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ABSTRACT

The present investigation examined the content specificity of math and English anxieties, tested the generality of predictions from the internal/external (I/E) frame of reference model to anxiety responses, and studied sex differences in anxiety responses. Structural equation models, using LISREL, were fit to data from the High School and Beyond (HSB) study. Subjects were the 14,825 respondents selected for the second follow-up of the sophomore cohort of the HSB study (N=5,000 was used for purposes of statistical significance testing). The results show a remarkable content specificity of math and English anxieties; despite the substantial correlation between math and verbal test scores, math and English anxieties were nearly uncorrelated. As predicted by the I/E model, better math skills were related to substantially lower math anxiety but slightly higher English anxiety, whereas better English skills were related to substantially lower English anxiety but slightly higher math anxiety. Stereotypic sex differences were observed (women had higher math anxiety scores whereas men had higher English anxiety scores), and these differences remained after controlling for the small sex differences in the achievement tests. The results strongly support the usefulness of separating math and English anxieties, and add to a growing body of research arguing for the content specificity of many academic affects. Four tables are provided. (Author/TJH)

The Content Specificity of Math and English Anxieties: The High School and Beyond Study

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The Content Specificity of Math and English Anxieties:
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ABSTRACT

The purposes of the present investigation were to examine the content specificity of math and English anxieties, to test the generality of predictions from the Internal/External (I/E) frame of reference model to anxiety responses, and to examine sex differences in anxiety responses. This was accomplished by fitting structural equation models, using LISREL, to data from the High School and Beyond (HSB) study. The results demonstrated a remarkable content specificity of these two academic anxieties; despite the substantial correlation between math and verbal test scores, math and English anxieties were nearly uncorrelated. As predicted by the I/E model, better math skills were associated with substantially lower math anxiety but slightly higher English anxiety, whereas better English skills were associated with substantially lower English anxiety but slightly higher math anxiety. Stereotypic sex differences were observed -- women had higher math anxiety scores whereas men had higher English anxiety scores -- and these differences remained after controlling for the small sex differences in the achievement tests. These results provide strong support for the usefulness of separating math and English anxieties, and add to a growing body of research arguing for the content specificity of many academic affects.

The Content Specificity of Math and English Anxieties: The High School and Beyond Study

The focus of the present investigation is on math and English anxieties. The purposes are to examine: a) the content specificity of anxieties math and English and the usefulness of their separation; b) the generality of the Internal/External (I/E) frame of reference model (Marsh, 1986) to math and English anxiety; and c) sex differences in the anxiety constructs.

Historically anxiety researchers emphasized a generalized anxiety that may be defined "as an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry, and by activation of arousal of the autonomic nervous system" (Spielberger, 1972, p. 482). More recently Sarason (1986, p.24) noted that the "concept of anxiety may so complex as to obscure important processes. It may also have too much excess meaning, and therefore be misleading." In response to concerns such as ' ese, researchers have sought more specific components of anxiety. Anxiety ma, for example, be differentiable into worry and emotionality (Morris, Davis & Hutchings, 1981; Sarason, 1986), into state and trait components (Spielberger, 1966) or may be specific to particular settings such as test or academic anxiety, sports anxiety, or social anxiety (Schwarzer, 1986). Social anxiety may be further differentiable into shyness, embarrassment, shame, and audience anxiety (Buss, 1980; Schwarzer, 1986). Test of the usefulness of such distinctions requires that the various subcomponents can be differentiated from each other and that they are uniquely related to appropriate criterion variables.

Educational psychologists have long found it useful to distinguish anxiety in an academic or test taking situation from general anxiety (e.g., Alpert & Haber, 1960; Tobias, 1979). In particular, academic outcome variables are more highly correlated with academic specific measures of anxiety than with general measures of anxiety. Other researchers have examined anxiety in specific academic subjects, particularly math anxiety (e.g., Eccles & Jacobs, 1986; Ramirez & Dockweiler, 1987; Richardson & Woolfolk, 1980). Implicit in the use of content-specific measures of anxiety is the assumption that anxieties in specific subject areas can be differentiated from each other, cannot be adequately explained in terms of a general academic anxiety, and are uniquely related to appropriate criterion variables.

