was consistent with their career decisions:

> The math-science group has a model of femininity which allows the widest range of educational and career choices without violation of sexual identity. Despite greater freedom in career behavior, including the freedom to compete with men in male dominated areas, these women appear to be more concerned with good relationships with significant men than their more conventional counterparts. (Hawley, 1972, p. 312)

Likewise, Raymond and Benbow (1986) reported that 59% of mathematically talented students did not sex-type mathematics.

The influences of gender-role and the processes that shape these perceptions of a career field appear to influence gender differences in achievement. There is little evidence regarding how it happens, however (Eccles, 1985).

Relationships with teachers, peers, and significant others. Teachers and significant others may also influence males and females differently. Sewell and Hauser (1975) reported that teacher support was a significant predictor of career aspiration to boys; while Armstrong (1985) found that teacher encouragement was the significant influence on course-taking for girls. Two-thirds of the women mathematicians (Luchins & Luchins, 1980) mentioned encouragement from teachers.

Teachers and significant others can influence career aspirations of their students as they interact as teacher, friend, counselor, and/or role model. Beck (1989) found the literature on mentoring in education to reveal that mentor relationships are "particularly beneficial to gifted students because they are independent, highly motivated learners" (p. 22). The impact of mentors on gifted females is sparse (Bolton, 1980; Moore, 1982; Shamanoff, 1985). Beck (1989) found that female mentors are particularly valuable role models to help gifted females deal with negative attitudes, recognize and value their own abilities, and become more independent and assertive.

The importance of these personal relationships is discussed in the literature review in the next section on the family. Because many studies examined the support of parents, peers and significant others, these variables are discussed together.

Family factors

The family factors that relate to achievement, plus the interactions with peers and significant others, are reviewed in this section. They include: a) family background; b) expectations of parents, peers, and significant others; and c) encouragement from parents, peers, and significant others.

Family background. Gender differences in career achievement in mathematics/science may also relate to family background, which includes socioeconomic status of the family, educational level of parents, and race or cultural influences.

Career aspirations are most influenced by background factors (Farmer, 1987). Through path analysis Farmer determined that all background variables (sex, social status, school location, race, age, and math and verbal ability) were significant influences on achievement motivation. Benbow and Arjmand (in press) investigated the possibility that such background variables influence achievement differently for the gifted compared to the average ability student. They found no evidence to support that view. These variables will, therefore, be explored in depth.

Socioeconomic status (SES) of parents has been identified as an influential factor in predicting occupational aspirations of males and females (Astin, 1984; Astin & Myint, 1971; Duncan et al., 1972; Goodale & Hall, 1976; Sewell & Hauser, 1976). Duncan and co-authors (1972) reported that SES background relates to higher education and acquisition of high prestige occupations. Sewell and Hauser (1976) indicated that SES remains an important influence on educational and occupational aspirations, even when other relevant variables are controlled (e.g., intelligence, community background, and various psychological characteristics of students):

> Whatever measure of socioeconomic status we use--parental income, father's or mother's education, father's occupation, or any combination of them--we find enormous differences in the educational attainments of the socioeconomic groups .... The high status student has approximately a 4 to 1 advantage in entering college, a 6 to 1 advantage in college graduation and a 9 to 1 advantage in graduate or professional education. (p. 13)

Similarly, Gottfredson (1981) found middle-class and upper-class persons had fewer limiting factors influencing their career aspirations than did lower-class persons. Further, gifted students tend to come from high SES families (Benbow & Stanley, 1980). Within a sample of gifted students, Astin (1974) reported a direct relationship between father's and mother's education and score on SAT-Math for both boys and girls. In addition, Goodale and Hall (1976) found mother's occupation was related to work values of gifted girls.

Helson (1980) found that creative women mathematicians had fathers who were professional men. Benbow and Arjmand (in press) used family background variables in their study of correlates of high and low achievement among an SMPY sample. The single variable with the greatest discriminating power was fathers' educational level.

Although SES relates to educational attainment for both males and females, "the educational attainments of women are uniformly less than those of men at every socioeconomic level" (Sewell & Hauser, 1976, p. 13). Using path analysis to link SES status to career plans, Goodale and Hall (1976) found a direct path linking parental background with students' college plans and with occupational plans of males. They concluded:

> Girls are more independent of the socioeconomic background of parents in formulating their career aspirations. Girls' career plans may be more dependent upon their own goals and ambitions than on those of parents. The fact that girls' occupational plans were high and did not differ from boys in the sample tends to support this autonomy .... Girls, in short, are less likely than boys to inherit the career attainment of their parents. (p. 29)

Race or cultural influences on achievement also have been found. Helson (1980) reported foreign cultural influences were apparent for male, as well as female, mathematicians:

> Foreign cultural influence was strong. Half of the creative women were born in Europe or Canada, and almost half of the native-born subjects had at least one parent born in Europe. (p. 25)

The difference in the number of foreign births in the creative versus the comparison groups of mathematicians was significant. Among highly mathematical talented youth (top 1 in 10,000) about 22% are of Asian-American background (Stanley et al., 1986).

Expectations of parents and significant others. Parental expectations have been linked consistently to both high achievement motivation and behavior (e.g., Crandall, 1969; Winterbottom, 1958) and career aspirations (Armstrong, 1985; Haven, 1972, Fox, 1977). In an edited volume of studies (i.e., Chipman et al., 1985), the important role of parents in influencing their daughter's participation in mathematics was emphasized. Specifically, in mathematics, Armstrong (1985) reported that:

> ... parental influence strongly affects a student's course taking, achievement in mathematics and career aspirations through role modeling, direct encouragement and expression of positive attitudes toward mathematics. (p. 63)

Expectations of parents are also important in that they relate to children's expectations, enrollment, and performance in mathematics courses, and perceived value of and the attitudes toward mathematics (Eccles et al., 1983; Fennema & Sherman, 1977; 1978; Haven, 1972).

Gender differences in parents' expectations may convey different messages about mathematics to boys and girls. As reviewed by Meece and co-authors (1982), parents, teachers, and significant others do have different expectations for male and female mathematical achievement (e.g., Armstrong, 1985; Astin, 1974; Fox, 1977; Fox & Richmond, 1979;

Parsons, Adler & Kaczala, 1982). Moreover, Armstrong (1985) found parental educational expectations influenced course-taking. In addition, Eccles and her colleagues (1983) found students' attitudes toward mathematics were strongly related to mothers' beliefs concerning the difficulty of mathematics for their children.

In summary, parents' expectations of their sons and daughters vary. Expectations of parents and students' perceptions of these expectations relate to career achievement.

Encouragement from parents and others. Encouragement from parents, peers, and significant others is important for career achievement in mathematics/science. They predict career aspirations (Benbow & Arjmand, in press; Farmer, 1980b; 1987; Rooney, 1983; Sewell & Hauser, 1975). Rooney (1983) found that parent support contributed more to career aspiration level than did teacher support. In a longitudinal study of high school students, Sewell and Hauser (1976) found parents' encouragement is twice as strong of an impact on aspirations as friends' plans, teachers' encouragement and social status.

In a SMPY sample, Benbow and Arjmand (in press) found that parents's "encouragement to pursue career and educational goals" could separate high from low achievers in science. In this group, encouragement to study mathematics and encouragement to study science were not significant, however.

In addition to parents' expectations and encouragement, teachers, and significant others may also influence males and females differently. Luchins and Luchins (1980) cited more women than men mathematicians who recalled being encouraged by their families and friends. Parents, fathers, and husbands were mentioned most frequently. Two-thirds of the women mathematicians also mentioned encouragement from teachers. For high school girls, Farmer (1980a, 1980b) found a measure for "support for women working" as the best predictor of career aspiration.

Thus, gender differences in encouragement have emerged. Parents, teachers, and significant others encourage males more than females to achieve in mathematics (e.g., Armstrong, 1985; Astin, 1974; Fox, 1977; Fox & Richmond, 1979; Parsons, Adler & Kaczala, 1982). Eccles and Jacobs (1986) argued that parents serve as critical socializers of gender differences in mathematics achievement and activities.

In a similar vein, Fennema and Sherman (1978) reported gender differences in the children's perceptions:

> Boys perceived both parents as more positive toward them as learners of math than did girls. These differences began in middle school and became significant in high school. It also appears that fathers were perceived by students of both sexes as being more positive toward them as learners of mathematics than were mothers. Boys perceived teachers more positively than girls and these differences were significant at high school level. (p. 200)

Among the high ability SMPY population, however, no gender differences in encouragement have been found. Arjmand, Benbow, and Lorenz (1988) and Raymond and Benbow (1986) found that patterns of parental support appeared to vary not as a function of child's gender but as a function of child's talent.

Benbow (1988) summarized the literature on parental encouragement:

> The general indication is that there are some differences in encouragement from significant others, especially parents, for males and females in mathematics, although the magnitude of these differences and their effect on the childrens' attitudes or achievement may not be great. (p. 176)

In summary, encouragement from parents, plus interactions with peers and significant others, seem to be important to career achievement and aspirations. Gender differences in encouragement exist among average ability students. Although, among mathematically precocious students no gender differences in parental encouragement have been found, parental encouragement does relate to achievement and aspirations.

Educational opportunities

Curriculum offerings. Educational opportunities are important variables in career achievement in mathematics/science. They shape the interests and build the knowledge base for students to succeed in school. "The path to high occupational status is through higher education" (Sewell & Hauser, 1976, p. 23). High educational and occupational aspirations lead to higher educational attainment and ultimately to higher levels of occupational achievement.

Educational preparation is affected by curricular offerings and flexibility of high schools, type and location of school, and instruction in mathematics and science. Location of school, for example, was found to relate significantly to career aspirations (Farmer, 1987; Sewell & Hauser, 1975). Urban and inner-city students score higher on aspiration measures than do rural students.

The quantity and quality of high school experiences determine the preparedness of students for college. Males and females are not equally prepared, especially not in mathematics and science. Sells' (1980) study of freshmen at University of California in 1972, demonstrated a "critical filter" in that 57% of males but only 8% of females had sufficient high school math to enroll in freshman calculus. Recent estimates indicate that such discrepancies in mathematics preparation have fortunately diminished (Armstrong, 1985).

Stanley (1986b) argued for "curricular flexibility" or acceleration to meet the educational needs of talented youth in mathematics. Although Kulik and Kulik's (1984) analysis of research on acceleration suggested it does not cause social-emotional problems, Feldhusen (1989) pointed out that "critics--especially school personnel--fear that gifted and talented youth will suffer from social immaturity in an accelerated setting" (p. 8). Indeed, females engage in acceleration less frequently than males despite its academic advantages (e.g., Benbow, 1983). Acceleration in mathematics among gifted students does not reveal any harmful effects as a result of acceleration (Brody & Benbow, 1987); it actually appears to enhance career aspirations in mathematics and science (Swiatek & Benbow, in preparation).

<u>In-school instruction</u>. Preparation in mathematics is important for career achievement in mathematics and science (Heller & Parsons, 1981). Thus, limiting the mathematical training of women precludes them from entering numerous careers. In the last two decades, analysis of course-taking in mathematics indicated boys took more math courses than girls (e.g., Armstrong, 1985; Benbow & Stanley, 1982; Eccles, Adler & Meece, 1984; Ernest, 1976; Fennema & Sherman, 1977; Mura, 1982). These gender differences in mathematics course participation in high school has become almost nonexistent in recent years (Armstrong, 1985, Benbow, 1988; Fennema & Sherman, 1977; Kimball, 1989). At the college level,

Boli and colleagues (1985) found no differences in undergraduate mathematics course participation between high ability males and high ability females.

For high ability students preparing for career options in science, DeBoer (1984) emphasized the importance of science courses:

> The more science courses students took in high school, the higher they rated their ability. The higher the grades the student received in those science courses, the more competent they felt .... Performance in early science courses [college] was related to the number of science courses taken in high school. (p. 8)

Thus, high school science courses serve as "interest development" in science for high ability students. If females enroll less frequently in such courses, their interest in science will be less well developed.

Benbow and Stanley (1982) and Benbow and Minor (1986) reported that SMPY males took somewhat more high school math and science than did SMPY females. Benbow and Arjmand (in press) found for males, and especially females, that high academic achievement in science related to preparation in math and science in high school. Benbow and Arjmand (in press) concluded:

> Schooling experiences designed for able students discriminated between high and low achievers .... Our data suggested that educational facilitation appears to be especially important for high female achievement .... Our data support the concept of intervention. To identify extremely mathematically talented youth early and then to provide them with special educational opportunities will increase the probability that students, especially female, remain in mathematics and science and attain high academic achievements. (p. 10)

Thus, educational experiences during adolescence are important influences on achievement in mathematics and sciences.

Out-of-school experiences. The influence of out-of-school activities are also powerful. Kimball (1989), in her review, found that outside of school boys have more science and mathematics related experiences than girls (e.g., Hilton & Bergland, 1974, Kahle, Matyas, & Cho, 1985). This is also the situation for mathematically talented students. Benbow and Stanley (1982) reported more boys than girls participated in math related activities outside the classroom. In science as well, Kahle (1985) suggested the advantages boys accrue due to more extracurricular science activities cannot be compensated by equal experiences in the science classroom.

Segal, Busse, and Mansfield (1980) found some relationship between adolescent experiences and adult creativity in science. In this male sample, 67% of the highly cited biologists had science related hobbies as children. One third reported an interest in science during high school and reported they spent a lot of free time working on extra projects and papers. Segal and colleagues determined that the variables associated with the college years (e.g., publishing articles, awards, etc.) were better predictors of success in careers. Yet, Segal and colleagues also acknowledged, that early experiences in high school may have developed or continued interest in science that stimulated the choice of college major.

Guidance activities. Guidance activities refer to opportunities to discuss career planning decisions with school personnel, including school counselors and teachers. Guidance activities are important because they provide a valuable source of information about personal awareness, careers, labor market needs, and requirements and opportunities in higher education.

Yet, in reality, the results of career counseling and guidance activities are not always positive. For example, Haven (1972) reported that 42% of the girls who were interested in math-related careers indicated that they had received no encouragement from their counselors to take advanced mathematics courses. Fox (1976) even noted that counselors actively discouraged mathematically talented girls from continuing their accelerated math training. From a guidance perspective for gifted students, Perrone (1979a) suggested counselors need to realize the unique career development needs of gifted individuals. Although the focus of career guidance is to facilitate decision-making, the results suggest that the gifted populations are not properly served. Post-Kammer and Perrone (1983) reported career-related perceptions of 648 adults identified as talented high school students. More than a quarter of them had felt unprepared to make career decisions after high school and indicated that their high school counseling had been poor or inadequate. Even among the gifted, Eccles and Hoffman (1984) reported that school counselors do not promote nontraditional education and occupational choices for either boys or girls.

Special achievements, and awards. Achievements or special recognitions are local, state, national, or international awards or prizes in any academic area received by students. These opportunities introduce students to contacts outside the family, school, or even community, and may spark greater interest in the field or, eventually, careers. Consistent with social learning theory of career decision-making (Krumboltz et al., 1976), special achievements or awards are highly reinforcing events to individuals. The public recognition of their talent or abilities reinforces feelings of self-confidence and achievement.

With mathematically talented students, over 67% of the SMPY students in Benbow's (1983) follow-up reported one or more academic awards during high school and 5% of SMPY students received a National Merit Scholarship (highest level of that competition).

Gender differences in participation in math and science contests exist with mathematically talented students. In a follow-up of talented students, Michael (1983) reported a negative relationship between SAT-M scores and extent of participation in science fairs for girls. The positive relationship for boys between SAT-M scores and amount of involvement in mathematics contests was not found for girls.

In summary, educational opportunities provided to secondary students, including the gifted and mathematically talented, are important variables affecting achievement. Curricular offerings, type and location of school, options for acceleration, and instructional activities (both in-school and out-of-school) provide a base of learning experiences that promote development of interest in mathematical and scientific fields.

Part Three: Summary and Research Questions

Theories of achievement motivation and career decision-making provide the background for this study. Achievement motivation suggests that individuals differ in their pursuit of goals. Gender differences in achievement motivation are apparent, but usually do not become significant until college. The review of literature indicated that personal factors, family factors, and educational experiences influence career aspirations.

Achievement-related personal traits associated with high achievement include perseverance, integration of goals, and self-confidence. High measured ability is important but serves as a floor effect. That is, beyond a certain level of ability, other factors become more important to career choice. Self-perceptions are also important for career achievement. Females have lower perceptions of their abilities than do males. This is even the case among the gifted. While interest in mathematics and viewing mathematics as valuable to future career goals are related to high achievement, gender-role orientation affects how the individual views subjects, such as mathematics. Mathematically talented females portray acceptance of many math-science careers as consistent with their gender identity.

Family factors such as socioeconomic status, type of school, and parents' educational level relate to career aspiration and achievement in mathematics and science. Expectations and encouragements of parents, plus interactions with peers and significant others, also relate to career achievement. Among mathematically precocious students no gender differences in parental encouragement have been found. Yet, parental encouragement does relate to achievement and aspirations.

Educational factors (e.g., curriculum offerings and flexibility, instruction, guidance activities, and special achievements) are related to career aspiration and achievement. That is, curriculum offerings and related course work during high school affect the preparedness of students for higher education and may spark interests in science careers. Many educational variables are important predictors of high achievement with mathematically talented students.

Guidance activities focus on career decision-making as a unifying theme of career counseling. Experiences with counselors as revealed by gifted students, especially such females, indicate that they may not be appropriately served. Special awards/recognitions received by talented students reinforce self-confidence and introduce students to opportunities beyond the family, school, or community. Adolescent creativity is related to later adult creativity, but productivity during the college years may be a better indicator of later creativity than similar experiences during high school. To determine the career aspirations of 700M females and the possible influences of personal, family, and educational factors, the following research questions were advanced.

Research Questions

1. What are the career aspirations of mathematically precocious females during adolescence and young adult years?
2. What are the educational choices of mathematically precocious females during the young adult years as indicated by college selected, college major, and plans for undergraduate and/or graduate study?

3. What are the lifestyle expectations of mathematically precocious females during the young adult years? How do they relate to career choice?

4. What personal factors influenced the career decisions of mathematically precocious females?

   4A. What influence/role did achievement-related personal traits play in career decisions?

   4B. What influence/role did measured ability play in career decisions?

   4C. What influence/role did self-perceptions play in career decisions?

   4D. What influence/role did attitudes and interests in school subjects play in career decisions?

   4E. What influence/role did sex-typing of occupations play in career decisions?

   4F. What influence/role did personal relationships play in career decisions?

5. What family factors influenced the career decisions of mathematically precocious females?

   5A. What influence/role did family background have on career decisions?

   5B. What influence/role did expectations of parents play in career decisions?

   5C. What influence/role did encouragement from parents play in career decisions?

6. What educational experiences influenced the career decisions of mathematically precocious females?

   6A. What influence/role did various acceleration options play in career decisions?

   6B. What influence/role did in-school instruction in mathematics and science play in career decisions?

   6C. What influence/role did out-of-school activities play in career decisions?

   6D. What influence/role did guidance activities play in career decisions?

   6E. What influence/role did special awards or recognition of achievement play in career decisions?

CHAPTER III. METHODS

Introduction

The purpose of this study is to document the career aspirations, educational choices, and lifestyle expectations of mathematically precocious females. Determining the possible influence of personal factors, family factors, and educational experiences upon career aspirations is the second objective of the investigation. The methods used in this study are explained in Chapter III, which includes an overview of qualitative methods, multiple-case study method and design, subjects, instrumentation, data collection, propositions, and analysis techniques. Because the alternate dissertation format is used, a brief statement of results follows each proposition.

Overview of Qualitative Methods

Qualitative research is also referred to as field research, naturalistic, ethnographic, phenomenological case study, interpretive, and descriptive (Bogdan & Biklen, 1982). In the late 1960s, qualitative research in education increased in popularity as a viable research method. In this methodological paradigm, Burgess (1985) explained:

> ... that researchers who have utilized a qualitative approach in their investigations have tended to use a range of methods, styles and strategies based upon social interaction with those whom they study, observation of people, situations and events, formal or informal interviewing, and the collection of documentary materials. (p. 4)

Burgess (1985) stressed that there are some common attributes in qualitative studies. The following principles apply to this study:

> 1. ... the findings are contextualized within a social, cultural and historical framework.
>
> 2. The research is conducted within a theoretical framework. While there may only be a small number of questions to orientate a study, further questions may arise during the course of the investigation.
>
> 3. The research involves close, detailed intensive work ....
>
> 5. Unstructured or informal interviews in the form of extended conversation ....
>
> 6. Personal documents may give depth and background to the contemporary account.
>
> 11. Research reports disseminate the knowledge which informants have provided without rendering harm to them, taking into account ethical problems that confront the researcher and the researched.
>
> 12. The researcher monitors the dissemination of materials and provides feedback to those who have been researched. (Burgess, 1985, pp. 4-5)

These principles guided this investigation.

Multiple-Case Study Method

Because the purpose of this study is descriptive, a multiple-case study method and design was deemed appropriate for investigating the career aspirations of mathematically precocious females. The researcher studied behaviors, decisions, and perceptions of mathematically precocious females (top 1 in 60,000) during late adolescence/young adult years. Specifically, the researcher asked: What are their career aspirations? What are their educational choices? What are their lifestyle expectations? What possible personal factors, family factors, and educational experiencess influenced their career decisions?

Process for multiple-case studies

A 10-step process for multiple-case studies (Yin, 1984), which consists of theory development, case selection, design, data collection, and cross-case analysis, involves the following:

(1) Develop Theory
   A. Relate study to previous theory
   B. Aim for explanation

(2) Select Cases

(3) Design Data Collection Protocol
   A. Define "process" operationally
   B. Define "process outcomes"
   C. Use formal data collection techniques

(4) Conduct 1st case study and write individual case report
   A. Interviews
   B. Documents

(5) Conduct 2nd case study and write individual case report

(6) Conduct remaining case studies, etc.

(7) Draw Cross-Case conclusions

(8) Modify Theory

(9) Develop Policy Implications

(10) Write Cross-Case Report. (Yin, 1984, p. 51)

Each of these 10 steps guided this study.

Multiple-case study design

When compared to a single-case study, evidence from multiple-case designs is usually considered "more compelling, and the overall study is considered more robust" (Yin, 1984, p. 48). Its drawback, however, is that multiple-case studies cannot consistently include the "unusual or rare case, the critical case," that are so often chosen in the single-case study. Yet, this study is unique because it is not subject to that criticism. All the individuals to be studied have been identified as "rare, unusual, or critical" on the basis of their extremely high scores on the SAT-M, i.e., the top one-hundredth of one percent (Stanley, 1986a).

This study utilized the embedded multiple-case study design (Yin, 1984) because within each case study there were six subunits of analysis: career aspirations, educational choices, lifestyle expectations, personal factors, family factors, and educational experiences. The embedded design was chosen because these subunits were identified by the literature review as possibly influencing achievement motivation and career decision-making.

Yin (1984) suggested that when the embedded design is used, each case study may in fact include the collection and analysis of highly quantitative data. Rather than pooling data across the subunits of analysis across individuals (e.g., survey results), the results from case studies are used to create individual profiles. Replications of findings across profiles are then made. Thus,

> ... each individual case study consists of a "whole" study in which convergent evidence is sought regarding the facts and conclusions for the case; each case's conclusions are then considered to be the information needing replication by other individual cases. (Yin, 1984, p. 52)

In this study, career aspiration profiles for each mathematically talented girl (i.e., case study report) were developed. These profiles were used to investigate the patterns and trends of career aspirations among mathematically precocious females.

Three design tests for case studies. Kidder (1981) identified three validity/reliablity tests that are appropriate for descriptive case study designs: construct validity, external validity, and reliability (cited in Yin, 1984). Each will be described below, as well as how they were operationalized in this study.

Construct validity (Kidder, 1981) refers to the challenge of developing an "operational" set of measures that can be used to collect the data (cited in Yin, 1984). To meet the requirement of construct validity, selected measures must reflect the characteristics or traits of interest. In this study several steps were taken to insure construct validity: (1) Each of the subunits (i.e., career aspirations, educational choices, lifestyle expectations, personal factors, family factors, and educational experiences) were operationally defined. (2) Research questions were formulated on each subunit and reviewed for appropriateness by a panel of experts from psychology, education, and anthropology. Revisions were then made by the researcher. (3) Multiple sources of information were used. Data from 700M females and their parents from four questionnaires were used because the subjects are part of a national longitudinal study. (4) Selected items from the questionnaire and interview protocol were matched with each research question; this outline was reviewed by the panel of experts and revised accordingly.

External validity involves generalization beyond the immediate study. Differences in the types of generalization allowed comprise an important distinction between inferential and descriptive studies. In case studies, only analytical generalizations are allowed. Analytical generalization involves "striving to generalize a particular set of results to some broader theory" (Yin, 1984, p. 39). A generalization is first made for one case study and then tested through replications of the findings with additional cases. In this study, external validity is assessed by replicating findings among the 700M females. If replication occurs to a great extent, analytical generalizations can be made. Such generalizations add to our broader understanding of career aspirations and achievement among mathematically precocious females.

Reliability refers to the possibility that another investigator could replicate the study with similar results. The goal of reliability is to minimize error and bias in a study (Yin, 1984). To insure reliability, Borg and Gall (1983) suggest the researcher records the interviews, completes the interview protocols, and then randomly selects several of the taped interviews to generate new protocols. The results of the two protocols for each subject are compared and reliability estimated. In this study, since all interviews were transcripted by the researcher and edited by a trained stenographer, all interview protocols were checked on two occasions. Corrections were made to original protocols to assure accuracy.

Subjects

Using the College Board's Scholastic Aptitude Test (SAT) as a screening device, 24 females were identified for the "700-800 on SAT-M before age 13" group by SMPY's talent searches conducted between 1981 and 1983. The subjects were born between 1968 and 1970 and, at the time of SAT-M testing, were 12 years of age. One subject had turned 13 before taking the test, but her score was adjusted to reflect the difference in age. The selected 24 females constituted the oldest and largest possible group with the fewest number of years variance in age. Upon investigation of student files, complete data from four questionnaires was available for 17 females (71%), therefore, they were selected as subjects for case studies. Single-case studies were completed for 15 700M females (88%) who agreed to be interviewed. The other 2 700Ms (13%) declined to be interviewed. Throughout this study the females identified as "mathematically precocious" at age 13 are referred to as "mathematically precocious" or "mathematically talented," although, at age 21, their precocity is less evident than at age 13.

The following information about SAT scores, family background, home state, as well as parents' annual income, educational level, and occupational choice is intended to present a more complete background on the subjects selected for this study. Background information on subjects was compiled from questionnaires completed after Talent Search identification and after high school. Data collected from telephone interviews were compared to this preliminary data to see if there were changes in these variables from age 13 to 19-21, and whether there were differences in the variables between the interview group and the noninterview group.

The SAT-M scores of the 24 eligible subjects ranged from 700 to 780. The mean SAT-M was 732 with a standard deviation of 24. The SAT verbal scores ranged from 360 to 630. The mean SAT-V was 528 with a standard deviation of 83. The Pearson product-moment correlation between SAT-M and SAT-V was -.074, which was not significant. This suggests that there is no relationship between their math scores and their verbal scores, as would be expected in this restricted group.

Similarly, the SAT-M scores of the 15 females interviewed ranges from 700 to 770 with a mean SAT-M of 730 with a standard deviation of 22. The SAT-M scores of the 9 females not interviewed ranged from 700 to 780 with a mean SAT-M of 734 and a standard deviation of 28. Using a t-test, these differences were not significant. The mean SAT-Verbal scores for the interview group were slightly higher (542) than the noninterview group (503), but again, these differences were not significant.

At Talent Search identification, the subjects lived in 12 states: California (2), Hawaii (1), Illinois (3), Kansas (1), Maryland (3), Michigan (1), New Jersey (7), New York (3), North Carolina (1), Virginia (1), Washington (1), and Wisconsin (1). At the time of interviews, families of the 15 700M females interviewed lived in 8 states, which included a combination of East Coast, West Coast and Midwest. The families of the noninterview group lived in 5 states with a similar geographic distribution.

In 1989, the 15 700M females interviewed attended colleges or universities in 6 different states and 1 foreign country. These included: Connecticut (1), Massachusetts (7), New Jersey (2), Rhode Island (2), Texas (1), Pennsylvania (1), and Oxford, England. Twelve of the 15 700M females (80%) attended out-of-state universities for their undergraduate education.

By 1989, when 19-21 years of age, one 700M female (6%) was working full-time after finishing graduate school and four 700M females (27%) had graduated from the following universities: Johns Hopkins, Massachusetts Institute of Technology, University of Washington, and the University of California, Berkeley. At the time of interviews, 14 700M females (93%) attended the following universities either as undergraduates, graduates or medical students: Brown, Harvard, Massachusetts Institute of Technology, Princeton, Rice, Swarthmore, Yale, Harvard/MIT Medical School and University College, Oxford, England. The 700M females in the noninterview group also attended prestigious universities such as Columbia, Duke, University of California at Berkeley, Harvard, and University of Maryland. Colleges selected for four 700M females (17%) was unknown.

Fourteen of the eligible subjects (58%) reported race/ethnic background as "White or Caucasian," while 10 of the subjects (42%) reported "Oriental, Asian-American, or Pacific Islander." The 15 interviewed consisted of 10 "White or Caucasian" females (67%) and 5 "Asian-Americans" females (33%). The noninterview group consisted of 4 "White or Caucasion" females (44%) and 5 "Asian-Americans" (60%). Although there were slightly more Asians in the noninterview group than might be expected, racial distribution of the interview group appeared to be consistent with the total group identified.

The 24 subjects had 10 older siblings and 18 younger sibling, with 13 brothers and 15 sisters. One subject was a twin. Fifteen females (63%) were the oldest child in the family, including 4 (17%) who were only children and 7 (29%) who were youngest children. From the 15 in the interview group, 11 females (73%) were the oldest including 3 (20%) who were only children and 4 (27%) who were youngest children in their family. Family composition of the interview group appeared to be similar to the total group identified.

Socioeconomic background, indicated by education, occupation, and income level of parents, was very high. All but 2 of the fathers had furthered their education beyond college. Overall, 23 of the fathers (96%) completed at least a B.A. degree, while 12 had Ph.D.s (50%) and 4 had M.D.s (17%), 1 had an advanced law degree (6%), 5 had master's degrees (20%). All but 6 of the mothers had furthered their education beyond college. Twenty of the mothers (83%) had completed at least a B.A. degree, while 5 had Ph.D.s (21%), 1 had a M.D. (6%), 11 had master's degrees (46%), and 2 had B.A. degrees (13%).

In the interview group, eight fathers (53%) of 700M females had Ph.D.s, two (13.3%) had M.D.s, four (27%) had master's degrees, and one father had a B.A. Similarly, in the noninterview group, four (44%) had Ph.D.s, two (22%) had M.D.s, while one father had a Doctorate of Jurisprudence, one had a master's degree and one had a technical-vocational program beyond high school. Educational level of the fathers of 700M females in both groups appears to be very similar.

In the interview group, three mothers (20%) of 700M females had Ph.D.s, seven (47%) had master's degrees, one (6%) had graduate hours beyond the B.A., and three (20%) had some college after high school graduation. Similarly, in the noninterview group, two (22%) had Ph.D.s, one had an M.D., four (44%) had master's degrees, one mother had a B.A., and one mother was a high school graduate. Educational level of the mothers of 700M females in both groups appeared to be very similar.

Fathers were generally engaged in professional occupations. Occupations of fathers of 700M females interviewed included: four college professors (math, economics and law), three physicians, two engineers, two managers, one physicist, one research associate, one magazine editor, and one electronics technician. Similarly, the occupations of fathers of 700M females in the noninterview group included two doctors, two engineers, one college professor, one manager, one physicist, one lawyer, and one mechanic.

Occupations of mothers of 700M females interviewed were more diverse by occupational titles, but could be grouped into clusters of education, medicine, business, or homemaking. Four mothers of 700M females (27%) worked in an educational setting as an assistant professor, an educational consultant, a violin teacher, and a financial aid counselor; five mothers who worked in math/science-medical-related fields included a research chemist, a pre-medical advisor, a school nurse, an information specialist, and a cost accountant. Three mothers (20%) worked in humanities and social sciences including an editor/writer, art historian/writer, and a counseling psychologist. Two (13%) were homemakers. In the noninterview group similar categories were represented with one clinical microbiologist, one secretary, one library director, and one associate editor and four (27%) homemakers.

Family incomes, based on 1983 dollars, with 19 families (80%) of 700M females reporting, ranged from \$20,000-\$29,999 to \$60,000+. Reported range of annual income from families of 15 700M females interviewed included: $20,000-$29,999 (1), $30,000-$39,999 (3), $40,000-$49,999 (1), $50,000-$59,000 (4), and $60,000+ (4), with two families not reporting the range. The reported range of annual income from families of 9 700M females not interviewed included $30,000-$39,000 (1), $60,000+ (5), with three families not reporting the range. The median range for the interviewed group was $50,000-$59,999 and the median range for the noninterviewed group was $60,000+. While the interview group scattered across five income ranges, the noninterview group clustered at the higher income range. However, with equal numbers at the $60,000+ range, these differences were not considered important differences in family income.

In summary, the 15 700M females who participated in this study were similar to the nine 700M females not interviewed on the following variables: SAT-M scores, SAT-V scores, age, ethnicity, geographic distribution of home state, size of family, family income, birth order, selection of college for undergraduate education, educational background, and occupational status of parents. Typically, 700M females tended to be the only child or the oldest child in a family where both parents were well educated, career-oriented, and maintained a relatively high annual income. At age 19 to 21 years, 700M females tended to be full-time undergraduate, graduate or medical students at prestigious universities on the East Coast. There were relatively few changes in these variables from age 13 to age 19-21 years.

