Sex Differences in Mathematical Ability: An Application of Attribution Theory of Achievement Motivation

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SEX DIFFERENCES IN MATHEMATICAL ABILITY: AN APPLICATION OF ATTRIBUTION THEORY OF ACHIEVEMENT MOTIVATION

by

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VITA

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INTRODUCTION

Mathematical ability, like spatial and verbal abilities, is an area in which fairly consistent sex differences have been found. Males out-perform females at tasks measuring mathematial and spatial abilities, while females out-perform males at tasks measuring verbal abilities (Maccoby & Jacklin, 1974).

Yet, it is not clear whether these differences are innate, or learned, or a combination of both. The purpose of this paper is to further explore one area of learned differences between the sexes, Attribution Theory of Achievement Motivation, that may explain the small yet significant difference (Fennema & Sherman, 1977; Hyde, 1981; Ridley & Novak, 1983) between males' and females' performance in one cognitive ability category, mathematics.

Quite a volume of research has looked for a biological basis for sex differences in cognitive abilities. Researchers have probed brain lateralization (Levy, 1981; Sherman, 1977), an X chromosome linked gene (Stafford, 1972) and hormonal differences (Money & Ehrhardt, 1972) in hopes of identifying biologically based causes for the observed gender differences (see Frieze, Parsons, Johnson, Ruble, & Zellman, 1978 for review). However, recent reviews of the literature on sex differences in mathematical ability have ruled out an innate ability difference as the primary causal determinant of the discrepancy in male and female performance at mathematical tasks (Fennema, 1977; Fox, 1977; Sherman, 1977). As Williams (1983) concludes, "evidence for biological contributions to males' superior performance in mathematics is weaker than it is for spatial ability and accumulating evidence is more supportive of socialization factors " (p. 135). Therefore, further investigation of learning experiences and socialization influences that are hypothesized to contribute to differences in mathematical ability is undertaken here.

One such promising area of investigation is the application of Attribution Theory of Achievement Motivation (ATAM) (Weiner, 1972a; Weiner, 1972b; Weiner, 1974; Weiner, 1985; Weiner, Frieze, Kukla, Reed, Rest, & Rosenbaum, 1971) to the study of sex differences in mathematical ability. It is the purpose of this study to examine sex differences in causal attributions for a mathematics task. No attempt is made to empirically validate a general theory which would apply to any task. The latter is probably not possible (e.g., McHugh, Fisher, & Frieze, 1982, for one example of generalizability limitations), while the former may help explain male and female differences in level of achievement for mathematically-related carrers like accounting, computer science, and engineering which typically offer higher status and higher pay than traditionally female dominated career areas (Fennema, 1977 cited in Pedro, Wolleat, Fennema, & Becker, 1981; Frieze, Parsons, Johnson, Ruble, & Zellman, 1978; Parsons, Meece, & Adler, 1982).

REVIEW OF RELATED LITERATURE

Causal attributions for one's success or failure is one of the three major areas cognitively oriented research has focused on to understand sex differences in achievement behavior (Frieze, Fisher, Hanusa, McHugh, & Valle, 1978; Frieze, Parsons, Johnson, Ruble, & Zellman; 1978). The other two major foci of research in this area are the study of differential motives or values and that men and women differentially define success. Generally, degree and direction of attributions for personal success or failure, as well as attributions made by an observer to an actor, are expected to differ depending on the sex of the person to whom the attributions apply (the self or the actor). Also, sex differences in attributional patterns are expected to be even more pronounced if the task is sex-typed, as is mathematics (Wolleat, Pedro, Becker, & Fennema, 1980).

Attribution Theory

Attribution Theory of Achievement Motivation springs from several more global theories of social behavior: Heider's Theory of Phenomenal Causality (1958), Kelley's Theory of External Attribution (1967), Atkinson's Expectancy Value Theory of Achievement Motivation (1964), Rotter's Reformulation of the Locus of Control Theory (1966), and Rosenbaum's Intentionality concept (1972; cited in Weiner, 1979).

Attribution Theory is based on cognitive-behavior theory, and thus has the "framework of an S-C-R model; where C symbolizes causal cognition and S and R represent stimulus-response or antecedent-consequent relationships" (Weiner, 1976, p. 180). A person's attention to, thought about, and interpretation of events is guided by assigning causes to these events (Kelley, 1967; Shaw & Costanzo, 1982). Attributions are cognitions which attempt to make sense out of events in the context of the internal and external environment.

Attribution Theory's cognitive mediational grounding thereby postulates individual variation in the causal interpretation of any given event. Individual's ascriptions to causality are the focus of Attribution Theory, and therefore, the theory addresses an individual's perception of causality. Yet, individual's perceptions of causality are subject to distortions and errors (Kelley, 1967). According to Kelley (1967) there are five potential sources of attributional errors: ignoring a relevant situation; making egocentric assumptions; one's emotions and self-esteem being affected by relevant events; interpreting misleading cues form the surrounding situation; and one's responses being affected by hidden causal factors. Specific hypotheses concerning differential attributional errors made by males and females from Weiner's perspective will be a major focus of the present paper.

Attribution Theory focuses on "'why' questions, or the relationship between phenomena (effects) and the reasons (responsible agents) for those events" (Weiner, 1972, p. 310) including the self. The answers to the "why" questions are referred to as perceptions of causality which Weiner (1972) defines as "the judgement of why a particular response occurred" (p. 203). A central assumption of Weiner's ATAM states that comprehension of causality, a basic search for understanding, is one of the primary sources of motivation and behavior (Weiner, 1979).

Perceptions of causality are of central importance according to attribution theorists. Attribution theorists propose perceptions of causality have a wide ranging effect on behaviors, affects and cognitions. ATAM proposes that an individual's search for understanding often leads to attributional questioning, a search of environmental cues and personal characteristics to explain an outcome to the questioner (Weiner, 1979). It is important to note that Attribution Theory applies to both interpreting prior events (postdicting) and predicting future events (Weiner, 1985).

Attribution Theory of Achievement Motivation

Attribution Theory of Achievement Motivation (ATAM) consists of three dimensions of attributional causality which serve as higher order conceptualizations by which to organize the specific causes used in the attributional questioning and ascription process. The three dimensions of causality include: the locus of causality (internality and externality), which is theoretically based on work by Heider (1958) and Rotter (1966); the stability dimension (stable versus unstable causes), based again on Heider's work (1958); and the dimension of controllability (controllable versus uncontrollable causes) based on Heider (1958) and Rosenbaum's concept of intentionality (1972, cited in Weiner, 1979). These dimensions are presented in Table 1.

The theoretical foundations of the locus of causality dimension are grounded, in part, in Rotter's concept of locus of control. Yet, an important distinction must be made between locus of control according to Rotter and the locus of causality in the Attribution Theory framework. Attribution theorists (Ickes & Layden, 1978) argue that Rotter does not make

Table 1

Attribution Theory of Achievement Motivation: Causal Dimensions and Causal Categories

	Internal		External	
	Stable	Unstable	Stable	Unstable
Uncontrol- lable	Ability	Mood	Task	Luck
Controllable	Typical Effort	Immediate Effort	Teacher Bias	Unusual Help from Others

the necessary distinction between "control" and "causality" but uses both concepts interchangably. Rotter's locus of control collapses the causality and controllability dimension into a single dimension. The dinstinction between the two concepts can be illustrated by considering "control" versus "cause" of a negative event. Control addresses the question of whether the person has the power to change the negative event: Is it within his or her power to control the event? On the other hand, "causality" addresses the issue of whether the subject caused the event or not: Was the cause of the event internal or external? Some events may be causally attributed to either one or both controllable and internal causes.

Weiner proposes that causes along each dimension of causality serve a particular purpose. Locus of causality is related to self-esteem related affects. Ascriptions along the stability dimension corresponds to degree of expectancy change for future success. And the controllability dimension relates to the perceiver's attributional evaluation of others (Weiner, 1985).

For the purposes of the present study, only the two dimensions which were offered in the original presentation of ATAM (Weiner et al., 1971) will be utilized. Judgments of causality along these two dimensions, locus of causality and stability, differentially affect intrapersonal evaluation (Weiner, 1985). The present study shall focus on an individual's causal attributions to himself or herself, or intrapersonal evaluation, thereby focusing on attributions regarding self-perception which are addressed by the locus of causality and stability dimensions. Although the importance of also examining a person's attributions to others has been documented (Frieze, Fisher, Hanusa, & Valle, 1978).

The third dimension, controllability, mediates attributional evaluation of others, which is not addressed here. Although many additional causal categories have been suggested (Weiner, 1979) and generated by research (Frieze, 1976), general consensus (Bar-Tal, 1978; Weiner, 1976; Weiner et al., 1971) and empirical evidence (Freize, 1976) support the use of the locus of causality and stability dimensions as those which generate the most explanatory power. It is important to utilize these dimensions as Valle and Frieze (1976) found that both the locus of causality dimension and the stability dimension affect future estimates of global success or failure and the degree rating of success or failure. A 2x2 summary table of

Weiner's original causal categories is presented (Table 2).

According to Weiner, individuals may use one or many causal categories to evaluate a given outcome event. In the original presentation of ATAM (Weiner et al., 1971) as reworded by Weiner (1979) the authors

> postulated that in achievement-related contexts the causes perceived as most responsible for success and failure are ability, effort, task difficulty, and luck. That is, in attempting to explain prior success or failure for an achievement-related event, the individual assesses his or her ability, the amount of effort that was expended, the difficulty of the task, and the magnitude and direction of the experienced luck. (The authors) ...assumed that rather general values are assigned to these factors and that the task outcome is differentially ascribed to the causal sources. (Weiner, 1979, p. 4)

The four causal categories mentioned above, which will be assessed in the present study, may be classified according to the pair of dimensional attributes which characterize each: ability is an internal, stable cause; effort is an internal, unstable cause; task is an external, stable cause; and luck is an external, unstable cause (see Table 2).