There is a growing body of research demonstrating a dramatic separation between academic affects in mathematics and English despite the fact that math and English achievement levels are substantially correlated. Marsh (1986) found that math and verbal self-concepts were nearly uncorrelated across a wide variety of studies involving subjects of different ages. Marsh (Marsh, 1984; Marsh, Cairns, Relich, Barnes & Debus, 1984) demonstrated that the self-attributional patterns that an individual uses to explain academic successes and failures are distinct for verbal and math content areas. Gottfried (1982, 1985) demonstrated the content specificity of intrinsic motivation and of anxiety in reading and math. Daly, Bell, and Korinek (1987) found relations between attitudes towards five academic interests (mathematics, science, reading, writing, and oral communication) could be explained by two uncorrelated factors representing verbal and math attitudes. Hence, one purpose of this study is to further examine the usefulness of the separation between math and English anxieties.

Marsh (1986) developed the Internal/External (I/E) model to explain the surprising lack of correlation between math and verbal self-concepts. The I/E model posits self-concepts to be formed in relation to both internal and external processes or frames of reference. According to the external process, students compare their own math and verbal skills with those of other students in their frame of reference and use this external, relativistic impression as one basis of their academic self-concepts in each of the two areas. According to the internal process, students compare their self-perceived math skills with their self-perceived verbal skills and use this internal, relativistic impression as a second basis of their academic self-concepts in each of the two areas. To clarify how these processes work, consider students who accurately perceive their math and verbal skills to be below average, but whose math skills are better than their verbal skills. These students have math skills that are below average relative to other students (an external comparison) but that are above average relative to their verbal skills (an internal comparison). Depending on how these two components are weighted, these students may have average or even an above-average math self-concepts despite their poor math skills. Consistent with these predictions from the I/E model, Marsh (1986) found that: a) whereas math and verbal achievement indicators are substantially correlated, math and verbal self-concepts were nearly uncorrelated; b) the direct effects of math achievement on math self-concept and of verbal achievement on verbal self-concept were positive; but c) the direct effects of verbal achievement on math self-concept and of math achievement on verbal self-concept were negative.

Marsh, Byrne, and Shavelson (in press) extended the generality of the I/E model in two respects. First, they demonstrated support for the I/E model with math and verbal self-concept scores from each of three different self-concept instruments. Second, they examined the role of sex differences in relation to the I/E model (also see Marsh, Smith and Barnes, 1985). They found that inclusion of gender had no effect on support for the I/E model. They did find, however, that girls had higher English self-concepts and lower math self-concepts than boys even after controlling for math and English school performance measures. Marsh, Byrne and Shavelson related this finding to a differential socialization model (e.g., Brophy, 1985; Eccles & Blumenfeld, 1985; Fennema & Peterson, 1985; Fennema & Sherman, 1977; Sherman, 1980; Marsh, Smith & Barnes, 1985; Meece, Parsons, Kaczala, Goff, & Futterman, 1982) that posits sex-linked differences in socialization patterns fail to reinforce adequately boys' positive attitudes, expectations, self-concepts and performance in verbal areas as well as failing to reinforce adequately girls' positive attitudes, expectations, self-concepts, and performance in math areas.

Support for the I/E model based on academic self-concepts to academic anxieties is tested through the application of structural equation modeling (SEM) using LISREL with data from the High School and Beyond study. The major components of this model are five constructs: gender, math and English achievement test scores (see Heyns & Hilton, 1982, for a review of the achievement tests used in the HSB study), and math and English anxiety scores. The path models to be tested are illustrated in Figure 1 and the variables used to define the constructs are described in Appendix I. Predictions to be tested are that:

1) Math and English anxiety measures should be relatively uncorrelated despite high correlations between math and English achievement scores;

2) Higher levels of math achievement should be associated with substantially reduced math anxiety but slightly increased English anxiety, whereas higher levels of English achievement should be associated with substantially reduced English anxiety but slightly increased math anxiety.

3) Girls have higher levels of math anxiety and lower levels of English anxiety than boys even after controlling for differences in corresponding achievement test scores.