Instrumentation

Questionnaire protocol

Background information on the subjects was obtained from the four questionnaires during 1982 to 1988. The Talent Search Questionnaire (TSQ), the first questionnaire to be completed at age 13 (100% return), included 48 items requesting general information, family background, general academic interests, academic coursework, and plans for the future. The Student Questionnaire (SQ) included 63 items requesting family background, school environment, educational experiences, leisure activities, attitudes, and achievements (88% return). The Questionnaire for Parents (PQ) had 47 items requesting information on background, physical characteristics, and home environment (88% return). These two questionnaire were completed by the subjects when they were in the 8th grade. The After High School Follow-up (AHS or RAHS), completed by the subjects in December of their 18th year (83% return), had 100 items requesting general information about grades 8-12, post-secondary education, achievements, attitudes and interests, employment and family information.

Each of the questionnaires was analyzed for information regarding the six research questions. An item was selected if it appeared to relate to one of the research questions: 1) Personal factors (e.g., achievement-related personal traits, measured ability, self-perceptions, attitudes and interests, gender-role orientation, and personal relationships), 2) Family factors (e.g., family background, expectations and encouragment of parents), 3) Educational experiences (e.g., curricular offerings, in-school instruction, out-of-school activities, guidance, awards, and achievements).

The outline of research questions and selected item from the questionnaires are included in Appendix A. A total of 112 items were selected: 29 items from the Student Questionnaire, 14 from the Parent Questionnaire, 24 from the Talent Search Questionnaire, and 45 from the After High School Follow-up.

Interview protocol

After preliminary data collection for 17 700M females, a draft copy of the interview protocol was critiqued by two members of the committee and revised. The interview protocol (Appendix B) guided the interviews which were tape recorded and transcribed. During October of 1989, each 700M's parents were contacted by letter to explain the purpose of the study and request their daughter's college address and phone. Follow-up telephone calls to parents not responding to the mail request were made to several parents. 700M females were then contacted by telephone to request their participation in telephone interviews. A week before the interview, a follow-up letter to each 700M female confirmed the date and time of the interview. Interviews were conducted from October to December of 1989 and ranged from 60 to 90 minutes in length.

Data Collection

The questionnaire protocol (Appendix A) guided the data collection for each subject. The use of computer data bases aided the researcher in recording, organizing, and analyzing data for each research question. A written narrative was developed for each case study. Analysis of the data bases and narratives generated questions and ideas for the telephone interviews. Written narratives were completed for all 17 questionnaire protocols.

After contacting the participants, interview protocols were completed during each interview. Before each interview, pertinent information from the subject's file was added to the interview protocol to document information at age 13 and age 18 on selected items. After each interview, the researcher listened to the tape immediately to verify a good recording and double-check coding of forced choice answers on the interview protocol. Manuscripts of the tapes were typed and edited by a trained stenographer. This insured accuracy of opened-ended answers when quoting 700M females.

As the case report was completed and/or revised as needed, information was added to the data base. The researcher examined the data and compared data to establish criteria to determine if the proposition was verified by each case study (a majority of criterion). From these findings and subsequent replication of propositions (a majority of 700M females), it was determined whether patterns or trends in the career aspiration profiles existed across the group of 700M females. A sample of a single-case study is included in Appendix C as an example of the types of information reported for each case and represents the 700M female who verified all but two of the propositions.

Analysis of Propositions

This section contains the propositions, procedures, predictions, and criteria for analysis for each research question. At the conclusion of each proposition there is a brief statement of results.

Research Question 1. What are the career aspirations of mathematically precocious females during adolescence and young adult years?

Proposition 1: During adolescence and young adult years mathematically precocious females aspire to mathematical, scientific, engineering, or medical careers.

Career aspirations (SQ 30, AHS 11, RAHS 11, and I 19) were listed verbatim from questionnaires and then coded by 1) field of study, 2) type of position, and 3) level or setting of the work place. The current career aspirations and reasons for choosing a particular field of study were explored during telephone interviews. Reasons were listed, grouped, and summarized in case study narratives.

Occupations were categorized following the procedures used in The Dictionary of Occupational Titles and its supplements (1982, 1986). According to this traditional source for occupational coding "0/1 Professional, Technical, and Managerial Occupations" consists of:

> occupations concerned with the theoretical and practical aspects of such fields of human endeavor as: architecture; engineering, mathematics, physical sciences; social sciences; medicine and health; education; museum, library and archival sciences; law; theology; the arts; recreation; administrative specialists; and management. (p. 15)

Prediction: Literal replication. If the stated career aspiration was found under the headings of occupations in: architecture, engineering, mathematics and physical sciences, life sciences, or medicine and health, the proposition was verified. Results indicated 700M females aspired to careers in mathematics, science, engineering, architecture, or medical fields at a 2 to 1 ratio over other career choices. Since replication occurred for a majority of cases, Table 1 indicated career aspirations of 700M females at three time intervals (i.e., age 13, age 18, and age 19-21). Table 1 demonstrated clustering in mathematical and scientific fields over time. Career aspirations of 700M females remained stable from late adolescence to young adulthood.

Research Question 2. What are the educational choices of mathematically precocious females during the young adult years as indicated by college selected, college major, and plans for undergraduate and/or graduate study?

Proposition 2. During the young adult years, mathematically precocious females aspire to advanced degrees in mathematics, science, engineering, or medicine from prestigious colleges and universities.

The intended college major (AHS 42, RAHS 41, I 13), the college selected (AHS 36b, RAHS 38, and I 1), and the educational aspiration or degree goal (AHS 9, RAHS 2-11, I 7) were examined. Interviews confirmed current college attended or graduation date, declared undergraduate major and plans for advanced degrees. The interviewer explored reasons for degree goal and major, which were listed, grouped, and summarized.

The college/university selected by each subject was rated according to Barron's Guide to the Most Prestigious Colleges, 4th Edition (1986). This guide acknowledges that:

Table 1. Career aspirations of SMPY 700M Females from adolescence to young adult years

Career Choice/ Code Name	Time 1 (13 yrs.) Field of study Position Level/Setting	Time 2 (18 yrs.) Field of study Position Level/Setting	Time 3 (19-21 yrs.) Field of Study Position Level/Setting
Architecture, engineering			
Wilma	Undecided	Architecture Architect Own firm	Architecture Architect Head of firm
Louann	Undecided Research	Electr. Engineer Res/Prof/Teaching University	Optics Communic. Dev/Research Corporate/Univ.
Mathematics			
Tara	Applied Math Statistician Upper Management	Applied Math Computer Scientist No response	Applied Math[a] Perform. Analyst[a] Distinguished member of of Technical Staff
Jane	Ph.D.	Mathematics Professor Head of Math Instruction	Mathematics Professor University Head of Dept.
Sandy	No response	Mathematics Teacher, Actuary Public, Private	Mathematics Professor Secondary School or University

[a]Achieved career aspiration.

Table 1. Continued

Career Choice/ Code Name	Time 1 (13 yrs.) Field of study Position Level/Setting	Time 2 (18 yrs.) Field of study Position Level/Setting	Time 3 (19-21 yrs.) Field of Study Position Level/Setting
Sciences			
Hilda	No response	Biochemistry Researcher Undecided	Biochemistry Researcher College/Government
Carol	Undecided	Neurology Molecular Biology Genetics, Biophysics, etc. Researcher/ Academician Undecided	Molecular Biology Researcher/ Professor University
Medicine			
Priscilla	Medicine Physician/ Researcher	Medicine Physician Undecided	Medicine Physician Hospital/ Private Practice
Tonya	Medicine Researcher	Medicine Physician No response	Medicine Physician Undecided
Trudy	Medicine Physician/ Researcher No response	Medicine Physician Researcher Professor Med School	Medicine Physician/ Researcher/ Professor Undecided

Table 1. Continued

Career Choice/ Code Name	Time 1 (13 yrs.) Field of study Position Level/Setting	Time 2 (18 yrs.) Field of study Position Level/Setting	Time 3 (19-21 yrs.) Field of Study Position Level/Setting
Other			
Rhonda	Undecided	Undecided	Sociology Sociologist University, Company/Government
Naomi	Law Lawyer No response	Immigration Law Lawyer No response	Immigration Law Lawyer (Defense) Undecided
Sally	Law, Math Philosophy Professor No response	Law, Philosophy Professor No response	Law, Philosophy Professor Law School
Gayle	Undecided	Russian, Computer Science Undecided Ph.D.	Undecided
Cathy	Undecided	Graduate school	Undecided

> Prestige, by its very nature, is difficult to assess .... Prestige is a very important phenomenon that, in the case of the college one attends, may play a very real part in a person's self-image and in others' perception of that person. On a more concrete level, the prestige enjoyed by a college can influence an alumnus' admission to graduate school or entry into employment .... We have defined [prestige,] as so many people do, as being synonymous with [admissions selectivity]. (p. iv)

In Barron's Guide to the Most Prestigious Colleges (1986), colleges and universities are grouped according to the "most competitive," "highly competitive," and "very competitive." According to this guide, the most competitive schools have very selective admission standards.

> In general, these colleges require high school rank in the top 10% to 20% and grade averages of A to B+. Median freshman test scores at these colleges are generally between 625 and 800 on the SAT and above 27 on the ACT. In addition, many of these colleges admit only a small percentage of those who apply--usually fewer than one-third. (p. v)

In contrast, the "highly competitive" schools accept students from the top 20 to 35 percent, median freshman scores range from 575 to 625 on the SAT and 26 to 27 on the ACT, and these schools generally accept up to one-half of their applicants (p. v).

Prediction: Literal replication. If the college or university selected by the subject was listed on either the "most competitive" or the "highly competitive" category; if the college major selected by the 700M female included: sciences, mathematics, engineering, architecture, or medicine (e.g., using the college or university department or program as a guide); and if the subjects aspired to an advanced degree beyond the Bachelors Degree, the proposition was verified.

Results indicated 700M females aspire to advanced degrees, (i.e., M.S., J.D., Ph.D, or M.D.) in their chosen career field, while choosing a variety of undergraduate majors in mathematics, sciences, engineering, architecture, or medicine (Table 2). Consistently, 700M females attended prestigious colleges and universities. Since replication occurred, Table 2 summarized degree goal, undergraduate major, and college attended by career field aspiration groups. There were no differences in educational goals by career field aspiration groups.

Research Question 3. What are the lifestyle expectations of mathematically precocious females during the young adult years? How do they relate to career choice?

Proposition 3. During the young adult years, mathematically precocious females indicate an intention to combine career-marriage options.

Lifestyle expectations (SQ 54a, 54b, 54h, 54i, and 54k; AHS 74a, 74b, 74h, 74i, and 74k; or RAHS 154, 155, 161, 162, and 164) were compared. Several items from these questions, such as 1) "being successful in my line of work," 2) "finding the right person to marry and having a happy family," 3) "living close to parents," 4) "getting away from the area," and 5) "having children" were entered into a data base with responses obtained at age 13 and age 18. These lifestyle expectations were described in the single-case study reports.

Lifestyle expectation (AHS 75, RAHS 166, and I 36) indicated an intention to combine career-marriage-family options. Marriage was deemed essential for the dual role of worker and homemaker, but the choice of having children was viewed as a third role of being a parent,

Table 2. Degree goal, college major, and college/university selected by SMPY 700M females, arranged by career aspiration group at age 19-21

Career Choice/ Code Name	Degree Goal	Undergraduate Major	Undergraduate College/ University Attended
Architecture, Engineering			
Wilma	MA	Architecture	Massachusetts Institute of Technology[a]
Louann	Ph.D.	Electrical Engineering[b]	University of Washington[b]
Mathematics			
Tara	MS[b]	Mathematical Sciences[b]	Johns Hopkins University[a,b]
Jane	Ph.D.	Mathematics	Massachusetts Institute of Technology[a]
Sandy	Ph.D.	Mathematics	Swarthmore College[a]
Sciences			
Hilda	M.D./Ph.D	Biochemistry	Harvard University[a]
Carol	Ph.D.	Physics	Harvard University[a]
Medicine			
Priscilla	M.D.	Biochemistry	Harvard University
Tonya	M.D.	Health and Society	Brown University
Trudy	M.D.	Biology[b]	Massachusetts Institute of Technology[a,b]
Other			
Rhonda	Ph.D.	Sociology	Yale University[a]
Naomi	J.D.	Spanish/History	Rice University[a]
Sally	J.D.	Philosophy[b]	University of California-Berkeley[a,b]
Gayle	M.S.	Russian Studies	Brown University[a]
Cathy	Undecided	Undecided	Princeton University[a]

[a]Prestigious rankings in Barron's Guide.

[b]Completed degree, major or graduate of institution.

and therefore optional. The interview confirmed intention to combine career-marriage-family options. The researcher explored reasons for lifestyle expectation during the interview, which were listed, grouped, and summarized. The relationship between career aspiration and lifestyle expectation was explored in the telephone interviews.

Prediction: Literal. If one of the following answers was given, the proposition was verified:

- Have a full-time career, marry, and have children.
- Have a part-time career when children are small, full-time before they are born and after they're grown.
- Full-time career, marry, but no children.

Results indicated 700M females aspired to full-time careers. Over 80% have expectations to combine marriage and careers and 46% plan to have children. Since replication occurred, Table 3 indicated intentions to combine career-marriage-family options by career aspiration group. Unlike career aspirations, lifestyle expectations were not stable from late adolescence to young adult years. However, there tended to be no particular pattern emerging from the changes in expectations from age 13 to 21.

Research Question 4. What personal factors influenced the career decisions of mathematically precocious females?

Proposition 4. During late adolescence and young adult years, mathematically precocious females will cite personal factors (i.e., achievement-related personal traits, measured ability, self-perceptions, interests, gender-role orientation, and personal relationships) to be the "greatest" influence on their career decisions.

Table 3. Lifestyle expectation of SMPY 700M females by career aspiration field at age 19-21

Career Choice/ Code Name	Lifestyle Expectations
<u>Architecture, Engineering</u>	
Wilma	Full-time career, marry, undecided about children
Louann	Full-time career, marry, undecided about children
<u>Mathematics</u>	
Tara	Full-time career, marry, no children
Jane	Full-time career, marry, and children
Sandy	Full-time career, marry, and children
<u>Sciences</u>	
Hilda	Full-time career, marry, and have children
Carol	Part-time career when children are small, full-time career, before they are born/after grown
<u>Medicine</u>	
Priscilla	Full-time career, marry, undecided about children
Tonya	Full-time career, marry, and children
Trudy	Full-time career, marry, and children
<u>Other</u>	
Rhonda	Full-time career, remained unmarried
Sally	Full-time career, remained unmarried
Naomi	Part-time career, when children are small full-time career, before they are born/after grown
Gayle	Full-time career, marry, and undecided about children
Cathy	Full-time career, undecided about marriage, undecided about children

At the conclusion of the telephone interviews the various personal, family, and educational factors were reviewed by the researcher. Each subject was asked to designate the factor with the "greatest" influence on her career decisions.

Prediction: Literal. If the 700M female designated personal factors as the "greatest" influence on her career decisions, the proposition was verified. Overall, 67% of 700M females indicated that personal factors were the "greatest" influence on their career decisions. Since replication occurred, Table 4 charted choices by career aspiration field. 700M females aspiring to nonmath/science careers tended to rank personal factors as the greatest influence (80%) compared to 60% of math/science career aspiration group.

Research Question 4A. What influence/role did achievement-related personal traits play in career decisions of mathematically precocious females?

Proposition 4A. Achievement-related personal traits of mathematically precocious females match those identified in the literature as conducive to the development of potential and achievement.

Eight achievement-related personal traits identified from the review of literature were listed on a matrix of traits and the number of matches were reported for each 700M female. Information on personality traits (PQ 39, SQ 51 and AHS 72), as well as interest in academic success, interest in being a leader, and recognition of accomplishments (AHS 15 a and b, or RAHS 14, AHS 26, RAHS 34, SQ 33, AHS 16, RAHS 17, AHS 33, RAHS 20, AHS 34 RAHS 21), were recorded in the data base.

Measures of self-confidence were taken from four items in SQ 52. Descriptions of achievement-related personal traits at age 13 and age 18 (where available) were summarized in the single-case study narratives.

Prediction: Literal Replication. If the subject had four (50%) or more matches of personal traits, the proposition was verified. Overall, 11 700M females (73%) matched achievement-related personal factors identified. As a group, they consistently supported three indicators of high achievement: 1) interest in high academic success, 2) in being a leader, and 3) in recognition of accomplishments. Of the remaining five personality descriptors, only two were consistently replicated. These traits were "self-sufficient or independent" and "self-confident." Table 4A demonstrated clustering of achievement-related personal traits by career aspiration field. The math/science aspiration group and those aspiring to other careers replicated the proposition. However, the nonmath/science group showed greater interest in being a leader and rated themselves as "risk-takers" more frequently than the math/science aspiration group.

Research Question 4B. What influence/role did measured ability play in career decisions of mathematically precocious females?

Proposition 4B. Recognition of high measured ability in mathematics was influential in career decisions of mathematically precocious females.

The influence of the high mathematical reasoning ability on career decisions was explored during interviews (I 49, I 50 and I 51). Responses from 700M females were classified as: "influential" or "noninfluential." The career decision and the reasons explaining the influence of high math ability were listed, grouped, and summarized. Explanations of influence of high math ability were included in single-case narratives along with other indicators of ability, including percentile rank in the graduating class (AHS 15a) and grades received (AHS 18).

Prediction: Literal Replication. If the subject stated that the recognition of her high measured ability in mathematics was "influential" in her career decision, the proposition was verified. Overall, 12 700M females (80%) indicated that their high mathematical ability was "influential" on their career decisions. Since replication occurred, Table 4B listed the type of influence by career aspiration group. The math/science aspiration groups (90%) were more likely to cite influence of high mathematical ability on career decisions than those aspiring to other careers.

Research Question 4C. What influence/role did self-perceptions play in career decisions of mathematically precocious females?

Proposition 4C. Self-perceptions among mathematically precocious females were positive.

Responses to six statements regarding self-perception of ability (TSQ 46, 47, SQ 52a, SQ 52c, SQ 52d, SQ 52h) were listed. The number of "agree" or "strongly agree" responses to four items measuring confidence or locus of control on SQ 52 were recorded. These measures included: 1) "I take a positive attitude toward myself." 2) "I feel I am a person of work on an equal plane with others. 3) "I am able to do things as well as most other people." and 4) "On the whole I am satisfied with myself." Two other questions measuring self-perceptions of ability (TSQ 46 and TSQ 47) were: "How comfortable are you with your high intellectual ability? How does your intellectual ability affect the opinion that others (friends, relative, etc.) hold of you?" Self-perceptions of intellectual ability at age 19-21 were explored during interview and descriptions were included in single-case narratives.

Prediction: Literal Replication. If 700M females agreed with three or more out of the six selected items on self-confidence and perceptions of ability, the proposition was verified. Overall, 14 700M females (93%) had positive self-perceptions at age 13 and with 9 700M females reporting at age 18, 9 (100%) had positive self-perceptions. Since replication occurred, Table 4C demonstrated influence of self-perceptions of ability on career decisions by career aspiration group. No differences in self-perception existed between the career aspirations groups at age 13 or at age 18.

Research Question 4D. What influence/role did attitudes and interests in school subjects play in career decisions of mathematically precocious females?

Proposition 4D. During adolescence mathematically precocious females hold positive attitudes toward a variety of subjects in school.

Responses by subjects at age 13 to items measuring attitudes held toward a variety of school subjects including: mathematics, computer science, English/literature, foreign language, natural science, physical science, and social studies (SQ 32, SQ 36 and SQ 37) were compared to responses after high school (AHS 24A and 67-70). Responses from each subject were described in narrative single-case study narratives. 700M females indicated whether they 1) liked the subject, 2) were confident in their abilities, and 3) whether they found the subject interesting, 4) easy, and 5) useful to their planned career. Positive answers were "very ..." or "somewhat ..." in each category. Where possible, comparisons of interests at age 13 and age 18 were made to determine if interests of mathematically precocious females toward a variety of school subjects changed during adolescence. The influence of attitudes and interests in school subjects on career aspiration and college major was discussed during interviews. Competing interests, other fields or majors considered were discussed and reported in single-case study narratives.

Prediction: Literal Replication. If the 700M female indicated positive responses on four of the five items as "positive," then responses were charted as "a positive interest in that subject field." If the 700M female expressed a "positive interest" in four of the seven subjects listed, then replication occurred. Generally, attitudes toward seven school subjects were positive at age 13 but declined by age 18. Since replication occurred, Table 4D summarized the interests of 700M females by career aspiration group. A greater percentage of the math/science group was positive toward the math/science subjects at age 13 compared to those aspiring to nonmath/ science careers. However, at age 18, more of those aspiring to nonmath/science careers were positive toward all the subjects with the exception of mathematics. At both ages, the math/science group held positive attitudes toward mathematics, computer science, natural science and physical sciences; while the other group held positive attitudes toward English, foreign languages, and social sciences.

Research Question 4E. What influence/role did sex-typing of occupations play in career decisions of mathematically precocious females?

<u>Proposition 4E. Mathematically precocious females will identify both masculine and feminine characteristics as descriptive of a variety of occupations.</u>

Masculine and feminine characteristics of a variety of occupations as measured by SQ 50, PQ 42, and AHS 71 provided information on how the subject at age 13 and age 18 and her parents viewed various occupations as "strongly masculine," "strongly feminine," "both masculine and feminine," or "neither masculine nor feminine." The occupational areas rated were: engineering and computer science, mathematics, natural sciences, physical sciences, humanities and fine arts, and social sciences. A description of whether the 700M females and their parents sex-typed the occupational areas was summarized in single-case study narratives.

Since sex-typing information at age 18 was only available for five subjects, the interviewer explored current conceptions of sex-typing to a variety of careers using the same items (AHS 71).

<u>Prediction: Literal Replication</u>. If the subjects identified "both masculine and feminine" or "neither masculine nor feminine" for four of the six disciplines, then sex-typing did not occur and the proposition was verified. Overall, 10 700M females (76% with 13 reporting) did not

sex-type a majority of career fields at age 13 and 8 700M females (53%) did not sex-type themselves. Since replication occurred, Table 4E summarized sex-typing of occupational fields by 700M females by career aspiration group.

Research Question 4F: What influence/role did personal relationships play in career decisions of mathematically precocious females?

Proposition 4F. Personal relationships with teachers, peers, and significant others influence career decisions of mathematically precocious females.

The influence of personal relationships with peers and significant others (TSQ 20 and 21, SQ 64a, AHS 55, RAHS 83) were identified. Additional information about personal relationships was explored by the interviewer (I 54, I 55, I 56). Six variables were identified: 1) significant person on educational decisions at age 13, 2) significant event influenced educational decisions at age 13, 3) significant person influence educational decisions at age 18, 4) significant event influenced educational decisions at age 18, 5) teacher or friend influenced career decisions at age 19-21, and 6) "other" significant influence (not parents) on career decisions. Responses to the types of relationships and the importance of these relationships were listed, grouped, and summarized in case study narratives.

Prediction: Literal Replication. If 700M females identified four of six "peer or significant other variables" as "influential" on educational and/or career decisions, the proposition was verified. Generally, eight 700M females (53%) cited peers, teachers, and significant others as "influential" on career decisions. Since replication occurred, Table 4F summarized the results by career aspiration group. The nonmath/science career group (60%) was influenced by peers and significant others similarly to the math/science group (50%).

Research Question 5. What family factors influenced career decisions of mathematically precocious females?

Proposition 5. During late adolescence and young adult years, mathematically precocious females will cite family factors (i.e., family background, expectations of parents and encouragement from parents) to be the "second greatest" influence on their career decisions.

At the conclusion of the telephone interviews the various personal, family, and educational factors were reviewed by the researcher. Each subject was asked to designate the factor with the "second greatest" influence on her career decisions. Responses were organized in a data-base.

Prediction: Literal. If the 700M females designated family factors as the "second" greatest influence on her career decisions, the proposition was verified. Less than 50% of the 700M females agreed that family factors were the "second greatest" influence on their career decisions, therefore, the proposition was not replicated. Table 5 summarized the family influences by career aspiration group. No differences were found between career aspiration groups.

Research Question 5A. What influence/role did family background have on career decisions of mathematically precocious females?

Proposition 5A. Family background variables of mathematically precocious females (i.e., high socioeconomic status, high educational level for parents, high occupational status for parents, and childhoods in urban settings) were influential on career decisions.

Six family background variables, which relate to high achievement motivation were identified from the literature: 1) the educational level achieved by the mother, 2) educational level of father, 3) occupation of mother, 4) occupation of father, 5) family income, and 6) size of hometown. The occupation of parents when subject was in the 8th and 12th grade (TSQ 12-13, AHS 96a and b) was recorded. The highest educational degree awarded to parent (TSQ 11 and 16) when subjects were in 8th grade was recorded. The family income in 1983 dollars (PQ 24) was recorded. The location of the home (PQ 23) indicated type of setting (i.e., small town, city, suburb, etc.) in terms of population. The influence of these family background variables on career decisions was explored in the telephone interviews (I 64, I 65).

Prediction: Literal replication. If 700M females met criteria established for at least four of the six family background indicators then this family factor was established using the following criteria: if the occupational title of the fathers and mothers was classified as I, Professional or II, Managerial (e.g., Roe's System), it was considered "high". If the highest educational level of parent was master's degree or above, it was considered "high". If the family income was $50,000 or above (in 1983 dollars), it was considered "high". If the location of the home was "in a large city" or "in a suburb of a large city" (e.g., over 100,000 population in 1983), it was considered "urban". If the 700M female cited socioeconomic factors in family background as "influential" on career decisions, the proposition was verified.

Overall, 12 700M females (80%) exhibited the predicted socioeconomic indicators. Interviews revealed that 14 700M females (93%) cited socioeconomic factors as "influential" on career decisions. Since replication occurred, Table 5A listed the family backgroud indicators of 700M females by career aspiration group. The presence of family background factors and the influence of these factors on career decisions at age 19-21 revealed no differences in career aspiration groups.

Research Question 5B. What influence/role did expectations of parents play in career decisions of mathematically precocious females?

Proposition 5B. Parents of mathematically precocious females express high career aspiration and educational achievement for their daughters.

Parents expectations included: 1) for their daughters to go to college (SQ 39), 2) the lowest level of educational attainment that they would be "satisfied" with (PQ 37), and 3) the type of career field (PQ 34) they preferred for their daughter. Moreover, expectations of father and mother and the influence on career decisions was explored during the interviews (I 62-63). Responses were listed, grouped, and summarized in single-case study narratives.

Prediction: Literal Replication. If parents of 700M females indicated three out of four expectations, the proposition was verified. These expectations included whether both parents expected their daughter to go to college; if the lowest level of acceptable educational attainment for their daughter was a bachelor's degree, and if one of the career field aspirations for their daughter was expressed as mathematics, engineering, science, and/or medicine. Parents of all 15 700M females (100%) had expectations for their daughter at age 13 to have a combination of higher education and career fields including mathematics, science, engineering and medicine. Since replication occurred, Table 5B reported results by career aspiration group. No differences were found between these groups.

Research Question 5C. What influence/role did encouragement of parents play in career decisions of mathematically precocious females?

Proposition 5C. Mathematically precocious females indicate that parents' encouragement influenced their career decisions.

Five variables relating to parents' encouragement were identified: 1) family support for career choices at age 19-21 (I 57); 2) level of support by family at 19-21 (I 62); 3) importance of family support for career choice at age 19-21 (I 61); 4) mother's encouragement toward the study of, the enjoyment of, and acceleration in mathematics and science at age 13 (SQ 35, TSQ 21) and age 19-21 (I 58); and 5) father's encouragement toward the study of, the enjoyment of, and acceleration in mathematics and science at age 13 (SQ 35, TSQ 21) and age 19-21 (I 59). The encouragement from parents was clarified in the interview. Responses to the types of encouragement and the importance of this encouragement were listed, grouped, and then summarized in single-case study narratives.

Prediction: Literal Replication. If 700M females indicated parent's encouragement on four of the five variables the proposition was verified. Overall, 9 700M females (60%) indicated that parents' encouragement was "influential" toward career decisions during young adult years. Since replication occurred, Table 5C listed the types of encouragement given at age 13 and age 19-21 by career aspiration groups. The math/science group perceived more support from parents for their career choices (70%) compared to those aspiring to other careers (40%).

Research Question 6. What educational experiences influenced the career decisions of mathematically precocious females?

Proposition 6. During late adolescence and young adult years, mathematically precocious females will cite educational experiences (i.e., diversity of curriculum offerings, in-school instructional activities, out-of-school activities, guidance activities, relationships with teachers and significant others, and special achievements and recognitions) to be "least" influential on their career decisions.

At the conclusion of the telephone interviews the various personal, family, and educational factors were reviewed by the researcher. Each subject was asked to list the three factors in order of greatest influence. Responses were organized in a data base.

Prediction: Literal. If 700M females designate family factors as the "third" or least influential of the three factors on career decisions, the proposition was verified. Less than 50% of 700M females indicated that educational experiences were the least influential on their career decisions. Thus, the proposition was not replicated. Table 6 summarized the educational influences by career aspiration group.

Research Question 6A. What influence/role did various acceleration options play in career decisions of mathematically precocious females?

Proposition 6A. Mathematically precocious females indicate positive effects of various types of acceleration during school years.

The types of acceleration selected by 700M females (AHS 45-52) were recorded. In addition, attitudes toward acceleration options (AHS 50) were examined. Six types of acceleration were identified, which included: 1) early entrance to elementary school, 2) grade skipping, 3) accelerated subject matter placement, 4) AP or other exams for college credit, 5) college classes while a high school student, and 6) early entrance to college (before age 18). The influence of these acceleration options on 16 personal and educational variables (AHS 50) at age 18, which included such items as effect on general academic progress, grades, interest in school, acceptance of abilities, etc.

During the interviews 700M females were asked to reflect on acceleration options at age 19-21 and current feelings (AHS 52) were explored.

Prediction. Literal Replication. If 700M females participated in at least 4 of 6 acceleration options, entered college before age 18, and 10 of 16 responses to personal and educational variables indicated that acceleration had a "strongly favorable effect" or "moderately favorable effect," on 700M females, the proposition was verified.

Overall, 8 of 11 700M's females (72%) expressed positive effects of acceleration on 10 of 16 personal and educational variables. Twelve (80%) entered college before their 18th birthday and 14 (93%) expressed at age 19-21 that they were "satisfied with what I did". Table 6A listed types of acceleration selected and the attitudes toward acceleration at age 18 and 19-21 years. No differences in type of acceleration options or the feelings about acceleration were demonstrated by career aspiration groups. The nonmath/science group was just as likely to use accelerative options during school years as the math/science group.

Research Question 6B. What influence/role did in-school instruction in mathematics and science play in career decisions?

Proposition 6B. Mathematically precocious females completed extensive coursework in mathematics and science through calculus and physics during high school.

The intended number of semesters of math/science coursework in several different fields (SQ 23) was compared to actual number of courses taken in high school (AHS 19-20-31). Enrollment in Advanced Placement courses, which are designed for the academically able child, were listed. Information about coursework in mathematics and science as well as types of Advanced Placement courses (AP) and exams was described in the single-case study narratives.

Prediction: Literal replication. If the number of semesters of mathematics and sciences exceeded four semesters (two years of each) and included Advanced Placement classes in math and science, (i.e., AP calculus, AP biology, AP chemistry, or AP physics), the proposition was verified. Overall, 13 700M females (87%) had completed extensive coursework in mathematics and science through calculus and physics. Since the propositions were replicated, Table 6B displayed the extent of coursework by career aspiration group. No differences in coursework seemed to appear between groups.

Research Question 6C. What influence/role did out-of-school activities play in career decisions of mathematically precocious females?

Proposition 6C. Mathematically precocious females participated actively in a variety of out-of-school activities during high school, which were influential on career decisions.

The types of out-of-school activities (SQ 44, TSQ 41,42, 43, and AHS 23) were examined. The most frequent types of activities were National Honor Society, academic clubs (e.g., speech/debate/drama, math and science groups), and music. The influence of these out-of-school activities on career decision making was discussed during the interviews.

Prediction: Literal Replication. The total number of out-of-school activities were listed. If 700M females participated in two or more years in at least three activities in junior high and high school, including at least two years of academic clubs (i.e., math, music, science, speech, and leadership roles in such activities), they were considered "active" in out-of-school activities. If 700M females indicated that these activities were "influential" to career decisions, the proposition was verified. Overall, 14 700M females (93%) were "active" in out-of-school activities. However, only six 700M females (40%) considered these activities to be "influential" on career decisions. The proposition was not replicated. Table 6C lists the types of activities and the influence on career decisions by career aspiration group. There were no differences between career aspiration groups on this proposition.

Research Question 6D. What influence/role did specific guidance activities play in career decisions of mathematically precocious females?

Proposition 6D. Mathematically precocious females indicated that guidance activities during junior high and high school years were ineffective in meeting their career planning needs.

The influence of guidance activities (SQ 38) at age 13 and influence on career planning at age 18 was examined during telephone interviews. The type and the effectiveness of particular guidance activities were explored. Results were listed, grouped and then summarized in the single-case study narratives.

Prediction: Literal Replication. If 700M females indicate that guidance activities were of "no influence" to their career decisions, the proposition was verified. Overall, 11 700M females (73%)

expressed that guidance activities were of "no influence" in their career decision-making. Table 6D listed the responses to items relating to guidance activities by career aspiration group. There were no patterns apparent by comparisons of career aspiration groups.

Research Question 6E. What influence/role did special awards or recognition of achievement play in career decisions of mathematically precocious females?

Proposition 6E. Mathematically precocious females indicated special awards or recognition of achievement influenced their career decisions.

The types of honors and awards received by 700M females included: National Honor Society (SQ 33, RAHS 17), special prizes, awards, National Merit Scholarship Program (AHS 33, RAHS 20), Presidential Scholar (AHS 34 RAHS 21), or other academic honors (AHS 59a RAHS 114-122). Achievements were entered into a data base. A summary of honors and achievements in mathematics, science, and other subject areas received at the regional, state, and national level were described in the single-case study narratives. The role of these special achievements or recognitions upon career decisions was explored during the interviews.

Prediction: Literal Replication. If the 700Ms received awards in four of five categories, it was considered to be "recognition" of achievements. If the 700M indicated that special achievements had an influence on her career decisions, the proposition was verified. Although 73% of 700M were consistently recognized for high achievement in a variety of math/science and other subject fields, only one 700M

(7%) indicated that these awards influenced career decisions. Table 6E listed the types of recognition and the influence. There were no differences between career aspiration groups.