The number of causal categories used to explain a given outcome is dependent on the expectancy (Atkinson, 1964) of that outcome. "In sum, when performance outcomes are uncommon (unexpected), attributions tend to include multiple causes; when performance outcomes are

Table 2

Attribution Theory of Achievement Motivation:

Original Causal Dimensions and Causal Categories

	Locus of Causality	
Stability	Internal	External
Stable	Ability	Task
Unstable	Effort	Luck/Environment

common (expected), attributions are made to only one cause" (Weiner, 1985, p. 342; parentheses added). For example, when a person expects to fail at a given task, Atkinson proposes that the person will tend to use several causes such as ability, effort and luck to explain the outcome. When a person anticipates success, Atkinson theorizes that the person will attribute the outcome to one causes such as ability.

Not only does the number of causes used vary, the frequency with which a cause is used also varies. Individuals, according to Weiner (1985), are predisposed to use certain attributional categories more heavily than others. There is a degree of flexibility within the attribution framework to understand individual differences in the use of causal attributions. Investigations in this area have grouped individuals, particularly by sex, to study the differential use of causal attributions, reasons for differential use, and consequences of differential use for each group. Investigations of this sort will be discussed in greater detail below.

In addition to using multiple causal categories, individuals use multiple cues to reach causal inferences (Weiner, 1972; Weiner, 1985; Weiner et al., 1971). The antecedents, or cues, used to infer attributions of causality include number and percent of prior successes and failures, pattern of performance, primacy and recentness effects, social norms, maximum level of performance, time spent at the task, and covariation of the outcomes with performance incentives.

More specifically, ability attributions are made dependent on the "degree of the past success at that and similar tasks" (Weiner et al., 1971, p. 5) Thus, the consistency and generality of performance are important cues regarding ability attributions. Comparisons to others or groups of others and the maximum performance level achieved, which indicates peak capabilities, are also important cues regarding ability attributions. Effort attributions are dependent on cues such as muscular tension, task persistence, and pattern of performance (increased attribution to effort when performance improves over time). But effort is most often a post-hoc attribution made after the outcome is known (Weiner, 1985; Weiner et al., 1971). Attributions to task difficulty are "inferred from social norms indicating the performance of others at the task" (Weiner et al., 1971, p. 5). If many succeed, the task is thought to be easy. If many fail, it is assumed to be difficult. More minor cues for attributions to task difficulty are characteristics of the task, such as length complexity and novelty (Weiner, 1985). Finally, attributions to luck are "inferred from the pattern of prior reinforcements: the more random or variable in pattern of outcomes, the higher the probability that luck will be perceived as a causal influence" (Weiner et al., 1971, p. 5). Other cues used to make luck attributions include the type of task and prior unique events salient to the person (Weiner, 1985).

Causality and Affective Reactions

Early writings on ATAM hypothesized the importance of the dimensions of locus of causality and stability in understanding the consequences of making a particular causal attribution. Specifically, it was hypothesized that attributions along the locus of causality dimension influence affective reactions of the person to goal attainment, and the attributions made along the stability dimension influence the person's expectancy for future change (Weiner, 1974). Correlates of the stability dimension will be addressed shortly.

Weiner's hypothesis concerning affective reactions to goal attainment corresponding to causal categories is grounded in Atkinson's proposed general dispositions: to seek success for the purpose of generating pride, and to avoid failure so one avoids shame that would be generated by failing (Atkinson, 1964). Atkinson also hypothesized that one takes greater pride in the accomplishment of a difficult task than an easy one, and one experiences greater shame at failing at an easy task than at a difficult one (Atkinson, 1964). Shame and pride were considered the dominant affects in achievement-related situations (Atkinson, 1964; McClelland, Atkinson, Clark, & Lowell, 1953).

Therefore, Weiner's and Atkinson's original hypotheses proposed affective reactions to goal attainment were dependent on whether the attributional cause used was an internal or an external one. Emotional reactions were assumed to be strongest given internal or self-esteem related attributions and weakest given external reactions (Weiner, 1979; Weiner, Russell, & Lerman, 1978). But, empirically the proposed degree of strength or weakness of reaction along the internal-external dimension and the pride-shame emotional dichotomy is unsupported (Weiner, 1977). Instead, a variety of emotions can result from causal attributions and these emotions result from ascriptions to each of the four causal categories (Weiner, Russell, & Lerman, 1978). Therefore, the locus of causality is not considered a moderator variable for affective reactions, but instead emotions relate more directly to each causal category in a unique way (Weiner, 1979; Weiner, Russell, & Lerman, 1978).

Research in this area asked subjects to generate a free-response list of potential affective responses to success and failure events (Frieze, 1976). Subsequently, subjects were asked to report the affective intensity of each response that would be experienced in a given success or failure situation (Weiner, Russell, & Lerman, 1978). The findings, which have been integrated into more recent writings on ATAM (Weiner, 1985), are threefold.

First, outcome of the task mediates an overall positive or negative emotional reaction. Success results in positive or "good" feelings, while failure results in negative or "bad" feelings.

Secondly, distinct emotions are most frequently paired with each causal category. For instance, a success attribution to ability elicits foremost a feeling of worth; whereas a success attribution to luck results mostly in surprise. (See Weiner, 1985 for a complete list.)

Finally, the causality dimension does play a role in mediating self-ascriptions or self-esteem related affects (internal versus external attributions), and thereby attaches a "pride" or "shame" emotional component to the emotional reactions described above.

Empirical evidence generated by others has supported Weiner's more recent proposition and has found that success, especially on difficult tasks, leads to positive affective responses; and failures, especially on easy tasks, leads to negative affective response (Ruble, Parsons, & Ross, 1976). Therefore, Atkinson's (1964) hypothesis concerning the amount of affective reaction to a success versus a failure at a difficult or easy task is partially supported. However, instead of considering pride and shame as the dominant emotions experienced, a more careful consideration of each causal category as well as the outcome is necessary to determine the type of affect(s) most likely to be expericed.

Causality and Expectancies

Weiner hypothesized that the dimension of stability plays a crucial role in determining a person's expectancy for success or failure. The cognitive reactions to a task, in the form of post-dictive attributions for an outcome, relate to the direction and the magnitude of expectancy change (Weiner, 1974; Weiner, 1976) to the degree to which the outcome is attributed to a stable cause versus an unstable cause. Theorists have argued (Phares, 1957;

Weiner, 1972; Weiner, 1976) that as the degree of attribution to a stable factor increases after success, the expectancy of future success increases. For example, as a person increases his or her attribution to ability or task difficulty following a successful outcome, his or her future expectancy for success will increase. Likewise, as the degree of attribution to an unstable factor after failure increases, the expectancy for future success also increases because this pattern leaves one's positive self-perception of ability intact (Merton, 1946). The person is able to disregard the failure outcome as a fluke event, and continue to anticipate the chance for a future success.

Therefore, a subject's expectancy for future change is strongest when one attributes an outcome to an unstable cause such as effort or luck. Effort and luck operate uncertainly at any point in time, so that for future events one may more easily exert more effort or one's luck may improve. It is less likely that one would be able to change ability at a task or make a given task easier. Since ability and the task difficulty are less likely to change over time, one has lower expectancies for change in these stable areas (Bar-Tal, 1978). These hypotheses have been verified by numerous empirical studies (McMahan, 1973; Ostrove, 1978; Rest, Nierenberg, Weiner, & Heckhausen, 1973; Weiner, Heckhausen, Meyer, & Cook, 1972; Weiner & Kukla, 1970; Weiner, Nierenberg, & Goldstein, 1976).

Causal attributions are viewed as partially determining an individual's affective experience, cognitive representations of future expectancies and behavioral reactions to a success or failure experience on an achievement-related task (Weiner et al, 1971). Attributions are expected to systematically relate to several major areas of one's functioning including affective reactions and cognitive reactions such as expectancies for future performance. Also related are behavioral consequences such as performance intensity, which is dependent on attributions along the stability dimension, and task persistence, which relates to attributions along the causality dimension (Dweck, Davidson, Nielson, & Enna, 1978). Weiner (1985) presents the above relationship as a type of a chain reaction in which attributions affect expectancies and emotions, which in turn, affect choice of, intensity of, and persistence of behavior.

Empirical evidence supports these hypotheses (Feather, 1969; Feather & Simon, 1971; Rest, 1976; Weiner et al., 1978; Lawrence & Festinger, 1962) and suggests attributions are related to actual subsequent achievement levels for laboratory and field tasks (Dweck, Davidson, Nelson, & Enna, 1978; Dweck & Repucci, 1973; Weiner, Heckhausen, Meyer, & Cook, 1972), and to continued course taking in mathematics (Pedro, Wolleat, Fennema, & Becker, 1981).

Research in the area of causal attributions to success or failure has found the effect of the task outcome on causal attributions to be a salient factor, thus confirming the post-dictive as well as pre-dictive nature of attributions (Weiner, 1985). Students who succeed at a task generally attribute causality for this outcome largely to internal cues such as ability and effort, while students who fail attribute causality largely to external cues such as luck and task difficulty (Arkin & Maruyama, 1979; Sweeney, Moreland, & Gruber, 1982). This issue shall be addressed in the present paper.

Attribution Theory of Achievement Motivation has been applied to a wide variety of achievement areas and cognitive abilities including mathematical ability (Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983; Eccles, Adler, & Meece, 1984; Leder, 1982, cited in Leder, 1984; Parsons, Meece, Adler, & Kaczala, 1982; Pedro, Wolleat, Fennema, & Becker, 1981; Wolleat, Pedro, Becker, & Fennema, 1980). ATAM has also been applied to other aspects of behavior such as depression, loneliness and affiliation, hyperactivity, mastery and parole decisions (Weiner, 1979).

ATAM is particularly applicable to the issue of sex differences (and racial differences; see Katz, 1967 for discussion) in specific cognitive abilities. ATAM provides an example of "how characteristics other than cognitive skills may affect an individual's performance on achievement tasks" (Bar-Tal, 1978; p. 266). "Females and individuals with certain causal perceptions may perform below their abilities because of their maladaptive patterns of attributions" (Bar-Tal, 1978, p. 267). The maladaptive patterns of attributions potentially adversely affect expectancies, emotional experiences, and behaviors which all appear to correlate with success experiences.