The basis for generalizing results from self-concept research to anxiety research is not strong. Commonsense and some theoretical work (e.g., Schwarzer, 1986) suggest that a poor self-concept in a specific academic content area may produce anxiety in relation to performance in that area. If self-concept is a causal determinant of anxiety, then processes affecting self-concept should also affect anxiety. It should be noted, however, that the models in Figure 1 provide a useful analytic framework for studying important questions in anxiety research: (a) are math and English anxieties sufficiently distinct so as to be useful constructs; (b) is math anxiety more strongly related to math achievement than to verbal achievement, and is English anxiety more strongly related to verbal achievement than to math achievement; (c) are there sex differences in math and English anxieties, do the size and direction of these sex differences vary, and are these sex differences mediated by differences in achievement.

A few words about the nature of the models in Figure 1 and causal modeling are in order. In these models, academic achievement is posited to be one determinant of academic anxiety. This should not be taken to mean that there are no other determinants, or to argue against a more dynamic model in which prior levels of academic achievement and anxiety are each determined by prior levels of academic achievement and anxiety. There is an unfortunate tendency in recent social science research to misuse the notion of causality when referring to the results of path analyses and particularly to SEMs. Path coefficients in SEMs are regression coefficients based on relations between latent variables, and there is almost never a sufficiently strong substantive or empirical basis for using these to infer any strong sense of causality (see Heise, 1975; Kenny, 1979; James, Mulaik & Brett, 1982; for further discussion).

Methods

Sample and Data

Subjects are the 14,825 respondents selected for the second follow-up of the sophomore cohort of the HSB study. A detailed description of this data base is available in the data file user's manual produced by the National Center for Educational Statistics (NCES, 1986). The sophomore cohort initially involved a two-stage probability sample of 1,015 high schools and approximately 36 sophomores within each of these high schools. The second follow-up consisted of a probability sample of 14,825 of the original sample. Included on the commercially available data file for the second follow-up study are variables collected in 1980 when respondents were high school sophomores, in 1982 when most respondents were high school seniors, and in 1984 two years after the normal time of high school graduation. All variables used here come from the 1980 survey when the respondents were sophomores (the anxiety measures emphasized here were only administered during the sophomore year). These responses were weighted so as to take into account the disproportionate sampling of specified subgroups in the HSB design (NCES, 1986, Table 3.5-1). Because of the cluster sampling in the HSB study, standard errors based on the assumption of simple random sampling substantially underestimate the sampling variability in summary statistics and distort tests of statistical significance. In order to compensate for this bias, the weight for each student was divided by the estimated design effect of 2.40 (NCES, 1986, Table 3.6-5), reducing the nominal sample size from 14,825 to 14,825/2.40 = 6177.

A correlation matrix (see Appendix 1) was constructed from the 13 variables using pair-wise deletion for missing data. After weighting, the number of nonmissing values for the 13 variables varied from 6177 to 4848, and an N of 5,000 was used for purposes of statistical significance testing. In unreported analyses, correlations based on listwise deletion of missing cases resulted in similar conclusions.

Statistical Analyses -- the Application of SEM.

Weaknesses of the traditional use of multiple regression for estimating path coefficients are well known (e.g., Joreskog & Sorbom, 1981; Long, 1983a, 1983b; McDonald, 1985; Pedhazur, 1982) and so are not reviewed here in detail. Perhaps the most serious weakness is the assumption that the single score typically used to infer each construct is measured without error. Particularly when multiple indicators of the inferred constructs are available, SEM provides important advantages. Although parameters for the entire model are estimated simultaneously, the model can be logically separated into measurement and structural models. The measurement model contains estimates of the relations between each latent construct and its multiple indicators (i.e., factor loadings) and error/uniquenesses associated with each measured variable. The structural model contains estimates of causal relations between the latent constructs (i.e., path coefficients) that are corrected for measurement error. In the present investigation 13 measured variables (represented by squares in Figure 1 and defined in the Appendix) were used to define 5 constructs. All but one of the constructs were defined by multiple indicators whereas sex (1=male, 2=female) was inferred from a single-indicator that was assumed to be measured without error. (The design matrices in LISREL (Joreskog & Sorbom, 1981) used to estimate parameters are illustrated in Tables 2 and 3 for two models to be developed later.)