Summary

In this study, six general research questions were advanced. Specifically, they focused on: career aspirations, educational choices, and lifestyle expectation of mathematically precocious females during adolescence and young adult years through multiple-case study methodology. In addition, personal, family, and educational factors that influenced career decisions were investigated. In total, 20 propositions were advanced. They were based on the literature review. Overall, 700M females replicated 16 of the 20 propositions (80%). The 700Ms were consistently alike in many aspects of aspiration and achievement. Less than 50% consensus was found only in the rankings of family (Proposition 5) and educational factors (Proposition 6), the influence of out-of-school activities (Proposition 6C), and influence of recognition of special achievements on career decisions (Proposition 6E).

The following propositions were replicated by a majority of 700M females:

Proposition 1: During adolescence and young adult years mathematically precocious females aspire to mathematical, scientific, engineering, or medical careers.

Proposition 2. During the young adult years, mathematically precocious females aspire to advanced degrees in mathematics, science, engineering, or medicine from prestigious colleges and universities.

Proposition 3. During the young adult years, mathematically precocious females indicate an intention to combine career-marriage options.

Proposition 4. During late adolescence and young adult years, mathematically precocious females will cite personal factors (i.e., achievement-related personal traits, measured ability, self-perceptions, interests, gender-role orientation, and personal relationships) to be the "greatest" influence on their career decisions.

Proposition 4A. Achievement-related personal traits of mathematically precocious females match those identified in the literature as conducive to the development of potential and achievement.

Proposition 4B. Recognition of high measured ability in mathematics was influential in career decisions of mathematically precocious females.

Proposition 4C. Self-perceptions among mathematically precocious females were positive.

Proposition 4D. During adolescence mathematically precocious females hold positive attitudes toward a variety of subjects in school.

Proposition 4E. Mathematically precocious females will identify both masculine and feminine characteristics as descriptive of a variety of occupations.

Proposition 4F. Personal relationships with teachers, peers, and significant others influence career decisions of mathematically precocious females.

Proposition 5A. Family background variables of mathematically precocious females (i.e., high socioeconomic status, high educational level for parents, high occupational status for parents, and childhoods in urban settings) were influential on career decisions.

Proposition 5B. Parents of mathematically precocious females express high career aspiration and educational achievement for their daughters.

Proposition 5C. Mathematically precocious females indicate that parents' encouragement influenced their career decisions.

Proposition 6A. Mathematically precocious females indicate positive effects of various types of acceleration during school years.

Proposition 6B. Mathematically precocious females completed extensive coursework in mathematics and science through calculus and physics during high school.

Proposition 6D. Mathematically precocious females indicated that guidance activities during junior high and high school years were ineffective in meeting their career planning needs.

A sample of a single-case study report, Trudy, is included in Appendix C as an example of the types of information reported for each case. Her case study report was selected because she represented the 700M female who best supported the predictions from the literature (e.g., Trudy verified 18 of 20 propositions).

Table 4. Rank order of personal factors[a] on career decisions of 700M females at age 19-21

Career Choice/ Code Name	Ranking First	
<u>Career Group: Math/Science (10)</u>		
<u>Engineering, Architecture</u>		
Louann	educational	
Wilma	personal[b]	
<u>Mathematics</u>		
Tara	personal[b]	
Jane	family	
Sandy	family	
<u>Science</u>		
Hilda	personal[b]	
Carol	personal[b]	
<u>Medicine</u>		
Priscilla	family	
Tonya	personal[b]	
Trudy	personal[b]	
Career Group: Math/Science (10) Total/Percent	6	60%[c]
<u>Career Group: Other (5)</u>		
Rhonda	personal[b]	
Naomi	personal[b]	
Sally	personal[b]	
Gayle	personal[b]	
Cathy	educational	
Career Group: Other (5) Total/Percent	4	80%[c]
Total/Percent	10	67%[c]

[a]Propositions: 4. ... personal factors were "greatest" influence on career decisions; 5. ... family factors were "second greatest" influence on career decisions; 6. ... educational experiences were "least" influential on career decisions.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 4A. Achievement-related personal traits of SMPY 700M females at age 13 by career choice area

Career Choice/ Code Name	Personality Traits[a] A	B	C	D	E	F	G	H	Total	
<u>Career Group: Math/Science (10)</u>										
<u>Engineering, Architecture</u>										
Wilma	yes	no	yes	no	no	yes	yes	yes	5[b]	
Louann	yes	no	no	no	no	yes	no	yes	3	
<u>Mathematics</u>										
Tara	yes	yes	yes	yes	yes	yes	yes	yes	8[b]	
Sandy	yes	no	yes	no	no	yes	yes	yes	5[b]	
Jane	yes	no	no	no	no	yes	no	yes	3	
<u>Sciences</u>										
Carol	yes	no	no	no	no	yes	no	yes	3	
Hilda	no	no	no	no	no	yes	no	yes	2	
<u>Medical</u>										
Priscilla	yes	no	yes	yes	no	yes	yes	yes	6[b]	
Trudy	yes	no	yes	no	no	yes	yes	yes	5[b]	
Tonya	yes	yes	yes	no	no	yes	no	yes	5[b]	
Career Group: Math/Science (10) Total/Percent									6	60%[c]
<u>Career Group: Other (5)</u>										
Sally	yes	yes	yes	yes	yes	yes	yes	yes	8[b]	
Rhonda	yes	yes	yes	yes	no	yes	yes	yes	7[b]	
Naomi	yes	no	yes	no	no	yes	yes	yes	5[b]	
Gayle	yes	no	no	no	no	yes	yes	yes	4[b]	
Cathy	no	no	yes	no	no	yes	yes	yes	4[b]	
Career Group: Other (5) Total/Percent									5	100%[c]
Total/Percent									11	73%[c]

[a]A = self-confidence; B = venturesome, risk taking; C = self-sufficient, independent; D = willing to experiment; E = imaginative; F = interest in high academic success; G = interest in being a leader; H = recognition of achievements.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 4B. SMPY 700M females perception of role of math ability on career decisions at age 19-21

Career Choice/Code Name	Role Perception	Total	
Career Group: Math/Science (10)			
Engineering, Architecture			
Wilma	slightly influential[a]		
Louann	influential[a]		
Mathematics			
Tara	influential[a]		
Jane	influential[a]		
Sandy	influential[a]		
Sciences			
Carol	influential[a]		
Hilda	noninfluential		
Medical			
Trudy	influential[a]		
Tonya	slightly influential[a]		
Priscilla	influential[a]		
Career Group: Math/Science (10) Total/Percent		9	90%[b]
Career Group: Other (5)			
Sally	influential[a]		
Naomi	noninfluential		
Rhonda	influential[a]		
Gayle	noninfluential		
Cathy	influential[a]		
Career Group: Other (5) Total/Percent		3	60%[b]
Total/Percent		12	80%[b]

[a]Proposition verified.

[b]Replication occurred for majority of 700M females.

Table 4C. Self-perceptions by 700M females at age 13 and age 18 (m = missing data

Career Choice Code Name	Questionnaire Items[a] A	B	C	D	E	F	Total Age 13	Age 18
Career Group: Math/Science (10)								
Engineering, Architecture								
Wilma	1(m)	5(m)	2(m)	1(m)	1	4	5[b]	m
Louann	2(5)	2(2)	2(2)	2(5)	m	m	4[b]	2/4[b]
Mathematics								
Tara	1(2)	1(2)	1(2)	1(2)	m	m	4[b]	4[b]
Jane	1(1)	1(1)	1(1)	1(1)	3	4	6[b]	4[b]
Sandy	1(m)	1(m)	1(m)	1(m)	1	4	6[b]	m
Sciences								
Carol	1(2)	1(1)	1(1)	1(2)	2	4	6[b]	4[b]
Hilda	3(m)	3(m)	3(m)	3(m)	3	2	2	m
Medical								
Trudy	2(1)	1(1)	1(1)	1(1)	m	m	4[b]	4[b]
Tonya	2(m)	2(m)	2(m)	2(m)	3	2	6[b]	m
Priscilla	2(2)	2(2)	2(2)	2(3)	m	m	4[b]	3/4[b]
Career Group: Math/Science (10)			Total				9	6/6
			Percent				90%[c]	100%[c]

[a]A = I take a positive attitude toward myself; B = I feel I am a person of worth on an equal plane with others; C = I am able to do things as well as most other people; D = On the whole I am satisfied with myself: 1) strongly agree, 2) agree, 3) disagree, 4) strongly disagree, 5) no opinion; E = How comfortable are you with high ability? F = How does intellectual ability affect opinions others hold of you? 1) very much, 2) somewhat, 3) does not affect me, 4) not at all.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 4C. Continued

Career Choice	Questionnaire Items[a]						Total	
Code Name	A	B	C	D	E	F	Age 13	Age 18
Career Group: Other (5)								
Rhonda	2(1)	2(1)	2(1)	2(1)	■	■	4[b]	4[b]
Sally	1(■)	1(■)	1(■)	1(■)	■	■	4[b]	■
Naomi	1(1)	2(2)	2(2)	1(1)	3	2	5[b]	4[b]
Gayle	2(1)	1(1)	2(1)	2(1)	■	■	4[b]	4[b]
Cathy	5(■)	2(■)	2(■)	3(■)	3	2	3[b]	■
Career Group: Other (5) Total							5	3/3
Percent							100%[c]	100%[c]
Total							14	9/9
Percent							93%[c]	100%[c]

Table 4D. School subject interests of 700M females at age 13 and age 18[a]

Career Choice	School Subjects[b]							Total	
Code Name	A	B	C	D	E	F	G	Age 13	Age 18
Career Group: Math/Science (10) Engineering, Architecture									
Wilma	P(N)	P(N)	P(N)	N(N)	N(P)	P(P)	N(N)	4[c]	(2)
Louann	P(m)	N(m)	P(m)	N(m)	N(m)	N(m)	N(m)	2	(m)
Mathematics									
Tara	P(P)	P(P)	P(N)	P(N)	N(N)	P(P)	N(N)	5[c]	(3)
Jane	P(P)	P(P)	P(P)	P(P)	P(P)	P(P)	P(P)	7[c]	(7)[c]
Sandy	P(P)	P(N)	N(N)	P(P)	N(N)	P(N)	N(P)	4[c]	(3)
Science									
Carol	P(P)	P(N)	N(P)	P(P)	N(P)	P(P)	N(P)	4[c]	(6)[c]
Hilda	P(m)	P(m)	P(m)	P(m)	P(m)	P(m)	P(m)	7[c]	(m)
Medical									
Trudy	P(P)	P(P)	P(P)	P(P)	P(P)	P(P)	N(P)	6[c]	(7)[c]
Tonya	P(N)	P(N)	P(N)	P(N)	N(N)	P(P)	N(P)	5[c]	(2)
Priscilla	P(P)	P(P)	P(P)	P(P)	P(P)	P(N)	N(N)	6[c]	(5)[c]
Career Group: Math/Science (10) Total								9	4/8
Percent								90%[d]	50%[d]

[a]P = positive in subjects (four or five responses); N = not as positive (three or less responses; (P) or (N) = after high school, if available; (m) = missing data. Positive responses for each subject included: 1) "I strongly like" or "moderately like" (subject); 2) "I feel very confident" or "somewhat confident" in (subject); 3) "I find (subject) very easy," "somewhat easy;" 4) to me (subject) is "very interesting" or "somewhat interesting;" 5) to my planned career, (subject) is "very useful," moderately useful.

[b]A = mathematics; B = computer science; C = natural science; D = physical science; E = English/literature; F = foreign language; G = social studies.

[c]Proposition verified.

[d]Replication occurred for majority of 700M females.

Table 4D. Continued

Career Choice Positive Code Name	School Subjects[b] A	B	C	D	E	F	G	Total Age 13	Age 18
Career Group: Other (5)									
Rhonda	N(P)	N(N)	N(P)	N(P)	N(P)	P(P)	P(P)	2	(6)[c]
Sally	P(P)	N(P)	P(P)	P(P)	P(P)	P(P)	P(P)	6[c]	(7)[c]
Naomi	P(m)	N(m)	N(m)	N(m)	P(m)	N(m)	P(m)	3	(m)
Gayle	P(N)	P(P)	P(N)	P(P)	N(P)	P(P)	P(P)	6[c]	(5)[c]
Cathy	P(m)	N(m)	N(m)	N(m)	N(m)	P(m)	N(m)	2	(m)
Career Group: Other (5) Total								2	3/3
Percent								40%	100%[d]
Total								11	(7/11)
Percent								73%[d]	64%[d]

Table 4E. Sex-typing of various occupations by 700M females at age 13[a]

Career Choice/ Code Name	Career field[b]							
	E&CS	M	NS	PS	H&FA	SS	Total	Self
Career Group: Math/Science (10)								
Architecture, Engineering								
Wilma	no	no	no	no	no	no	6[c]	no
Louann	r	r	r	r	r	r	0[c]	no
Mathematics								
Tara	m	m	m	m	no	no	2	yes
Sandy	no	yes	no	no	yes	no	4[c]	yes
Jane	no	no	no	no	no	no	6[c]	yes
Sciences								
Carol	m	m	m	m	m	m	0	no
Hilda	yes	yes	yes	no	yes	yes	1	no
Medical								
Priscilla	no	no	no	yes	no	yes	4[c]	no
Tonya	no	no	no	no	no	no	6[c]	no
Trudy	no	no	no	no	yes	no	5[c]	yes
Career Group: Math/Science (10) Total							7/9	6
Percent							78%[d]	60%[d]

[a]no = did not sex-type career field; yes = sex-typing; m = missing data, r = refused to answer.

[b]E&CS = Engineering and computer science; M = mathematics; NS = natural science; PS = physical science; H&FA = humanities and fine arts; SS = social studies.

[c]Proposition verified.

[d]Replication occurred for majority of 700M females.

Table 4E. Continued

Career Choice/ Code Name	Career field[b]							
	E&CS	M	NS	PS	H&FA	SS	Total	Self
<u>Career Group: Other (5)</u>								
Rhonda	no	no	no	no	no	no	6[c]	no
Sally	yes	no	yes	no	no	no	4[c]	yes
Naomi	yes	no	yes	yes	no	yes	2	yes
Gayle	■	■	■	■	■	■	0	yes
Cathy	no	no	no	yes	no	no	5[c]	no
Career Group: Other (5) Total							3/4	2
Percent							75%[d]	40%
Total							10/13	8[d]
Percent							76%[d]	53%[d]

Table 4F. Influence of personal relationships of 700M females on career decisions at age 13, 18, and 19-21[a] (m = missing data)

Career Choice/ Code Name	Relationships[a] A	B	C	D	E	F	Total
Career Group: Math/Science (10)							
Engineering, Architecture							
Wilma	yes	no	no	no	yes	no	2
Louann	yes	yes	yes	m	yes	yes	5[b]
Mathematics							
Tara	no	no	no	no	yes	yes	2
Sandy	m	yes	yes	yes	yes	no	4[b]
Jane	m	m	no	yes	no	yes	2
Science							
Hilda	no	yes	yes	no	yes	yes	4[b]
Carol	yes	yes	yes	no	yes	no	4[b]
Medicine							
Priscilla	no	no	no	no	no	no	0
Tonya	no	no	yes	no	no	no	1
Trudy	yes	yes	yes	yes	yes	yes	6[b]
Career Group: Math/Science (10) Total							5
Percent							50%[c]

[a]A = At age 13 cited significant person on educational decisions; B = At age 13 cited significant event on educational decisions; C = At age 18 cited significant person on educational decisions; D = At age 18 cited significant event on educational decisions; E = At age 19-21 cited teachers or friends as "influential" on career decisions; F = At age 19-21 cited "others" (not parents) as "influential on career decisions.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 4F. Continued

Career Choice/ Code Name	Relationships[a]						Total
	A	B	C	D	E	F	
<u>Career Group: Other (5)</u>							
Rhonda	yes	no	no	no	no	no	1
Sally	no	yes	yes	no	yes	yes	4[b]
Naomi	yes	m	no	no	no	no	1
Gayle	yes	yes	yes	yes	yes	no	5[b]
Cathy	yes	yes	m	m	yes	yes	4[b]
Career Group: Other (5) Total							3 60%[c]
Total							8
Percent							53[c]

Table 5. Rank order of family factors[a] on career decisions of 700M females at age 19-21

Career Choice/ Code Name	Ranking Second	
<u>Career Group: Math/Science (10)</u>		
<u>Engineering, Architecture</u>		
Louann	personal	
Wilma	educational	
<u>Mathematics</u>		
Tara	family[b]	
Jane	educational	
Sandy	educational	
<u>Science</u>		
Hilda	family[b]	
Carol	family[b]	
<u>Medicine</u>		
Priscilla	personal	
Tonya	family[b]	
Trudy	family[b]	
Career Group: Math/Science (10) Total/Percent	5	50%[b]
<u>Career Group: Other (5)</u>		
Rhonda	educational	
Naomi	family[b]	
Sally	educational	
Gayle	educational	
Cathy	family[b]	
Career Group: Other (5)	2	40%
Total/Percent	7	47%

[a]Propositions: 4. ... personal factors were "greatest" influence on career decisions; 5. ... family factors were "second greatest" influence on career decisions; 6. ... educational experiences were "least" influential on career decisions.

[b]Proposition verified.

Table 5A. Family background variables of 700M females at age 13 and age 19-21

Career Choice/ Code name	Background Variables[a] A	B	C	D	E	F	Total	G
Career Group: Math/Science (10)								
Engineering, Architecture								
Wilma	yes	yes	yes	yes	yes	no	5[b]	yes[b]
Louann	yes	yes	yes	no	yes	no	4[b]	yes[b]
Mathematics								
Tara	yes	yes	yes	yes	yes	yes	6[b]	no
Sandy	yes	yes	no	no	no	no	2	yes[b]
Jane	yes	no	yes	no	yes	no	3	yes[b]
Science								
Hilda	yes	m	yes	no	no	yes	3	yes[b]
Carol	yes	no	yes	yes	yes	yes	5[b]	yes[b]
Medical								
Priscilla	yes	yes	yes	yes	yes	yes	6[b]	yes[b]
Tonya	yes	yes	yes	yes	m	no	4[b]	yes[b]
Trudy	yes	yes	yes	yes	yes	no	5[b]	yes[b]
Career Group: Math/Science (10) Total							7	9
Percent							70%[c]	90%[c]

[a]A = occupational title of father, Level I (professional) or Level II (managerial); B = occupational title of mother, Level I (professional) or Level II (managerial); C = highest educational degree achieved by father (Master's or above); D = highest educational degree achieved by mother (Master's or above); E = family income in 1983 dollars as $50,000 or above; F = setting of home was urban; G = during interviews cited socioeconomic factors as influence on career decisions (age 19-21).

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 5A. Continued

Career Choice/ Code name	Background Variables[a] A	B	C	D	E	F	Total	G
Career Group: Other (5)								
Rhonda	yes	yes	yes	yes	no	yes	5[b]	yes[b]
Sally	yes	yes	yes	yes	no	yes	5[b]	yes[b]
Naomi	yes	yes	yes	yes	no	yes	5[b]	yes[b]
Gayle	yes	yes	yes	yes	■	no	4[b]	yes[b]
Cathy	yes	yes	yes	no	yes	yes	5[b]	yes[b]
Career Group: Other (5) Total							5	5
Percent							100%[c]	100%[c]
Total/Percent							12	14
							80%[c]	93%[c]

Table 5B. Parental expectations of 700M females at age 13

Career Choice/ Code Name	Parental Expectations[a] A	B	C	D	Total	
Career Group: Math/Science (10)						
Engineering, Architecture						
Wilma	yes	yes	Ph.D	yes (3)	4[b]	
Louann	yes	yes	M.S.	yes (2)	4[b]	
Mathematics						
Tara	yes	yes	B.A.	yes (3)	4[b]	
Sandy	yes	yes	M.S.	yes (2)	4[b]	
Jane	yes	yes	B.A.	m	3[b]	
Sciences						
Hilda	yes	yes	Ph.D.	yes (3)	4[b]	
Carol	yes	yes	B.A.	no	3[b]	
Medicine						
Priscilla	yes	yes	B.A.	yes (3)	4[b]	
Tonya	yes	yes	Ph.D.	no	3[b]	
Trudy	yes	yes	Ph.D.	yes (2)	4[b]	
Career Group: Math/Science (10) Total/Percent					10	100%[c]
Career Group: Other (5)						
Rhonda	yes	yes	Ph.D.	yes (1)	4[b]	
Naomi	yes	yes	B.A.	no	3[b]	
Sally	yes	yes	B.A.	yes (1)	4[b]	
Gayle	yes	yes	B.A.	no	3[b]	
Cathy	yes	yes	Ph.D.	yes (1)	4[b]	
Career Group: Other (5) Total/Percent					5	100%[c]
Total/Percent					15	100%[c]

[a]A = father expected daughter to go to college; B = mother expected daughter to go to college; C = lowest level of educational degree attainment that parents would be satisfied with; D = one of three career field choices for their daughter was mathematics, science, engineering, or medicine (actual number of choices out of three).

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 5C. Parents' encouragement of 700M females for career choices at age 19-21 (m = missing data)

Career Choice/ Code Name	Encouragement[a] A	B	C	D	E	Total	
Career Group: Math/Science (10)							
Engineering, Architecture							
Wilma	yes	1	1	yes	yes	5[b]	
Louann	yes	1	1	no	yes	4[b]	
Mathematics							
Tara	yes	1	2	yes	yes	4[b]	
Sandy	yes	1	1	no	no	3	
Jane	yes	1	1	yes	yes	5[b]	
Science							
Hilda	yes	2	m	yes	yes	3	
Carol	yes	1	2	yes	yes	4[b]	
Medical							
Priscilla	yes	1	2	yes	yes	4[b]	
Tonya	yes	1	2	no	no	2	
Trudy	yes	1	1	yes	no	4[b]	
Career Group: Math/Science (10) Total/Percent						7	70%[c]

[a]A = family supportive for career choice (yes or no); B = level of support for career choice: 1) no pressure for this career choice, 2) pressure from family for this career choice; C = importance of family support for career choice: 1) very important, 2) somewhat important; D = mother's encouragement toward 1) study of mathematics, 2) study of science, 3) to enjoy mathematics, 4) to enjoy science, 5) to accelerate in mathematics, 6) to accelerate in science [cited four or more of six]; E = father's encouragement toward 1) study of mathematics, 2) study of science, 3) to enjoy mathematics, 4) to enjoy science, 5) to accelerate in mathematics, 6) to accelerate in science [cited four or more of six].

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 5C. Continued

Career Choice/ Code Name	Encouragement[a] A	B	C	D	E	Total	
Career Group: Other (5)							
Rhonda	yes	1	1	no	no	3	
Sally	yes	1	1	yes	yes	5[b]	
Naomi	yes	1	1	na	na	3	
Gayle	yes	1	2	no	yes	3	
Cathy	yes	1	1	yes	yes	5[b]	
Career Group: Other (5) Total/Percent						2	40%
Total/Percent						9	60%[c]

Table 6. Rank order of educational factors[a] on career decisions of 700M females at age 19-21

Career Choice/ Code Name	Ranking Third	
<u>Career Group: Math/Science (10)</u>		
<u>Engineering, Architecture</u>		
Louann	family	
Wilma	family	
<u>Mathematics</u>		
Tara	educational[b]	
Jane	personal	
Sandy	personal	
<u>Science</u>		
Hilda	educational[b]	
Carol	educational[b]	
<u>Medicine</u>		
Priscilla	educational[b]	
Tonya	educational[b]	
Trudy	educational[b]	
Career Group: Math/Science (10) Total/Percent	6	60%[c]
<u>Career Group: Other (5)</u>		
Rhonda	family	
Naomi	educational[b]	
Sally	family	
Gayle	family	
Cathy	personal	
Career Group: Other (5) Total/Percent	1	20%
Total/Percent	7	47%

[a]Propositions: 4. ... personal factors were "greatest" influence on career decisions; 5. ... family factors were "second greatest" influence on career decisions; 6. ... educational experiences were "least" influential on career decisions.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 6A. Diversity of curricular offerings-acceleration options during school years of 700M females

Career Choice Code Name	Curriculum Offerings/Options[a]									
	A	B	C	D	E	F	G	Total	H	I	J
Career Group: Math/Science (10)											
Engineering, Architecture											
Wilma	no	no	3	yes	no	no	yes	3	no	yes	yes
Louann	no	yes	3	na[b]	na	yes	yes	4[c]	yes[c]	yes	yes
Mathematics											
Tara	no	yes	3	yes	yes	yes	yes	6[c]	yes[c]	yes	yes
Sandy	yes	no	1	yes	yes	yes	yes	7[c]	yes[c]	yes	yes
Jane	yes	yes	3	yes	yes	yes	yes	7[c]	yes[c]	yes	yes
Science											
Hilda	no	yes	1	yes	yes	yes	yes	6[c]	yes[c]	yes	yes
Carol	no	yes	3	yes	yes	yes	yes	6[c]	m[b]	m	yes

[a]A = early entrance to elementary school (before age 6); B = grade skipping; C = accelerated subject matter placement (1. math, 2. English, 3. both math and English); D = AP or other exams for college credit; E = college class while a high school student; F = early entrance to college (before 18); G = summer programs, college classwork, math/science; Total (5 of 7 verified the proposition, with exception of Louann who had 4, but accelerated four years); H = positive influence of acceleration items (10 of 16 items positive); I = age 18, view of acceleration was "satisified with what I did;" J = age 19-21, view of acceleration was "satisfied with what I did."

[b]na = not applicable, m = missing data.

[c]Proposition verified.

Table 6A. Continued

Career Choice Code Name	Curriculum Offerings/Options[a] A	B	C	D	E	F	G	Total	H	I	J
Medicine											
Priscilla	yes	no	3	yes	no	no	yes	4	yes[c]	yes	yes
Tonya	yes	yes	1	yes	yes	yes	yes	7[c]	no	yes	yes
Trudy	no	yes	3	yes	no	yes	yes	5[c]	yes[c]	m	yes
Career Group: Math/Science (10) Total								8	7/9	8/8	10
Percent								80%[d]	78%[d]	100%	100%
Career Group: Other (5)											
Rhonda	no	yes	3	yes	yes	yes	yes	6[c]	no	yes	yes
Sally	yes	yes	1	yes	yes	yes	yes	7[c]	m	m	yes
Naomi	no	yes	1	yes	yes	yes	yes	6[c]	m	yes	yes
Gayle	yes	yes	3	yes	yes	yes	yes	7[c]	yes[c]	yes	yes
Cathy	no	no	3	yes	yes	no	yes	4	m	no	no
Career Group: Other (5) Total											
Percent								4	1/2	3/4	4
								80%[d]	50%[d]	75%	80%
Total								12	8/11	11/12	14
Percent								80%[d]	72%[d]	91%	93%

[d]Replication occurred for majority of 700M females.

Table 6B. Mathematics and science coursework of 700M females during high school, including college classes while in high school

Career Choice/ Code Name	Mathematics and Science Coursework[a] A	B	C	D	E	F	G	Total
Career Group: Math/Science (10)								
^Engineering, Architecture^								
Wilma	6	2	6	yes[b]	no	yes	yes	5[c]
Louann	na[d]	na	na	na	na	na	na	0
Mathematics								
Tara	9	2	10	yes[b]	no	yes	yes	5[c]
Sandy	9	4	8	yes	no	yes(2)	yes	5[c]
Jane	6	2	2	yes[b]	no	yes	yes	5[c]
Science								
Hilda	6	2	6	yes[b]	no	yes	yes	5[c]
Carol	8	2	8	yes[b]	yes	yes	yes	6[c]
Medical								
Priscilla	10	4	6	yes[b]	yes	yes	yes	7[c]
Tonya	3	0	4	yes	no	no	yes	4[c]
Trudy	10	2	8	yes[b]	yes	yes	yes	6[c]
Career Group: Math/Science (10) Total/Percent								9/9 100%[e]

[a]A = number of semesters in mathematics; B = number of semesters in natural sciences; C = number of semesters in physical sciences; D = math work included calculus; E = AP Biology; F = AP Chemistry and/or Physics (2) = Both; G = Physics.

[b]Under Category D, math work included AP calculus.

[c]Proposition verified.

[d]na = not applicable, m = missing data.

[e]Proposition replicated.

Table 6B. Continued

Career Choice/ Code Name	Mathematics and Science Coursework[a]							Total
	A	B	C	D	E	F	G	
Career Group: Other (5)								
Rhonda	10	8	4	yes[b]	no	no	yes	5[c]
Sally	4	4	4	yes[b]	no	yes	yes	6[c]
Naomi	4	3	2	yes[b]	no	no	yes	4[c]
Gayle	7	2	5	yes	no	no	yes	4[c]
Cathy	8	2	4	yes[b]	no	yes	m[d]	4[c]
Career Group: Other (5) Total/Percent								5 100%[e]
Total								13
Percent								87%[e]

Table 6C. Types of out-of-school instructional activities of 700M females (na = not applicable; m = missing data)

Career Choice/ Code Name	Out-Of-School Instructional Activities[a] A	B	C	D	E	F	Total	G
Career Group: Math/Science (10)								
Engineering & Architecture								
Wilma	no	yes	no	no	yes	yes	3[b]	yes[b]
Louann	na	no	no	yes	no	na	1	no
Mathematics								
Tara	yes	yes	yes	no	no	no	3[b]	yes[b]
Sandy	no	yes	no	yes	no	yes	3[b]	no
Jane	yes	m	yes	yes	no	yes	4[b]	yes[b]
Science								
Hilda	yes	yes	yes	yes	no	no	4[b]	no
Carol	yes	yes	yes	yes	no	no	4[b]	no
Medical								
Priscilla	yes	yes	yes	yes	yes	yes	6[b]	no
Tonya	yes	no	yes	no	no	yes	3[b]	no
Trudy	yes	yes	yes	yes	yes	yes	6[b]	yes[b]
Career Group: Math/Science (10)		Total					9	4
		Percent					90%[c]	40%

[a]A = active participant in three or more out of school activities at age 13; B = participated in two or more years in National Honor Society during high school; C = participated in two or more years in academic clubs, such as speech/debate/drama, math, and/or science during high school; D = participated in two or more years in music during high school; E = exhibited leadership role in two or more activities during high school; F = participated in two or more years in activity not listed in B, C, and D (journalism, athletics, performing arts, theater, religious organizations); G = indicated out-of-school activities were "influential" on career decisions at age 19-21.

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 6C. Continued

Career Choice/ Code Name	Out-Of-School Instructional Activities[a] A	B	C	D	E	F	Total	G
Career Group: Other (5)								
Rhonda	no	yes	no	yes	no	yes	3[b]	no
Sally	yes	yes	yes	yes	no	no	4[b]	yes[b]
Naomi	yes	no	yes	yes	yes	no	4[b]	no
Gayle	yes	no	yes	yes	no	yes	4[b]	no
Cathy	no	yes	yes	yes	yes	yes	5[b]	yes[b]
Career Group: Other (5) Total/Percent							5 100%[c]	2 40%
Total							14	6
Percent							93%[c]	40%

Table 6D. Influence of guidance activities on educational decisions at age 13 and/or career decisions at age 18 (na = not applicable)

Career Choice/ Code Name	Guidance Activities[a] A	B	C	D	Total	
Career Group: Math/Science (10)						
Engineering & Architecture						
Wilma	3	3	4	3	4[b]	
Louann	2	na	na	na	1	
Mathematics						
Tara	3	2	2	2	1	
Sandy	2	3	2	3	2[b]	
Jane	3	3	4	3	4[b]	
Science						
Hilda	2	3	4	3	3[b]	
Carol	2	3	2	3	2[b]	
Medical						
Priscilla	1	3	2	3	2[b]	
Tonya	2	2	4	3	2[b]	
Trudy	1	3	2	1	1	
Career Group: Math/Science (10) Total/Percent					7	70%[c]

[a] A = Talk to guidance counselor when planning school program at age 13: 1) a great deal, 2) somewhat, 3) not at all; B = Influence of high school guidance counselor on career decisions: 1) very influential, 2) moderately influential, 3) no influence); C = Type of assistance from high school guidance counselor: 1) enrollment and information about high school classes, 2) college planning and selection, 3) career planning, 4) none; D. Rating of assistance from guidance counselor: 1) very effective, 2) moderately effective, 3) not effective).

[b]Proposition verified.

[c]Replication occurred for majority of 700M females.

Table 6D. Continued

Career Choice/ Code Name	Guidance Activities[a] A	B	C	D	Total	
Career Group: Other (5)						
Rhonda	2	3	3	3	2[b]	
Sally	1	3	2	3	2[b]	
Naomi	3	3	1	na	2[b]	
Gayle	2	3	3	1	1	
Cathy	3	3	4	3	4[b]	
Career Group: Other (5) Total/Percent					4	80%[c]
Total/Percent					11	73%[c]

Table 6E. Influence of achievements and awards on career decisions of 700M females at age 19-21 (na = not applicable, m = missing data)

Career Choice/ Code Name	Achievements and Awards[a] A	B	C	D	E	Total	F
Career Group: Math/Science (10)							
Engineering, Architecture							
Wilma	yes	yes	yes	yes	no	4[b]	no
Louann	na	na	no	yes	yes	2	no
Mathematics							
Tara	yes	yes	no	yes	no	3	no
Sandy	yes	yes*	yes	yes	no	4[b]	no
Jane	m	yes	yes	yes	no	3	no
Science							
Hilda	yes	yes*	yes	yes	yes	5[b]	no
Carol	yes	yes*	yes	yes	yes	5[b]	no
Medical							
Priscilla	yes	yes**	yes	no	yes	4[b]	no
Tonya	yes	yes	yes	yes	no	4[b]	no
Trudy	yes	yes*	yes	yes	yes	5[b]	no
Career Group: Math/Science (10) Total						7 70%[c]	0

[a]A = National Honor Society; B = National Merit Letter of Commendation, Semi-finalist, Finalist, Scholarship winner*, and Presidental Scholar**; C = won regional, state or national competitions in mathematics; D = won regional, state or national competitions in science; E = won awards in three or more subject areas other than math/science; F = influence on awards/achievements on career decisions.