Perhaps investigating attributional patterns will be useful in further exploring the ways in which women and men differentially ascribe causality for success and failure experiences in the area of mathematics. By narrowing the focus of the present study to a specific task, mathematics in a noncompetitive setting, generalizability of the findings to other tasks will be limited. But these limitations are necessary because factors such as sex-role appropriations of the task

(McHugh, Fisher, & Frieze, 1982), the competitiveness of the setting (Teglasi, 1977), and the type of task (Levine & Uleman, 1979) have been shown to relate to sex differences in attributional patterns.

<u>ATAM and Sex Differences</u>

Causal attributions for one's success or failure is one of the three major areas cognitively oriented research has focused on to understand sex differences in achievement behavior (Frieze, Fisher, Hanusa, McHugh, & Valle, 1978; Frieze, Parsons, Johnson, Ruble, & Zellman, 1978). The other major areas of research include the study of differential motives and values and differential definitions of success between males and females. Generally, degree and direction of attributions for personal success or failure, as well as attributions made by an observer to an actor, are expected to differ depending on the sex of the person to whom the attributions apply (the self or the actor). Also, sex differences in attributional patterns are expected to be even more pronounced if the task is sex-typed, as is mathematics (Wolleat, Pedro, Becker, & Fennema, 1980).

However, because the authors of ATAM have not articulated specific predictions concerning sex differences in causal attributions for achievement-oriented tasks, the result has been two-fold. First, researchers have generated several models based on Weiner et al.'s (1971) original conceptualization while also drawing on other more general theories of behavior and sex differences. These models, in turn, have specified more exact hypotheses concerning sex differences in achievement behavior including actual acievement, course taking behavior, and expectancies for future performance (Dweck et al., 1978; Dweck, & Repucci, 1973; Fontaine, 1974; McMahan, 1973; Ostrove, 1978; Valle & Frieze, 1976; Weiner, 1972a; Weiner, Niernberg, & Goldstein, 1976).

Yet, researchers in this area have not compared the predictive power of the models, nor have they consistently specified predictions for each of the four causal categories within any given model. Instead research has often made predictions for sex differences occurring in one or two of the cells depicted in Table 2, but has ignored the remaining cells, the higher-order dimensions of causality and their correlates.

Nicholls (1975) said more than ten years ago that "previous studies of causal judgments after success and failure do not all make the joint distinction between internal-external and stable-unstable causes" (p. 387), but little note was taken. Many years and publications later, few papers have presented the three models and subjected all three to empirical verification. This study will present the three major models, and attempt to empirically test their predictions.

Three Models for Predicting Sex Differences in Causal Attributions

EXTERNALITY MODEL

This model contends that women tend to make external attributions for both success and failure, while men tend to make internal attributions for both events. Several versions of the Externality model offer different explanations, yet make the same predictions, and therefore are merged under the Externality label (Table 3).

Horner's (1969) conceptions of "fear of success" and "fear of failure" are used to explain women's withdrawl from achievement situations. The "fears" are motivational forces that interact with conceptions of one's sex role. Particularly feminine identified females may be more motivated to avoid success because of the possible negative consequences (e.g. male disapproval) of doing as well or better than a male on a task (Simon & Feather, 1973). Following withdrawl from achievement situations, it is hypothesized that women lose touch with the internal causes that correlate with their

Table 3

Hypotheses from Three Models concerning Causal Attributions for Success and Failure by Sex

	Task Outcome Success			
Model	Ability	Effort	Task	Luck
Externality				
females	Low	Low	High	High
males	High	High	Low	Low
Self-Derogatory				
females	Low	Low	High	High
males	High	High	Low	Low
Low Expectancy				
females	Low	High	Low	High
males	High	Low	High	Low

	Task Outcome Success			
Model	Ability	Effort	Task	Luck
Externality				
females	Low	Low	High	High
males	High	High	Low	Low
Self-Derogatory				
females	High	High	Low	Low
males	Low	Low	High	High
Low Expectancy				
females	High	Low	High	Low
males	Low	High	Low	High

subsequent successes and failures. Women rely solely on external cues to determine where they may attribute causality (Deaux, 1976; Feather, 1969; Simon & Feather, 1973). In other words, the model suggests women depend on an external locus of causality to mediate judgments of causality. They attribute any outcome, whether success or failure, to the luck and/or task difficulty causal categories.

A second source for hypotheses that fall under the Externality Model originate from a sociological perspective. Women and other low-status groups, such as racial minorities, tend to perceive that they have less control over outcomes, and probably do have less control in some instances, than higher-status males and other high-status groups. The cumulative effect of continually perceiving and experiencing lessened control gives them the expectation and experience of attributing causality for both successes and failures to external forces (Merton, 1968; Wiley, Crittenden, & Birg, 1979). As a result of making this pattern of causal attributions for success and failure, "past performance does not provide a basis for generalization to future trials since S [the subject] is not the effective agent in obtaining reinforcements" (Phares, 1957, p.341). The person ascribing causality in an external manner perceives him- or herself at the mercy of environmental influences.

Sweeney, Moreland, and Gruber (1982) have argued that the characterization of women as external is not as important as the portrayl of men and objectively successful women as internally determined. Their argument for the "internality bias" among men relates this pattern of attributions to the need for internal control of outcomes as part of the male sex role.

Empirical support for the Externality model has been mixed. In operationalizing the model many researchers neglected to include hypotheses for all four causal categories (e.g., Deaux, 1976; Deaux & Farris, 1977, experiment 1; Feather & Simon, 1973; Phares, 1957; Wiley et al., 1979). The latter only make predictions for the causal categories of ability and luck: males or those with higher general control attribute causality to ability (internal-stable) more often than women; women or those with low general control attribute causality to luck (external-unstable) more often than men. Support for the predictions concerning the ability and luck causal categories has been fairly consistent and confirmatory.

Despite the lack of consistency in testing the Externality model, several studies do provide a starting point for evaluating the model's predictions for all four causal categories. Feather (1969), Simon and Feather (1973), and Wiley et al. (1979) report that females make higher attributions to external factors than males regardless of the task outcome, and that males utilize the internal attribution categories more often than do females. Additional support for the Externality model can be found by examining the mean attributional ratings by sex in studies that do not test all of the hypotheses generated by the models. This process yields varying degrees of support for the Externality model (Bar-Tal & Darom, 1979; Bar-Tal & Frieze, 1977; Deaux & Farris, 1977; McArthur, 1976).

SELF-DEROGATORY MODEL

The Self-Derogatory model, as it shall be referred to in the present paper, has appeared under multiple labels in the Attribution Theory literature. It has also been termed Learned Helplessness (Diener & Dweck, 1978; Dweck & Bush, 1976; Dweck, Davidson, Nelson, & Enna, 1978; Dweck & Gotez, 1978; Dweck & Reppucci, 1973; Wolleat et al., 1980), Self-Defeating (Heilman & Kram, 1978), and Attributional Egotism in referrence to male's attributional style (Forsyth & Schlenker, 1977; Snyder, Stephan, & Rosenfield, & Stephan, 1976).

This model assumes women tend to be lower in amount of self-esteem than men, and thus attribute failure to internal characteristics of themselves in a self-derogatory manner. Females attribute success to external causes such as an easy task and good luck while males display this attributional pattern in response to failures. "Causal Attributions of males tend to resemble those of high self-esteem subjects, whereas the responses of females on the same measures resemble those of low eslf-esteem subjects" (Ickes, & Layden, 1978, p.124).

Therefore, the model proposes women take personal responsibility for a failure, but they do not take any credit for a success (Crandall, Katkowsky, & Crandall, 1965; Forsyth & Schlenker, 1977; Frieze, Fisher, Hanusa, McHugh, & Valle, 1978(a); Ickes & Layden, 1978; Levine, Gillman, & Reis, 1982; Nicholls, 1975). Women "see themselves as responsible only for negative, not for positive, performance outcomes" (Heilman & Kram, 1978, p.497). Given the actual equivalence of males and females in many achievement-related tendencies (Maccoby, & Jacklin, 1974), one would expect females to learn to respect their abilities and efforts once they have the opportunity to experience success (Heilman & Kram, 1978). But this is not the case according to the Self-Derogatory model.

For women their attributional style "perpetuates a self-fulfilling cycle of negative self-regard" (Heilman & Kram, 1978, p. 498) because it dismisses any favorable information and embraces personal responsibility for negative information.

Men, who generally report higher levels of self-esteem for achievement tasks (Snyder, Stephan, & Rosenfield, 1976; Frieze et al., 1978a), are hypothesized to exhibit the opposite pattern of causal attributions (Heilman & Kram, 1978; Ickes & Layden, 1978) (see Table 3). This pattern has been termed a self-serving bias (Arkin & Marvyama, 1979), self-enhancing (Levine & Gillman, 1982) and egotistical (Stephan et al., 1976; Snyder et al., 1978). Egocentric attributions, as those made by males, have been "interpreted as evidence for a self-serving motivational bias which functions to protect self-esteem and/or the self-perception process" (Forsyth & Schlenker, 1977, p. 215-216) by attributing success (an expected outcome) to internal factors and failure (unexpected) to external factors. The motivation bias is a need to maintain the best possible image of oneself (Snyder et al., 1978).

Levine et al. (1982) have explicated the process by which the self-enhancing bias operates for men:

> It is assumed that such a cognitive bias will allow the individual to incorporate favorable information and exclude unfavorable information from his or her self-concept ... (while) a self-derogatory bias would lead to exactly the opposite pattern - greater attribution of success to external and failure to internal causes. In this manner, positive cognitions are excluded from the self-concept, while negative information is incorporated. (p. 455-456)

Results of the proposed attributional styles for males and females indicate several potential outcomes. First, if females attribute failure internally, the result will be decreased motivation following failure which interferes with actual task performance (Ickes & Layden, 1978).