An important, unresolved issue in SEM is the assessment of goodness of fit -- particularly when sample size is very large as in the present investigation. On the basis of theory, the logic of the data, and, perhaps, previous analyses, the researcher typically posits a set of alternative models designed to explain relations among the measured variables. To the extent that the hypothesized model is able to fit the observed data, there is support for the model. The problem of goodness of fit is how to decide whether the predicted and observed results are sufficiently alike to warrant support for a model. Whereas X^2 values can be used to test whether these differences are statistically significant, there is a growing recognition of the inappropriateness of the classical hypothesis testing approach. Because restricted models are only designed to approximate reality, all such models are a priori false and will be shown to be false if tested with a sufficiently large sample size (Cudeck & Browne, 1983; Marsh, Balla & McDonald, in press; Marsh, McDonald & Balla, 1987; McDonald, 1985). Model selection must be based on a subjective combination of substantive issues, inspection of parameter values, goodness of fit, model parsimony, and a comparison of the performances of competing models. A variety of fit indices have been derived to aid in this process such as the X^2/df ratio, the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), and the Bentler-Bonett Index (BBI; Bentler & Bonett, 1980) that are considered here. In simulation studies of these and other indices Marsh, Balla and McDonald (in press) and Marsh, McDonald, and Balla (1987) found that the TLI was the only frequently used index that was relatively independent of sample size and imposed an apparently appropriate penalty function for the inclusion of additional variables to control for capitalizing on chance, and so it is emphasized in the present investigation.

One additional complication warrants further discussion. Many of the variables considered here are dichotomously scored. Non-interval, dichotomous data may be inappropriate for factor analysis, and related violations of multivariate normality assumptions may make dubious the maximum likelihood test statistics and associated probability levels. Muthen and Kaplan (1985) describe alternative approaches to the analysis of such data. They also, however, noted important practical limitations in these approaches and so evaluated the robustness of the traditional methods used here in a simulation study. They found that it is was not the dichotomous nature of variables that produced problems with the traditional approach, but rather the skew and kurtosis of the measured variables. Fortunately, they also found that maximum likelihood estimators and associated chi-square statistics are quite robust when skewes and kurtoses are moderate, and variables are not highly correlated, as is the case in the present application.

Results

Model 1 (Figure 1) posits a particular pattern of relations among five latent constructs -- sex, math achievement, verbal achievement, math anxiety, verbal anxiety -- and the measured variables associated with each construct. The primary substantive interest is in the path coefficients relating these latent constructs, but it is first necessary to determine whether the model is able to adequately fit the data.

Insert Table 1 About Here

The ability of Model 1 to fit the data is only modest (Table 1). Both the logic of the data and inspection of the modification indices provided by LISREL (Joreskog & Sorbom, 1981) suggested that it was necessary to add correlated uniquenesses to the model. In particular, there were correlated uniquenesses relating responses to pairs of items from the math and English anxiety scales that had parallel wording (e.g., I dread mathematics class and I dread English class). The inclusion of these 4 correlated uniquenesses substantially improved the goodness of fit indicators (see Model 2 in Table 1). Because method effects associated with the parallel wording of items on different scales are common in SEM, the inclusion of these correlated uniquenesses was anticipated. Inspection of the modification indices for Model 2 suggested that a correlated uniqueness between two of the math anxiety items (I am usually at ease in mathematics class and mathematics class does not scare me at all) would further improve the fit. The inclusion of this one additional correlated error resulted in a very small but statistically significant (due to the extremely large sample size) improvement in fit (see Model 3 in Table 1). The parameter estimates for Models 1 and 3 are presented in Tables 2 and 3, and summarized in Figure 1. Whereas the substantive discussion of the results emphasizes Model 3, it is important to note that Models 1, 2 and 3 all result in substantively similar conclusions. That is, even though the addition of correlated errors had a large impact on goodness of fit, it had nearly no effect on substantive interpretations of the findings.