[b]Proposition verified.

[c]Replication occurred for majority of 700M.

Table 6E. Continued

Career Choice/ Code Name	A	Achievements and Awards B	C	D	E	Total	F
<u>Career Group: Other (5)</u>							
Rhonda	yes	yes	yes	no	yes	4[b]	indirect*
Sally	yes	no	yes	yes	no	3	no
Naomi	yes	yes	yes	no	yes	4[b]	no
Gayle	yes	yes	yes	yes	no	4[b]	no
Cathy	yes	m	yes	yes	yes	4[b]	no
Career Group: Other (5) Total						4 80%[c]	1 20%
Total Percent						11 73%[c]	1 7%

CHAPTER IV. ARTICLE: CAREER ASPIRATIONS OF MATHEMATICALLY PRECOCIOUS FEMALES

Introduction

This chapter contains an article to be submitted for publication entitled, "Career aspirations of mathematically precocious females." The article is based on the first objective of the study, i.e., documenting the career aspirations of mathematically precocious females in their late adolescence and young adult years. The career aspirations, educational choices, and lifestyle expectations are described. The format and length is consistent with current professional journals, such as Gifted Child Quarterly.

Abstract

How are gifted adolescents making the transition from childhood precocity to adult productivity? The present study documented career aspirations of 15 extremely mathematically precocious females (top 1 in 60,000 in mathematical ability) during the young adult years through multiple-case study analysis. Mathematically precocious females have focused career goals by age 18; two-thirds had entered mathematics/ science-related fields by age 19-21. The typical lifestyle expectation was full-time career with marriage and family options. Remarkably high educational and career achievement aspiration was evident throughout the single-case study reports. These extremely talented young women were taking responsibility for translating their potential in mathematics and

science into achievement in mathematics or science during the young adult years.

Career Aspirations of Mathematically Precocious Females

The "development of potential" is often cited in the gifted child movement as the goal of educational intervention on behalf of the gifted (Feldman & Goldsmith, 1986). Developing potential is a lifelong task and the transition time from childhood precocity to adult creativity is a concern of many researchers (Gruber, 1982; Wallace, 1985; Tannenbaum, 1983; Wallach, 1985; Feldman & Goldsmith, 1986). Wallace (1985) refers to this critical transition time as "self construction." She indicates that "virtually nothing" is known about how gifted adolescents outgrow and leave a network of parents, teachers, and mentors who have supported the gift or talent and then take on responsibility for translating their potential into adult achievement. This transition is not always successful, resulting in a loss of talent.

Fox and Zimmerman (1985) revealed that the "disparity between potential and achievement is considerably less for men than it is for women" (p. 219). Historically, gifted women have achieved less in terms of education and vocational attainment than their gifted male peers (Terman & Oden, 1947; Oden, 1968). Although considerable advances have been made by women during the last decades, women remain, nevertheless, underrepresented in mathematical, scientific, engineering, and medical careers (Farmer, 1976; Maccoby & Jacklin, 1974; Rossi & Calderwood, 1973). Despite almost two decades of intensive research, clear explanation still eludes us.

Eccles (1985) has suggested, however, that career decisions are based on "varied" and "competing" interests of gifted women and are made within the context of a "complex social reality." Especially with gifted women, this challenge of choosing between multiple interests is not an easy decision for either short-range goals (e.g., enrolling in a biophysics class) or long-term goals (setting career goals). Farmer (1987) concluded that the "transition time into adulthood may have diminished women's long range career commitment," and suggested that future "research should provide further information on the stability of this motivation dimension over time" (p. 8). This present study addresses that concern.

Mathematical reasoning ability is thought to be a forerunner of high level achievement in mathematics and science (Astin, 1968; Green, 1989; Krutetskii, 1976; Stanley & Benbow, 1986). Indeed, mathematically precocious youth tend to exhibit, at age 23, high academic achievement, especially in mathematics and science (Benbow & Arjmand, in press). Yet, in the past, most young women with such talents do not pursue scientific careers or majors in college; many actually abandon majors in mathematics or science during the college years (Albright, 1988; Benbow & Arjmand, in press; Hollinger, 1986). According to Steinkamp and Maehr (1984), "America can no longer afford the luxury of inefficient use of the scientific talent and education of women" (p. xii), especially at a time when the proportion of young adults is rapidly declining (Mumford & Gustafson, 1988) and there is a declining pool of candidates for Ph.D.s in science (National Science Board, 1987).

During the young adult years, important career, educational, and lifestyle decisions are being made that promote adult achievement (Farmer, 1987). Are current mathematically precocious females considering and preparing for a future which includes math/science careers? We address that question by studying the transition time from childhood potential to exceptional adult achievement for extremely mathematically precocious females.

Because the number of extremely precocious (top 1 in 60,000) females is small, causal-comparative or correlational studies aimed at the discovery of possible causes of phenomenon being studied are not appropriate (Borg & Gall, 1983). Yet, there is sufficient number of females to warrant an investigation through descriptive research methods. Borg and Gall (1983) suggest that descriptive studies are primarily concerned with finding out "what is" (p. 354). Therefore, this study focused on discovering the career aspirations of mathematically precocious females.

We adopted a multiple-case study design to document the career aspirations of mathematically precocious females in adolescence and young adult years. Yin (1984) defined the case study design as an empirical inquiry that:

> investigates a contemporary phenomena with its real-life context, when the boundaries between phenomena and context are not clearly evident and in which multiple sources of evidence are used. (p. 23)

When compared to a single-case study, evidence from multiple-case designs is usually considered "more compelling" (Yin, 1984) because of the replication theory. One drawback, however, is that multiple-case studies cannot consistently include the "rare" or "critical" case that are so often chosen in the single-case study. Yet, this investigation is unique because it is not subject to that criticism. All 15 young women have been identified as "rare" or "critical" on the basis of their extremely high scores (700-800 on the SAT-M before age 13; approximate frequency 1 in 60,000).

Specifically, we attempted to determine: (1) the career aspirations of mathematically precocious females during adolescence and young adult years; (2) their educational choices during that time as indicated by college attended, college major, or plans for undergraduate study and/or graduate study; (3) their lifestyle expectations and their relationship to occupational choice; and (4) the stability of their expectations and decisions.

Methods

Subjects

Case studies were completed for 15 of 17 females identified by the Study of Mathematically Precocious Youth (SMPY) during 1981-1983 as having scored at least 700 on the SAT-M before age 13 (700Ms). Their mathematical abilities represent the top 1 in 60,000 among females. The 15 700M females were born between 1968 and 1970. Ten (67%) were "Caucasian" and 5 (33%) were "Asian-American." During childhood, 8 females (53%) lived on the East Coast, 5 (33%) in the Midwest, and 2 (14%) on the West Coast. Typically, 700M females tended to be the only child or the oldest child in a family where both parents were college educated (100% of fathers and 73% of mothers), had a professional career-orientation (100% of fathers and 80% of mothers), and maintained an annual income of over $50,000 in 1983 dollars (53%). Approximately 93% of the fathers and 67% of the mothers had advanced professional degrees (e.g., M.A., M.S., J.D., M. D., or Ph.D.).

Procedure

A multiple-case study design (Yin, 1984) was used to document career aspirations of the 15 mathematically precocious females. Effective casework depends on "triangulation," which uses "multiple-sources of evidence" (Yin, 1984) to reduce bias (Goetz & LeCompte, 1984). This study followed that procedure. Information was drawn from several questionnaires, which were completed during 1982-1988 and covered grades 7 to 12. Additional information was also taken from in-depth telephone interviews in 1989, when 700M females were 19-21 years of age. Using these data, career aspiration profiles were developed. These profiles documented career aspirations, educational choices, and lifestyle expectations.

The degree goal, college/university selected, intended college major, career and educational aspirations, and lifestyle expectations were recorded in computer databases. The reasons for their degree/career goals and choice of major were listed, grouped, and summarized. The college or university selected by each subject was rated using Barron's Guide to the Most Prestigious Colleges (1986) and Gourman's scale (1989) for the graduate institutions.

The stated career aspirations, expressed in long-range career goals at ages 13, 18, and 19-21, were listed and then coded by: 1) field of study, 2) type of position, and 3) level or setting of the work place (Table 1). Descriptive data on educational plans including degree goal, undergraduate major, and university attended are listed in Table 2. The lifestyle expectations stated after high school and in college or thereafter were coded for intentions to combine career-marriage-family options (Table 3).

Results

The following narrative reports the major findings in the three areas: educational choices, career aspirations, and lifestyle expectations, followed by descriptions abstracted from case study narratives.

Educational choices

At age 13, 15 700M females (100%) had educational plans that included not only a college education, but also an advanced degree (see Table 2). At age 19-21, 14 700M females (93%) aspired to advanced professional degrees: 3 (20%) were intending to complete the M.S., 2 (13%) the J.D., 3 (20%) the M.D., 5 (33%) the Ph.D., and 1 (7%) an M.D./Ph.D. The 15th, Cathy (not real name), was undecided about her degree goal. She had not declared her major at Princeton and her long-range career plans were still uncertain. Overall, 14 700M females (93%) had enrolled, however, in prestigious undergraduate universities (Table 2). Ten females (67%) had elected undergraduate majors in mathematics, sciences, engineering, architecture, or medicine (Table 2). The selection of a college major represented the unique path being taken by each individual to reach their career goal. With one exception, no two females chose the same major.

Reasons for educational choices. The most frequently cited reasons for desire to obtain advanced professional degrees were "it's required" (i.e., physician, lawyer, college professor, etc.), "to learn more about the subject," "interest," and "usefulness" of the degree. Comparison of degree goals by field of study indicated that there were no differences in the type of or reasons for a degree among those pursuing math/science versus other careers.

Despite the diversity of majors selected, the reasons given for selecting majors were similar and very much reflected the reasons given for their choices of career. After high school, 10 700M females (67%) cited "interest, enjoyment" as their reason for selecting a college major. During the interviews, their responses were more specific and lengthy but did not differ in substance. Yet, at that time, eight 700M females (53%) did add that their college major provided flexibility and opportunities to combine multiple interests.

Quality of undergraduate/graduate institutions. Consistently, 700M females selected prestigious undergraduate colleges and universities. Overall, 14 700M females (93%) chose institutions which were ranked in the "most competitive" or "highly competitive" in Barron's Guide to the Most Prestigious Colleges (1986). Reasons for choosing an undergraduate college/university centered on "departmental quality" and "prestige and reputation of the school" for 10 of the 700M females (67%).

Graduate schools attended were highly prestigious. Louann entered MIT's graduate program in electrical engineering, which is rated #1 by the 1989 Gourman Report (p. 30). Similarly, Tara completed her M.S. in applied mathematics at Johns Hopkins which is rated in the "top 20" leading institutions for that field of study (p. 12). Even though all 700M females were of undergraduate age when interviewed, five (30%) had been accepted into graduate or medical schools, with four (27%) having already entered graduate or medical programs. By age 20, one 700M female (7%) had received a master's degree, and two (13%) were scheduled to complete their master's degree within the year.

Progress toward educational goals. The following descriptions of 700M females is abstracted from case study narratives. They reflect the rapid rate at which the 700M females were completing their education. Opportunities for advanced degrees already have been realized, at least for one individual. In 1989, after four years at Johns Hopkins University, Tara, age 20, received her master's degree in Mathematical Sciences from the College of Engineering. She reported having carried 20 credits per semester and that she "filled out the right paper work" to receive her master's degree concurrently with her Bachelor's. This remarkable accomplishment represents at least three years of acceleration.

Three other 700M females were in graduate or medical schools when interviewed, with another one on her way to medical school. In 1987, Louann, at age 18, received her B.A. in Electrical Engineering from the University of Washington. In spring of 1990, Louann is scheduled to receive her master's degree in Electrical Engineering from Massachusetts Institute of Technology.

Sally traveled a unique path to reach her career goal. During her senior year at University of California-Berkeley, Sally ended her search for graduate schools by accepting a Marshall scholarship to study at

University College, Oxford, England. At 20, Sally is currently a second year graduate student in philosophy working on the B. Phil. degree, which is comparable to a master's degree in the United States. When Sally returns to the United States, she plans to attend law school in order to teach law and philosophy.

At 19, Trudy had entered the Health, Science and Technology medical program sponsored jointly by MIT and Harvard. Trudy selected this program because it was "more quantitative in its approach," she was familiar with the locale, and she wanted to continue her association with MIT. At age 16, Tonya was accepted for an eight-year undergraduate and medical program at Brown University. Tonya chose this program because she felt less pressure to make straight A's, she did not have to worry about graduate medical exams, or go through the application process for medical school after college.

The educational accomplishments of this highly talented group of females at age 19-21 is remarkable. Collectively, they aspire to advanced degrees at academically difficult colleges and are pursuing well-articulated educational goals. These goals were formulated as early as age 13 and did not change in the last 6-8 years.

Career aspirations

At age 13, 6 700M females (40%) had career aspirations for mathematics, medicine and law (Table 1). At age 18, and at time of telephone interviews (age 19-21), 10 700M females (67%) aspired to career fields in mathematics, sciences, engineering, architecture, or medicine. [Three females (20%) aspired to careers in mathematics.] The remaining 5 700M females (33%) aspired to careers in sociology and law, or were undecided.

During the college years, the 10 700M females (67%) who aspired to careers in mathematics, science, engineering, architecture, or medicine, were evenly split between the corporate and the university work place. Interests in research activities was a common theme in either setting. Expectations for teaching were expressed by half of this group.

Overall, the career aspirations of the 700M females were largely unfocused at age 13 (Table 1). Nine SMPY 700M females (60%) were either undecided or did not express a career goal at this age. Yet, for the six 700M females (40%) who had formulated career goals at age 13, their preferences remained stable for the next six to nine years. At age 18, however, a different picture is presented. Career aspirations of 700M females were then clearly focused for 12 700M females (80%). Their plans also remained unaltered during the next few years. Three of the mathematically precocious females were undecided at age 18 (Table 1). Shortly thereafter, one did formulate a career plan, while the other two were in the process of doing so. Taken in composite the evidence indicated that career aspirations when finally formulated, mostly during late adolescence, remained stable from late adolescence to young adulthood. Moreover, career aspirations of 700M females at age 19-21 were generally scientific in orientation. Career choices clustered across the fields of mathematics, science, engineering, architecture, and medicine at a 2 to 1 ratio over other fields such as sociology or law.

Reasons for career plans. Each mathematically precocious female cited a number of reasons for their career choices, ranging from four to seven reasons per female. The most frequently cited reason for choosing a career field was "interest" or "enjoyment" (80%). This category incorporated a variety of responses, such as being interested in subject matter, classes, and/or processes. Others found their field "exciting" (40%) or stated "that's what I'm good at" (40%). The next most frequently cited reason for a career choice related to other people: the impact of parents (53%), professional role models (33%), and "helping other people" (40%). Those with math/science aspirations did not differ from the 700M females with nonmath/science aspirations in either type or number of reasons provided for their career choice.

The following description of career aspirations were abstracted from case study narratives. In 1989, at ages 19-21, Tara, Jane, and Sandy had career goals in mathematics. Tara was interested in applied mathematics and computer science and was currently employed as a Performance Analyst by a subsidiary of a major telephone company. Jane and Sandy planned to teach mathematics. Jane wanted to be a professor of mathematics and teach calculus in a university about the size of MIT. Sandy was considering either becoming a college professor of mathematics or a junior high school mathematics teacher. She felt the professorial role would be more "challenging," but she recognized a need for "really good female math teachers" in junior high school.

Louann and Wilma had career goals in architecture or engineering. As an electrical engineer, Louann aspired to a position in research or development of fiber-optics communication networks in a corporation or university. Wilma saw herself as an architect, as she specialized in design aspects of residential housing.

Hilda and Carol also aspired to scientific fields. After completing the M.D./Ph.D., Hilda planned on conducting basic research, perhaps in protein chemistry, within a governmental setting. She considered the possibility to "go international" with her interests and talents. Carol, in contrast, planned to become a professor of molecular biology at a university. Both aspects of the professorial role, teaching and research, had great appeal to her.

Trudy, Priscilla, and Tonya aspired to careers in medicine. Trudy hoped to become a physician, researcher, and/or professor, specializing in cardiology, while Priscilla and Tonya wanted to become "practicing" physicians.

The 700M females with nonmathematics/science aspirations were interested in the fields of sociology and law. Rhonda planned to conduct sociological research in either a university, company, or governmental setting. Both Naomi and Sally aspired to careers in the legal field. Naomi wanted to specialize in immigration law as a defense attorney for either a public or private firm; Sally hoped to do political and legal consulting, while teaching law and/or philosophy in law school.

Gayle and Cathy were undecided about long-range career goals. Gayle was completing a major in Russian Studies with almost a second major in computer science. In 1990, she hoped to receive a fellowship position in one of the east block country consulates within the Soviet Union before returning to graduate school. On the other hand, Cathy was deliberating between chemistry or music as her undergraduate major and was also undecided about long-range career goals; however, she had ruled out teaching, medical school, and law school.

Career goals for these extremely mathematically precocious females are ambitious and reflect an "achievement" orientation in mathematics and scientific fields of study.

Lifestyle expectations

Thirteen of SMPY's 700M females (87%) aspired to full time careers (Table 3), while two (13%) were considering a combination of part-time/full-time career options. Twelve females (80%) had lifestyle expectations that combined careers with marriage; with seven (47%) planning on having children (Table 3).

Lifestyle expectations remained stable from adolescence to young adult years in the context of wanting full-time careers, but expectations for marriage and children changed for 67%. A comparison of lifestyle expectations by field of study revealed no significant differences between the math/science career aspirations group versus the other career groups in terms of lifestyle expectations (Table 3) There was a trend, however, whereby 60% of the math/science group combined careers with marriage and children versus only 20% for the nonmath/ science career group.

Reasons for lifestyle choices. Reasons for lifestyle expectations were explored during the interviews. Surprisingly, those who planned to combine careers with marriage and children (47%) justified their choices on the basis of their desire for a career rather than on the importance of marriage or family life. Typical responses involving careers were: 1) "it's really important;" 2) "I want to work," i.e., "not working would be boring" or "never occurred not to work;" 3) "women need outside interests beside their kids;" 4) "something to invest my energy in;" or 5) "huge waste of my talent," [if I didn't work].

The 700M females undecided about marriage or children or deciding not to marry or not have children (53%) focused their remarks on lifestyle rather than career. In open-ended responses, they expressed concern for 1) "combining career and family responsibilities," 2) "don't have much faith in institution, [of marriage]" or "doubt commitment for life," and 3) "don't like to be around little kids." Consequently, they made fewer comments about their careers.

Discussion

Educational choices and lifestyle expectations are important to career aspiration (Astin & Myint, 1971; Farmer, 1987; Sewell & Hauser, 1976). The extremely mathematically precocious females had much more than the necessary ability to pursue high level careers in the math/sciences. How are they turning their potential into reality during late adolescence and young adult years as they become independent from family, friends, and support networks? What are their career goals and how are they reaching for those goals? These two questions served as the primary focus for this study.

Two-thirds of the 700M females interviewed aspired to career fields in mathematics, science, engineering, architecture, or medicine. Although they shared different aspirations for career fields and thus different college majors, analysis of the degree goal and college or university attended revealed no major differences between those who aspired to math/science careers and the others. When interviewed at 19-21 years old, the 700M females tended to be full-time undergraduate (60%) or graduate students (33%) at prominent universities in the East (80%).

Typically, the 700M female developed an early interest in mathematics and science during the school years, and had childhood expectations of careers in these fields. During the high school years, career and educational decisions were made. They involved a college education with an advanced degree from a prestigous university in the East and career aspirations in areas related to mathematics and science. The 700M females discovered unique paths to their career goal, which were a reflection of their interests. Inclusion of research activities into a variety of occupations was a prevalent theme. Although lifestyle expectations were not as clearly defined nor as stable as career goals, the 700M female planned on a full-time career with marriage (80%) and the possibility of children (47%).

Benbow and Arjmand (in press) reported that 50% of mathematically gifted females at age 18 intend to pursue careers in mathematics and sciences at the beginning of college but only 37% actually complete such bachelor degree in their intended majors. Similar results are reported by Albright (1988). In this study, which surveyed the females with the most exceptional mathematical ability, 67% of 700Ms at ages 19 through 21 not only aspired to careers in mathematics, science, or medicine, but one-third of them were actively pursuing those career paths by completing undergraduate degrees in math/science areas or were enrolled in graduate or medical school by age 21. These results are encouraging as these highly talented females in mathematics work toward achieving well-articulated goals in math/science career fields.

Multiple-case study analysis revealed striking similarities in 700M females. These extremely talented females tended to make career decisions between ages of 13 and 18 and then persist in their pursuit of them. At the three time-points surveyed not one girl reported a change in direction of their career. Interviews established that many options were considered, as predicted by Eccles (1985), even into the college years; yet, once a decision was made, it remained stable. These results indicate, therefore, that any interventions aimed at encouraging mathematically talented females to enter math/science careers need to take place during the early high school years.

It was also very encouraging to note that an extremely high number of 700M females aspired to and were working toward advanced professional degrees. Although related to career choice, these high degree goals were well articulated by age 13. The importance of education as preparation for professional careers, as advanced by Sewell and Hauser (1976), thus appears to be a integral part of the career aspiration of extremely mathematically precocious females.

College or university selected for undergraduate and graduate education is also an important career decision to study since most of the top level scientists in the United States graduate from a few academically difficult colleges (Davis, 1965; Werts, 1967). In this study, extremely mathematically precocious females consistently attended highly selective and academically difficult colleges. Graduate programs included prominent universities, such as MIT, Johns Hopkins, and Brown. Not only did the 700M females pursue academically difficult colleges, but 80% attended out-of-state or international universities and cited "department quality" or prestige, reputation of school as the most frequent reason.

As a group, these extremely high ability females tended to prefer science (including medicine) over mathematics over other career fields. Both groups of females, however, cited remarkably similar reasons for their career choices--"interest, enjoyment." This is consistent with Eccles (1985) prediction that career choice for the gifted, and especially for gifted women, is an outcome of interests. Such a finding makes sense in view of the gifted youth's "multi-potentiality" (Barbe & Renzulli, 1981; Rodenstein, Pfleger & Colangelo, 1977).

Also studied were these gifted females' lifestyle expectations and their relationship to career choice. Lifestyle expectations of 700M females tended to change during late adolescence and young adult years. There were no specific patterns to the types of changes, although 67% of the females indicated different options at the two time points of analysis. It appears that lifestyle expectations do not seem to be as "set" or "stable" as career aspirations during this transition time.

Farmer (1987) suggests these lifestyle expectations present a "great challenge" to career choices of women today. Overwhelmingly the 700M females aspired to full-time careers, with over 80% planning to combine careers with marriage and 47% expressing plans to have children. These expectations seem realistic and similar to successful women scientists. Studies of women mathematicians (Helson, 1980; Luchins & Luchins, 1980), for example, have found that high achieving women have successfully combined home and work goals. Luchins and Luchins' (1980) study of 350 female members of the Association for Women in Mathematics indicated that 43% were married, with over 70% of those who were or had been married having children.

Interestingly, those mathematically gifted females who planned to combine careers-marriage-family options (47%), were more focused on the rationale for the career, rather than being concerned about the logistics of managing career and family. They had seemed to have gone beyond that stage. Interestingly, the 53% who were undecided about having children had mothers who had combined career and family roles. They expressed concern about "how they would manage" the lifestyle with career-marriage and family options. It appears that mothers as models in "dual" home/career roles does not guarantee combined home and career lifestyles for their daughters. Internalizing the role and self-perceptions as "homemaker" and "mother" and "professional" appear yet to be developed by over half of this group at ages 19-21.

In review, the career aspirations at 19-21 of 15 females who had been previously identified as extremely mathematically precocious were studied. A limitation with this study is the reliance on self-report data. Therefore, additional information was drawn from a number of sources: from questionnaires supplied by both 700M females and their parents and telephone interviews. Also, we did not ask the subjects to recall events or aspects of their behavior at a much earlier age. This is an advantage. The telephone interviews also provided another source to clarify answers.

We conclude that for extremely mathematically precocious females career aspirations and educational choices are clearly defined by age 18. A greater number of such females aspire to careers in mathematics and science than their somewhat less gifted counterparts. Although lifestyle expectations were less well defined, just as Cray-Andrews (1983) and others have found, 93% of these talented females aspired to advanced degrees from highly prestigious universities.

During this transition time from late adolescence to young adult years, mathematically precocious females were actively engaged in making career and educational decisions. In the words of Wallace (1985), they were in the process of self-construction. As they left their childhood network of support from family and friends, they had already made remarkable achievements and were striving to develop their potential in mathematics and science.

CHAPTER V. ARTICLE: FACTORS THAT INFLUENCE CAREER ASPIRATIONS OF MATHEMATICALLY PRECOCIOUS FEMALES

Introduction

This chapter contains an article to be submitted for publication entitled, "Factors that influence career aspirations of mathematically precocious females." The article is based on the second objective of the study, which was to identify possible factors influencing the career decisions of mathematically precocious females in their late adolescence and young adult years. The possible influences of personal factors, family factors, and educational experiences are described. The format and length are consistent with professional journals such as American Educational Research Journal or Developmental Psychology.

Abstract

What factors influence the career aspirations of mathematically precocious females? The present multiple-case study examined possible personal, family, and educational influences on career decisions of 15 extremely mathematically precocious females (1 in 60,000 in mathematical ability) during the young adult years. Questionnaires completed at age 13, in 8th grade, and after high school graduation were used. In-depth telephone interviews at 19 to 21 years provided further data. As a group, two-thirds aspired to careers in mathematical or scientific fields, as well as advanced professional degrees from prestigious undergraduate and graduate institutions. In this study, four personal factors, three family factors, and four educational factors were

identified as possibly influencing career decisions of mathematically precocious females. The 700M females aspiring to careers in math/ science versus other careers differed along several dimensions. Both groups exhibited achievement-related personal traits, especially for the math/science group; they did not sex-type themselves or occupations. The math/science career group had greater interests in math and science during adolescence, while the other career group exhibited stronger interests and abilities in the verbal areas. Family influences on career decisions were important for both groups, but were stronger for those who chose math/science careers. Career choices often corresponded to their father's career field. Both groups achieved academically at an outstanding level; all were accelerated (all but two skipped a grade). Their solid academic preparation enabled them to enter any career track, especially the nonmath/science career group. Guidance activities were not viewed as helpful by 700M females. Yet most reported that a significant person (e.g., a teacher or mentor) or an event had affected their career decisions. These mathematically precocious females ultimately made their career decision based on their interests which evolved from early family influences and educational experiences.

Factors That Influence Career Aspirations of Mathematically Precocious Females

Although considerable advances have been made by women during the last decades, women remain, nevertheless, underrepresented in mathematical, scientific, and engineering careers (Farmer, 1976; Maccoby & Jacklin, 1974; National Science Board, 1987; Rossi & Calderwood, 1973). Despite almost two decades of intensive research, clear explanation still eludes us.

Mathematical reasoning ability is thought to be the forerunner of high-level achievement in mathematics and the sciences (Green, 1989; Krutetskii, 1976; Stanley & Benbow, 1986). Indeed, mathematically precocious youth tend to exhibit at age 23 high academic achievement, especially in mathematics and science (Benbow & Arjmand, in press). There are, however, large gender differences in science achievement among the mathematically precocious. Most young women with the requisite talent do not pursue science careers or majors in college; many actually abandon majors in mathematics and sciences during the college years (Albright, 1988; Hollinger, 1986; Benbow & Arjmand, in press).

According to Steinkamp and Maehr, "America can no longer afford the luxury of inefficient use of the scientific talent and education of women" (1984, p. xii), especially now when the proportion of young adults is rapidly declining in America (Mumford & Gustafson, 1988). This is resulting in a declining pool of candidates for Ph.D.s in science--the individuals needed to meet the technological needs of tomorrow (Green, 1989; National Science Board, 1987).

Research findings during the last decade have changed our understanding of how various factors influence female achievement. Holden (1987) reports that "math anxiety is no longer much in evidence" (p. 660). As for enrollment of women in mathematics courses, Datta (1985) suggests that "currently the number of women well-prepared in mathematics has exceeded the number actually entering mathematically related careers" (p. ix). In an attempt to resolve the importance of math ability, Hollinger (1986) observed that even females who "persist in taking upper level mathematics courses and continue to excel on standardized tests of math achievement do not persist in pursuing careers in mathematics" (p. 133). Moreover, Albright (1988) found, within a group of highly mathematically talented students, that ability alone cannot explain why some females choose and then continue to study a science major, while most do not. Albright (1988) suggested there may be a floor effect for mathematical ability. Beyond a certain level of high ability, other factors become more important in career choice. What are these factors?

Several models have been proposed to explain the career choices and career achievement of women. Farmer's (1987) multidimensional model is based upon a broad range of interacting factors, including background, environmental, and personal. Together they influence career motivation. Eccles (1985), on the other hand, links choices of women in the area of educational and vocational achievement to two factors: "the individual expectations for success and the importance or value the individual attached to the various options perceived as being available" (p. 264).

Eccles (1985) also considers career choice as the outcome of interests, especially for the gifted. The "multipotentiality" of gifted individuals, coupled with their broad ranging interests, produces many career options from which to choose. As a result, the decision process is more difficult for them (Barbe & Renzulli, 1981, Rodenstein, Pfleger, & Colangelo, 1977).

Taking a different approach, Krumboltz, Mitchell and Jones (1976) emphasized four categories of factors as influencing career decision-making: (1) genetic endowment and special abilities, (2) environmental conditions and events, (3) learning experiences, and (4) task approach skills. These four factors are actually similar to those cited by Tannenbaum (1983) and Feldman and Goldsmith (1986) as important for the development of potential. Mitchell and Krumboltz (1984) suggest, however, that "each individual has a unique history of learning experiences that results in the chosen career path" (p. 241). Each career path is shaped by decisions, with decisions made during the transition time from late adolescence to young adult years promoting or inhibiting achievement (Farmer, 1987; Wallace, 1985). Therefore, this time period seemed especially critical and was studied in this investigation.

In this study, we investigate the career aspirations and achievements of extremely precocious females--females who have more than the required ability to perform highly in science. Because the number of extremely precocious (top 1 in 60,000) females is small, a causal-comparative or correlational study aimed at the discovery of possible causes of phenomenon being studied are not appropriate (Borg & Gall, 1983). An investigation through descriptive research methods was deemed appropriate.

Borg and Gall (1983) suggest that descriptive studies are primarily concerned with finding out "what is" (p. 354). Guided by previous theories (e.g., Eccles, 1985; Farmer, 1987; Krumboltz, Mitchell & Jones, 1976), we attempt to determine what are the learning experiences (i.e., personal, family or educational) that differentiate, influence, or reinforce career decisions among extremely mathematically precocious females. This requires an in-depth study of such individuals, which is possibly best accomplished by the multiple-case study method.

Yin (1984) defined the case study design as an empirical inquiry that:

> investigates a contemporary phenomena with its real-life context, when the boundaries between phenomena and context are not clearly evident and in which multiple sources of evidence are used. (p. 23)

When compared to a single-case study, evidence from multiple-case designs is usually considered "more compelling" (Yin, 1984). Its drawback, however, is that multiple-case studies cannot consistently include the "rare" or "critical" case that are so often chosen in the single-case study. Yet, this investigation is unique because it is not subject to that criticism. All 15 young women were identified as "rare" or "critical" on the basis of their extremely high scores (700-800 on the SAT-M before age 13; approximate frequency is 1 in 60,000).

Specifically, we attempted to determine the possible influences of personal, family, and educational factors on career decisions and whether they could discriminate between those females selecting math/science careers versus other careers. Personal factors studied were those identified by Farmer (1987): self-esteem and locus of control (self-concept), math and verbal ability, and self-perception of ability. Two other personal factors, interests and gender-role orientation, were investigated. While interests, especially in school subjects, or gender role orientation may develop in family or educational settings, these personal choices are reflections of interests and gender-role orientation long after they have left home and school settings. In this study, then, the personal factors were broadened to reflect personal choices related to career decision-making, which may result from "interactions" with and perceptions of others, as well as traditional background or "input" factors, such as age, gender, and ability.

Whereas Farmer (1987) considered environmental variables to include, school, family, and community, we separated these factors to determine possible influences of family and educational factors. This is consistent with the approach taken by other researchers (e.g., Benbow & Arjmand, in press; Raymond & Benbow, 1989, Rooney, 1983; Van Tassel-Baska & Olszewski-Kubilius, 1989). The size and location of community were considered, along with other background variables, in the family background cluster. Expectations of parents and parents' encouragement of career decisions were also investigated. Educational experiences were divided into possible influences of acceleration options, extent of coursework in mathematics and science, out-of-school activities, guidance activities, relationships with teachers and significant others, and influence of awards and achievements on career decisions.

Based on the relevant literature on gifted women in mathematics, achievement motivation, and career decision making, several propositions were advanced to guide the study. Five propositions on personal factors proposed that mathematically precocious females would:

1) display achievement-related personal traits;

2) acknowledge the influence of high math ability on career decisions;
3) have positive self-perceptions;
4) display positive attitudes and interests in a variety of school subjects; and
5) exhibit a gender role orientation that included both masculine and feminine characteristics of a variety of occupations.

Three propositions on family factors proposed that mathematically precocious females would:

1) identify family background variables as influential on career decisions, and
2) cite parental encouragement as influential on career decisions.

In addition, it was proposed that:

3) parents of 700M females would express high educational and career aspirations for their daughters.

Six propositions for educational factors proposed that mathematically precocious females would:

1) take advantage of acceleration options during school years;
2) complete coursework in mathematics and science through calculus and physics during high school;
3) participate actively in a variety of out-of-school activities, which were influential on career decisions;
4) cite guidance activities as ineffective in meeting their career planning needs;
5) indicate special achievements or recognition of awards influenced their career decisions, and

6) cite relationships with teachers, peers, or significant others as influential on career decisions.