Secondly, the consequences of this attributional pattern on self-referent affects should be considered more closely. Failure experiences tend to reinforce feelings of low self-esteem, whereas successful experiences will tend to reinforce feelings of high self-esteem (Fitch, 1970). High and low self-esteem related to task performance might be better termed self-efficacy (Bandura, 1977) or a person's estimate of how well he or she can perform a given task. Levine and Uleman (1979) recommend thinking of self-esteem within this model in terms of the specific task. Women will tend to perpetuate their low self-efficacy for a task by attributing success to external factors. They, therefore, avoid positive feelings about their accomplishments and do not increase self-efficacy. But women do experience negative self-evaluative feelings for their failures and decrease self-efficacy after a failure (Arkin & Marvyama, 1979; Atkinson, 1964).

Empirical support for the Self-Derogatory model has also been mixed. As is the case with empirical evidence for the Externality model, researchers do not always evaluate all four causal categories in the analysis of their data. However, Stephan et al. (1976) found empirical support for both a self-derogatory attributional pattern among female subjects and an egotistical attributional patern among the males. Snyder et al. (1976) also found an egotistical pattern among males, but found the pattern for females was dependent on the sex of their partner. Females produced the expected attributional pattern when paired with a male partner, but an egotistial pattern resulted when they were paired with another female.

Contridictory to predictions made by the Self-Derogatory model, Feather (1969) reports that actual measures of self-esteem did not predict attributional rating.

LOW EXPECTANCY MODEL

The third major model to be presented assumes that females generally have lower expectancies for success than men at achievement-related tasks. The Low Expectancy model hypothesizes females will tend to predict they will not succeed, and they will consistently expect a low level of performance. Therefore, when success is experienced, it will be seen as an unstable, fluke event. Failure will confirm the low expectancy and reinforce failure attributions to stable causal categories (Fennema, Reyes, Perl, Konsin, & Drakensberg, 1980; Frieze et al., 1978a; McMahan, 1973; Pedro, Wolleat, Fennema, & Becker, 1981; Valle & Frieze, 1976; Weiner, 1976; Wolleat et al., 1980). "Failure, being more consistent with females' expectations, will receive the stable attributions of causality, ability and task difficulty" (Deaux, 1976, p. 358).

By discounting success and considering failure as indicating stable attributes, females prevent raising their expectations for future tasks and actually lower these expectations.

> A person who is initially expected to do poorly (whether because of race, age, sex, or lack of education) will find it difficult to change these low expectations. If the individual is successful,

> this will be attributed to unstable traits and will have little influence on later expectations (Valle & Frieze, 1976, p. 586) (see Table 3).

Empirical evidence for the Low Expectancy model includes the work of a variety of authors (Bond & Deming, 1982; Deaux, 1976; Leder, 1984; McMahan, 1973; Parsons et al., 1982; Weigers & Frieze, 1977; Wolleat et al., 1980). As with the preceding two models, many of the researchers did not make hypotheses concerning all four causal categories or report their results in terms of the categories and the two dimensions which superpose the causes.

The Low Expectancy model may prove to be particularly salient for studying sex differences on a stereotypical masculine task, such as math, as it has been suggested that women have exaggeratedly low expectancies for these tasks (Deaux, 1976).

Meta-Analysis and Methodological Issues

To assess which of these models is best supported by existing empirical data Frieze, Whitley, Hanusa, and McHugh (1982) performed a meta-analysis on 19 studies which assessed sex differences in causal ratings for success and failure experiences. The sample was limited to those studies using adolescent and adult subjects. Overall, the meta-analysis found few consistent sex differences. When women succeed they are more likely than men to see the task as easy (an external, stable attribution). Regardless of outcome (success or failure) men view themselves as possessing more ability than women, and men are less likely to say luck was responsible for an outcome than women.

Yet, several potentially critical variables and a set of hypotheses were not addressed in the meta-analysis. First, the sex-type of the task was not considered when performing the meta-analysis, although this is a potentially critical variable in the study of sex differences in causal attributions research (Frieze et al., 1982). Eccles et al. (1984) point out that more consistent differences may emerge if investigations would focus on sex-typed tasks such as mathematics and English because sex differences in causal attributions are strongest for sex-typed achievement tasks. Only a few studies have looked at sex differences in causal attributions for math tasks (e.g., Parsons, Meece, Adler, & Kaczala, 1982) despite these precautionary statements.

Secondly, only studies which utilized adult and adolescent subjects were included in the meta-analysis, despite empirical evidence that attributional patterns are established fairly early. Bond and Deming (1982) conclude from their research that "different attributional patterns for explaining male and female performance appear well established by seven-eight years of age and remain strikingly stable through development" (p. 1205).

Finally, no predictions were made for men's attributional patterns although the models do specify such patterns (see Table 3).

More recent studies focusing on sex differences in causal attributions for success and failure in mathematics have produced mixed results and have failed to plan a test of all three models presented here: Externality, Self-Derogatory, and Low Expectancy. For example, Eccles et al.'s (1984) conclusions support both the Self-Derogatory and Low Expectancy models, but makes no test of the dissimilar predictions made by the models. Leder's (1984) results most closely conform to the predictions made by the Low Expectancy model, but again, no analyses aimed at testing the complete model are made.

Several minor, but potentially critical, components have been lacking in past studies applying Attribution Theory to sex differences in mathematics ability. Eccles (1984) points out the need for studies on school specific areas and achievement tasks presented in naturalistic settings to increase external validity of experimental findings. Also, there has been little consistency in the type of attributional measuring device used. In their meta-analysis of this area, Frieze et al. (1982) separated studies using "causal" wording from those using "informational" wording. The Mathematics Attribution Scale (MAS) (Wolleat, Pedro, Becker, & Fennema, 1980), a step in remedying inconsistencies which utilizes informational wording, has published norms for adolescents and has been used in several investigations (Leder, 1982; Pedro, Wolleat, Fennema, & Becker, 1981).

The sex of the experimenter, although this variable has been shown to have a significant effect on sex differentiated performance on experimental tasks (Harris, 1971), particularly when a mathematics task is the performance measure (Pedersen, Shinedling, & Johnson, 1968), has not been controlled, manipulated, or even reported in much of the research in this area.

Competitiveness and cooperativeness of the task performance setting has been found to influence attributional patterns for males and females and the findings from these studies to date seems to generalize to other settings (McHugh, Frieze, & Hanusa, 1982). However, settings that require neither competetiveness nor cooperativeness between pairmates are needed in the area of attribution research for sex differences in achievement motivation (Teglasi, 1977). Also, prompting attributional statements by measuring them before the experimental task will not be utilized in the present study, as it has been hypothesized to differentially affect male and female attributional statements when measured following task feedback (Fitch, 1970). Finally, a limited use of minority subjects has hindered the generalizability of past research efforts (Frieze, Fisher, Hanusa, McHugh, & Valle, 1978).

A formal exposition of the three models presented and the hypotheses the models generate has been very limited in the research literature on sex differences in causal attributions for achievement tasks. (Frieze et al., 1982). A planned investigation of the interpretations of Weiner's Attribution Theory of Achievement Motivation to sex differences in mathematics (and other sex stereotyped tasks) would be a valuable contribution to the research literature in this area.

The present study attempts to partially fill this gap by comparing and contrasting the three models in the limited achievement/cognitive area of mathematical ability, and by addressing the methodological flaws of past studies as is possible within the scope of the present project.

METHOD

Subjects

The subjects were 63 undergraduate students enrolled in Introductory Psychology at a mid-sized Catholic University, located in a major U.S. city. Subjects volunteered for the experiment in exchange for course credit. Subjects were 34 females and 29 males. Their mean age was 18.83 years, with a range of 17 to 22 years. Fourty-seven subjects were White, 11 were Black, three were Asian, and two were Hispanic. There were no significant differences between the age or ethnicity of male and female subjects. Subjects had a mean of 3.52 years of high school mathematics and .71 semesters of college mathematics. There were no significant sex differences on the two measures of mathematics course-taking behavior, although male subjects consistently reported taking more math in high school and in college than female subjects.

Task

Subjects were informed that the purpose of the study is to assess the math and verbal abilities of college students. They were asked to complete the math and spelling sections of the Wide Range Achievement test (WRAT) (1979). This assessment tool is used widely in educational and vocational counseling settings to classify subjects according to grade level of achievement (kindergarten through a grade 20 achievement level) in each area assessed. Subjects are given ten minutes to complete the math subtest while completion of the orally administered spelling test varies. The WRAT, as it was administered in the present study, is considered a noncompetitive, as well as noncooperative, task. Task performance, scoring, and task outcome are all individual, and are not dependent on other subjects.

Independent Variables

An approximately equal number of male and female subjects were recruited for the experiment. Males and females were randomly assigned to the two levels of the second independent variable (success and failure) described below.

There was one manipulated independent variable: success or failure feedback on the math test. Success was arbitrarily defined as ten points above the national average of college students taking this test, while failure was defined as ten points below the national average of college students. All subjects received neutral feedback (within the average expected range of college students taking this test) for the spelling test.

The decision to give false test feedback to subjects was made to control for the selection threat to internal validity (Cook & Campbell, 1979) as when essentially different pre-existing groups, such as males and females, receive different experimental treatments, such as success or failure feedback on a test. Since males consistently outperform females on measures of mathematical achievement, a pre-existing difference between the groups is operating. Without randomized subject assignment, relatively more females would receive failure feedback and relatively more males would receive success feedback.

A third potential independent variable, sex of the experimenter, was controlled by using a male-female co-experimenter team. Future research in this area needs to manipulate this variable to partial out each independent variable's effects (Harris, 1971; Pedersen, Shinedling, & Johnson, 1968). However, this manipulation was beyond the scope of the present study.

Dependent Variable Measures

The subject's causal attribution statements, the dependent variable, was measured by a modified version of the Mathematics Attribution Scale (MAS) (Fennema, Wolleat, & Pedro, 1982) after receiving false performance feedback.