Insert Tables 2 and 3 and Figure 1 About Here

The most important prediction, perhaps, is that math and English anxiety would be relatively uncorrelated. Support this prediction would clearly demonstrate that the two anxiety constructs are sufficiently distinct to support their further consideration. The nonsignificant covariation between the residual variances (-.033 in Model 3) is the relation between math and English anxiety after controlling for sex, math achievement, and English achievement. The actual correlation between math and English anxiety without partialling variance attributable to other variables (-.024) is also close to zero. The inclusion of correlated errors between math and English anxiety items does affect the size of this correlation. However, in Model 1 the covariation between the residual variances (.043) and the corresponding correlation between the unpartialed factors (.051) are also close to zero. In summary, the results of these analyses demonstrate that math and English anxiety scores in the present investigation are nearly uncorrelated.

The second set of predictions refer to relations between the achievement and anxiety constructs. The two achievement constructs in combination with sex are able to explain 10% and 12% of the variance in math and English anxieties respectively. Not surprisingly, though consistent with the predictions, better math skills are associated with substantially lower levels of math anxiety and better verbal skills are associated with substantially lower levels of English anxiety. What is surprising, though still consistent with the predictions, is that better math skills are associated with slightly higher levels of English anxiety and better verbal skills are associated with slightly higher levels of math anxiety. This contrasting set of relations provides strong support for the discriminant validity of the English and math anxieties.

The final set of predictions is that there would be stereotypic sex differences in math and English anxieties beyond what could be explained in terms of math and English achievement. Two features of the relevant results are important. First, as hypothesized, girls have higher levels of math anxiety and lower levels of English anxiety than do boys. The sizes of these sex differences are not, however, as large as expected. Second, the sex differences in Math and verbal achievement test scores are unexpectedly low. The sex difference for verbal achievement is not even statistically significant, whereas the sex difference for math achievement (-.046, indicating higher scores for boys) is very small (i.e., less than 1/4 of 1% of the variance explained). Because there are almost no sex differences in the achievement test scores, partialling out the effects of sex has nearly no influence on the sex differences in the anxiety scores. In this respect, the interpretation of the sex differences in the anxiety measures is facilitated. The surprising lack of sex differences in achievement is important because of the size, quality and national representativeness of the HSB data base. This finding, though not a focus of the present investigation, warrants further investigation.

Summary and Implications

The purposes of the present investigation were to examine: a) the content specificity of math and English anxieties; b) the generality of the I/E model to math and English anxieties; and c) sex differences in the anxiety constructs. Consistent with a growing body of research for math and English affects, math and English anxieties are nearly uncorrelated. Consistent with predictions based on the I/E model better math skills were associated with reduced math anxiety but higher English anxiety whereas better English skills were associated with reduced English anxiety but higher math anxiety. Even after partialling out the effects of math and English achievement, boys still had less math anxiety and higher English anxiety than did girls.

Historically researchers considered global measures of anxiety, but a large body of research has suggested that more specific components of anxiety are more useful for understanding specific outcome measures. One of these more specific components has been academic or test anxiety. The results presented here, however, suggest that general academic measures of anxiety should be replaced with math and English measures of anxiety. Because math and English anxieties seem to be nearly uncorrelated, it may be unjustified to subsume these two measures into a more general measure of academic anxiety. If the role of anxiety research in academic settings is to better predict academic behaviors and accomplishments, to provide outcome measures for academic interventions, and to relate academic anxiety to other constructs, then math and English anxieties may be more useful than a general academic anxiety. From this perspective it is recommended that future research examines math and English anxiety measures in relation to important theoretical issues in anxiety research such as the state/trait and worry/emotionality distinctions.