Methods

Subjects

Case studies were completed for 15 of the 17 females identified by the Study of Mathematically Precocious Youth (SMPY) during 1981-1983 as having scored at least 700 on the Scholastic Aptitude Test-Mathematics (SAT-M) before age 13 (700Ms). Their mathematical ability among females represents the top 1 in 60,000. The 15 700M females were born between 1968 and 1970 and are being longitudinally studied by SMPY. Ten females (67%) were "Caucasian" and 5 (33%) were "Asian-American." During childhood, 8 females (53%) lived in the Eastern Coast states, 5 (33%) in the Midwest, and 2 (14%) on the West Coast.

Typically, 700M females tended to be the only child or the oldest child in a family (73%), where both parents were college educated (100% of fathers and 73% of mothers). Approximately 93% of the fathers and 67% of the mothers had advanced professional degrees (e.g., M.A., M.S., J.D., M.D., or Ph.D.) by the time their daughters were age 13. Generally, both parents had a professional career-orientation (100% of fathers and 80% of mothers) and maintained an annual income of $50,000-60,000+ in 1983 dollars (53%).

Procedure

A multiple-case study design (Yin, 1984) was used to document the influences on career aspirations of 15 mathematically precocious females. Effective casework depends on "triangulation," which uses "multiple-sources of evidence" (Yin, 1984) to reduces bias (Goetz & LeCompte, 1984). We adopted that procedure. Information was drawn from several questionnaires completed during 1982-1988 and covering grades 7 to 12, as well as data collected in 1989 from in-depth telephone interviews when 700M females were 19-21 years of age. Using these data, career aspiration profiles were developed. These profiles documented the influences of personal, family, and educational factors on career aspirations, educational choices, and lifestyle expectations.

Single case profiles were then used to investigate the patterns and trends of career aspirations among mathematically precocious females. A total of 14 propositions were advanced based on the literature review. If evidence collected from 700M females met the stated criteria, the proposition was "verified" for that individual. If a majority of 700M females verified the proposition, then "replication" of multiple-case studies occurred. Results were tabulated separately for the females in the math/science group and the females in the other career group.

Background information on the subjects was obtained from four questionnaires completed from 1982 to 1988 (Appendix A). From analysis of preliminary data, questions for telephone interviews were developed. Telephone interviews were conducted from October to December of 1989, and ranged from 60 to 90 minutes in length. The interview protocol (Appendix B) guided the interviews, which were tape recorded and transcribed.

Results and Discussion

A review of the career decisions of mathematically precocious females [i.e., their career aspirations and educational choices at age 19-21, see Montgomery (1990) for further details] precedes the major findings of the possible influences of personal, family, and educational factors on career decisions. Personal narratives abstracted from case studies were selected to further clarify the possible influences of these three factors on career decisions.

Career decisions

At age 19-21, 700M females selected undergraduate majors in mathematics, sciences, architecture, engineering, or medicine (67%), at prestigious institutions (93%), and aspired toward advanced professional degrees (e.g., M.S., M.D., J.D., Ph.D.) (93%). Career aspirations remained stable from late adolescence to young adult years. At age 18, and at time of interviews (ages 19-21), over two-thirds of 700M females aspired to math/science career fields. Career aspirations were generally scientific in orientation and evenly distributed across of the fields of mathematics, sciences, engineering, architecture, or medicine. The remaining one-third aspired to careers in sociology or law or they were undecided about career goals. These findings represent a higher than expected number of mathematically precocious females who pursue math/science careers. Benbow and Arjmand (in press) reported that while 50% of mathematically gifted females intend to pursue careers in mathematics and sciences at the beginning of college, only 37% actually complete such majors. Similar results are reported by Albright (1988).

What factors influenced the trend in this study of the females with the most exceptional mathematical ability to aspire to mathematics and science-related career fields?

Analysis of possible personal, family, and educational factors by career aspiration group (i.e., those aspiring to careers in mathematics and sciences versus those who aspired to other careers, are discussed in more detail below.

700M Females with Career Aspirations
for Mathematics and Sciences

Personal factors

Five personal factors were studied to determine their possible influences on career decisions of 700M females who aspire to careers in mathematics and sciences, including engineering, architecture, and medicine.

Achievement-related personal traits. These included self-ratings of personality traits at age 13 and age 18, as well as parent's ratings of their daughter's personality traits at age 13, and self-report data on three other achievement-related personal traits. Overall, 6 700M females (60%) exhibited achievement-related traits. They were more likely to be described as: interested in academic success (100%), interested in recognition of accomplishments (100%), self-confident (90%), self-sufficient (60%) or interested in being a leader (50%) rather than venturesome, risk-taking (20%) or willing to experiment (20%).

One 700M female, Tara, who aspires to a career in applied mathematics, displayed all achievement-related personal traits. Her self-confidence and interest in academic success was apparent when she signed up for 20 credits as a first semester freshman, against her advisor's warnings, and consistently made A's in most of her courses each semester thereafter. This enabled her to graduate from Johns Hopkins at age 20 and receive her master's degree in Applied Mathematics, concurrently with her B.A., from the School of Engineering.

Helson (1980) identified similar traits that characterized women mathematicians--"superior intellectual functioning, and unusual combination of perseverance, adaptiveness, and sensitivity to the new and unforeseen" (p. 26). Over half of the 700M females had these same personal characteristics.

Influence of math ability and self-perceptions. Using measures of self-confidence and internal locus of control, 700M females held positive self-perceptions at age 13 (90%) and age 18 (100%) (see Table 4C). Generally, these 700M females agreed with statements such as: 1) "I take a positive attitude toward myself;" 2) "I feel I am a person of worth on an equal plane with others;" and 3) On the whole, I am satisfied with myself." On measures of self-perception of ability, they were "comfortable" with their high ability (100%) and felt that their intellectual precocity did not affect opinion others held of them (66%). During interviews at age 19 to 21 years, all but one of the 700M females (90%) related that they considered their mathematical ability to be a factor affecting their career choice (Table 4B).

Hilda, who aspires to a career in research and is a junior biochemistry major at Harvard University, disagreed with the self-confidence and internal locus of control measures at age 13. She also indicated that her mathematical ability was not an influence on career decisions. She explained,

> I don't consider it a high mathematical ability, so no [not an influence] ... it just seems that there are a lot of people out there who are a lot smarter and have a lot more promise. I really think I'm just a good test taker and not like a mathematician. (Hilda, Interview #49, October 12, 1989)

A similar view of her intellectual precocity was expressed at age 13, when Hilda wrote, "It's [giftedness] generally common because I'm in a G/T school and there is a concentration of gifted children." In Hilda's school, beginning in 2nd grade, gifted children with over 140 IQ and teacher recommendation were grouped into classrooms of 20-30 students for their entire educational program. Hilda related, "I've never been the smartest, but just more like everyone else." (Hilda, Interivew #47, October 12, 1989).

Typically, however, self-perceptions from the math-science career group were positive and varied. For example, while Carol saw it as an "asset" at age 13, Trudy viewed her special intellectual precocity from a positive but perfectionistic point of view. She wrote,

> I am happy and fortunate, but I wish I could be a bit smarter--such as making a perfect score before age 13. (Trudy, Student Questionnaire #66, 1982).

A strong work ethic was expressed by Priscilla, who viewed her intellectual precocity as "99% perspiration and 1% inspiration."

Positive self-perceptions at age 13 and the recognition of high measured ability in mathematics as an influence on career decisions were characteristics of 700M females aspiring to math/science careers at age 19-21. This is consistent with previous findings of high mathematical ability being a predictor of career motivation in general (Astin, 1968; Astin & Myint, 1971) and in science (Benbow, 1983; Benbow & Arjmand, in press). But not only is measured ability important, Covington and Omelich (1981) argue that self-perception of ability is an even greater influence on achievement behaviors. Our findings support this view.

Attitudes and interests. Using measures of attitudes and interests, 700M females indicated whether they 1) "liked" certain academic subjects, 2) were "confident" in their abilities, 3) found the subject "easy" or 4) "interesting", and 5) "useful" to their planned career. Positive answers were "very ..." or "somewhat ..." in each category. If the 700M demonstrated "positive" attitudes on four of the five items listed above, then the responses were considered "positive" (see Table 4D). In the group, nine 700M females (90%) expressed positive attitudes in four or more of the seven academic subjects. Thus, their attitude towards academics or school was judged positive.

They were more likely to hold positive attitudes and interests toward mathematics (100%), computer science (90%), foreign language (90%), natural sciences (80%) and physical sciences (80%) than English/literature (40%) or social studies (20%). Moreover, a higher percentage of this group expressed positive interests and attitudes at age 13 (90%) than at age 18 (50%) for all subjects, except foreign languages (see Table 4D). This indicates that their enjoyment of school declines during adolescence. Nonetheless, their positive attitudes and interests in math/science subjects seemed to have had important implications; they apparently guided career choice. At age 19-21, 700M females based their career decisions on their "interest" and fields of study that they "enjoyed" and found "interesting" and "challenging" (Montgomery, 1990).

For example, Trudy, Priscilla, and Tonya, who aspire to careers in medicine, tended to base these career decisions on a combination of their abilities, attitudes, and interests. Trudy's career aspirations seem to have stemmed from her high ability in mathematics. She related that from mathematics she got interested in science and from there eventually medicine. During the school years, early interests focused on mathematics, natural and physical sciences and later narrowed to biology, when she took an undergraduate biology course at MIT. She also expressed that knowledge of the SAT-M score reinforced her belief in herself to pursue her goals and reach her potential.

Personal interests also may dictate the different paths taken for reaching career goals. Both Priscilla and Tonya had career goals in medicine but yet have very different intentions. Priscilla is interested in the scientific side of medicine and chose biochemistry as her undergraduate major at Harvard. Such a major involved taking a wide variety of courses in biology, chemistry, and biochemistry, which satisfied her intellectual needs. In her interview, she expressed that she has always been interested in science and has worked in research labs. These interests and experiences broadened her focus as a pre-med major. Tonya, on the other hand, chose as her undergraduate program, Health and Society, an interdisciplinary pre-med major at Brown. This major is a combination of political science, sociology, and community health, which Tonya became interested in as a result of a course she took during her freshman year.

Thus, our data are consistent with the viewpoint posited by Eccles (1985) that for gifted women career choices are based on interests. These mathematically precocious females envisioned a career as "their life's work" that represents their "unique or personal" expression of their abilities and interests. For 700M females aspiring to careers in mathematics and science, it was the early positive attitudes and interests in these fields, coupled with a "narrowing" of interests by age 18, that characterized their choice patterns for both short-range goals (i.e., choosing courses) and long-range goals (i.e., choosing a career).

Gender-role orientation. Seven 700M females (78% with nine reporting) did not sex-type the following occupations as either "strongly masculine," or "strongly feminine": engineering and computer science (88%), natural sciences (88%), physical sciences (88%), social sciences (78%), mathematics (75%), and humanities/fine arts (67%). In addition, six 700M females (67%, with 9 reporting) did not sex-type themselves. Four 700M females sex-typed themselves as "strongly feminine." Yet among these four, three (75%) aspired to careers in mathematics.

Single-case study narratives further clarify the importance of this concept. Wilma who aspires to a career in architecture, views her field as "pretty mixed, pretty even." During junior high school and at age 18, Wilma did not sex-type any occupational fields as "strongly masculine" or "strongly feminine." Exploring the relationship between sex-typing and career choice, Carol, a junior in physics at Harvard suggested,

> I know that more males are in it [physics] and interested in it [physics], but I certainly wouldn't hold that against females trying to go into it [physics]. (Carol, Interview #52, October 18, 1989)

Many of the 700M females disagreed with even the concept of sex-typing of career fields. At age 13, Louann refused to mark the answers on her questionnaire and indicated that it "can't be done." Louann certainly did not allow sex-typing of career fields to interfere with her career choices. In the spring of 1990, she will graduate with her master's degree in Electrical Engineering from MIT at age 21. Likewise Tara, who graduated with a master's degree in Applied Mathematics from Johns Hopkins Univerisity at age 20, remarked, "I think most people have stereotypes about what sort of persons should go into a certain field. I think that's pretty silly" (Tara, Interview # 52, October 17, 1989).

Gender-role orientation is acknowledged by Sandy as an important consideration in the career decisions of women but saw it as unfortunate.

> A woman, whether she admits it or not, would be uneasy about going into a field that she feels is strongly masculine. And I think that would be a deterrent to her. I think that's a shame because she may be wasting a talent in a field that she would be very good at. (Sandy, Interview # 52, October 16, 1989)

Perhaps, Trudy best expressed how gender-role orientation emerges and becomes compatible with her career choice of medicine. While Trudy considers herself to be both "masculine" and feminine," she explained that "at MIT in science you feel that you've developed a masculinity as well" (Trudy, Interview #52, October 13, 1989).

These comments are consistent with gender schema theory (Bem, 1985). Having the capacity to cross sex-type is thought to confer an intellectual advantage (Maccoby & Jacklin, 1974). This may be especially the case for mathematically talented females. Mathematics is often linked with "masculine" characterics (Benbow, 1988). Moreover, our results are also consistent with Lesser and coauthors (1963) who commented that "achieving girls perceive intellectual achievement goals as a relevant part of their own female role" (p. 63). This sentiment was clearly apparent from the females' comments.

In summary, five personal factors were replicated by multiple-case studies (see Table 7). It appears that personal factors tend to influence career decisions of those 700M females aspiring to careers in mathematics and sciences. Such mathematically precocious females exhibited achievement-related personal traits (60%) that promote development of potential, held positive self-perceptions at age 13 (90%) and age 18 (100%), and held positive attitudes and interests in a variety of academic subjects at age 13 (90%). Their early positive attitudes and interests toward mathematics continued through adolescence, while their other interests declined somewhat. Mathematically precocious females aspiring to careers in mathematics and sciences also did not sex-type a variety of occupations at age 13 (78%). Finally, at age 19-21, these 700M females (90%) acknowledged the influence of their high ability in mathematics on their career decisions.

Table 7. Proposition x case matrix for personal factors that influences the career aspirations of 700M females at age 19-21

Career Choice/ Code Name	Propositions[a]					
	4	4A	4B	4C	4D	4E
Career Group: Math/Science (10)						
Engineering, Architecture						
Wilma	yes	yes	yes	yes	yes	yes
Louann	no	no	yes	yes	no	yes
Mathematics						
Tara	yes	yes	yes	yes	yes	no
Sandy	no	yes	yes	yes	yes	yes
Jane	no	no	yes	yes	yes	yes
Science						
Hilda	yes	no	no	no	yes	no
Carol	yes	no	yes	yes	yes	no
Medical						
Priscilla	no	yes	yes	yes	yes	yes
Tonya	yes	yes	yes	yes	yes	yes
Trudy	yes	yes	yes	yes	yes	yes
Career Group: Math/Science (10)						
Total	6	6	9	9	9	7
Percent	60%[b]	60%[b]	90%[b]	90%[b]	70%[b]	70%[b]

[a]Propositions: 4. Personal factors were "greatest" influence on career decisions; 4A. Achievement-related personal traits, ... conducive to development of potential and achievement literature; 4B. Recognition of high measured ability in mathematics influenced career decisions; 4C. Self- perceptions were positive; 4D. Held positive attitudes toward variety of subjects in school; 4E. Identified both masculine and feminine characteristics as descriptive of a variety of occupations.

[b]Proposition replicated.

Table 7. Continued

Career Choice/ Code Name	Propositions[a]					
	4	4A	4B	4C	4D	4E
Career Group: Other (5)						
Rhonda	yes	yes	yes	yes	no	yes
Sally	yes	yes	yes	yes	yes	yes
Naomi	yes	yes	no	yes	no	no
Gayle	yes	yes	no	yes	yes	no
Cathy	no	yes	yes	yes	no	yes
Career Group: Other (5)						
Total	4	5	3	5	2	3
Percent	80%[b]	100%[b]	60%[b]	100%[b]	40%	60%[b]
Total	10	11	12	14	11	10/13
Percent	67%[b]	73%[b]	80%[b]	93%[b]	73%[b]	76%[b]

<u>Family Factors</u>

Three family factors were studied to determine possible influences of family background, parents' expectations, and parental encouragement on career decisions of 700M females aspiring to math/science careers.

<u>Family background</u>. Family background factors investigated included: the career-orientation of parents, educational attainment of parents, family income, and location of the home.

For the 700M females in the math/science career aspiration group, both fathers (100%) and mothers (78%) had a professional career orientation and advanced professional degrees including master's degree, Ph.D., M.D., or J.D. (e.g., 90% of fathers and 60% of mothers) by the time their daughters were age 13 (see Table 5A). These findings are strikingly similar to Helson's (1980) observation that creative women mathematicians tended to have professional fathers. A closer examination of occupational titles revealed that all fathers of the math/science career group were specialized in sciences (80%) and mathematics (10%). Likewise, their mothers were also highly represented in science (30%) or mathematical (20%) careers. Parents of seven 700M females (78% with nine reporting) listed family incomes of $50,000 or above in 1983 dollars.

In the math/science group, nine 700M females (90%) cited the influence of family background factors on their career choice. The most frequently cited family factors were: family income (50%), father's educational level (50%), and mother's educational level (50%). In open-ended responses all three 700M females aspiring to medicine cited influence of both parents. Trudy pointed out, "my dad had a Ph.D. and my mom had a master's, so they were expecting higher education" (Trudy, Interview #64, October 13, 1989). In similar responses, these 700M females explained that educational achievement was important in their homes and that their parents expected them "to go to college."

Similarly, Benbow and Arjmand (in press) found father's educational level to have the "greatest discrimination power" in their study of correlates of high and low achievement among a math-talented sample. In this study, the educational level of the mother was cited in open-ended responses as frequently as the father's educational level. Thus, educational attainment of both parents were identified as family background influences on career decisions of 700M females.

Yet, career choices of 700M females closely paralleled their father's career choices (60%). For example, Louann's father is an electrical engineer for a major airlines. Although she aspires to a career in fiber optics research in either a corporate or university setting, electrical engineering was her undergraduate major at University of Washington and her area of specialization for her master's work at MIT. Likewise, Carol, whose father is a physicist, chose physics with a biophysics emphasis as her undergraduate program at Harvard.

Morever, both Tonya and Priscilla, who also aspire to careers in medicine, have fathers who are medical doctors. Priscilla and Tonya became interested in medicine as young girls. They grew up with the idea of becoming a doctor and never seriously considered another field. Both mentioned frequent trips to the hospital to "see Daddy" when they were young, spending time there, and playing games at home that developed scientific interests. Because Priscilla's family moved to the West Coast just before her 9th grade, she became dependent upon her family during adolescence. After graduation, she returned to the East for her pre-med program at Harvard, but at age 20, she wants to return to California for medical school in order to be closer to her family.

Similarly, two 700M females also made career choices which related to their mother's career choice. For example, Priscilla, whose mother is a research chemist, wants to be a practicing physician, but has not ruled out medical research. Moreover, Tara engages in "computer shop talk" with her mother, who is an information specialist for a "competing firm" and works with similar mainframe programming tasks.

Family background factors identified by 700M females during interviews focused on family income, educational achievements and career decisions of their parents. Whereas fathers were consistently in science and mathematical careers, half of the mothers also chose math/science careers. The 700M females indicated the level of education achievement by both parents influenced their career decisions. Family income was also important as their parents continued to support their education through graduate and medical school programs.

Parental expectations. All 10 sets of parents (100%) reported high parental expectations for their daughter's educational and career achievement (see Table 5B). As a group, all parents (100%) expected their daughters to "go to college." The lowest level of educational degree attainment that the parents "would be satisfied with" was the B.A. for 40% of the parents, the M.S. for 20% of parents, and the Ph.D. for 40% of parents. These are clearly high but possibly appropriate expectations given these females' ability. When parents reported the career fields they would like to see their daughter enter, all sets of parents reported at least one response that involved mathematics, science, engineering or medical fields, with 7 sets (70%) of parents listing two responses and 4 of those sets (57%) citing all three career choices in mathematics or science fields.

Jane, a MIT math major who wants to teach calculus and do research at the university level, related that her father, who also went to MIT and received his Ph.D. in mathematics, influenced her. She shared that it never occurred to her not to go to college, not to get the Ph.D. Since she loved mathematics and was good at it, she chose that career field. She and her father disagree, however, on her future career goals. He would prefer that she enter a profession where she can make more money, but Jane reminds him that it's really important that she enjoy what she is doing. In this case, family expectations coupled with personal interests and values influenced career decisions. Incidently, her love for teaching started at age 15 as a teaching assistant for a summer accelerated math program, which demonstrates that there are multiple influences (e.g., personal, family, and educational) on career decisions.

<u>Parents' encouragement</u>. Consistently throughout all interviews, 10 700M females (100%) stated that their parents were "supportive" of their career decisions (see Table 5C). Family support was characterized as "very important" (55%) and "somewhat important (45%) for these 700M females. Typically, there was "no pressure for this career choice" (90%). Seven 700M females (70%) cited their father and/or their mother

(70%) as having encouraged them in mathematics and science. Overall, 7 700M females (70%) noted the important influence of parents' encouragement in mathematics and sciences on their career choices.

For example, Sandy, a math major at Swarthmore College, who wants to teach mathematics in a magnet school for mathematics and science, related that her parents have always encouraged her to make the most of her ability. This type of encouragement was important for her because it enabled her to take college classes as a high school student. Her parents instilled in her the importance of taking her "gift" and doing something with it to benefit other people.

Interestingly, Priscilla, whose father is a physician and mother a research chemist, was almost apologetic for her admission of "family" influence. Apparently, at Harvard, it's "shameful" to admit that your parents influenced your career decisions. Priscilla asked the interviewer, "Is it wrong if your career decisions make your parents happy?"

Typically, parents of 700M females held high expectations, encouraged their daughters, and supported her career decisions without pressure. These results support earlier findings that link parental expectations to both high achievement motivation and behavior (e.g., Crandall, 1969; Winterbottom, 1958) and career aspirations (Armstrong, 1985; Fox, 1977; Haven, 1972).

In summary, three family factors were replicated by 700M females (Table 8). It appears that family factors strongly influence the career decisions of 700M females aspiring to careers in mathematics and sciences. Overall, these 700M females emerged from advantaged families

Table 8. Proposition x case matrix for family factors that influenced the career aspirations of 700M females at age 19-21

Career Choice/ Code Name	Propositions[a] 5	5A	5B	5C
Career Group: Math/Science (10)				
Engineering, Architecture				
Wilma	no	yes	yes	yes
Louann	no	yes	yes	yes
Mathematics				
Tara	yes	no	yes	yes
Sandy	no	yes	yes	no
Jane	no	yes	yes	yes
Science				
Hilda	yes	yes	yes	no
Carol	yes	yes	yes	yes
Medical				
Priscilla	no	yes	yes	yes
Tonya	yes	yes	yes	no
Trudy	yes	yes	yes	yes
Career Group: Math/Science (10)				
Total	5	9	10	7
Percent	50%[b]	90%[b]	100%[b]	70%[b]

[a]Propositions: 5. Family factors were "second greatest" influence on career decisions; 5a. Family background variables (SES) influenced career decisions; 5b. Parents expressed high career aspiration and educational achievement for daughters; 5c. Parents' encouragement influenced career decisions.

[b]Proposition replicated.

Table 8. Continued

Career Choice/ Code Name	Propositions[a] 5	5a	5b	5c
<u>Career Group: Other (5)</u>				
Rhonda	no	yes	yes	no
Sally	no	yes	yes	yes
Naomi	yes	yes	yes	no
Gayle	no	yes	yes	no
Cathy	yes	yes	yes	yes
Career Group: Other (5)				
Total	2	5	5	2
Percent	40%	100%[b]	100%[b]	40%
Total	7	14	15	9
Percent	47%	93%[b]	100%[b]	60%[b]

(78%) and cited at least one socioeconomic factor as influential on career decisions (90%). Parents' expectations for their daughters included educational achievement at the master's level or beyond (60%) and careers in mathematics or sciences (70%). Encouragement of parents supported their career choice. For those aspiring to careers in mathematics and sciences, both mothers (70%) and fathers (70%) encouraged their daughters to study, enjoy, and to accelerate in mathematics and sciences.

Educational factors

Four of six educational factors studied were determined to possibly influence career decisions of 700M females who aspire to careers in mathematics and science.

Diversity of curricular offerings. Eight 700M females (80%) had used more than four acceleration options during their school years (see Table 6A). The most popular among these options were: summer programs that offer college level course work (100%), Advanced Placement (AP) courses or other exams that could lead to college credit (100%), and early entrance to college (80%).

Positive influences of acceleration options on a variety of personal, social, and emotional measures were reported at age 18 (78%). In regard to acceleration options at age 18, 8 700M females (100%), stated they were "satisfied with what I did." During interviews, 10 700M females (100%) again expressed positive attitudes and satisfaction with previous decisions to accelerate.

A variety of acceleration options were implemented by 700M females who aspired to careers in mathematics and sciences. After being identified as highly mathematical talented and an accelerated summer program in mathematics, Trudy completed the 7th grade in her junior high school and then was accepted as a 10th grader in the North Carolina High School for Mathematics and Science. Three years later, she was honored as valedictorian of her graduating class.

Following the lead of their brothers, who also scored at least 700 on the SAT-M before age 13, Jane and Hilda actually entered MIT and Harvard, respectively, without high school diplomas. Unlike Jane, who majored in math and whose brother majored in physics at MIT, Hilda and her brother are both biochemistry majors and frequently enroll in the same classes at Harvard.

Louann was the most radical in use of acceleration. She left 6th grade to attend a special early entrance program at the University of Washington. She lived at home while attending college classes in mathematics and science and "transitional" classes in other areas. By her junior year in college, she was integrated into all university classes and then graduated with a high grade point average in electrical engineering at age 18. Louann, who has a twin brother who also participated in SMPY Talent searches, followed her lead the next year. After 7th grade, he entered the transitional program and graduated in business the same year that Louann graduated.

Regardless of the types of accelerative options utilized, our multiple-case study analysis revealed positive attitudes and feelings about acceleration. These results support similar findings for other mathematically precocious youth (Benbow, in press; Brody & Benbow, 1987; Swiatek & Benbow, in preparation) and intellectually gifted youth (Feldhusen, 1989, Janos & Robinson, 1985; Kulik & Kulik, 1984).

In-school instruction. The 700M females completed extensive coursework in mathematics and science in high school (Table 6B). There were nine 700M females (100% with one not attending high school) who had completed mathematics course work through calculus; seven (78% with nine reporting) had AP calculus while two enrolled in colleges courses in calculus. High achievement was also noted in science. All nine 700M females (100%) had completed science coursework through physics, with eight 700M females (89%) having AP physics or chemistry. Extensive coursework in mathematics and science was replicated by multiple-case studies of 700M females.

Typically, 700M females had exhausted their schools' offerings in mathematics by the 9th grade. During the junior high school years, most attended math classes at the high school or nearby colleges. When courses were not available, many enrolled in nearby community colleges. Carol, who lived in a large surburban city in the Midwest, was carpooled to a university class with several other classmates during junior high school. She reported encountering a "reluctant" and "pessimistic" college professor at the beginning of the semester. After the "younger" students had successfully completed the course with the "highest" grades, he changed his "perspective."

Guidance activities. Seven 700M females (78%) indicated that guidance activities during high school were not effective in meeting their career planning needs (Table 6D). At time of interviews, 70%

viewed guidance activities as "not influential" on career decisions. These findings are consistent with the literature; guidance activities have been seen as ineffective in meeting the needs of gifted students.

Relationships with teachers and significant others. Five 700M females (50%) cited teachers or significant others as "influential" on their career decisions (see Table 4F). Data collected at age 13, age 18 and also at age 19-21 revealed that by age 13, half of the group cited a significant person (other than family) or a significant event (70%) as having had an influence on their educational decisions. Their influence was reaffirmed at age 18 and between ages 19-21. This affirms the importance of chance factors in the development of talent (Tannenbaum, 1983) or of "crystalizing experiences" (Walters & Gardner, 1986).

Louann, who majored in engineering, cited a professor of electrical engineering as exerting a significant effect on her. She had worked for him and he had served as a mentor. Apparently he encouraged her to go to graduate school at MIT in electrical engineering. She related, "he told me that I could do it. I didn't know whether I could do it .... He helped me get into graduate school" (Louann, Interview # 53, December 31, 1989).

For Trudy, it was the influence of a serious illness, acute myocarditis at age 16, which hospitalized her for several weeks and delayed her college entrance, that influenced her career decisions. Her resulting exposure to professional role models who were working in a hospital setting and the life and death crisis reinforced her career decisions for medicine, heightened her interest in the disease process, and introduced her to a possible specialization in cardiology.

Seven 700M females (70%) mentioned specific teachers who influenced them. Consistently, these teachers were in the same fields of study that the 700M females later choose as career fields. For example, Wilma, who is preparing for a career in architecture, cited teachers in math and mechanical drawing as influential. Sandy and Tara, both math majors, mentioned "female" math teachers. Trudy, a biology major at MIT and Carol, a physics major at Harvard, mentioned teachers in biology and physics, respectively. Thus, teachers of a "favorite subject" appear to be influential on career decisions.

Out-of-school activities and recognition of achievements and awards were also investigated. While all nine (100%) were very active in out-of-school activities (see Table 6C) only four 700M females (44% with nine reporting) indicated these activities were "influential" on career decisions. While seven 700M females received awards of recognition for their achievements (see Table 6E), including five National Merit Scholarship winners and one Presidental Scholar, these achievements apparently had no influence on their career decisions.

In this study, four of six educational factors were replicated by the multiple-case studies (see Table 9). The 700M females aspiring to careers in mathematics and sciences: 1) expressed positive views of acceleration during the school years (80%); 2) completed mathematics and science coursework through calculus and physics during high school (100%); 3) cited relationships with teachers and significant

Table 9. Proposition x case matrix of educational factors that influenced career aspirations of 700M females at age 19-21

Career Choice/ Code Name	Propositions[a] 6	6A	6B	6C	6D	6E	6F
Career Group: Math/Science (10)							
Engineering, Architecture							
Wilma	no	no	yes	yes	yes	no	no
Louann	no	yes	no	no	no	no	yes
Mathematics							
Tara	yes	yes	yes	yes	no	no	no
Sandy	no	yes	yes	no	yes	no	yes
Jane	no	yes	yes	yes	yes	no	no
Science							
Hilda	yes	yes	yes	no	yes	no	yes
Carol	yes	yes	yes	no	yes	no	yes
Medical							
Priscilla	yes	no	yes	no	yes	no	no
Tonya	yes	yes	yes	no	yes	no	no
Trudy	yes	yes	yes	yes	no	no	yes
Career Group: Math/Science (10)							
Total	6	8	9	4	7	0	5
Percent	60%[b]	80%[b]	90[b]	40%	70%[b]		50%[b]

[a]Propositions: 6. Educational experiences were "least influential" on career decisions; 6A. ... indicated positive effects of acceleration during school years; 6B. ... participated in extensive coursework in mathematics and science during high school; 6C. ... participated actively in variety of out-of-school activities, which influenced career decisions; 6D. ... guidance activities during junior high and high school were ineffective in meeting their career planning needs; 6E. ... indicated special achievements or recognitions influenced their career decisions; 6F. Teachers, peers and significant others influenced career decisions.

[b]Proposition replicated.

Table 9. Continued

Career Choice/ Code Name	Propositions[a] 6	6A	6B	6C	6D	6E	6F
Career Group: Other (5)							
Rhonda	no	yes	yes	no	yes	yes	no
Sally	no	yes	yes	yes	yes	no	yes
Naomi	yes	yes	yes	no	yes	no	no
Gayle	no	yes	yes	no	no	no	yes
Cathy	no	no	no	yes	yes	no	yes
Career Group: Other (5)							
Total	1	4	4	2	4	1	3
Percent	20%	80%[b]	80%[b]	40%	80%[b]	20%	60%[b]
Total	7	12	13	6	11	1	8
Percent	47%	80%[b]	87%[b]	40%	73%[b]	7%	53%[b]

others as an influence on career decisions (50%); and 4) agreed that guidance activities had "not been effective" in meeting their career needs (70%).

Summary

Overall, 700M females aspiring to careers in mathematics and sciences replicated five personal, three family, and four educational factors (i.e., 12 of 14 propositions). The 700Ms aspiring to careers in mathematics and sciences were consistently alike in many aspects of aspiration and achievement, yet individual differences and preferences enabled them to take different paths toward their career goals.

700M Females with Career Aspirations
for Nonmath/Science Fields

Personal factors

Achievement-related personal traits. The five 700M females (100%) who aspired to careers in sociology or law, or who at age 19-21 were undecided about career goals replicated achievement-related personal traits. They were more likely to be described as interested in high academic success (100%), in being a leader (100%), and in having recognition of accomplishments (100%). They were self-confident (80%), self-sufficient, independent (80%) rather than venturesome, risk-taking (40%) or willing to experiment (40%).

Only one 700M female in this group, Sally, displayed all achievement-related personal traits: venturesome, willing to take risks, self-sufficient, independent, willing to experiment, imaginative, interested in academic success and in being a leader, and desiring recognition for accomplishments.

Sally exemplified these "achievement traits" by "dropping out" of high school at age 15 to enter the University of California at Berkeley. Her achievement-related needs were not being met during junior high and high school. She skipped 9th grade because she was ready for calculus; later she skipped 12th grade, because she was unhappy and bored. She related,

> I was really bored and I don't like hierarchy, and I don't like power and I don't like to be ordered around, so I hated the set up of high school. I hated feeling imprisoned and I was really bored. During that year [11th grade] I was just so unhappy with the amount of time I thought I was wasting that I decided that I would leave. (Sally, Interview # 66, November 2, 1989)

Sally shared that she tried taking college classes during high school but that college enrollment was difficult because she was frustrated with the "dual life" and "constantly having to hide what I was doing from people in order to fit in." Her attitudes and self-perceptions improved at Berkeley as she related:

> For the first time in my life I didn't feel bored all the time. I felt as if I could, in the classroom, be honest about what I was thinking and not have to either be quiet or pretend I didn't know what was going on or seem like a show off. I felt like I could actually just be in the classroom as a student. I thought I was around people who were thinking at the same intellectual level I was and I appreciated sort of being in that community. I just felt a lot happier. (Sally, Interview #66, November 2, 1989)

With a successful adjustment to college life, Sally majored in philosophy, joined the debating team, competed nationally, and graduated with a B.A. in 1988 at age 19.