The MAS, a five-point Likert scale, was designed for use with high school students to measure their causal attributions to success and failure experiences in mathematics. Algebra and geometry were chosen as representative high school mathematics courses. Two versions of the test were developed, one for each of these subjects. The MAS is comprised of eight subscales, one for each attributional causal category paired with success or failure events. It is a unique attribution instrument in several ways. First, by treating attributions to success and failure events as independent, the MAS is able to assess the attributional categories separately for success and failure. Secondly, the MAS renames the "luck" causal category in ATAM. It's new name, "environment", was chosen as a more appropriate name covering "the wider range of unstable, external attributions" (Wolleat et al., 1980, p. 359) that have been classified as fitting in this category by empirical data (Frieze, 1976; Wolleat et al., 1980) (see Table 2). See Appendix A for the version of the MAS used in the present study.

> Scores for the eight attribution subscales are obtained by summing each of the four categories of attribution statements across Success event stems and doing the same for the Failure stems. Subscale scores can range from four to 20. There is no meaningful overall score. Reliability coefficients obtained ... on the MAS subscales via the Cronbach alpha technique were Success-Ability=.77; Success-

Effort=.79; Success-Task=.39; Success-Environment=.48; Failure-Ability=.63; Failure-Effort=.66; Failure-Task=.48; and Failure-Environment=.48
(Wolleat et al., 1980, p. 359).

The MAS was modified slightly for use in the present study according to Fennema et al.'s (1982) instructions for modification. Reference is made to a generic math task versus the specified subjects of algebra and geometry to accomodate subjects who have a varied background in math. Also, wording of the causal statements was altered slightly to make the scale consistent with assessment of a single testing time versus assessment of performance over a longer period of time, such as a semester (see Appendix A).

The MAS and the modified version used here allows subjects to attribute causality for both success and failure outcomes to four possible causal sources: ability, effort, task and luck. These causal sources lie on two dimensions, stability and locus of causality, as illustrated in Table 2. No restriction on responses was made because Weiner (1985) suggests subjects use a varying number of attributional categories to explain an event. Although preceding studies have restricted responses to conform to the reciprocal nature of within-person and outside-person causal attributions (Fitch, 1970) as specified by Heider's (1958) theory.

Design

The design of the experiment conforms to a 2 (individual feedback: success vs. failure) by 2 (sex of the subject: female vs. male) factorial design. The total design consists of four experimental conditions with approximately 15 subjects per cell (17 females in each of the success and failure task outcome conditions, 15 males in the success outcome condition, and 14 males in the failure outcome condition). Random assignment to experimental groups was achieved by assigning subjects to the success or failure conditions alternately for each sex. Specifically, subjects were assigned an identification number upon arrival to the experimental sessions. Females were given numbers one through 10, 21-30, and 41-50. Males were given numbers 11-20, 31-40, and 51-60. All odd-numbered subjects were assigned to the failure condition, and even numbered subjects to the success condition. Therefore, the only experimentally determined component of the randomization process was the placement of the first two subjects of each sex in the failure or success conditions, with the first subjects for each sex (failure condition) arriving to the experimental session before the second subjects (success condition). Thereafter, half of the success condition subjects arrived before the other half of the success condition subjects for any experimental session. The same process was in effect for the failure condition subjects. Finally, no limitation (minimum or maximum) was put on the number of or sex of the subjects who signed up for each experimental session. Therefore, after the first experimental session, the alternate assignment process to success or failure conditions continued where the preceeding session left off. Subject assignment for second, third, etc. sessions was constrained only by the number of and sex of the subjects in previous sessions, and was not experimentally manipulated.

Subjects were tested in groups over the course of the college semester. The experimental setting utilized was a typical college classroom adjacent to currently used classrooms in an effort to increase the external validity of any experimental findings by conducting the experiment in a naturalistic setting for an achievement task (Eccles, 1984).

Procedure

Subjects were introduced to the experimental procedure with a brief oral description of the experiment. Subjects were informed that the purpose of the study was to assess the math and English abilities of college students in light of the recent concern over the decline in these scores over all age groups. They then completed the math and spelling sections of the WRAT, which contains 55 and 46 items respectively. Subjects were asked to fill out several questionnaires which served as filler tasks while one experimenter prepared the test feedback. Following completion of the questionnaires, the experimenters provided feedback for each individual's performance on both portions of the WRAT. Feedback was expressed in relation to a national average of college students. Subjects then filled out an adaptation of the MAS, providing a measure of causal attributions.

Finally, the subjects were completely debriefed, both orally and in written form. The nature of the deception was explained and they were assured that the feedback they received in no way reflected their actual performance. Any questions were answered at this time, and the author of this paper encouraged subjects to contact her if they had any questions, concerns, comments or interests in the study. No such contacts were made, so it is assumed that no lasting negative effects resulted from the experimental manipulation of the success and failure feedback.

RESULTS

Before the analyses of the dependent measures used to test the hypotheses are discussed, several points of clarification and preliminary analyses will be presented.

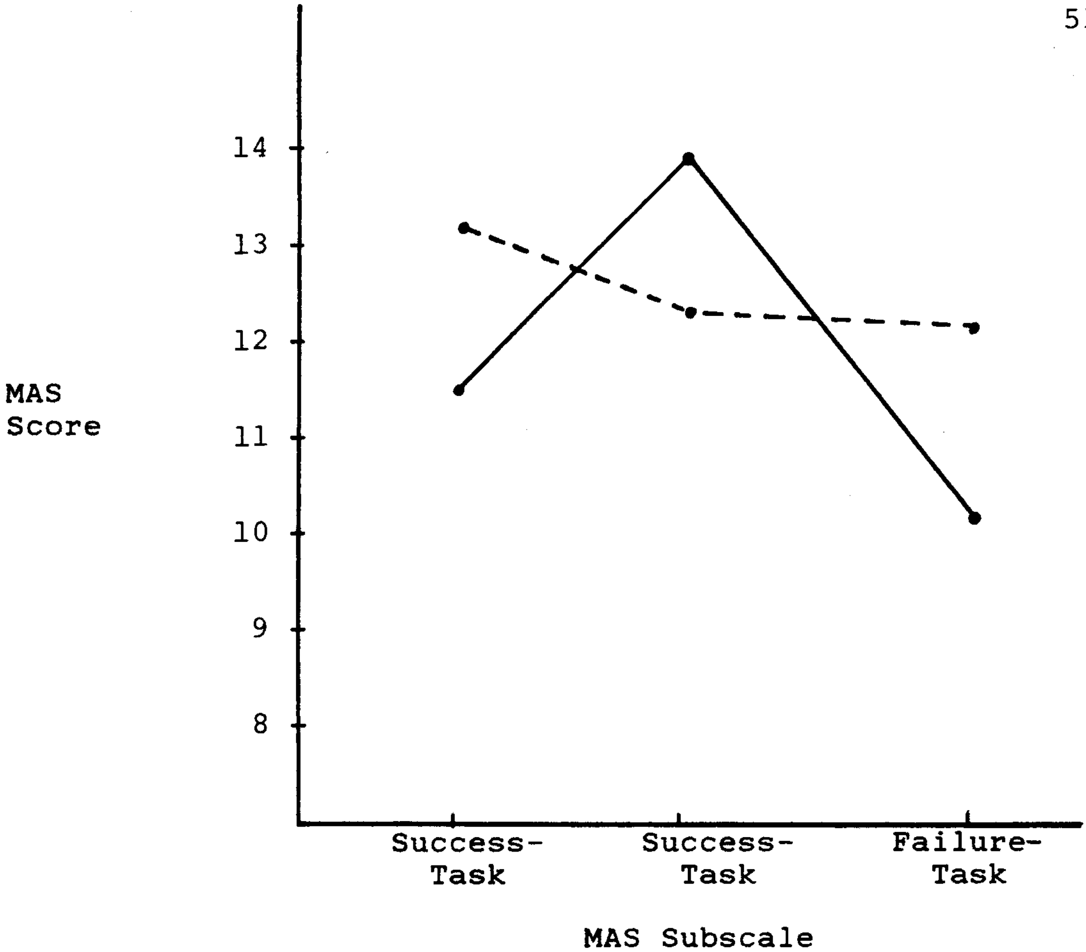
The eight dependent measures, Success-Ability, Success-Effort, Success-Task, Success-Environment, Failure-Ability, Failure-Effort, Failure-Task, Failure-Environment, subscales of the MAS, each produce scores that may range from four to 20. A score of four represents strong disagreement that the particular causal category being rated had an influence on the corresponding success or failure as described in each item's scenario. A score of 20 indicates strong agreement that the particular category was an influence on the task outcome depicted. A sample MAS is included in Appendix A. The actual range of scores is listed in Table 4, along with the means and standard deviations for these variables by sex of the subject.

As a check of random assignment to groups for the success or failure manipulated task outcome, a one-way analysis of variance was conducted on the task outcome variable (success or failure determined by random assignment to groups) and the actual (undisclosed) WRAT math score. There was no effect of group placement by actual math achievement as measured by the WRAT, $F(1,61)=1.57$, $p > .05$, therefore, random assignment to groups according to mathematics achievement level is supported.

Before discussing the findings regarding the hypotheses tested, it should be noted that the analyses for hypotheses I through IV were performed across the sex of the subject (a between-subjects factor), and not across the success vs. failure dimension of the MAS items (a within-subjects factor) (Winer, 1971). Although other researchers have interpreted the models discussed earlier in the present paper as not addressing this issue (Frieze et al., 1982), the literature was understood by this author as clearly distinguishing predictions as relatively "high" or "low" across the sex of the subject (see Table 3). This oversight by Frieze et al. (1982) may be related to an exclusion on their part, the aforementioned lack of specific predictions for male subjects' attributional patterns. These specific predictions have been clearly put forth in much of the literature in this area (e.g., Forsyth & Schlenker, 1977; Levine et al., 1982; Sweeney, Moreland & Gruber, 1982).