At age 20, Sally aspires to a career in law and jurisprudence and currently is a Marshall Scholar in her second year of graduate work in philosophy at Oxford, England. Her pursuit of educational attainment, [e.g., B.A., B. Phil., (England)] and her aspirations for the Ph. D. and J.D. exemplify her achievement-related personal traits.

Influence of high math ability and self-perceptions. The 700M females aspiring to non math/science careers also held high self-perceptions at age 13 and age 18 (100%). Likewise, they were comfortable with their intellectual precocity at age 13 (100%). However, two-thirds felt that intellectual ability did affect opinions that other held of them. Three 700M females (60%) in this group felt that their high mathematical ability influenced career decisions (see Table 4B). Sally related the importance of math ability to her career choice: "my mathematical training has made me a better philosopher than I otherwise would have been." When questioned about opting out of mathematics as a career field, it was her personal attitude toward mathematics that influenced her career decision.

> If I did math, I really liked pure math more than applied math. But I really didn't think it was socially responsible to devote my life to pure mathematics. And I also found that I didn't attend classes in math, because I could just do the work at home and didn't have to go to class. I began to think it was so ridiculus to be in college and not attend my classes that I could probably get more out of doing something else. I would learn more through interacting with other people. I decided I should pursue another field that I would find a little more challenging and socially responsible. So I decided not to do math anymore. (Sally, Interview #15, November 2, 1989)

Rhonda, who aspires to a career in sociological research, related the importance to math ability to her career decisions.

> In sociology we had to take data analysis with statistics and some people got scared off by that, but I didn't have any problems in that whatsoever. In fact, I'm kind of interested in statistics, so I might want to go into quantitative work rather than qualitative. I think sociologists can use a lot of mathematics. (Rhonda, Interview #49, October 25, 1989)

High math ability contributed to Cathy's indecision regarding career choices. She related that she has been conditioned to believe that anyone with "her ability" who doesn't do science is an "intellectual lightweight". As a sophomore at Princeton, she is waivering between majoring in chemistry or music. Chemistry would provide a strong science base for graduate school, but, on the other hand, she considers music to be her "best natural talent." She related,

> Music is something that has been second nature to me for as long as I can remember. I grew up with my mother's being a musician, and I've done music for as long as I can remember. Therefore, I have an instinctual knowledge of music, much more than other people... And the reason I would do that is it seems to be the only thing that I can do that doesn't take much effort, that I get good grades in and something to get me through Princeton. (Cathy, Interview # 13, October 10, 1989)

At this time the conflict of undergraduate major occurs because Cathy doesn't know what career opportunities would evolve from music. At 19, she is caught between the choice of a career in science (which will "pay the bills") or a career in music (which she "really likes").

Naomi, who plans to specialize in immigration law, related that she "never cared for math that much" and "just did it to get it over with." In some ways, math wasn't "human enough." She did acknowledge, however, that "it was what was behind my math ability [that influenced me], not something I learned in geometry." And Gayle, who is undecided about career plans, but majored in Russian studies at Brown, felt that high mathematical ability did not influence her career decisions. Apparently, these females did not enjoy mathematics as a career, but saw their ability as an asset--something that makes them more competitive.

Other abilities, especialy verbal abilities, may have influenced career decisions. Three of these five females had SAT-Verbal scores over 600 before age 13, with the fourth 700M over 500. Sally, who aspired to law, along with Gayle and Cathy, who are undecided about long-range career goals, scored over 600 on the SAT-V before age 13. Naomi was in the 500s and Rhonda in the 400s at age 13. Their high verbal ability may partially explain their career choices at this age, or the difficulty in career choices. Stanley (1986a) predicted that from this high-high combination of both high math and verbal scores "should come the most vocationally successful adults ..." (p. 239). He also predicted that the high-highs will choose different occupations from the high math-lower verbals; with the former choosing more verbally oriented ones. This prediction was certainly true as Sally chose law, Gayle chose language (Russian) and Cathy was undecided between chemistry or music.

Attitudes and interests. Four of five 700M females (80%) aspiring to nonmath/science careers held positive attitudes and interests in mathematics at age 13 (80%) and at age 18 (67%). Typically, at age 13, they were more likely to be interested in mathematics (80%), foreign languages (80%), and social studies (80%) or English/literature (67%) than either computer science (20%), natural science (40%), or physical science (40%). By age 18, with three of five reporting (60%) a greater percentage were interested in physical sciences, English/literature, foreign languages, and social studies (100%). Consistently, across the seven academic subjects, the nonmath/science career group did not demonstrate positive interests in a variety of subjects at age 13 but became more positive by age 18 (see Table 4D).

They exhibited especially strong interests in verbal areas. Both Sally and Naomi participated in debate during high school or college. In 8th grade, Naomi's class conducted a mock trial and she liked "the argumentative, the researching of evidence and the structuring of arguments." Naomi spent a year in South America, perfecting her Spanish, and Gayle spent four months in Lennigrad working on Russian. Computer science, another strong interest for Gayle, who took extra courses at Brown, was also an interest for Cathy, who used computer graphics in her part-time job with a Princeton professor.

<u>Gender role orientation</u>. Three 700M females (75% with four reporting) did not sex-type a variety of occupations at age 13 (see Table 4E). With four of five reporting (90%), they consistently did not sex-type mathematics (100%) and humanities/fine arts (100%), followed by natural sciences (75%) and social sciences (75%). They were evenly divided in their perceptions of engineering, computer science, and physical sciences (50%) as they did not sex-type these fields.

Rhonda expressed frustations with sex-typing careers.

> I hate these things [sex-typing careers] because obviously society thinks they're masculine. But I think that society's sex roles are pretty stupid and [careers] don't need to be limited to men or that men can necessarily do it better. (Rhonda, Interview #52, October 25, 1989)

Two of the three who did sex-type themselves as "strongly feminine" aspired to legal careers. Sally and Naomi commented that there may be certain traits, like "being argumentative" that are associated with masculinity, but that doesn't interfer with their being "feminine."

In summary, five personal factors were replicated by multiple-case studies (see Table 7). It appears that personal factors also tend to influence the career decisions of those 700M females aspiring to careers in sociology or law, or who were undecided at age 19-21. These 700M females: exhibited achievement-related personal traits (100%) that promote the development of potential, held positive self-perceptions at age 13 (100%) and age 18 (100%), and held more positive attitudes and interests in a variety of academic subjects at age 18 (100%) than age 13 (40%). Their early positive attitudes and interests toward mathematics continued through adolescence, but during this time they became interested in a greater variety of subject fields by end of high school. Their interests were more verbally oriented, possibly because these females had extremely high verbal ability. Although these factors were replicated, when compared to the math/science career group, more of these 700M females tended to sex-type a variety of occupations (40% compared to 30%) and fewer 700M females indicated that high math ability had influenced their career decisions (60% compared to 90%).

Family factors

Family background. Fathers of 700M females aspiring to non math/science career fields were employed in professional careers (100%), as were their mothers (100%). They held advanced professional degrees (100% of fathers and 80% of mothers) by the time their daughter was age 13. A closer examination of occupational titles of fathers revealed that fathers' careers were in math/sciences (60%) and humanities (40%). Morever, the careers of all their mothers were in the humanities (80%) or the social sciences (20%).

A large percentage of these families (80%) lived in urban settings over 100,000 population (1983), but only one family (with four of five reporting) had an annual income of $50,000 or above in 1983 dollars. All five 700M females (100%) agreed that family background factors had influenced their career decisions and the most frequent factor cited was family income (80%). Like the math aspiration group, parents were supporting their daughters through graduate and law school. Naomi and Gayle both mentioned family support in financing their college education through graduate or law school as an important influence on their decisions to pursue these careers.

Parental expectations. All five sets of parents (100%) reported high parental expectations for their daughters educational and career achievement (Table 5B). As a group, all parents (100%) expected their daughters "to go to college." The lowest level of educational degree attainment that the parents "would be satisfied with" was the B.A. for 60% of the parents, and the Ph.D. for 40% of the parents. When parents reported the career fields they would like to see their daughter enter, at least one of the three responses involved mathematics, sciences, engineering or medical fields for 3 sets of parents (60%).

Parents' encouragement During interviews 5 700M females (100%) stated that their parents were "supportive" of their career decisions, or in the case of Cathy and Gayle, their career "indecision" (Table 5C). Family support was characterized as "very important" for 80% and only "somewhat important" for 20% of 700M females. Typically, there was "no pressure for this career choice" (100%). Three 700M females (60%) cited their father's and two 700M females (40%) cited their mother's as having encouraged them in mathematics and science. Because only two 700M females (40%) acknowledged the influence of parents' encouragement on their career choices, this family factor was not replicated for the 700M females aspiring to non math/science careers.

Our measure of parental encouragement was based on fathers' and mothers' encouragement to study, to enjoy, and to accelerate in mathematics and science. Although these parents may have expressed "expectations" for math/science careers for their daughters, their daughters' perceptions were of not being encouraged in these directions. Morever, the 700M females expressed that there were "no pressures" from parents regarding particular career choices.

Sally shared that for a long time her father did not talk to her about teaching law "to make sure he didn't push me into the field he was doing." Sally commented that she didn't have to explain why she wanted to teach law.

> My father teaches law, my mother used to teach, my grandparents all taught, and their brothers and sisters teach. It's something they've all gone into because they like it, not because it was a family thing to do. But, as a matter of fact, my family has a lot of teachers in it. (Sally, Interview #59, November 2, 1989)

For those aspiring to nonmath/science careers, two family factors were replicated. Parents had high educational attainment (100%) and professional careers (100%). They tended to live in more urban settings (80%) and their daughter cited the influence of family income on her career decisions, as parents continue to offer financial support through undergraduate, graduate, and law school. Likewise, parents of these 700M females held high expectations for their daughters educational and career achievement (100%). The factor not replicated was parental encouragement for mathematics and sciences (40%).

Educational Factors

Four of six educational factors studied were determined to possibly influence career decisions of 700M females who aspire to careers in nonmath/science fields.

Diversity of curricular offerings. Four 700M females (80%) had used more than four acceleration options during their school years (Table 6A). The most popular among these options were: summer programs that offer college level course work (100%), Advanced Placement (AP) courses (100%), and early entrance to college (80%). Positive influences of these acceleration option on a variety of personal, social, and emotional measures were reported at age 18 by one of two reporting (50%) with three 700M females omitting items in this part of the questionnaire. By age 18, however, three 700M females (75% with four reporting) indicated that in regard to acceleration they were "satisfied with what I did" and expressed similar views at ages 19-21 when interviewed (80%). Cathy was the only 700M female who had expressed disatisfaction with acceleration options and who had not skipped any grades. At age 19-21, however, she felt that perhaps she could have been accelerated one or more years, in addition to having taken advantage of other options such as AP classes, summer programs, and subject matter acceleration in math and language arts.

All five females participated in summer programs and AP courses. In addition, three 700M females in this category (60%) had skipped at least one grade during elementary school. Rhonda had enrolled in a private preschool-elementary school. When she made the transition to public school, she skipped into the second grade. Naomi skipped second grade and Gayle skipped kindergarten. All three females were also accelerated in subject matter placement: Naomi in math and Rhonda and Gayle in both mathematics and language arts.

At the high school level, Naomi found curricular "inflexibility" to directly affect her career decisions. When she was unsatisfied with her high school schedule for her junior year (i.e., she couldn't take the classes she needed or wanted until her senior year), she arranged for a private exchange and spent that year in South America attending a Colombian school. Here she perfected her Spanish language skills and became intensely interested in newly emerging immigration laws. She developed her long-range career goal in law with a specialization in immigration law. Naomi is preparing for this career by completing double majors in history and Latin American studies at Rice University.

During high school, the 700M females completed extensive coursework in mathematics and science (Table 6B). All 5 700M females (100%) had mathematics coursework through calculus, with 4 taking AP calculus (80%). Likewise in science 4 700M females (100% with 4 reporting) had taken high school physics. They tended not to take AP Biology, but 40%

had completed AP Chemistry or Physics. Morever, they took AP courses in the humanities. Both Rhonda and Naomi took AP English and English/Literature, with Naomi adding AP Spanish and Rhonda completed AP American History and AP Music Theory. Thus, their achievement-related needs were met by these advanced courses. Personal interests seemed to dictate their choice of AP class.

These extremely able females quickly exhausted mathematics coursework offerings in their schools and took mathematics classes in nearby colleges and universities (100%). Whereas the math group was more likely to take mathematics or science classes at the university level, those aspiring to other careers often took other courses (80%) in addition to the math courses. For example, Naomi took several courses in Spanish, while Sally took French, Genetics, and Logic. Rhonda also took two semesters of composition at a community college. These educational decisions seem related to the multiple interests expressed by this group.

Relationships with guidance counselors were generally "ineffective" in meeting the career development needs of these 700M females. Yet, 3 700M females (60%) cited relationships with teachers and significant others as influencing their career decision. During the interviews, important influences of a teacher was revealed for 4 700M females. They cited teachers who instructed in the area later chosen for an undergraduate major (i.e., music, foreign language, history, and philosophy). Thus, a subject area of high interest and a "favorite" instructor was an influential combination on their career decisions.

For those aspiring to careers other than mathematics and sciences, four educational factors were replicated. Multiple-case study analysis indicated that 700M females aspiring to careers in sociology and law, or who were undecided about career goals at age 19-21: 1) expressed positive views of acceleration during school years (80%), 2) completed mathematics and science coursework through calculus and physics during high school (80%), 3) cited relationship with teachers as an influence on career decisions (60%), and 4) agreed that guidance activities had "not been effective" in meeting their career needs (80%).

Summary

Overall, 700M females aspiring to careers other than mathematics and sciences replicated five personal, two family and four educational factors (i.e., 11 of 14 propositions). The 700Ms aspiring to careers in other than mathematics and science seemed to have broadening spans of interests, complemented by energy to pursue new and different challenges.

Comparison of Career Aspiration Groups

The 700M females with math/science career aspirations (10, 67%) and those 700M females with nonmath/science career aspirations (5, 33%) cited five personal factors as influencing career decisions. While both groups displayed positive self-perceptions, and gender-role orientations that did not sex-type careers, there were some rather marked differences in achievement-related personal traits, attitudes, and interests.

The math/science career aspiration group and those aspiring to other careers were similar in terms of self-perceptions, self-confidence, and internal locus of control age age 13. Likewise both groups were equally "comfortable" with their intellectual precocity. Both groups acknowledged math ability had influenced career decisions, with a greater percentage of those being in the math science group (90%) as compared to the other group (60%). Females in the other career group viewed their high math ability as an asset for their career rather than an influence on their career. Since these factors were replicated by both groups, it appears self-perceptions, for the most part, do not differentiate between the extremely precocious females who chose mathematics and science careers versus those who did not. This finding is consistent with those of Albright (1988) and Hollinger (1986).

A greater percentage of the math/science aspiration group compared to the other group did not sex-type occupations in engineering and computer science (88% compared to 50%), natural sciences (88% compared to 75%), physical sciences (88% compared to 50%), and social sciences (78% compared to 75%). In contrast, a greater percentage of the nonmath group did not sex-type mathematics (100% compared to 75%) and humanities/fine arts (100% compared to 67%). Although differences in groups are slight, it appears that less sex-typing of career fields occurs within the math/science career aspiration group. Thus, the ability to perceive both masculine and feminine roles may foster career decisions in these fields.

Although both groups of females displayed achievement-related personal traits, the 700M females in the nonmath/science career group were more likely to be "interested in being a leader" (100% versus 50%). They were also more likely to display several traits associated with creativity [i.e., venturesome, risk-taking (40% vs. 20%), willing to experiment (40% vs. 20%) and imaginative (20% vs. 0%)] at age 13 than the math/science career aspiration group.

With equally high intellectual precocity in mathematics, perhaps it is these achievement-related personal traits (i.e., leadership and creativity) that enable 700M females to choose careers in other fields than mathematics and sciences. Certainly it is common for people to choose career fields where their talents or abilities are reinforced (Krumboltz et al., 1976); for mathematically precocious females, there may be more risk in seeking out other career fields than mathematics.

The second difference between the two groups of talented females is also related to attitudes and interests. A greater percentage of the math/science career aspiration group held positive attitudes and interests in the math/science subjects at age 13 compared to those aspiring to nonmath/science careers. At both ages the math/science career group held more positive attitudes toward mathematics, computer science, natural and physical sciences, while the other group help positive attitudes toward English/literature, foreign languages, and social studies. Apparently early positive attitudes and interests in mathematics and sciences at age 13 differentiate the math/science group from those aspiring to other careers.

Moreover, after high school, the nonmath/science career group had more varied interests than the math/science career aspiration group. Their varied and competing interests, coupled with their exceptional verbal ability, probably contributed to the career indecision of 2 700M (40%) females in the nonmath/science group.

While both career groups were similar in terms of influence of family background and parents' expectations, they differed in terms of parental encouragement in mathematics and sciences. Morever, a comparison of parent's occupations revealed that 90% of fathers of 700M females who aspired to math/science careers were themselves in math/science careers. In contrast 40% of the fathers of 700M females who aspired to nonmath/science career were in the humanities.

Family expectations for their daughters' educational achievement and careers in mathematics and sciences were high for parents of both groups of 700M females. Within both groups, 40% of the parents wanted their daughters to obtain a Ph.D. Although both sets of parents listed math/science occupations as appropriate for their daughters (70% for math/science versus 60% for the others), this view was more evident for the parents of the math/science career group. Approximately 57% of their parents listed all of their three career choices for their daughters in mathematics and science.

The importance of family encouragement in their career decision-making process was noted by the 700M females in the math/science group (70%), but to a lesser extent by those 700M females aspiring to "other" careers (40%). None of these females experienced any "pressure" to elect certain careers.

A comparison of the use of acceleration by both career aspiration groups revealed no differences. Uniformly both groups went to fast-paced summer programs, took AP classes, took college classes while in high school and entered college early. The math/science group, however, tended to be more satisfied with accelerative options at age 18 (100% versus 75%) and again at ages 19-21 (100% versus 80%).

Students in both groups graduated from high school with impressive academic records, having obtained mostly A grades. There was no differences in the amount of high school coursework in mathematics. All females in both groups had completed math courses through calculus, with 78% of the math/science group completing AP Calculus and 80% of the other career group. The remaining 20-22% of 700M females took calculus at nearby colleges or universities. There was also no difference in the science coursework, which included physics for both groups (100%).

A difference did exist in terms of AP classes in the sciences. The math/science career group took more AP courses in science, while the other group took more AP courses in the social sciences and humanities. In the math/science career group, 33% of 700M females completed AP Biology and 89% completed either AP Chemistry or AP Physics. In contrast, among the other group of females, 40% of the other group took AP Chemistry or Physics; with none having taken AP Biology.

The guidance activities provided to 700M females did not differ between career aspiration groups. Both groups were likely to conclude that guidance activities were ineffective in meeting their career exploration needs. However, over half of both career aspiration groups (50% for math/science versus 60% for other) cited relationships with teachers and significant others as having an influence on career decisions. At the time of interviews the math/science group were likely to cite the influence of a teacher or friend (70% compared to 60%) or have a mentor (50% to 40%). Of those who cited mentors, two were in mathematics and three were in sciences. The role of relationship also seems to be related to age, with younger relationships being more important to the other group and later (i.e., after high school) relationships being important to the math/science group.

Conclusions

Personal, family, and educational factors are important influences on career aspiration (Astin & Myint, 1971; Farmer, 1987; Farmer & Backer, 1977; Hollinger, 1986), career achievement (Helson, 1980; Sewell & Hauser, 1976; Oden, 1968), career decision-making (Eccles, 1985; Krumboltz, Mitchell & Jones, 1976; Roe, 1953, 1956;), and development of potential (Gruber, 1982; Feldman & Goldsmith, 1986; Tannenbaum, 1983). We investigated, using a multiple-case study design, if personal, family, and educational factors can discriminate between mathematically precocious females (top 1 in 60,000 in ability) who aspire to careers in mathematics or science during late adolescence and young adult years and such females who do not. Two-thirds of extremely mathematically precocious (700M) females aspire to careers in mathematics or science. We concluded that, even though both groups of 700M females share many similarities, those who entered math/science career tracks did indeed differ along several important dimensions from those choosing careers in other areas. First, we will describe how these mathematically precocious females were similar. We will then conclude with a listing of characteristics that separated the females taking different career paths.

Typically, the 700M female was described as an independent, self-sufficient individual with a positive self-concept and positive attitudes toward her talent in mathematics. She developed early interests in mathematics and science and was highly successful in academic endeavors, maintaining an A/A-grade point average. At age 19-21, 700M females based their career decisions on their "interests" and fields of study that they "enjoyed" and found "interesting and challenging."

Their achievement-related personal attributes, especially self-sufficiency and independence, have been identified as important traits that promote the development of potential. Individuals who have high achievement motivation are characterized by traits such as perseverance, integration of goals and self-confidence (Cox, 1926; Galton, 1869; Goertzel & Goertzel, 1962; Gruber, 1982; Roe, 1953). For example, Oden (1968) revealed that the "high-achieving" men in the Terman sample had "above average interest in school success, in leadership, in having friends" (p. 90). She suggested that these traits provide the "motivation, the drive, and the implementation of ambition that lead to the realization of potential" (p. 92). Thus, self-directed, self-initiated, and self-organizing skills, which emerge in Wallace's (1985) period of self-construction, are important to achievement motivation. Most 700M females possessed these traits.

Typically, the 700M female exhibited high achievement in high school and extensively utilized accelerative alternatives to make her school program commensurate with her advanced abilities. During elementary school, she was advanced in subject matter placement in mathematics and often in language arts as well. After SMPY identification, she participated in several accelerated summer programs in mathematics or science, which developed her interests and skills in mathematics and science through fast-paced instruction. During high school, she participated in extensive coursework, including Advanced Placement classes in calculus and science. The cumulative effect of these acceleration options enabled her to enter a university as a full-time undergraduate before age 18. She had more than the necessary academic preparation to pursue any career paths; thus, she evinced multi-potentiality.

Among the gifted, inappropriate educational experiences have been posited to relate to lower achievement motivation and academic underachievement (Benbow, in press; Feldhusen, 1989). Acceleration is thought to combat these problems. Acceleration of mathematically precocious students in mathematics, for example, do appear to enhance career aspirations in mathematics and science (Swiatek & Benbow, in preparation). The multiple-case studies of 700M females exemplify well how a combination of accelerative options can enhance their educational plans and enable them to get a "head start" on their educational and career aspirations, many of which will require years of graduate studies.

For those 700M females who started college early, one as early as 13 and another at age 15, no special problems were reported. Consistently, 700M females expressed positive attitudes toward their educational decisions; the only dissatisfaction came from the one 700M female who did not skip a grade. Consistent with Kulik and Kulik's (1984) analysis of research, acceleration options did not cause social-emotional problems.

Preparation in mathematics is important for career achievement in mathematics and science (Heller & Parsons, 1981). Thus, limiting the mathematical training of women precludes them from entering numerous careers. As Sells' (1980) study of freshman at University of California in 1972 demonstrated, 57% of males but only 8% of females had sufficient high school math to enroll in freshman calculus at that time. In this study, all 700M females who attended high school for at least two years (14, 94%) completed mathematics and science course work through calculus and physics, either through AP courses or classes at nearby colleges or universities. Thus, they had the necessary preparation to enter any major in college.

It also has been frequently suggested that because females have less confidence in their mathematical ability than do their male counterparts (e.g., Ernest, 1976; Fennema & Sherman, 1977, 1978), they may develop less achievement motivation in math and science and as a result have lower achievement. Our finding that mathematically talented females who demonstrate high achievement in math and science uniformly had a high perceptions of their abilities is encouraging.

Beck (1989) reported that mentor relationships (i.e., with teachers or significant others) are beneficial for gifted students. As a result of their participation in the SMPY summer programs by age 13, the typical 700M female had established contacts with "significant others" at the university level across the country. These people were usually professors who were associated with summer programs. Their relationships developed and grew during the adolescent years. These relationships, as well as those with a teacher of a favored subject, had great impact upon the career choices made by these talented females. Tannebaum (1983) classified such relationships under his category of "chance factors." Chance factors are linkages between performance and fulfillment.

Typically, at the end of high school, the 700M female was recognized for her high scholastic attainment (i.e., being in the top 10 graduates in her class). She was recognized by the National Merit Scholarship program as a finalist or scholarship winner. In addition, she frequently won regional, state, and national awards in mathematics and science. This impressive "track" record of achievement, scholarships, trophies, and awards reinforced self-confidence or assisted with finances of college, but were "not influential" on career decisions. In contrast, family characteristics and encouragement had strong influences on career decisions. Moreover, the mathematically precocious females tended to select careers that often corresponded to their father's career field.

The career decisions of these talented young women reflect the unique paths that they have chosen. The important influences of family and educational opportunities were considered, acknowledged, and appreciated by 700M females. Most took paths that led to careers in math/science, while a minority did not.

What factors differentiated between these two groups of 700M females? The 700M females aspiring to careers in mathematics or science were more likely to:

1. acknowledge the influence of math ability on career decisions.
2. be positive toward a variety of subjects at age 13 and focus their interests on mathematics and sciences by age 18.
3. have fathers with careers in science or mathematics.
4. have a family income over $50,000 in 1983 dollars.
5. receive both their mother's and father's encouragement for career choice in mathematics or sciences.
6. take AP classes in biology, chemistry or physics in high school.
7. skip a grade after 7th grade.
8. choose a career related to father's field of study.
9. cite the influence of teachers or mentors at age 18.

The 700M females aspiring to careers in other fields (e.g., sociology, law or undecided) were more likely to:

1. assume leadership roles in out-of-school activities.
2. describe self as a risk taker, or venturesome.
3. not hold positive attitudes in a variety of subjects at age 13, and indicate their broad-base of interests at age 18.
4. live in urban areas-- over 100,000 population.
5. take AP classes in fine arts, foreign language or history.
6. skip a grade before 7th grade.
7. cite the influence of teachers at age 13.

8. receive little encouragement from mother or father for career choices in mathematics or sciences.

9. take college courses in humanities and fine arts during high school.

Both groups were likely to:

1. hold positive self-perceptions.

2. not sex-type a variety of occupations.

3. have parents who held expectations for college and career achievement.

4. indicate family background influenced career choice.

5. have completed extensive coursework through calculus and physics.

6. not cite influence of out-of-school activities on career decisions.

7. not cite influence of achievement and awards on career decisions.

8. indicate guidance activities were not effective in meeting career planning needs.

9. cite that their favorite teacher was in their field of study.

10. take college courses in mathematics during high school.

We studied possible influences of personal, family, and educational factors on career decisions of 15 mathematically precocious females at ages 19-21, using a longitudinal approach. A limitation with this study was the reliance on self-report data. To somewhat compensate for this factor, we drew information from a number of sources: from questionnaires, completed by both 700M females and their parents over a five year period, and from telephone interviews, where responses could be clarified.

Career choices are not easy or made in isolation from other social or environmental factors. Because of the inter-relatedness of personal, family, and educational factors, additional research needs to more clearly define the parameters of each factor and, perhaps through path analysis, continue to explore the relationships between these factors and career decision-making of the mathematically precocious females.

Just as Eccles (1985) and others, we found career choices of gifted women to reflect "multiple" interests. While 700M females followed the educational achievements of their parents, and for the math/science career aspiration group, the career field of their father, it was apparent that the career decisions of 700M females had been personalized to the extent that each 700M female rationalized her career choice as a reflection of her interests, which she acknowledged stemmed from early family influences and educational opportunities. Overall, career decisions of mathematically precocious females reflect the "individuality or spark" reported by Helson's (1980) work with creative women mathematicians. Collectively, these young women reinforce an encouraging portrait of success for the future. They are creating challenges for themselves and constructing a life, where their potential in mathematics can be realized.

REFERENCES

Albright, P. N. (1988). Factors affecting mathematics and science careers: Mathematically precocious females. Unpublished Specialist's thesis, Iowa State University, Ames.

Alper, T. (1974). Achievement motivation in women: Now-you-see-it-now-you-don't. American Psychologist, 29, 194-203.

American Heritage Dictionary, Revised Edition. (1983) New York: Dell.

Arjmand, O., Benbow, C. P., & Lorenz, F. O. (1988). Attitude and parental encouragement patterns among intellectually talented males and females. Unpublished manuscript, Iowa State University, Ames.

Armstrong, J. M. (1985). A national assessment of participation and achievement of women in mathematics. In S. F. Chipman, L. R. Brush and D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 59-94). Hillsdale, NJ: Lawrence Erlbaum Associates.

Astin, H. S. (1968). Stability and change in the career plans of ninth grade girls. Personnel and Guidance Journal, 46, 961-966.

Astin, H. S. (1974). Sex differences in mathematical and scientific precocity. In J. C. Stanley, D. P. Keating, & L. H. Fox, (Eds.), Mathematical talent: Discovery, description and development (pp. 70-87). Baltimore: Johns Hopkins University Press.

Astin, H. S. (1984). The meaning of work in women's lives: A sociopsychological model of career choice and work behavior. The Counseling Psychologist, 12(4), 117-126.

Astin, H. & Myint, T. (1971). Career development of young women during the post high school years. Journal of Counseling Psychology, 18, 369-393.

Atkinson, J. Ed. (1958). Motives in fantasy, action and society. Princeton, NJ: Van Nostrand.

Atkinson, J. Ed. (1978). The mainsprings of achievement-oriented activity. In J. Atkinson & J. Raynor (Eds.), Personality, motivation and achievement (pp. 11-39). New York: Halstead.

Atkinson, J. W. & Raynor, J. O. (1978). Personality, motivation and achievement. New York: Halstead.

Backman, M. E. (1972). Patterns of mental abilities: Ethnic, socioeconomic and sex differences. American Educational Research Journal, 9, 1-12.

Baker, D. R. (1981). The difference among science and humanities males and females. Paper presented at the 54th Annual Meeting of the National Association for Research in Science Teaching, Grossinger's in the Catskills, Ellenville, NY, April 5-8, 1981. (ERIC Document Reproduction Service No. ED 204 148)

Bandura, A. (1978). The self system in reciprocal determinism. American Psychologist, 33, 344-458.

Barbe, W. B. & Renzulli, J. S., Eds. (1981). Psychology and education for the gifted (3rd Ed.). New York: John Wiley & Sons.

Bardwick, J. (1971). The psychology of women. New York: Harper & Row.

Bardwick, J. (Ed.) (1974). Reading on the psychology of women. New York: Harper & Row.

Barron's Educational Series. (1986). Guide to the most prestigious colleges (4th Ed.). Compiled and edited by the College Division. New York: Barron's Educational Series.

Beck, L. (1989). Mentorships: Benefits and effects on career development. Gifted Child Quarterly, 33(1), 22-27.

Bem, S. (1974). The measurement of psychological androgyny. Journal of Consulting and Clinical Psychology, 42, 155-162.

Bem, S. (1981). Gender schema theory: A cognitive account of sex-typing. Psychological Review, 88, 354-364.

Bem, S. (1983). Gender scheme theory and its implications for child development: Raising gender-aschematic children in a gender-schematic society. Signs, 8, 598-616.

Bem, S. (1985). Androgyny and gender schema theory: A conceptual and empirical integration. In T. B. Sonderegger (Ed.), Nebraska symposium on motivation: Psychology of gender (pp. 179-226). Lincoln: University of Nebraska Press.

Benbow, C. P. (1983). Adolescence of the mathematically precocious: A five-year longitudinal study. In C. P. Benbow & J. C. Stanley, (Eds.), Academic precocity: Aspects of its development (pp. 9-37). Baltimore, MD: Johns Hopkins University Press.

Benbow, C. P. (1986). SMPY's model for teaching mathematically precocious students. In J. S. Renzulli (Ed.), Systems and models in programs for the gifted and talented (pp. 1-25). Mansfield Center, CT: Creative Learning Press.

Benbow, C. P. (1988). Sex differences in mathematical reasoning ability in intellectually talented preadolescents: Their nature, effects, and possible causes. Behavioral and Brain Sciences, 11(2), 169-183.

Benbow, C. P. (in press). Meeting the needs of gifted students through the use of acceleration: An often neglected resource. Ames: Iowa State University.

Benbow, C. P. & Arjmand, O. (in press). Factors associated with high academic achievement in mathematics and science among mathematically talented students: A longitudinal study. Manuscript submitted for publication.

Benbow, C. P. & Minor, L. L. (1986). Mathematically talented students and achievement in high school sciences. American Educational Research Journal, 23, 425-36.

Benbow, C. P. & Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? Science, 210, 1262-64.

Benbow, C. P. & Stanley, J. C. (1981). Mathematical ability: Is sex a factor? (Letter). Science, 212, 118-19.

Benbow, C. P. & Stanley, J. C. (1982). Consequences in high school and college of sex differences in mathematical reasoning ability: A longitudinal perspective. American Educational Research Journal, 19, 598-622.

Benbow, C. P. & Stanley, J. C. (1983a). Academic precocity: Aspects of its development. Baltimore, MD: Johns Hopkins University Press.

Benbow, C. P. & Stanley, J. C. (1983b). Constructing bridges between high schoool and college. Gifted Child Quarterly, 27, 111-113.

Benbow, C. P. & Stanley, J. C. (1983c). Differential course-taking hypothesis revisited. American Educational Research Journal, 20, 469-473.

Benbow, C. P. & Stanley, J. C. (1983d). Sex differences in mathematical reasoning ability: More facts. Science, 222, 1029-31.

Benbow, C. P. & Stanley, J. C. (1984). Gender and the science major. In: M. W. Steinkamp & M. L. Maehr (Eds.), Advances in motivation and achievement, (Vol. 2, pp. 165-198), Greenwich, CT: JAI Press.

Bledsoe, C. E. (1982). Career aspirations of gifted junior and senior girls currently enrolled in Georgia high schools. (Doctoral Dissertation, Georgia State University, 1982). Dissertation Abstract International, 43, 06A, 1916. (University Microfilms, Georgia State University, Int. No. DA82-25-249.

Bogdan, R. C. & Biklin, S. K. (1982). Qualitative research for Education. Boston: Allyn and Bacon, Inc.

Boli, J., Allen, M. L., & Payne, A. (1985). High ability women and men in undergraduate mathematics and chemistry courses. American Educational Research Journal, 22, 605-626.

Bolton, E. B. (1980). A conceptual analysis of the mentor relationship in career development of women. Adult Education, 30, 195-207.

Borg, W. R. & Gall, M. D. (1983). Educational research. An introduction (4th Edition). New York: Longman.

Boswell, S. L. (1985). The influence of sex-role stereotyping on women's attitudes and achievement in mathematics. In S.F. Chipman, L.R. Brush and D. M. Wilson (Eds.) Women and mathematics: Balancing the equation (pp. 175-198). Hillsdale, N.J.: Lawrence Erlbaum Associates.

Brody, L. E. & Benbow, C. P. (1987). Acceleration strategies: How effective are they for the gifted? Gifted Child Quarterly, 31, 105-109.

Brody, L. & Fox, L. H. (1980). An accelerative intervention program for mathematically gifted girls. In L. H. Fox, L. Brody, & D. Tobin (Eds.), Women and the Mathematical Mystique. Baltimore, MD: Johns Hopkins University Press.

Brown, D. & Brooks, J. (1984). Introduction to Career Development: Origins, evolution and current approaches. In D. Brown & J. Brooks (Eds.), Career choice and development (pp. 1-7). Washington: Jossey Bass Publishers.

Burgess, R. G. (1985). Issues and problems in educational research: An introduction. In R. G. Burgess (Ed.), Issues in educational research: Qualitative methods (pp. 1-20). London: The Falmer Press.

Card, J., Steel, L. & Abeles, R. (1980). Sex differences in realization of individual potential for achievement. Journal of Vocational Behavior, 17, 1-21.

Chipman, S. F., Brush, L. R. & Wilson, D. M. (Eds.). (1985). Women and mathematics: Balancing the equation. Hillsdale, NJ: Lawrence Erlbaum Associates.

Chipman, S. F., & Thomas, V. G. (1985). Women's participation in mathematics: Outlining the problem. In S. F. Chipman, L. R. Brush & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 1-24). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chipman, S. F., & Wilson, D. M. (1985). Understanding mathematics course enrollment and mathematics achievement: A synthesis of the research. In S. F. Chipman, L. R. Brush & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 275-328). Hillsdale, NJ: Lawrence Erlbaum Associates.

Covington, M. V. & Omelich, C. (1981). As failures mount: Affective and cognitive consequences of ability demotion in the classroom. Journal of Educational Psychology, 73, 796-808.

Cox, C. M. (1926). The early mental traits of three hundred geniuses. Genetic Studies of Genius, Vol. II. Stanford, CA: Stanford University Press.

Crandall, V. C. (1969). Sex differences in expectancy of intellectual and academic reinforcement. In C. P. Smith (Ed.), Achievement-related behaviors in children. New York: Russell Sage Foundation, 1969.

Cray-Andrews, M. J. (1983). Gifted female adolescents perceptions of career and lifestyle aspirations. (Doctoral dissertation, University of Connecticut, 1983). Dissertation Abstracts International, 44 09A, 2732. (University Microfils, University of Connecticut, Int. No. DA83-29-387.

Crites, J. O. (1974). Career counseling: A review of major approaches. The Counseling Psychologist, 4, 3-23.

Datta, L. (1985). Foreward. In: S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation, (pp. vii-xi). Hillsdale, NJ: Lawrence Erlbaum Associates.

Davis, J. A. (1965). Undergraduate career decisions: Correlates of academic choice. NORC Monograph in Social Research, 2.

DeBoer, G. E. (1984). Sense of competence in science as a factor in the career decisions of men and women. Paper presented at the 57th Annual Meeting of the National Association for Research in Science Teaching, New Orleans, LA, April 28, 1984. (ERIC Reproduction Service No. ED 243 716)

Dubin, R. (1956). Industrial workers' worlds: A study of the "central life interests" of industrial workers. Social Problems, 3, 131-142.

Duncan, O. D., Featherman, D. L. & Duncan, B. (1972). Socioeconomic background and achievement. New York: Seminar Press.

Eccles J. (1983). Sex differences in mathematics participation. In M. Steinkamp & M. Maehr (Eds.), Women in science (pp. 80-110). Greenwich, CT: JAI Press.

Eccles J. (1984). Sex differences in mathematics participation. In M. W. Steinkamp & M. L. Maehr (Eds.), Women in science: Advances in motivation and achievement. Vol. 2 (pp. 93-138). London: JAI Press.

Eccles J. (1985). Why doesn't Jane run? Sex differences in educational and occupational patterns. In M. D. Horowitz & M. O'Brien (Eds.), The gifted and talented: Developmental perspectives (pp. 251-293). Washington, DC: American Psychological Association.

Eccles, J. S. & Hoffman, L. W. (1984). Sex roles, socialization and occupational behavior. In H. W. Stevenson & A. E. Siegel (Eds.), Research in child development and social policy. Vol. 1 (pp. 367-420). Chicago: University of Chicago Press.

Eccles, J. S. & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. Signs, 7(2), 367-80.

Eccles, J. Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C.M., Meece, J. L., & Midgley, C. (1983). Expectations, values and academic behaviors. In J. T. Spence (Ed.), Achievement and achievement motivation (pp. 75-146). San Francisco: W. H. Freeman.

Eccles, J., Adler, T. & Meece, J. L. (1984). Sex differences in achievement: A test of alternative theories. Journal of Personality and Social Psychology, 46(1), 26-43.

Eccles, J., Adler, T. F., Futterman, R. Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1985). Self-perceptions, task perceptions, socializing influences, and the decision to enroll in mathematics. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation, (pp. 95-122). Hillsdale, NJ: Lawrence Erlbaum Associates.

Ernest, J. (1976). Mathematics and sex. American Mathematical Monthly, 83, 595-612.

Ethington, C. A., Wolfle, L. M. (1986). A structural model of mathematics achievement for men and women. American Educational Research Journal, 23(1), 65-75.

Farmer, H. S. (1976). What inhibits achievement and career motivation in women? The Counseling Psychologist, 6(2), 12-15.

Farmer, H. S. (1980a). Environmental, background and psychological variables related to optimizing achievement and career motivation for high school girls. Journal of Vocational Behavior, 17, 58-70.

Farmer, H. S. (1980b). The importance of family and career roles for high school girls. Paper presented at the 88th Annual Convention of the American Psychological Association, Montreal, Quebec, Canada, September 1-5, 1980. ERIC ED 201 928.

Farmer, H. S. (1983). Career and homemaking plans for high school youth. Journal of Counseling Psychology, 30(1), 40-45.

Farmer, H. S. (1984). Development of a measure of home-career conflict related to career motivation in college women. Sex Roles, 10(9/10), 663-675.

Farmer, H. S. (1985a). Helen Astin's model of career choice for women and men: Some missing pieces. Paper presented at the 93rd Annual Convention of the American Psychological Association, Los Angeles, CA, August 23-27, 1985. (ERIC Reproduction Service No. 267 355)

Farmer, H. S. (1985b). Model of career and achievement motivation for women and men. Journal of Counseling Psychology, 32(3), 363-390.

Farmer, H. S. (1987). A multivariate model for explaining gender differences in career and achievement motivation. Educational Researcher, 16(2), 5-9.

Farmer, H., & Backer, T. (1977). New career options for women: A counselor's sourcebook. New York: Human Sciences Press.

Feingold, A. (1988). Cognitive gender differences are disappearing. American Psychologist, 43, 95-103.

Feldhusen, J. (1989). Synthesis of research on gifted youth. Educational Leadership, 46(6), 6-11.

Feldman, D. H. & Goldsmith, L. T. (1986). Nature's gambit: Child prodigies and the development of human potential. New York: Basic Books, Inc.

Fennema, E. (1974). Mathematics learning and the sexes: A review. Journal for Research in Mathematics Education, 5, 126-39.

Fennema, E. & Sherman, J. (1977). Sex related differences in mathematics achievement, spatial visualization, and sociocultural factors. American Educational Research Jounral, 14, 51-71.

Fennema, E. & Sherman, J. (1978). Sex-related differences in mathematics achievement and related factors: A further study. Journal for Research in Mathematics Education, 9, 189-203.

Fortner, M. (1970). Vocational choices of high school girls: Can they be predicted? Vocational Guidance Quarterly, 19(3), 203-205.

Fox, L. H. (1973, August). Values and career interests of mathematically precocious youth. Paper presented at 81st Annual Meeting of the American Psychological Association, Montreal, Canada. (ERIC Document Reproduction Service No. ED 105329)

Fox, L. H. (1976). Sex differences in mathematical precocity: Bridging the gap. In D. P. Keating (Ed.), Intellectual talent: Research and development (pp. 183-214). Baltimore, MD: Johns Hopkins University Press.

Fox, L. H. (1977). The effects of sex-role socialization on mathematics participation and achievement. In J. Schoemaker (Ed.), Women and mathematics: Research perspectives for change, National Institute of Education Papers in Educator and Work, No. 8. Washington, D.C.: Education and Work Group, The National Institute of Education, United States Department of Health, Education and Welfare.

Fox, L. H. (1982). Sex differences among the mathematically gifted. Paper presented at the annual meeting of the American Association for the Advancement of Science, Washington, D.C.

Fox, L. H. & Richmond, L. J. (1979). Gifted females: Are we meeting their counseling needs? Personnel and Guidance Journal, 57, 256-59.

Fox, L. & Zimmerman, W. (1985). Gifted women. In J. Freeman (Ed.), The Psychology of Gifted Children (pp. 219-239). New York: John Wiley & Sons, Ltd.

Fox, L. H., Brody, L. & Tobin D. (Eds.). (1980). Women and the mathematical mystique. Baltimore, MD: Johns Hopkins University Press.

Fox, L. H., Benbow, C.P. & Perkins, S. (1983). An accelerated mathematics program for girls: A longitudinal evaluation. In C. P. Benbow & J. C. Benbow (Eds), Academic precocity: Aspects of its development (pp. 113-138). Baltimore, MD: TheJohns Hopkins University Press.

Fox, L. H., Tobin, D. & Brody L. (1985). The impact of early intervention programs upon course-taking and attitudes in high school. In S. F. Chipman, L. R. Brush & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 249-274). Hillsdale, NJ: Lawrence Erlbaum Associates.

Freeman, H. E. (1984). A meta-analysis of gender differences in mathematics achievement. (Doctoral dissertation, The University of Alabama, 1984). Dissertation Abstracts International, 45, 2039A. (University Microfilms, The University of Alabama, Int. No. DA94-23-477)

Galton, F. (1869). Hereditary genius. New York: Macmillan.

Ginzberg, E., Ginzberg, S. W., Axelrod, S., & Herman, J. T. (1951). Occupational choice: An approach to a general theory. New York: Columbia University Press.

Goetz, J. P. & LeCompte, M. D. (1984). Ethnography and qualitative Design in Educational Research. Orlando, FL: Academic Press.

Goertzel, V. & Goertzel, M. G. (1962). Cradles of eminence. Boston: Little, Brown & Company.

Goertzel, M. G., Goertzel, V. & Goertzel, T. G. (1978). Three hundred eminent personalities. San Francisco, CA: Jossey-Bass, Inc.

Goodale, J. G., & Hall. D. T. (1976). Inheriting a career: The influence of sex, values and parents. Journal of Vocational Behavior, 8, 19-30.

Gourman, J. (1989). The Gourman report. A rating of graduate and professional programs in American and international universities. (5th Ed.) Northridge, CA: National Education Standards.

Gottfredson, L. S. (1981). Circumscription and compromise: A developmental theory of occupational aspiration. Journal of Counseling Psychology Monograph, 28, 545-579.

Green, K. C. (1989). A profile of undergraduates in the sciences. American Scientist, 77, 475-480.

Gruber, H.E. (1982). On the hypothesized relation between giftedness and creativity. In D. H. Feldman (Ed.), Developmental approaches to giftedness and creativity (pp. 7-29). San Francisco, CA: Jossey-Bass.

Hackett, G., & Betz, N.E. (1981). A self-efficacy approach to the career development of women. Journal of Vocational Behavior, 18, 326-339.

Harmon, L. (1972). Variables related to women's persistence in educational plans. Journal of Vocational Behavior, 2, 143-153.

Haven, E. W. (1972). Factors associated with the selection of advanced academic mathematics courses by girls in high school. Research Bulletin, 72-12. Princeton, NJ: Educational Testing Service.

Hawley, P. (1972). Perceptions of male models of femininity related to career group. Journal of Counseling Psychology, 19(4), 308-313.

Heller, K. A. & Parsons, J. E. (1981). Sex differences in teachers' evaluative feedback and students' expectancies for success in mathematics. Child Development, 52, 1015-19.

Helson, R. (1980). The creative woman mathematician. In L. H. Fox, L. Brody & D. Tobin (Eds.), Women and the mathematical mystique (pp.23-53). Baltimore, MD: Johns Hopkins University Press.

Herr, E. L. & Cramer, S. H. (1979). Career guidance and counseling through the life span. Boston: Little, Brown & Company.

Hilton, T. L. & Bergland, G. W. (1974). Sex differences in mathematics achievement: A longitudinal study. Journal of Educational Research, 67, 231-237.

Holden, C. (1987). Female math anxiety on the wane. Science, 236, 660-661.

Holland, J. (1966). The psychology of vocational choice. Waltham, MA: Blaisdell.

Hollinger, C. (1983). Multidimensional determinants of traditional and nontraditional career aspirations for mathematically talented female adolescents. Journal for the Education of the Gifted, 6(4), 245-265.

Hollinger, C. (1986). Career aspirations as a function of Holland personality type among mathematically talented female adolescents. Journal for the Education of the Gifted, 9(2), 133-145.

Horner, M. S. (1978). The measurement and behavioral implications of fear of success in women. In J. W. Atkinson & J. O. Raynor (Eds.), Personality, motivation, and achievement (pp. 41-70). New York: Halstead Press.

Hoyt, K. B. & Hebeler, J. R. (Eds.). (1974). Career education for the gifted and talented students. Salt Lake City: Olympus.

Humphreys, L. G. (1985). A conceptualization of intellectual giftedness. In M.D. Horowitz & M. O'Brien (Eds.), The gifted and talented. Developmental Perspectives (pp. 331-360). Washington, DC: American Psychological Association.

Iowa State University. (1985). Graduate college thesis manual. Ames: Iowa State University

Jacklin, C. N. (1989). Female and male: Issues of gender. American Psychologist, 44(2), 127-133.

Janos, P. M. & Robinson, N. M. (1985). Psychosocial development in intellectually gifted children. In F. D. Horowitz & M. O'Brien, The gifted and talented, developmental perspectives (pp. 149-195). Washington, DC: American Psychological Association.

Kahle, J. B. (1985). An assessment of the impact of science experiences on the career choices of male and female biology students. Journal of Research in Science Teaching, 22(5), 385-94.

Kahle, J. B., Matyas, M. L., & Cho, H. (1985). An assessment of the impact of science experiences on the career choices of male and female biology students. Journal of Research in Science Teaching, 22, 385-394.

Keating, D. P. (1974). The study of mathematically precocious youth. In J. C. Stanley, D. P. Keating & L. H. Fox. (Eds.), Mathematical talent: Discovery, description, and development (pp. 23-46). Baltimore, MD: Johns Hopkins University Press.

Keating D. P. & Stanley, J. C. (1972). Extreme measures for the exceptionally gifted in mathematics and science. Educational Researcher, 1(9), 3-7.

Kimball, M. (1989). A new perspective on women's math achievement. Psychological Bulletin, 105(2), 198-214.

Krumboltz, J.D., Mitchell, A. M., & Jones, G. B. (1976). A social learning theory of career selection. The Counseling Psychologist 6(1), 71-81.

Krutetskii, V. A. (1976). The psychology of mathematical abilities in school children. Chicago: University of Chicago Press.

Kulik, J. A. & Kulik, C. C. (October, 1984). Synthesis of research on effects of accelerated instruction. Educational Leadership, 42(2), 84-89.

Lantz, A. (1985). Strategies to increase mathematics enrollments. In S. F. Chipman, L. R. Brush & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 329-354). Hillsdale, NJ: Lawrence Erlbaum Associates.

Laws, J. L. (1976). Work aspiration of women: False leads and new starts. Signs, 1, 33-49.

Laycock, F. (1979). Gifted children. Glenview, IL: Scott, Foresman and Company.

Lesser, G. S., Krawitz, R. N., Packard, R. (1963). Experimental arousal of achievement motivation in adolescent girls. Journal of Abnormal and Social Psychology, 66(1), 59-66.

Lips, H. M. (1984). Math/Science self-schemas and curriculum choices among university women. Paper presented at the 92nd Annual Convention of the American Psychological Association, Toronto, Canada, August 24-28, 1984. (ERIC Document Reproduction Service No. ED 250 194)

Luchins, E. H. & Luchins, A. S. (1980). Female mathematicians: A contemporary appraisal. In L. H. Fox, L. Brody & D. Tobin (Eds.), Women and the mathematical mystique (pp. 7-21). Baltimore, MD: Johns Hopkins University Press.

Maccoby, E. E. & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

Matlin, M. W. (1987). The psychology of women. New York: Holt, Rinehart and Winston.

McBain, L. L. & Woolsey, L. K. (1986). Career and life role aspirations of high ability women undergraduates. Canadian Journal of Counseling, 20(3), 157-177.

McClellan, D.C. (1951). Personality. New York: William Sloane.

McMahill, J. A. (1985). The national impact of experience based career education upon 1978-1982 graduates. (Doctoral dissertation, Iowa State University, Ames, Iowa.)

Measor, L. (1985). Interviewing: A strategy in qualitatve research. In R.G. Burgess (Ed.), Strategies of Educational Research: Qualitative methods (pp. 23-54). London: The Falmer Press.

Meece, J. L. Parsons, J. E. Kaczala, C. M. Goff, S. B., & Futterman, R. (1982). Sex differences in math achievement: Toward a model of academic choice. Psychological Bulletin, 91(2), 324-348.

Michael, W. B. (1983). Manifestation of creative behaviors by maturing participants in the study of mathematically precocious youth. In C. P. Benbow & J.S. Stanley (Eds.), Academic Precocity (pp. 38-50). Baltimore, MD: Johns Hopkins University Press.

Mills, C. (1980). Sex-role related personality correlates of intellectual abilities in adolescents. Roeper Review 2(3), 29-31.

Mitchell, L. K. & Krumboltz, J. D. (1984). Social learning approach to career-decision making: Krumboltz's theory. In Brown, D. & Brooks, J. Career choice and development (pp. 235-264). Washington: Jossey Bass Publishers.

Montgomery, J. L. (1990). Factors that influence the career aspirations of mathematically precocious females. Unpublished doctoral dissertation, Iowa State University, Ames.

Moore, K. M. (1982). Developing leaders for academe. Educational Record, 63(1), 22-28.

Moore, E. G. J. & Smith, A. W. (1987). Sex and ethnic group differences in mathematics achievement: Results from the National Longitudinal Study. Journal for Research in Mathematics Education, 18, 25-26.

Mozans, H. J. (1974). Woman in science. Cambridge, MA: The MIT Press (Originally published in 1913).

Mumford, M. D. & Gustafson, S. B. (1988). Creativity syndrome: Integration, application, and innovation. Psychological Bulletin, 103(1), 27-43.

Mura, R. (1982). Gender and mathematics in Canada. In E. Schildkamp-Kuendiger (Ed.), An international review of gender and mathematics (pp. 32-43). Columbus, OH: Ohio State University, The ERIC Science, Mathematics and Environmental Educational Clearinghouse.

Mura, R. (1987). Sex-related differences in expectations of success in undergraduate mathematics. Journal for Research in Mathematics Education, 18, 15-24.

National Science Board. (1987). Science and engineering indicators--1987. National Science Board. Washington, DC: U.S. Government Printing Office

Oden, M. (1968). The fulfillment of promise: 40 year follow-up of the terman gifted group. Genetic Psychology Monographs, 77, 3-93.

O'Leary, V. E. (1977). Toward understanding women. Monterrey, CA: Brooks/Cole Publishing Company.

O'Leary, V. E. (1974). Some attitudinal barriers to occupational aspirations in women. Psychological Bulletin, 81, 809-826.

Parker, L. (1988). Two perspectives on gifted students: Time One of a longitudinal study of academically gifted Iowa students, and program evaluation of CY-TAG, a summer residential program for highly gifted seventh and eighth grade students. (Doctoral dissertation, Iowa State University, Ames.)

Parsons, F. (1909). Choosing a vocation. Boston: Houghton Mifflin Company.

Parsons, J. E. & Goff, S. B. (1980). Achievement motivation: A dual modality. In L. J. Fyans (Eds.), Recent trends in achievement motivation: Theory and research (pp. 349-373). Englewood Cliffs, NJ: Plenum Press.

Parsons, J. E. Adler, T. F., & Kaczala, C. (1982). Socialization of achievement attitudes and beliefs. Parental influences. Child Development, 53, 310-321.

Perrone, P. A. (1979a). The Career development needs of talented students: A perspective for counselors. Madison, WI: Wisconsin University, Department of Counseling and Guidance. (ERIC Reproduction Service No. ED 185 731)

Perrone, P. A. (1979b). Career development needs of talented students: A perspective for counselors. School Counselor, 27(19), 16-23.

Perrone, P. A. (1986). Guidance needs of gifted children, adolescents and adults. Journal of Counseling and Development, 64(9), 564-66.

Perrone, P. A. & Van Den Heuvel, D.H. (1981). Career development of the gifted: Horizons unlimited. Journal of Career Education, 7(4), 299-304.

Post-Kammer, P. & Perrone, P. (1983). Career perceptions of talented individuals: A follow up study. Vocational Guidance Quarterly, 31(3), 203-11.

Raymond C. L. & Benbow, C. P. (1986). Gender differences in mathematics: A function of parental support and student sex-typing. Developmental Psychology, 22(6), 808-819.

Raymond, C. L. & Benbow, C. P. (1989). Educational encouragement by parents: Its relationship to precocity and gender. Gifted Child Quarterly, 33(4), 144-151.

Rodenstein, J. M. (1980). Sex differences in the mathematical-related attitudes and activities during high school on the status of a gifted student's occupation. (Doctoral dissertation, University of Wisconsin, Madison, 1980). Dissertation Abstracts International. 41, 09A,3889. (University Microfilms, University of Wisconsin, Int. No. DA80-25-846)

Rodenstein, J. Pfleger, L. R., & Colangelo, N. (1977). Career development of gifted women. The Gifted Child Quarterly, 21, 340-358.

Roe, A. (1953). Making of a scientist. New York: Dodd, Mead & Company.

Roe, A. (1956). The Psychology of Occupations. New York: Wiley.

Rooney, G. (1983). Distinguishing characteristics of the life roles of worker, student, and homemaker for young adults. Journal of Vocational Behavior, 22, 324-342.

Rossi A., & Calderwood, A. (Eds.). (1973). Academic women on the move. New York: Russell Sage Foundation.

Sanderson, B. & Helliwell, C. (1978). Career development theory. Module 1. National Consortium on Competency-Based Staff Development. American Institutes for Research. ISBN 0-89785-552-3.

Segal, S. M., Busse, T. V., & Mansfield, R. S. (1980). The relationship of scientific creativity in the biological sciences to predoctoral accomplishments and experiences. American Educational Research Journal, 17(4), 491-502.

Sells, L. W., (1980). The mathematics filter and the education of women and minorities. In L. H. Fox, L. Brody, & D. Tobin (Eds.), Women and the mathematical mystique (pp. 66-75). Baltimore, MD: Johns Hopkins University Press.

Sewell, W. & Hauser, R. (1975). Education, occupation and earnings: Achievement in the early career. New York: Academic Press.

Sewell, W. & Hauser, R. (1976). Causes and Consequences of higher education: models of the status attainment process. In W. H. Sewell, R. M. Hauser & D. L. Featherman (Eds.), Schooling and achievement in American society (pp. 9-27). New York: Academic Press.

Shamanoff, G. A. (1985). The women mentor project: A sharing approach. Roeper Review, 7(3), 163.

Sherman, J. (1983). Girls talk about mathematics and their future. A partial replication. Psychology of Women Quarterly, 7(4), 338-342.

Srebalus, D. J., Marinelli, R. P., & Messing, J. K. (1982). Career development concepts and procedures. Monterey, CA: Brooks/Cole Publishing Co.

Stallings, J. (1985). School, classroom and home influences on women's decisions to enroll in advanced mathematics courses. In S. F. Chipman, L. R. Brush, & D. M. Wilson (Eds.), Women and mathematics: Balancing the equation (pp. 199-224). Hillsdale, NJ: Lawrence Erlbaum Associates.

Stanley, J. C. (1986a). Fostering use of mathematical talent in the USA: SMPY's rationale. In A. J. Cropley, K. K. Urban, H. Wagner, & W. Wieczerkowski (Eds.), Giftedness: A continuing world challenge (pp.227-243). New York: Trillium Press.

Stanley, J. C. (1986b). The urgent need for an academic focus. Paper presented at 67th Annual Conference of the American Educational Research Association, San Francisco, CA, April,16-20. (ERIC Reproduction Services No. ED 277 205)

Stanley, J. C. & Benbow, C. P. (1982). Educating mathematically precocious youth: Twelve policy recommendations. Educational Researcher, 11(5), 4-9.

Stanley, J. C. & Benbow, C. P. (1983). Extremely young college graduates: Evidence of their success. College and University, 58(4)(Summer), 361-371.

Stanley, J. C. & Benbow, C. P. (1986). Youths who reason exceptionally well mathematically. In R. J. Sternberg & J. E. Davidson (Eds), Conceptions of giftedness (pp. 361-387). New York: Cambridge University Press.

Stanley, J. C., Huang, J. & Zu, X. (Summer, 1986). SAT-M scores of highly selected students in Shanghai tested when less than 13 years old. College Board Review, 140, 10-13, 28-29.

Stanley, J. C., Keating, D. P., & Fox, L. H. (Eds.). (1974). Mathematical talent: Discovery, description and development. Baltimore: Johns Hopkins University Press.

Steinkamp, M. W. & Maehr, M. L. (1984). Foreword. In M. W. Steinkamp & M. L. Maehr (Eds.), Women in Science: Advances in motivation and achievement. Vol. 2 (pp.xi-xv). London: JAI Press.

Strang, R. (1958). The nature of giftedness. In National Society for the Study of Education. Education for the Gifted: 57th Yearbook Part II (pp. 64-84). Chicago: University of Chicago Press.

Super, D. (1957). The psychology of careers. New York: Harper and Row.

Super, D. E. (1976). Career education and the meanings of work. Monographs on Career Education. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

Super, D. (1980). A life-span, life-space approach to career development. Journal of Vocational Behavior, 16, 282-298.

Swiatek, M. A. & Benbow, C. P. (submitted). Effects of fast-paced mathematics courses on the development of mathematically precocious students. Ames: Iowa State University.

Tannenbaum, A. (1983). Gifted children: Psychological and educational perspectives. New York: Macmillan Publishing Co., Inc.

Terman, L. M. (1925). Genetic studies of genious: Vol. 1. Mental and physical traits of a thousand gifted children. Stanford, CA: Stanford University Press.

Terman, L. M. & Oden, M. H. (1947). Genetic studies of genious: Vol. 4. The gifted child grows up. Twenty-five years' follow-up of a superior group. Stanford, CA: Stanford University Press.

U.S. Bureau of the Census. (1988). Statistical abstract of the United States: 1988 (108th edition). Washington, DC: U.S. Bureau of the Census.

U.S. Department of Labor, Employment and Training Administration. (1982). Dictionary of occupational titles (4th Ed.). Washington, DC: U.S. Department of Labor, Employment and Training Administration.

Van Tassel-Baska, J. L. & Olszewski-Kubilius, P. (Eds.). (1989). Patterns of influence on gifted learners: The home, the self, and the school. New York: Teachers College Press, 264pp.

Wallace. D. B. (1985). Giftedness and the construction of a creative life. In F. D. Horowitz and M. O'Brien (Eds.), The gifted and talented. Developmental Perspectives (pp. 361-386). Washington, D.C.: American Psychological Association.

Wallach, M.A. (1985). Creativity testing and giftedness. In M.D. Horowitz & M. O'Brien (Eds.), The gifted and talented. Developmental Perspectives (pp. 99-124). Washington, D.C.: American Psychological Association.

Walters, J. & Gardner, H. (1986). The crystalizing experience: Discovering an intellectual gift. In R. J. Sternberg & J. E. Davidson (Eds.), Conception of giftedness (pp. 306-331). New York: Cambridge University Press.

Werts, C.E. (1967). Career changes in college. Sociology of Education, 40, 90-95.

Whitley, B. E. (1983). Sex role orientation and self-esteem: A critical meta-analytic review. Journal of Personality and Social Psychology, 44(4), 765-778.

Wilson, S. (1981). A new decade: The gifted and career choice. Vocational Guidance Quarterly, 31(1), 53-59.

Winterbottom, M. R. (1958). The relation of childhood training in independence to achievement motivation. In Atkinson J. (Ed.), Motives in fantasy, action and society. Princeton, NJ: Van Nostrand.

Yin, R. K. (1984). Case study research design and methods. Applied Social Research Methods Series, 5. Beverly Hills, CA: Sage Publications.

Yogev, S. (1983). Judging the professional woman: Changing research, changing values. Psychology of Women Quarterly, 7, 219-234.

Zuckerman, H. (1974). The scientific elite: Nobel laureates' mutual influence. In R. S. Albert (Ed.), Genius and eminence (pp. 171-186). New York: Pergamon Press.

ACKNOWLEDGMENTS

My special thanks go to: Dr. Camilla Benbow who guided this research, to Dr. Helen Schuster who assisted in the case study methodology, to Dr. Lynn Glass, who directed my doctoral program, and to Dr. Ann Thompson and Dr. Gary Phye who served on my doctoral committee.

Support from my family and friends has continued to be an inspiration. My special thanks go to: Jack, John, and Jill who believed in me, to Lori and Barb for assistance in preparing the manuscripts, and to Joane for her encouragement and support.

Most importantly, I would like to thank the 15 young women that I interviewed. These young women took time from their studies, research, and other activities to discuss their career plans with me; they were cooperative in exploring the influences on their career goals; and thus, enabled career aspirations to be documented during the young adult years. Special support from Dr. Benbow and SMPY staff at Iowa State University for assistance in locating questionnaires and providing access to information which enabled me to pursue this longitudinal study was greatly appreciated.

APPENDIX A. QUESTIONNAIRE PROTOCOL

The following outline of research questions and selected items from four questionnaires was initially used to help define the parameters of each research question and determine the sources of evidence from the questionnaires. From this protocol, data were collected and organized into data bases. This protocol was used when planning the interview protocol as it identified the amount of information available for specific research questions.

The four questionnaires used were: Talent Search Questionnaire (TSQ), Student Questionnaire (SQ), Questionnaire for Parents (PQ), After High School Follow-up (AHS), and a revised form of the After High School Follow-up (RAHS), which had similar items but a different numbering system.

Research Question 1: What are the career aspirations of mathematically precocious females during adolescence and young adult years?

AHS 10 ten occupational fields of interest

AHS 11 type of position, career goals

RAHS 11 type of position, career goals

SQ 30 long-range goals for career field, type of position and level

TSQ 35 four specific occupations that appeal to you

Research Question 2. What are the educational choices of mathematically precocious females during the young adult years as indicated by college selected, college major, or plans for undergraduate study, and/or graduate study?

SQ 26 lowest level of education with which you would be satisfied?

SQ 27 highest level of education you plan to complete?

AHS 9 degrees earned or plans to earn (RAHS 2-11)

AHS 35 present educational status

AHS 36b type of college selected (RAHS 38)

AHS 37 other colleges applied (deleted on RAHS)

AHS 39 influence for decision of college (RAHS 40)

AHS 42 intended major, field of study (RAHS 41)

AHS 43 factors that influenced major, field of study (RAHS 32)

Research Question 3. What are the lifestyle expectations of mathematically precocious females during the young adult years? How do they relate to occupational choice?

SQ 53 attitude about dual-roles for women

SQ 54 how important are lifestyle factors in future life? (AHS 74, RAHS 154-151, PQ 41)

AHS 75 career life style expectations (forced options) (RAHS 166)

AHS 74 How important are 12 lifestyle factors in future life? (same as SQ 54 and PQ 41)

Research Question 4. What personal factors influenced the career decisions of mathematically precocious females?

4A. What influence/role did achievement-related personal traits play in career decisions of mathematically precocious females?

PQ 39 personality characteristics

SQ 51 personality characteristics

AHS 72 personality characteristics (deleted on RAHS)

SQ 52 self-confidence

SQ 33 scholastic recognition by age 13

4B. What influence/role did measured ability play in career decisions of mathematiclly precocious females?

AHS 32 Measured aptitude, SAT PSAT (RAHS 19) M SAT and V SAT scores

AHS 15a Rank in High School, 15b if top 10% (RAHS 14)

AHS 18 high school grades (RAHS 14)

4C. What influence/role did self-perceptions of ability play in career decisions of mathematically precocious females?

TSQ 46 how comfortable are you with high intellectual ability (deleted on early TSQ)

TSQ 47 how does your intellectual ability affect the opinion that others hold of you?

SQ 60a self rating of talent in 12 areas.

AHS 73 how do I feel toward self (8) (deleted RAHS)

SQ 52 self-concept (a, c, d, h)

4D. What influence/role did interests in school subjects play in career decisions of mathematically precocious females?

SQ 32 topics of outside study or reading not assigned in school

SQ 36 attitude toward other subject areas (like, dislike)

SQ 37 a. (confident, anxious)

b. (easy, difficult) c. (interesting, boring)

d. (useful, not useful)

AHS 67-70 repeat of attitudes toward subject areas (RAHS 22-34 and RAHS 146-153)

TSQ 18 general academic interests - attitude

AHS 24-25 attitude toward subjects

TSQ 34 how important are school subjects in your future careers

4E. What influence/role did sex-typing of occupations play in career decisions of mathematically precocious females?