Sex Differences

To test the hypothesis that males' and females' causal attributions for success and failure task outcomes shall differ, a 2 (sex of the subject) by 2 (success or failure task outcome) multivariate analysis of variance was done with sex, and the task outcome to be discussed below, treated as between-subjects factors. The expected main effect for sex was statistically significant, $F(8,52)=2.92$, $p<.009$. Univariate F-tests revealed that females attributed success as due to an easy task, an external stable cause, more often than males, $F(1,59)=5.78$, $p<.019$; whereas males described themselves as having greater ability, an internal stable cause, following a success, $F(1,59)=3.88$, $p<.05$. Also, males attributed failure outcomes as due to a difficult task, an external stable cause, signigicantly more often than did females, $F(1,59)=3.98$, $p<.05$ (see Figure 1). Thus, as expected, there were significant differences between male's and female's attributional styles, the pattern of which will be further addressed by hypothesis IV. Means and standard deviations for male's and female's scores are presented in Table 4, and Figure 1 presents a graph of the signifcant differences in scores.



<u>Figure 1</u>: Pattern of Significant Sex Differences on the MAS Subscales

<u>Note</u>. Maximum score = 20, minimum score = 4.

●——— Females

●- - - - Males

Table 4

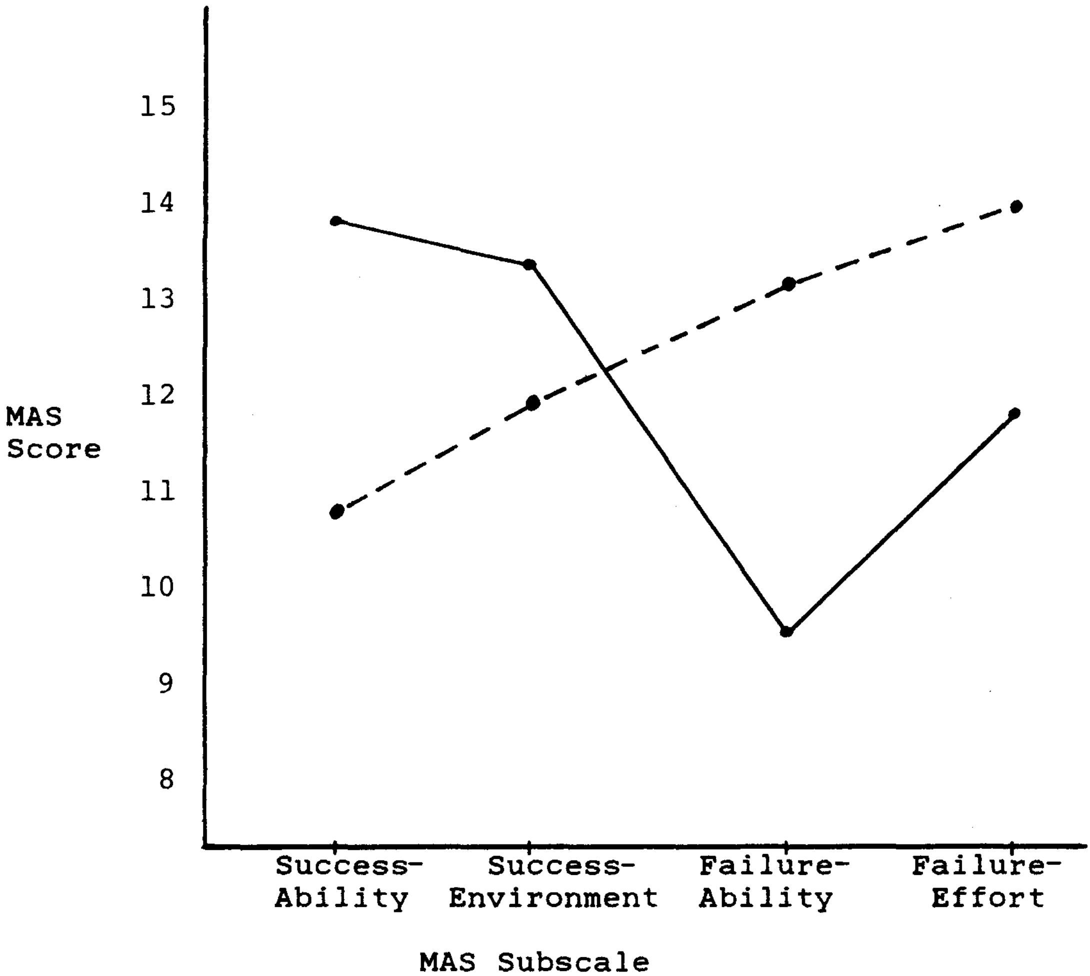
Means, Standard Deviations and Ranges of the MAS Subscales for Males and Females

Subscale		Mean	STD	Range
Success				
Ability	females	11.529*	3.449	5-19
	males	13.069	3.555	7-20
Effort	females	12.706	3.167	7-19
	males	13.552	3.601	6-20
Task	females	13.824***	2.355	9-18
	males	12.379	2.336	8-17
Environ	females	12.559	2.956	7-18
	males	12.586	2.626	7-19
Failure				
Ability	females	11.559	3.544	5-19
	males	11.241	3.651	5-20
Effort	females	13.265	2.906	8-18
	males	12.621	2.665	8-17
Task	females	10.294**	3.589	4-18
	males	12.103	3.447	5-17
Environ	females	8.176	2.249	4-14
	males	8.931	2.698	4-14

*$p < .01$
**$p < .05$
***$p < .02$

Task Outcome

The second between subjects factor of the MANOVA refered to above addresses the task outcome; regardless of sex of the subject, successful task outcomes will elicit more internal attributions than external attributions and vice-versa for failure task outcomes. The expected main effect for task outcome was statistically significant, $F(8,52)=4.05$, $p < .001$. Univariate F-tests revealed that responses to the "failure" stems of the MAS did support the hypothesis; subjects who failed at the math task attributed their failure to their ability and effort, internal causes, significantly less than those subjects who succeeded; for ability $F(1,59)=21.00$, $p < .0001$, and for effort $F(1,59)=10.46$, $p < .002$ (Table 5). The responses to the "success" stems of the MAS only partially support the hypothesis; subjects who succeeded attributed their success as significantly less due to luck than those who failed, $F(1,59)=4.15$, $p < .046$, yet successful subjects also attributed their success as less due to their ability, an internal factor, than those who failed, $F(1,59)=12.40$, $p < .001$ (see Figure 2). Means and standard deviations for the success and failure conditions are presented in Table 6, while descriptive statistics for male and female subjects by task outcome



<u>Figure 2</u>. Pattern of Significant Differences by Task Outcome on the MAS Subscales

<u>Note</u>. Maximum score = 20, minimum score = 4.

●———— Failure manipulation

●- - - - Success manipulation

Table 5

Means and Standard Deviations for Subjects by Task Outcome

Condition	Mean	STD
Success		
Success-Ability	10.875	3.108
Success-Effort	12.469	3.556
Success-Task	12.813	2.494
Success-Environment	11.875	2.960
Failure-Ability	13.188	3.587
Failure-Effort	14.031	2.559
Failure-Task	11.656	3.534
Failure-Environment	8.531	2.449
Failure		
Success-Ability	13.645	3.479
Success-Effort	13.742	3.098
Success-Task	13.526	2.365
Success-Environment	13.290	2.438
Failure-Ability	9.581	2.487
Failure-Effort	11.871	2.630
Failure-Task	10.581	3.668
Failure-Environment	8.516	2.541

Table 6

Means and Standard Deviations of the MAS Subscales for Males and Females by Task Outcome

	Success		Failure	
	females	males	females	males
Success-Ability	10.529 (3.145)	11.267 (3.127)	12.529 (3.538)	15.000 (2.987)
Success-Effort	12.176 (3.187)	12.800 (4.021)	13.235 (3.153)	14.357 (3.028)
Success-Task	13.765 (2.412)	11.733 (2.187)	13.882 (2.369)	13.071 (2.368)
Success-Environ	11.882 (3.120)	11.867 (2.875)	13.235 (2.705)	13.357 (2.170)
Failure-Ability	13.235 (3.580)	13.133 (3.720)	9.882 (2.667)	9.214 (2.293)
Failure-Effort	14.647 (2.827)	13.333 (2.093)	11.882 (2.315)	11.857 (3.060)
Failure-Task	10.588 (3.144)	12.286 (3.661)	10.000 (4.062)	11.286 (3.124)
Failure-Environ	8.176 (1.980)	8.933 (2.915)	8.176 (2.555)	8.929 (2.556)

assignment are presented in Table 6.

Interaction Effect

It was expected that sex of the subject and success or failure task outcome variables would interact significantly, such that females would score significantly different from males on the eight MAS subscales depending on whether the subject has experienced a success or failure. The hypothesized two-way interaction (sex by task outcome) was not statistically significant, $F(8,52)=.48$, $p <.867$, nor were any of the resultant univariate tests of significance. Discussion of this, and other findings, will be addressed in the next section.

A Test of the Models

In order to assess which of the models, Externality, Self-Derogatory or Low Expectancy, best predicts the causal attributions made by males and females for success and failure experiences, two sets of three Pearson chi-squared goodness-of-fit tests were performed (Hayes, 1981). All tests were planned a priori. The chi-squared tests were accomplished by partitioning each dependent variable, regardless of sex of the subject, by its median to establish relative "high" and "low" scores as specified by the models.

This was done twice, once for the subjects in the failure experimental condition and again for those in success condition. Then a count of the number of males and females whose score fit into either the high or low range was made for each causal category. Each subject's scores for each category was then coded as a "hit" or a "miss" for the appropriate manipulation condition; a hit if a male scored in the high group or if a female scored in the low group, or a miss if a male scored in the low group and a female scored in the high group. The results of this procedure are presented in Table 7 under the outcome label.

Six Pearson chi-squared goodness-of-fit tests were performed comparing the expected pattern, as predicted by each model, to the outcome pattern. None of the three models produced a significantly "good-fit" to the data: Externality model for success $\underline{X2}(3)=45.50$, $\underline{p} >.05$, for failure $\underline{X2}(3)=84.15$, $\underline{p} >.05$; Self-Derogatory model for success $\underline{X2}(3)=45.5$, $\underline{p} >.05$, and for failure $\underline{X2}(3)=37.14$, $\underline{p} >.05$, and Low Expectancy for success $\underline{X2}(3)=76.30$, $\underline{p} >.05$, and for failure $\underline{X2}(3)=68.16$, $\underline{p} >.05$ (see Table 7).

The expected outcome pattern for each model was derived by first considering the predictions made by each model (see Table 3). Since the models make

Table 7

Pearson Chi-Squared Goodness-of-Fit Tests Applied to the Three Models

Model	Success Task Outcome and MAS scores	Failure Task Outcome and MAS scores
Externality	45.50	84.15
Self-Derogatory	45.50	37.14
Low Expectancy	76.30	68.16

Note. None of the chi-squared values reached significance at the .05 level.

relative predictions rather than point predictions, relative numeric values for the expected outcome cells in Table 3 were coded with the lowest number possible in any one cell. Hayes (1981) states no cell in a Pearson chi-square goodness-of-fit test can by empty, and recommends five observations per calls as a minimum to perform the test. Therefore, five observations per cell were expected in the "low" cells, while the remainder of the observations were expected in the "high" prediction cells.

Table 8 is presented to illustrate this process. Each of the three models is presented contrasting the "predicted" pattern of outcome as predicted by that model versus the actual "outcome" produced by the data. The expected pattern for each model was generated by following the "high" and "low" relative predictions for each model as presented in Table 3. Scoring was accomplished by recording a "hit" or "1" if males were expected to score higher than females, and a "miss" or "0" if females were expected to score lower than males. A tally of expected hits and misses for each task outcome (success and failure) was made while taking into account the cell size assumptions of a chi-squared goodness-of-fit test. The predicted cells were then contrasted with the outcome cells described earlier by

Table 8

Six Pearson Chi-Squared Coodness-of-Fit Tables Contrasting the Outcome Predicted by each Model versus the Data Outcome for Success and Failure Outcomes

Outcome

Success

N=33

Models	Ability	Effort	Task	Environment
Externality				
Predicted	27	27	5	5
Outcome	18	17	10	18
Self-Derogatory				
Predicted	27	27	5	5
Outcome	18	17	10	18
Low Expectancy				
Predicted	27	5	27	5
Outcome	18	17	10	18

Failure

N=31

Models	Ability	Effort	Task	Environment
Externality				
Predicted	26	26	5	5
Outcome	15	13	19	18
Self-Derogatory				
Predicted	5	5	26	26
Outcome	15	13	19	18
Low Expectancy				
Predicted	5	26	5	26
Outcome	15	13	19	18

performing six Pearson chi-squared goodness-of-fit tests.

Although no support was obtained for any of the models using the Pearson chi-squared test, an examination of the mean scores on the MAS subscales for males and females reveals some interesting trends (Table 9). There are significant differences between males' and females' MAS scores on three of the eight subscales. The observed difference in the mean attribution scores for success to an ability cause is congruent with all three models. Men tend to attribute success to ability more than do women. Women tend to attribute success to an easy task more so than do men. This finding supports the Externality and Self-Derogatory models, but not the Low Expectancy model. And women tend to attribute failure to a difficult task less often than do men, thus supporting only the prediction made by the Self-Derogatory model.

An examination of the statistically different mean MAS scores for males and females reveals a pattern of differences in the MAS scores for the subscales Success-Effort, Failure-Ability, Failure-Effort, and Failure-Environment which mimics the pattern proposed by the Self-Derogatory model. The Success-Environment MAS subscale produced mean values which were approximately

Table 9

Means, Directional Trends as Compared to the Opposite Sex, and Significance Levels of the Mean Differences between Males and Females of the MAS Subscales for Males and Females

	Task Outcome			
		Success		
	Ability	Effort	Task	Luck
Females				
Mean	11.529	12.706	13.824	12.559
Directional Trend	Low	Low	High	Low
Males				
Mean	13.069	13.552	12.379	12.586
Directional Trend	High	High	Low	High
Significance Level of the Mean Differences	p=.051	p=.325	p=.018	p=.969

(continued)

Table 9 (continued)

Means, Directional Trends as Compared to the Opposite Sex, and Significance Levels of the Mean Differences between Males and Females of the MAS Subscales for Males and Females

	Task Outcome Failure			
	Ability	Effort	Task	Luck
Females				
Mean	11.559	13.265	10.294	8.177
Directional Trend	High	High	Low	Low
Males				
Mean	11.241	12.621	12.103	8.931
Directional Trend	Low	Low	High	High
Significance Level of the Mean Differences	p=.728	p=.366	p=.047	p=.231

equal in value and in the opposite direction to that predicted by the Self-Derogatory model. The Success-Environment MAS subscale produced mean values which were approximately equal in value and in the opposite direction to that predicted by the Self-Derogatory model (see Tables 3, 8 and 9).

DISCUSSION AND CONCLUSIONS

The findings of the present study support some of the past research in the area of applying ATAM to sex differences and shall be reviewed briefly. First, males and females attribute causality for success and failure task outcomes to causal categories in a significantly different manner. These patterns of attributions can best be predicted by the Self-Derogatory model. The Self-Derogatory model claims that females attribute causality for success to external causes and for failure to internal causes, while males attribute in a self-enhancing manner by attributing success to internal causes and failure to external causes. Also, the present study confirmed predicted attributional differences used by persons who experience success versus failure. Subjects who succeeded at the math task attributed their success to internal factors more than external ones, while those who failed attributed their failure to external factors more than to internal ones.

The purpose of this study was to apply ATAM in an investigation of a specific cognitive ability, mathematics, in which fairly consistent sex differences are found (Maccoby & Jacklin, 1974). The sex-stereotyped nature of mathematics prohibits generalization of the findings to other tasks as males' and female's causal attributions differ depending on the nature of the task (McHugh et al., 1982, cited in Frieze et al., 1982; Wolleat et al., 1980).

The findings of the present study also may be only applicable to college aged students. Continued research in this area contrasting the Externality, Self-Derogatory and Low Expectancy models using various subject groups of differing ages, education and other backround variables would address the generalizability of the present findings. Yet, the findings can and should be discussed in terms of mathematics achievement which has impact on career choice and attainment (Frieze et al., 1978a; Parsons et al., 1982).

Discussion of the Major Findings

The existence of sex differences in the use of causal attributional categories for success and failure experiences is supported by the present study. An overall main effect for the sex of the subject was highly significant. Females' and males' use of causal attributional categories were significantly different from one another. Significant univariate effects were achieved for only three of the eight MAS subscales by sex, and none of the three models produced a significantly good-fit to the data as measured by

Pearson chi-squared goodness-of-fit tests, yet the three significant univariate F-tests do differentiate the models to some extent. All three models predict the significant difference found on the Success-Ability MAS subscale; men tend to attribute success to their own ability, an internal stable cause, more than do women. The next significant MAS subscale difference to be discussed supports the Externality and Self-Derogatory models, but not the Low Expectancy model (see Table 3). Women tend to attribute success to an easy task while men minimize this cause in their explanation of a success experience. Thirdly, women tend to attribute failure to a difficult task less often than do men, a finding which is predicted by the Self-Derogatory model alone. Thus, only one model, the Self-Derogatory model, accurately predicted the significant sex differences in causal attributions for success and failure at a math task.

Further information may be gleaned by examining the statistically nonsignificant differences in males' and females' MAS subscale scores. The directional trends in males' and females' mean MAS scores (see Table 8) highlights additional information. ATAM theorists and researchers have emphasized that subjects use a variety of causal categories for any one event, so predominance of category use is of primary importance (Feather, 1969; Weiner, 1985). Therefore, examining trends in the use of causal categories seems to be a salient modus operandi from a theoretical point of view.

Trends in the sex differences in mean scores for the Success-Effort, Failure-Ability, Failure-Effort, and Failure-Luck accurately reproduce the relative "high" and "low" score predictions made by the Self-Derogatory model. Only the Success-Luck subscale mean difference between males and females contradicts the Self-Derogatory model. The Externality and Low Expectancy models, on the other hand, are contradicted by trends in five of the eight subscale scores. In light of the preceding discussion, it appears that the Self-Derogatory model has the most, although not overwhelming, support and generates the most predictive power when applied to sex differences in attributions for achievement in mathematics. The Self-Derogatory model anticipates females will not take credit for a success by making internal attributions for that event, but instead attribute success to external factors such as an easy task, luck, or some other favorable evnvironmental factor. Yet, females blame their lack of ability and low amount of effort as causing failure experiences, while ignoring external factors that may have contributed to their poor performance. Thus, females tend to perpetuate low levels of self-esteem for success at a math task.

According to the Self-Derogatory model, men attribute causality for success and failure in a self-enhancing or egotistical way. Males maintain a high degree of self-esteem in task specific areas or self-efficacy (Bandura, 1977), by attributing success to internal factors and failure to external factors. Therefore, men incorporate favorable information and ascribe it to themselves and disregard negative information as inapplicable to oneself.

Implications of a self-derogatory attributional style for females and a self-enhancing bias for males are several. First, empirical evidence shows internal attributions for failure result in decreased motivation and decrements in actual task performance (Ickes & Layden, 1978). Women may experience failure at mathematics with increasing frequency as their attributions for one such failure experience affects motivation and actual performance, thus adding to the self-perpetuating cycle of negative self-regard discussed as a result of the attributional pattern itself (Heilman & Kram, 1978).

Secondly, women's affective experience, including their self-esteem for the task specific behaviors, are generally negative. According to Weiner (1985) an attribution for success to external factors results in surprise and gratitude, whereas success attributed to internal causes results in feelings of competence. Also, attributions for failure to external causes result in anger or aggression, whereas attributions for failure to internal causes result in shame, guilt and incompetence. Therefore, women will tend to experience negative affective experiences for failure and few self-referent and/or positive affects for success. Men, on the other hand, will experience positive feelings such as competence after a success and direct any negative feelings following failure towards external sources.

The hypothesis that the manipulated task outcome, regardless of sex of the subject, would have a significant effect on attributional statements lying along the internality-externality dimension was supported. It was predicted that subjects who succeed tend to take personal responsibility for the outcome by attributing their success to internal causes such as ability and effort. Subjects who fail tend to shun personal responsibility for the outcome by attributing their failures to external causes such as bad luck and a difficult task.