SQ 50 Perceptions of others who work in certain field as masculine/feminine

PQ 42 parent ratings of same items

AHS 71 same as SQ 50

4F. What influence/role did relationships with teachers, peers, and significant others play in career decisions of mathematically precocious females?

SQ 15	peer attitude toward achievement
SQ 39	what do other people think you ought to do after high school?
SQ 35	persons that encouraged your enjoyment of, your study of, favors your acceleration in studying, favors your skipping a grade, favors your entering college early
SQ 64	a person or event that had a significant major influence on any of your educational decisions
AHS 55	significant person/event (RAHS 83, same as SQ64)
TSQ 21	degree of support and from whom (groups)

Research Question 5: What family factors influenced their career decisions of mathematically precocious females?

5A. What influence/role did family background have on career decisions of mathematically precocious females?

PQ 3	parent's highest educational level
PQ 4	father's present occupation,
TSQ 9-12	father (AHS 96 a and b)
PQ 5	mother's present occupation
TSQ 13-16	mother (AHS 96 a and b)
PQ 23	location of the home
PQ 24	family income level
PQ 28	availability of books in the home

TSQ 7 number of siblings (AHS 97)

5B. What influence/role did expectations of parents play in career decisions of mathematically precocious females?

SQ 39 what do other people think you ought to do after high school?

PQ 36 would you be upset if your child chose another field?

PQ 37 lowest level of educational attainment by your child with which you would be satisfied

PQ 34 which careers or fields would you like your child to enter?

5C. What influence/role did encouragement of parents play in career decisions of mathematically precocious females?

SQ 10 parents' role in school work

SQ 35 persons that encouraged your enjoyment of, your study of, favors your acceleration in studying, favors your skipping a grade, favors your entering college early

SQ 64 a. person or event had a significant major influence on any of your educational decisions

AHS 55 identify significant major influence on educational decisions

PQ 35 would you actively encourage your child to enter these fields

AHS 30 people effected your like,dislike of school

PQ 3 Parent perception of contribution to child's enjoyment of ...; child's study of .... child's; interest in a career in ... grade skipping ... entering college early ....

TSQ 20 describe your amount of encouragement and support for your interest in and study of ....

TSQ 21 degree of support and from whom (groups)

Research Question 6: What influence/role did educational opportunities play in career decisions of mathematically females?

6A. What influence/role did diversity of curriculum offerings play in their career decisions?

SQ 11 type of school

SQ 21 acceleration - skipping grades

AHS 45-52 acceleration

SQ 23 courses plan to take

6B. What influence/role did in-school instructional activities play in career decisions of mathematically precocious females?

SQ 12c self-ratings of "quality of academic instruction"

TSQ 22 received formal instruction in....

TSQ 24 coursework in Mathematics

TSQ 25 coursework in science

TSQ 26a coursework in English

TSQ 26b elements of 26a

TSQ 27 coursework in social studies

TSQ 28 study foreign language

AHS 19 mathematics coursework

AHS 20 science coursework

AHS 31 AP courses

AHS 18 # semesters of coursework

6C. What influence/role did out-of-school instructional activities play in their career decisions?

TSQ 41 special courses or programs

TSQ 42 summer programs

TSQ 43 competitions

SQ 44 participation of extra curricular activities

AHS 23 college courses taken in high school

6D. What influence/role did specific guidance activities play in career decisions of mathematically precocious females?

SQ 38 did you talk to the following people about planning your school program.

6E. What influence/role did special achievements or recognitions play in career decisions of mathematically precocious females?

AHS 57-60 math & science contests

RAHS 114-122 other academic honors

AHS 61 special creative or original accomplishment

SQ 33 types of recognition available in your school and ones you received

AHS 33 National Merit finalist (RAHS 20)

AHS 34 Presidential Scholar (RAHS 21)

RAHS 17 National Honor Society

APPENDIX B: TELEPHONE INTERVIEW PROTOCOL

Date ____________________ Time start ____________ Stop ________

Subject Code ________________ Total minutes ____________

Phone number ________________

Hi (Name). This is Janey Montgomery of SMPY at Iowa State University. (Pause.) I'm really glad that you could visit with me, today/tonight. I know you have a busy schedule. How's your semester going? (From response indicate frame of mind: happy, tired, frustrated, depressed, other.)

As I explained earlier over the phone, I'm interviewing several young women in the SMPY 700M group for my doctoral dissertation. This interview will be similar to other questionnaires that you have completed, only this time I will be asking you some specific questions about your career plans. Your answers will be kept confidential.

If you don't mind, I will record the interview so that transcripts of our conversation can be typed. (Pause.) Is that okay? I really appreciate your cooperation. Please speak directly into the telephone receiver and talk at your normal volume.

While I check out the tape recorder, why don't you tell me about where you are and what it looks like? Is anyone else present? (Check out volume, red light, etc.) If answer = yes ... ask: Is this a bad time? I could call you back, if you would prefer to speak privately? (Pause.)

Name, I'll be asking you some questions about your career aspirations, some educational decisions that you have made, and I'd like for you to think about some of the factors that have influenced these career decisions.

Let's start with your current college or work setting ....
IF COLLEGE (Go to 1) .... IF WORK (So when did you graduate?).

1) What is your current status at ______________________
(name college/university)

2) 1 2 3 4 5 year.

3) FTU or PT?

4) So, when did you graduate? ________________

5) When do you plan to graduate? ______________

6) Any plans for graduate school or advanced degrees? yes no

7) Degree __________

8) When ____________

9) Could you tell me why do you want the _________ degree?

10) How do you like _____________ (name college)?

* What other colleges did you apply to and were accepted?

11) Have you ever considered transferring to another college/university?

12) Have you declared a major? yes no

13) What is/ was your major?

* Was it your original major? yes no

So, your Major Field is ____________________

14) Did you have a Minor field? _________________

15) Why did you choose ____________ major over other majors?

16) What ones were you considering?

17) Have you changed your major since you enrolled at (college name)?

18) What things prompted this change?

19) How would you describe your current career goal?

20) So, the field you intend to enter is ________________________.

21) And the type of position would be ___________________________.

22) What ultimate level do you intend to reach ___________________.

23) With this type of career, what would you like to accomplish in 5 to 10 years?

24) Name, that really sounds interesting, could you elaborate on why you chose (field) for your career or life's work?

25) Was there anything else that was important to you, or that influenced you to make this career choice?

26) Were there any other fields that you considered as strongly as this field?

27) Are you employed now? yes no (If answer = no, skip to 32.)
If yes: full time or part time

28) Tell me about your job

29) So, you're employed by (name firm).

30) And your job title is (rephrase title). Is that correct?

31) How long have you worked there?

As you look ahead (to when you will have finished your educational training,) which of the following career options would be most consistent with your future plans?

32) Do you plan to have a full time or part time career? F P

33) Do you plan to marry someday? yes no

34) Do you plan to have children? yes no

35) Do you plan to work outside the home? yes no

So, in other words, would this description best fits you.

36) PICK ONE TO RESTATE:

a. Have a full time career, marry and have children.

b. Have a full time career, marry but have no children.

* Have a full time career, marry, and undecided about children.

c. Have a full time career and remain unmarried

d. Have a part time career while my children are small and a full time career before they are born and after they are grown.

e. Have a part time career always

f. Have a full time career only until I marry

g. Have a full time career only until my children are born, then stop working outside the home to raise the children

h. Never work outside the home.

37) Can you share some of your reasons why you chose this particular combination of career-marriage-family options?

38) (If marry = yes) Is there anyone special in your life that you date on a regular basis? yes no

39) When I talk to my colleagues about the achievement of young women, somehow they have a tendency to want to know about"social life." So, how would you describe your "social life"--for example, your

friendships/relationships with males and females during high school?

40) ... during college?

41) Would you, then, describe your social life as (more active) (less active) or (about the same as your friends)?

42) Do you think your giftedness has interferred with, or made it more difficult to have strong relationships or an active social life? yes no

43) In what ways?

44) Let's go back to when you were 12 and took the SAT-M. How did you feel about this test?

45) Were you surprised by the results?

46) Did this exam and your high score change the way you thought about yourself?

47) You have stated that: "quote" in regard to your intellectual ability, do you still feel that's an accurate statement?

48) Would you add or change anything about this statement. How?

49) Do you think that your high mathematical ability had anything to do with your career decision to enter ...? yes no

50) In what ways, could you elaborate?

51) So, would you say that your high mathematical ability was (influential) or (noninfluential) on your career decisions?

52) In earlier questionnaires, you indicated that you considered certain fields to be strongly masculine or strongly feminine, both masculine and feminine, or neither feminine or masculine. For example, you said that you considered:

Mathematics to be ---	y n	.....	Would you say that's
Science to be ---	y n		an accurate
Computer science to be ----	y n		reflection of how you
Your field ---	y n		currently think?
You ---	y n		

53) If no, how would you change your response?

* How do you define whether a field is masculine or feminine?

54) What about teachers or special friends, were they (influential) or (noninfluential) in your career decisions?

* Who were your favorite teachers?

55) In what ways?

56) In earlier questionnaires, you cited significant others such as ______________________ as having a "significant major influence on your educational decisions." Has anyone else had a significant major influence on your career decisions?

57) Was your family supportive of your career decision? yes no

58) Could you tell me their reactions? How did your mother react?

59) What did your father say when you told him you were considering ______________________ as a career choice?

60) As you think back, were there any particular ways in which your parents encouraged you that you remember or stand out as important to you?

61) Would you say that these types of encouragement, were (very important) (somewhat important) (not important) to your career decisions?

62) Do you feel, or did you feel, any pressure from the family, that there were expectations for you to enter ____________________, or would you have done it anyway?

63) So, in summary, there was: (choose one for confirmation)

a. pressure for this career choice

b. pressure for another career choice

c. no pressure for this career choice

d. there was pressure, but you resisted the pressure, and made your own decision in another area.

e. other

Is that correct?

64) As you think back, there are some givens, the socioeconomic factors in your family background such as family income, your parent's education and their career choices, your position in the family, the size of city that you lived in when you were growing up. Do you think that any of these factors were an influence on your career decisions?

65) In what ways?

This really is interesting. I think that ... as a career field sounds very challenging, and your reasons are certainly good. It sounds like you've given this some thought.

66) Let's think back to your educational experiences. From your questionnaire I understand that you were accelerated in ----- grade. Correct?

67) After high school you reported that (i.e., you were satisfied with what you did.) Would you say that this positions reflects your current thinking on the acceleration that you experienced? yes no

68) (If yes or no) ...? Can you explain why?

68) You listed several out of school instructional activities such as taking classes at a university setting or taking college classes during high school. Did these experiences influence your career decisions?

69) How would you rate the influence of your high school guidance counselor on your career decisions? (very influential) (moderately influential) (no influence)

70) What types of assistance did you receive from the guidance counselor?

71) How would you rate this type of assistance as you made career decisions? (very effective) (moderately effective) (not effective)

72) Where did you get information about classes or college programs?

73) You received several special awards or achievements during high school such as (National Merit Scholarship, etc.). Did these awards or achievements influence your career decisions?

74) Can you think of anything else that might have been influential to your career decisions and aspirations that we haven't talked about.

75) Name, if you were talking to a younger and highly precocious girl in mathematics, how would you describe the career path that you have chosen? I mean, what's it like out there every day in your university classes competing with other high ability students?

76) How do you feel about your intellectual precocity now that you're older.

77) If you had to arrange the personal, family, and educational factors in rank order, which one had the greatest influence on your career decisions? Restate subcategories of each:

1.
2.
3.

Name, I really appreciate your time and I would like to thank you for participating in this interview. Do you have any questions or comment you'd like to make before we close. (Pause.) Thanks, again. Bye.

APPENDIX C: SAMPLE CASE STUDY: TRUDY

In January of 1982, three months before her 13th birthday, Trudy, an Asian-American, scored 700 on the math section of the Scholastic Aptitude Test (SAT-Math) and 490 on the SAT-Verbal. This level of mathematical performance is comparable to the top 5% of college-bound males. To achieve these results as a seventh grader places Trudy in the top 1 in 10,000 of her agemates or 1 in 60,000 females (Stanley, 1986a). At time of identification, through an SMPY Talent Search, she lived with her parents and attended school in a small city in North Carolina. Trudy is an only child of professional parents. Her father is a college professor of economics with a Ph.D. in Economics; her mother is also a profèssor and received her master's degree in Library Sciences.

Career Aspirations

Trudy aspired to career fields in medical, natural and physical sciences as early as age 13. Four occupations that appealed to her as fields for "her life's work" were: physician, biochemist, computer scientist, and physicist. In eighth grade, her long-range goal was "to become a physician, and to become a medical researcher" (Trudy, Student Questionnaire #30, 1982).

By the end of high school her interests had narrowed to medical sciences. At age 18, her long-range goal included, "medicine, physician with Ph.D. specialized in cardiology, professor/researcher in med school" (Trudy, After-High School Follow-up #11, 1988). Currently, Trudy aspires to a medical career, as a physician, researcher, professor, or possible combination of the three. She has postponed any decisions about specialities until after medical school. When asked about cardiology, she replied,

> I'm still kind of toying with that idea, but I know that I can't really make a decision until I've gone into wards and started doing rounds in the hospital. ... that is one of my possible considerations. (Trudy, Interview #19, October 13, 1989)

In five years, Trudy hopes to finish her internship and be in residency. She is excited about the transition from college to medical school and becoming a physician. Trudy chose medicine for her career field for several reasons:

> Obviously, ... my interest in biology would correlate with my interest in medicine. In biology, I could have chosen research or medicine. But one of the reasons I sort of went into medicine, no matter what you do, you would be affecting a lot of people's lives. And so, in that sense, ... the biggest reason is just wanting to help people. One other influence is that time when I had myocarditis. That also had a big influence. I had some really good physicians that made me see what it was like to be a physician and I knew what it was like to be a patient. (Trudy, Interview #25, October 13, 1989)

Although Trudy "always sort of" knew that she wanted to have a career in medicine, she shared that this decision did not finalize until the college years.

Educational Choices

Trudy aspires to a high level of education. During secondary school, she planned to obtain a Ph.D. and an M.D. As a first year medical student, at age 19, her degree goal is the M.D.; however, she has not ruled out a Ph.D.

> I think, the benefit of going into the Ph.D. would be if I decide I want to go more into research rather than doing clinical medicine .... In that sense, the Ph.D. would most definitely, help .... it's a way of getting into research. (Trudy, Interview #9, October 13, 1989)

In addition to these early aspirations for advanced degrees during adolescence, Trudy had hoped to attend a four-year private college or university. After high school, she was admitted to several prestigious universities including Princeton, Johns Hopkins, and Duke. She entered Massachusetts Institute of Technology (MIT) in February of 1986 at age 16, where she planned to major in biology, chemistry, and/or biotechnology. She reported the most important factor influencing her choice of college was "prestige and reputation" of the university. As for the most important factor in her choice of major, it was "interest, enjoyment." Trudy explained her choice of biology, as an undergraduate major.

> I knew that I was interested in science, but I thought biology would relate more to things that I could have some sort of visual or kind of understanding of ... in physics and math--it's completely abstract. Biology had to do with life and cells and DNA and things that I really had a grasp of .... So, I think that's why I probably went into it. (Trudy, Interview # 15, October 13, 1989)

Trudy expressed that her interest in biology has been intense since high school. A high school female biology teacher was one of her favorite teachers. She chose biology over other possible majors (i.e., chemistry and physics) because she really enjoyed the biology classes that she took during her freshman year at MIT. She enjoyed both the content of the field as well as the professors. Initially, Trudy had been quite interested in physics and had taken several semester of physical sciences in high school. Her extensive coursework in high school enabled her to test out of elementary physics at MIT. In college, however, she never took another physics course.

After a serious illness during adolescence, Trudy entered college at mid-year and completed a biology major in three years. She graduated from MIT in February of 1989. From there she went to medical school. Trudy had been accepted into four medical schools: Harvard, Yale, Johns Hopkins, and Duke. After spending part of the summer of 1989 in Taiwan on holiday with her family, Trudy entered the Health, Science and Technology Medical Program, jointly sponsored by Harvard and MIT, in September of 1989. This decision reflected her satisfaction with MIT and desire to continue her association with that university. Trudy also preferred this new combined program because, "it's supposed to be more scientific and more quantitative in its approach" (Trudy, Interview #4, October 13, 1989).

Trudy has held various part-time jobs in research settings, such as The Dana Farber Institute, MIT's Cancer Research Center, and the Whitehead Institute. Usually Trudy worked on research only during the summer months. Yet, during her senior year, she continued her research project into the fall semester.

Lifestyle Expectations

Lifestyle expectations are becoming more important to Trudy as she grows older. At age 13, Trudy indicated only one expectation as "very important" to her life's work. It was "being successful in my line of work." After high school she rated six lifestyle expectations as "very important." They included: 1) "being successful in my line of work,"

2) "find the right person to marry and having a happy family life," 3) "having strong relationships," 4) "working to correct social and economic inequalities," 5) having children," and 6) "having leisure time to enjoy my own interests" (Trudy, After High School, #74, 1986).

At 18, Trudy indicated the career option most consistent with her future plans was to "have a full time career, marry and have children." During the interview, at age 19, her lifestyle expectations have not changed. She explained her lifestyle choices:

> I haven't really ever considered doing anything but full-time work. I always wanted to be, in some sense, independent, have my own career, be financially independent, and things like that. I think that most women, in general, would just like to have kids as well. I don't see any difficulty in handling kids and a full-time job .... My mom worked full-time, she raised me, too. I've never seen it any other way .... I don't know what it's like to stay home and take care of the kids. (Trudy, Interview # 37, October 13, 1989)

As a medical student Trudy shared that there is not "anyone special" that she dates on a regular basis. She confided that she had more time for relationships in college. She has a few really good friends in medical school, and also tries to keep in touch with a few friends from high school. She does not feel that her giftedness has interfered with developing relationships or her social life. "You meet a lot of people who are gifted ... here [medical school]; we relate to each other well" (Trudy, Interview #42, October 13, 1989).

Factors That Influence Career Decisions

Personal Factors

A discussion of personal factors such as: self-perception of ability, measured ability, achievement-related personal traits, sex-typing, and interests follows.

Self-perception of ability. In the early teens, Trudy was very "comfortable" and "satisfied" with herself and took a positive outlook toward her intellectual ability. Trudy shared that her high score on the SAT-M changed her self-perception of her ability. "I wasn't really sure if I was that smart. Probably after that [scoring high on the SAT-M], I thought I really can handle a lot more academically" (Trudy, Interview #46, October 13, 1989). During junior high school, Trudy viewed her special intellectual precocity from a positive, but perfectionistic, point of view. "I am happy and fortunate but I wish I could be a bit smarter. Such as making a perfect score before 13" (Trudy, Student Questionnaire #66, 1982). During the interview, she laughed at this statement. When asked if she still felt this way, she commented:

> I think I just pretty much accept the way I am. I don't wish I was born smarter any more. I like to know that I'm growing as a person ... but I don't wish I was born with different traits. (Trudy, Interview #48, October 13, 1989)

In addition to her intellectual abilities, Trudy considered herself at age 13 to be "accomplished or talented" in the fine arts as an artist, musician, and writer." At age 18, she added composer, playwright, and poet to the list. At 19, she shared that her involvement with the fine arts did not influence her career decisions for medicine. They did, however, shape her personality and how she sees the world. "It [fine arts] is one of those things that keeps you sane" (Trudy, Interview #74, October 13, 1989).

Measured ability. From 7th grade through high school (four years), Trudy maintained a 4.0 (A) average. As an 11th grader, she took the SAT exam again and scored a perfect 800 on the SAT-M and 680 on the SAT-Verbal. She also took AP exams in math (Calculus BC), biology, chemistry, and physics, and obtained scores of 5, 5, 4, and 4, respectively. Generally, her scores placed her in the top percentile of students electing to take these achievement tests. Trudy graduated first in her class of 200 students who attended a the North Carolina High School for Science and Mathematics. Trudy indicated that her high mathematical ability did have an influence on her career aspirations.

> Yes, I'm sure it [math ability] did in an indirect sense. I mean from math I got into science ... and from there I went into medicine. If you don't have a really strong ability in math, chances are you're not going to have an easy time getting through science. With most people, if you are good at something, chances are you like it; and if you're not good at something, you're probably not going to like it as much.... (Trudy, Interview #49, October 13, 1989)

Achievement-related personal traits. At age 13, Trudy's personality was described by her and her parents as warm hearted, socially adept, sentimental, happy-go-lucky, inhibited, shy, no risks taken, submissive, humble, imaginative, and emotionally stable. After high school Trudy described herself as more sober and restrained, but more willing to take risks, more venturesome, more self-sufficient, more willing to experiment, more imaginative, and more emotionally stable than at the earlier age. On the Strong-Campbell Interest Inventory she scored "high" on Investigative as compared to other scales (i.e., Realistic, Artistic, Social, Enterprising, and Conventional). Within the Investigative scale, she scored "High" on mathematics, sciences, and medical sciences.

Sex-typing. At 13, Trudy sex-typed engineering and computer science as "strongly masculine." Humanities and fine arts were marked as "strongly feminine." She did not sex-type careers in mathematics, natural sciences, physical sciences, or social sciences. She indicated her own intended career field was "strongly masculine," while she considered herself to be "strongly feminine." As she grew older, she indicated more sex-typing of various professions. After high school, she considered the fields of mathematics, natural sciences, and physical sciences also to be "strongly masculine." Ratings of sex-typing were not consistent with her parents, as they did not sex-type any field.

Trudy explained that her sex-typing of a career field is based on the number of women in the field and also on the way that the men in the field think of the women. She explained,

> ... a lot of guys think they're smarter in science than girls, or at least they have that in their heads or something. And so, in that sense, it's more biased because I think that's not true. Hopefully, I've convinced the people whom I know, that's not true. (Trudy, Interview #52, October 13, 1989)

Currently, Trudy views herself as both "masculine" and "feminine". She explained that "at MIT in science you feel that you've developed a masculinity as well" (Trudy, Interview #52, October 13, 1989).

Attitudes and interests. In junior high school, Trudy "strongly liked": school in general, mathematics, biology, chemistry, physics, English and social studies. She indicated that mathematics, biology, chemistry, physics, English, and writing would be most important to her career. Her favorite subjects at that time were: 1) mathematics, 2) physical science, and 3) natural sciences. At 18, when ranking several math and science subjects, her favorites in order were: biology, mathematics, and chemistry/physics.

Through junior high school and high school, Trudy remained very confident about her abilities in foreign language, mathematics, and the sciences. She perceived these three subjects as "very easy," but only mathematics and the sciences were viewed as "very interesting." When asked to indicated which subjects were "very useful to my planned career," she included English/literature, foreign language, mathematics, natural and physical sciences.

Summary. Personal factors that influenced Trudy's educational and career aspirations seem to have stemmed from the early identification of her high ability in mathematics. She expressed that knowledge of the SAT-M score reinforced her belief in herself to pursue her goals and reach her potential. However, the influence of a serious illness (acute myocarditis at age 16) which hospitalized her for several weeks and delayed her college entrance, cannot be underestimated. This exposure to professional role models working in a hospital setting, in a life and death crisis, reinforced her career decisions for medicine, her interest in the disease process, and a possible specialization in cardiology.

Family factors

The second major influence on Trudy's career decisions included family factors, such as family background, parents' expectations and parental encouragement.

Family background. Trudy's mother and father have advanced professional degrees and full-time careers. Both parents were foreign born. They received their undergraduate education in Taiwan and their advanced degrees from a large Midwestern university. Their family income was estimated in 1983 dollars as $50,000 to $59,999. During Trudy's school years, the family lived in a small city (less than 50,000 people) in North Carolina. Trudy indicated her parents' education was a factor influencing her career decisions. "They were expecting higher education" (Trudy, Interview # 64, October 13, 1989).

Parents' expectations. In junior high school, Trudy reported that both parents, her guidance counselor, teachers, friends, and significant others expected her to go to college. Her parents had identified four occupational fields that they would like their daughter to enter, which were: medicine, college teaching, science, or engineering. Trudy's parents indicated they would be upset if she chose another field. The "lowest level of educational attainment" for Trudy that her parents would be "satisfied" with was the "Ph.D., M. D., or J.D. or other advanced doctoral level degrees" (Trudy, Parent Questionnaire #37, 1982).

Trudy felt that her parents wanted her to go into medicine but she did not think they ever pressured her. In fact, her parents suggested engineering at the beginning of college and also encouraged her in mathematics. Trudy stated that her parents do not want her to go into math. "They worry about the practical considerations--there really isn't a job market" (Trudy, Interview # 62, October 13, 1989). If math had been her preference, her parents would have prefered she become an engineer. Trudy felt she was not interested in engineering. To her, it was not related enough to people.

> All the technology will have an enormous effect on people's life, but I guess I wanted something more closely related [to people]. (Trudy, Interview, #62, October 13, 1989)

Trudy elaborated on her relationship with her parents.

> They think of what they think is best for me and then they let me go off and make decisions .... Sometimes my decisions correlate with theirs .... There are quite a number of times that they don't understand, especially with my social life. They have this idea of what kind of people should be my friends, and I don't listen to any of those kinds of things. It's like they always have their say, but whether I follow it is up to me. (Trudy, Interview # 62, October 13, 1989)

Trudy reported the family was supportive when she told them of her decision to enter medicine. Indeed, her mother had anticipated this decision.

> She [mother] wasn't surprised at all. I mean, my parents kind of thought I should go into medicine .... It was me that wasn't sure .... My parents just figured that I'd end up making the decision. (Trudy, Interview # 58, October 13, 1989)

Her father was very happy with her decision. Trudy explained:

> He was really happy. He was especially estatic when I got into Harvard. He graduated from the National Taiwan University .... I think Asians have this big thing about Harvard, because they were all telling me, "This [National University] is like the Harvard of Taiwan." So, I should go to the Harvard of America. (Trudy, Interview #59, October 13, 1989)

Along with the summer experiences and college mentors, Trudy cited her parents as having a "significant major influence on her educational decisions." At 19, she also confirmed their influence on her career decisions.

Parental encouragement. Trudy suggested that her parents have always supported her and encouraged her. Both her mother and father kept close track of how well she was doing in elementary and junior high school, while her mother was "strongly associated" with her enjoyment, study of and her acceleration in mathematics." Both parents indicated they encouraged Trudy's interests toward a career in science. Neither parent encouraged her interests toward a career in mathematics, literature, history, social studies, or writing, however. Trudy suggested that her parents' encouragement was "very important" to her career decisions.

> It's much harder if you don't have your family to back you up .... Medical school is tough .... I have friends and their families are not really supportive and it's really hard on them. So, even though you're out of college, ... their support is really essential. (Trudy, Interview #61, October 13, 1989)

> It's something you can't pick out, ... they still support me to this day. They call me ... it's a natural part of my life. It's not anything I can pick out. (Trudy, Interview #60, October 13, 1989)

Summary. Family factors that influenced Trudy's career decisions stemmed from the high educational attainment of her parents. They expected her to achieve in higher education beyond the bachelor's degree, just as they had. Her parents preferred that their daughter pursue a career in medicine, science, or engineering over mathematics.

Family dynamics allowed for her parents' suggestions to be considered, but Trudy made the ultimate decisions. Trudy acknowledged that her parents' financial and emotional support continues to be important in medical school. She stays in close contact with her parents and respects their opinions.

Educational factors

The following narrative describes the accelerative options, in-school instruction, out-of-school instruction, guidance, relationships, awards, and achievements that may have played a special role in her career development.

Curricular flexibility and acceleration options. Trudy entered first grade after her sixth birthday. She attended a public school in North Carolina through the 7th grade, which provided her with "good" academic instruction. Beginning in third grade, she was accelerated in subject matter placement in mathematics. Her school had an elementary gifted program and she participated in the mathematics and English options.

> ... when it came time for math, we would all go to a different place .... I remember in sixth grade or something, when we had GT English, we went to another school and had to get bus transportation. (Trudy, Interview #67, October 13, 1989)

After participating in SMPY talent searches, Trudy skipped grades 8 and 9 and she entered the North Carolina High School for Mathematics and Science. She reported her SAT score was "influential or helpful" in skipping grades, acceleration of subject matter, and in overall educational development.

At 18, Trudy indicated her accelerative options had a "strongly favorable effect" on: general academic progress, grades, interest in school and in learning, interest in mathematics and science, acceptance of ability, ability to get along with mental peers and adults, social life, general emotional stability, acceptance of self and self-awareness. Trudy felt that she would not have been accelerated as much without SMPY's help. After high school, Trudy reported her feelings about acceleration as "satisfied with what I did" (Trudy, After High School #52). When asked the same question, at 19, she laughed and said:

> Yes, definitely, especially considering how long this medical school route is. I would prefer to end it when I'm still young. I'm beginning to think that two years isn't enough. By the time you come out, you'll be thirty or something. (Trudy, Interview #65, October 13, 1989)

In-school instruction. During 7th, 10th, 11th, and 12th grade, Trudy completed 1 semester of business, 2 semesters of social science, 2 semesters of natural science, 6 semesters of French, 8 semesters of physical science, 9 semesters of English, and 10 semesters of mathematics. Trudy's math classes included calculus in 10th grade, advanced calculus in 11th grade, and linear analysis in 12th grade. Her science classes included chemistry, advanced biology in 10th grade, advanced chemistry in 11th grade, and organic chemistry and advanced physics in 12th grade. In addition, Trudy completed four AP exams in Calculus BC, biology, chemistry, and physics; thereby, Trudy was able to enter college with advanced standing.

Out-of-school instructional activities. Trudy indicated that because she attended a state-sponsored school for science and mathematics, and the curriculum was rigorous, she did not take college classes during high school. She did participate during the two summers after 7th and 10th grade (1982 and 1983) in several fast-paced classes--SMPY biology, physics, precalculus math and computer programming (PASCAL). Trudy explained that these out-of-school instructional activities had an indirect effect on her career decisions.

> I think the fact that I could accelerate in areas of science kept up my interests in that area .... If you ever feel stifled in an area, you might not even go into that. (Trudy, Interview # 68, October 13, 1989)

Also instrumental were the significant others who counseled her and an accelerated summer program in mathematics, which she participated in after talent search identification.

Guidance. In junior high school, Trudy indicated that she talked to her guidance counselor "a great deal" about planning her school program. Yet, Trudy felt that the high school guidance counselor had "no influence" on her career decisions. The high school counselor assisted with college applications and was "very effective" for this process. Yet, he did not have an impact on her career decisions.

Relationships. In junior high school, Trudy cited two significant others at the university level and two summer programs in accelerated mathematics instruction as "having a significant major influence on her educational decisions." After high school, she again cited one significant other (Dr. Julian Stanley) at the university level and the university's (Johns Hopkins) accelerated mathematics program as a significant influence. During the interview, she explained.

> I'm not sure that I would have gone into any of these things if it hadn't been for his [Dr. Stanley's] encouragement ....

> I mean, I was from a very small town in North Carolina and that's kind of why I said the 700 would make a difference. Because even if you're a big fish in a little pond, you don't know how good you'd be in a bigger pond. He [Dr. Stanley] was completely instrumental in helping me skip the two years ... and go to try to reach my potential. I think that was pretty revolutionary in my life at that time. (Trudy, Interview #56, October 13, 1989)

In regard to her career decisions in medicine, Trudy shared that one of the doctors that took care of her during her illness encouraged her to go into medicine, as well as several professors in the MIT Biology Department. During the school years, her interests focused around mathematics, natural and physical sciences. Later, when she took biology at the undergraduate level, these interests became more focused upon biology.

Special achievements/recognitions. Trudy was valedictorian of her high school graduating class of 200. She received a National Merit Scholarhsip, as well as several local and school awards in art, state and regional awards in foreign language and science, and national awards in mathematics, music, and writing. Yet, Trudy still played an active role in extracurricular activities--four years of: Honor Society, an academic club, a social club, and music, three years in a community organization, and two years in a vocational club and student government. In seven of these activities, she indicated she had taken on a leadership role, including president of student government in seventh grade. Trudy indicated that these special achievements, honors, and recognitions did not influence her career decisions, but acknowledged they gave her some financial assistance.

Summary. Educational factors shaped her opportunities for advancement within the sciences. Early exposure to biology, physics, and pre-calculus during SMPY fast-paced summer programs peaked her interest in scientific fields. Her selection to a highly competitive state high school for math and science, which provided quality course offerings and rigorous competition among the students, prepared Trudy for the academic challenge of higher education. Her active participation in extracurricular activities, on the other hand, developed her leadership skills. Not to neglect her personal development, she devoted considerable time to the fine arts.

At the time of her interview, Trudy projected an image of a bright, articulate, and happy 19-year-old in her first month of medical school. Although excited about the future and worried about the next exam, she seemed to have an exceptionally focused self-concept. When questioned about this self-acceptance, she shared:

> When you are younger, children are not as accepting for the way that people are. So, ... when you are younger, you feel more that you have to fit in, ... but when you get older, you find out who you are and where you fit into the world .... But, I think that's pretty typical of most people. (Trudy, Interview # 48, October 13, 1989)

Trudy explained that college was also influential in stablizing her confidence in her abilities. How does she view her intellectual precocity now that she's older?

> I think college helped me realize to have confidence in my ability .... Since this is the beginning of medical school, I'm a little shaky, a little not so sure. But, I think when I get into it, I'll have the same feelings of confidence in the ability that I can do whatever I want to do.... At least that's usually how the process goes, I'm a little nervous at the beginning and then I get used to it. And

> then I see that I can excel at it. (Trudy, Interview 76, October 13, 1989)

When the interview concluded, and Trudy was asked, "What advice would you give to younger mathematically precocious females following a similar career path? Trudy responded,

> I think the most that I could say is that they should feel really good about themselves .... A lot of people in college are not sure who they are. This is their growing up time and they're becoming independent. And if you're totally lost in that sense, then life will be hard.... Just keep a good balance of who they are and where they fit in. (Trudy, Interview # 75, October 13, 1989)