Three of the eight MAS subscale mean scores by sex resulted in significant differences as predicted by hypothesis II. Subjects who failed at the math task attributed the outcome significantly less often to ability and effort, both internal causes, than those subjects who succeeded. Also, subjects who succeeded considered luck, an external cause, a less important cause of the outcome than those who failed.

Yet, contradictory to the predictions made in hypothesis II, successful subjects also attributed causality to an ability factor, an internal cause, less than those who failed. While this finding may be initially somewhat surprising, it may be that female's attributions to ability for a success event are infrequent, as predicted by all three models addressed by hypothesis IV, and confirmed by empirical evidence (Frieze et al., 1982). Therefore, the females' attributions for the Success-Ability score are low enough to deflate the effect of higher scores from the male subjects. The hypothesis remains unconfirmed for this causal category, yet the effect of strong sex differences on the Success-Ability score may be a contributing factor which overrides attributional differences predicted by the task outcome.

The lack of support for an interaction between the sex of the subject and the manipulated task outcome is puzzling and difficult to explain. Perhaps this indicates sex of the subject and the task outcome must be considered jointly in future research and in evaluating past research in this area. Each main effect examined in the study significantly affects causal attributions for success or failure at a math task. However, the differences are embedded in variations along each effect such that sex differences must be discussed separately for success or failure at math tasks.

In sum, ATAM and the Self-Derogatory model interpretation of the theroy appears to be one area of investigation which may aid in explaining the observed differences in male's and female's mathematical ability as a learned difference. ATAM and the Self-Derogatory model gained some empirical support from the present study which is one of few studies in the area of sex differences in attributions of causality for success and failure which focused on a meaningful as well as sex-typed task.

Further Issues for Consideration

In addition to considering the factors discussed above in interpreting the present study's results, several additional factors need to be considered. Past research has found that ability and effort are the most salient attributional categories among the six that the revised ATAM has proposed (Frieze, 1976; Weiner, 1979). Therefore, it may be problematic in verifying a model using all four causal categories. The causal categories task and luck will likely be used less often and may not be directly comparable to attributions to ability and effort. Attributions for failure to task and luck/environment appear to be somewhat less frequently endorsed (see Table 4). The effect of this discrepancy on experimental findings should be evaluated in future research.

Secondly, linked to the aforementioned factor, the Failure-Task, Success-Task, Failure-Environment, and Success-Environment subscales of the MAS have relatively low reliability coefficients (Fennema et al., 1979). These subscales may not be accurately tapping the intended causal category and produce nonsignificant results where there actually are differences. Future research in this area may advance more quickly with the development and use of consistent and reliable measures of attributional causality.

The lack of support for any of the three models in a recent meta-analysis (Frieze et al., 1982) may be dependent on several factors. Although meta-analysis has proven to be a useful technique for summarizing an area of research (Glass, 1977), the scope of its applicability from which conclusions can be drawn is determined by the scope of the studies it uses to obtain effect sizes and the basis for inclusion or exclusion of a study from the meta-analysis. Two such issues must be raised in regard to Frieze et al.'s (1982) findings and the present study. First, Frieze et al. (1982) included studies from the attributional research literature which utilized a wide variety of achievement tasks in a wide variety of areas. Some of these tasks appear very trivial (color matching, Phares, 1957), while others are much more salient to the subject (an examination grade, Simon & Feather, 1973; Sweeny et al., 1982).

The disparity among the tasks for which achievement motivation has been assessed limits the generalizability of any one of the studies to other task areas. Likewise, the applicability of Frieze et al.'s (1982) meta-analysis is potentially severely confounded. Perhaps their application of meta-analysis to this area of research was premature; more research needs to be done focusing on specific task-types, as well as making more comphrensive predictions across all causal dimensions for studies in this area.

Secondly, Frieze et al. (1982) chose to exclude studies in this area which used children as subjects, although empirical evidence has demonstrated that "different attributional patterns for explaining male and female performance appear well established by seven-eight years of age and remain strikingly stable through development" (Bond & Deming, 1982, p. 1205). By including the many studies in this area that use children as subjects, Frieze et al. (1982) may have reached a very different conclusion.

Thus, ATAM and the Self-Derogatory model appear to possess some explanatory power for sex differences in mathematics achievement. However, it appears to be necessary to conduct future research in sex differences in mathematics achievement and other areas of achievement by studying multiple psychological factors that correlate with gender (Levine et al., 1982) on distal as well as proximal levels (Bandura, 1977), to arrive at a more complete understanding of the sources and the environmental-societal causes of sex differences in mathematics achievement.

It is recommended that future research efforts continue to investigate sex differences in mathematics achievement by applying ATAM and the Self-Derogatory model in conjunction with efforts to tap other causal sources of the sex difference. Some of these include situational variables such as sex of a pairmate at a task (Heilman & Kram, 1978; Synder et al., 1978); cooperative versus competetive tasks (McHugh et al., 1982); other sex-typed tasks (Wolleat et al., 1980); and individual variables such as subjective perceptions of success and failure (Sweeney et al., 1982), sex-role identity (Williams, 1983), math anxiety (Plake & Parker, 1982), value of success at a task (Atkinson, 1964) and many others.

Finally, it is suggested that future research in this area discontinue viewing women and men (or any other group) as homogenous because many variables determine any one person's actions in any given situation (Bandura, 1977). Only when more complex research projects are undertaken utilizing sophisticated methodological and statistical techniques soundly, and considering multiple causal sources, will solutions to puzzles such as the one addressed in this study be solved.

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APPENDIX A

MATHEMATICS ATTRIBUTION SCALE

Imagine that the events described below occured. You must rate each of the four causes listed under each event in terms of its likelihood.

Event A: A section of your math test was wrong.

Causes

1. You just couldn't remember how do to the steps.
2. You were careless about completing it.
3. The part marked wrong included a step which was more difficult.
4. You were unlucky.

Be sure to rate all four possible causes of each event according to how you feel it applies to you. Do you STRONGLY AGREE, AGREE, are you UNDECIDED, do you DISAGREE, or STRONGLY DISAGREE with number 1 of Event A? Mark your answer in the appropriate column on your answer sheet. Then do the same with cause number 2, 3 and 4 for Event A. Now move on to Event B and do the same. Even though some of the events may seem repetative, be sure to answer each cause for each event.

Event B: You got the grade you wanted on the math test.

5. The content of the test was easy.
6. In the past you spent a lot of time studying math.
7. Your past math teachers have been good at explaining math.
8. You have a special talent for math.

Event C: You had trouble with some of the problems.

9. The testing room was too loud and distracted you.
10. You don't think in the logical way that math requires.
11. You didn't take the time to answer the questions carefully.
12. They were difficult problems.

Event D: You did not perform as well as the rest of the group on the math test.

13. Students sitting around you didn't pay attention and distracted you.

14. You didn't spend much time working on the test.
15. The material is difficult.
16. You have always had a difficult time in math.

Event E: You were able to complete a math test easily.

17. The problems were interesting.
18. The effort you put into the test helped.
19. You are a very able math student.
20. You lucked into taking an easy version of the test.

Event F: You were able to understand a difficult unit on a math test.

21. Your past math teachers presented the material well.
22. Your ability is more obvious when you are challenged.
23. You put extra hours of study time into learning those types of problems.
24. The problems were easy.

Event G: You received a low grade on a math test.

25. You are not the best student in math.
26. You have studied those types of problems, but not hard enough.
27. There were questions you have never seen before.
28. Past math teachers of yours spent too little time on this type of problem.

Event H: You have passed most math tests with no trouble.

29. Past teachers made learning math interesting.
30. You are talented in math.
31. You spent hours of extra time studying math.
32. The test covered simple problems.

Event I: There are times when you just can't solve certain types of math problems.

33. It is a task which doesn't interest you.
34. Even though you try, you don't understand it well.
35. Other class members disturbed your concentration.
36. You don't spend enough time studying them.

MAS Answer Sheet

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Event A:	Cause 1.					
	" 2.					
	" 3.					
	" 4.					
Event B:	" 5.					
	" 6.					
	" 7.					
	" 8.					
Event C:	" 9.					
	" 10.					
	" 11.					
	" 12.					
Event D:	" 13.					
	" 14.					
	" 15.					
	" 16.					
Event E:	" 17.					
	" 18.					
	" 19.					
	" 20.					
Event F:	" 21.					
	" 22.					
	" 23.					
	" 24.					
Event G:	" 25.					
	" 26.					
	" 27.					
	" 28.					

MAS Answer Sheet- pg. 2

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Event H: Cause 29.					
" 30.					
" 31.					
" 32.					
Event I: " 33.					
" 34.					
" 35.					
" 36.					

MAS SCORING MANUAL

Instructions: Fill out the following charts for each subject, total across rows, then total each subscale (i.e., Success-Ability, Failure-Task) to get eight subscale scores for each subject.

	1	2	3	4	5	raw total	subscale score
Success-Ability							
statement 8.							
statement 19.							
statement 22.							
statement 30.							
Success-Effort							
statement 6.							
statement 18.							
statement 23.							
statement 31.							
Success-Task							
statement 5.							
statement 17.							
statement 24.							
statement 32.							
Success-Environment							
statement 7.							
statement 20.							
statement 21.							
statement 29.							
Failure-Ability							
statement 10.							
statement 16.							
statement 25.							
statement 34.							
Failure-Effort							
statement 11.							
statement 14.							
statement 26.							
statement 36.							

	1	2	3	4	5	raw total	subscale score
Failure-Task							
statement 12.							
statement 15.							
statement 27.							
statement 33.							
Failure-Environment							
statement 9.							
statement 13.							
statement 28.							
statement 35.							

APPROVAL SHEET

The thesis submitted by Suzanne Fechner-Bates has been read and approved by the following committee:

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The final copies have been examiend by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts.

Dec 3, 1986
Date

Richard Maier PhD
Director's Signature