The results of the present investigation demonstrated that predictions ...lleling those supported in self-concept research were strongly supported ...ested with anxiety measures. In fact the math and English anxiety ...s considered here acted remarkably like math and verbal self-concept ...as considered elsewhere. At least three, perhaps related, explanations may be consistent with these findings. First, it may be that academic self-concepts and anxiety are reasonably distinct constructs that are formed in similar ways. From this perspective, partialling out the effects of academic self-concepts from the achievement/anxiety relations, or partialling out the effects of academic anxieties from the achievement/self-concept relations, would leave the pattern of results essentially unaffected. Second, it may be that effects of academic achievements on academic anxiety are largely mediated by academic self-concept. That is, poor academic skills lead to poor academic self-concepts which produce high levels of academic anxiety. Schwarzer (1986), for example, suggested that "a lack of perceived self-efficacy leads to an imbalance between the appraised task demands and the appraised subjective coping resources, resulting in test anxiety" (p. 6). In this case, partialling out the effect of academic self-concepts from the achievement/anxiety relations would largely eliminate achievement/anxiety relations. Third, it may be that supposedly distinct affective constructs -- anxiety, self-concept, self-efficacy, attributional dispositions, locus of control, self-determination, intrinsic motivation, etc. -- all measure largely the same construct. That is, whereas math and English affects are clearly distinguishable, the different affective constructs may not be. In this case, partialling academic self-concepts from the achievement/anxiety relations or partialling academic anxieties from the achievement/self-concept relations would eliminate most of the achievement/affect relations. From this perspective it is important to study the reliable variance in each of the constructs that is unique from variance in the other constructs. Tests of these and alternative explanations require researchers to consider within the same study well constructed measures of achievement, academic self-concept, academic anxiety, and, perhaps, other affective measures that are specific to mathematics and English.

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Table 1

Goodness of Fit Indices For Alternative Models

Model	X^2	df	X^2/df	BBI	TLI
0	19,682	78	252.33	0	0
1	1,240	56	22.14	.867	.897
2	270	52	5.19	.973	.977
3	211	51	4.13	.980	.984

Note. BBI = Bentler-Bonett Index; TLI = Tucker-Lewis Index. Model 0 is a null model used to compute the BBI and TLI that is of no substantive interest. Models 1 - 3 refer to the same basic model shown in Figure 2 without any correlated uniquenesses (Model 1), with 4 correlated uniquenesses between the 4 pairs of Math and English anxiety items with the same wording (Model 2), and with the 4 correlated uniquenesses in Model 2 and one additional correlated uniqueness between two Math anxiety items.

Table 2

Parameter Estimates for Models 1 (see Figure 2)

Variable	Factor Loadings (LAMBDA) Sex	MACH	EACH	MAnx	EAnx	Error/ Uniquenesses[a] (THETA)
1	1	0	0	0	0	0
2	0	933	0	0	0	130
3	0	727	0	0	0	472
4	0	0	830	0	0	311
5	0	0	859	0	0	263
6	0	0	C	725	0	475
7	0	0	0	-638	0	593
8	0	0	0	604	0	635
9	0	0	0	-597	0	644
10	0	0	0	0	695	517
11	0	0	0	0	-706	502
12	0	0	0	0	522	728
13	0	0	0	0	-558	688

Path Coefficients (BETA)

	Sex	MACH	EACH	MAnx	EAnx
Sex	0				
MAch	-046	0			
EAch	-027	0	0		
MAnx	082	-472	275	0	
EAnx	-141	116	-408	0	0

Factor Variance/Covariances (PSI)

	Sex	MACH	EACH	MAnx	EAnx
Sex	1				
MAch	0	998			
EAch	0	833	999		
MAnx	0	0	0	909	
EAnx	0	0	0	043	881

Note. All coefficients are presented in standardized form to facilitate interpretation. Three digit coefficients represent values between +1 and -1 presented without decimal points, whereas values of 0 or 1 represent coefficients fixed by the design of the model (factor loadings of 0) or the nature of the variable (e.g., sex is a single-item factor assumed to be measured without error). All parameter estimates are statistically significant except the path leading from sex to English achievement (in Beta). The LISREL design matrices used to fit the model are LAMBDA (factor loadings), THETA (error/uniqueness and correlated uniquenesses), BETA (path coefficients) and PSI (factor variances, factor residuals, and correlated factor residuals).

a -- In Model 1 error/uniquenesses are all posited to be uncorrelated so that the corresponding design matrix (THETA) is diagonal and can be presented as a column of values.

Table 3

Parameter Estimates for Model 3 (see Figure 2)

Variable	Factor Loadings (LAMBDA)					Error/Uniquenesses (THETA)												
	Sex	MACH	EACH	MAnx	EAnx	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	0	0	0	0	0												
2	0	932	0	0	0	0	131											
3	0	727	0	0	0	0	0	472										
4	0	0	830	0	0	0	0	0	311									
5	0	0	859	0	0	0	0	0	0	263								
6	0	0	0	670	0	0	0	0	0	0	553							
7	0	0	0	-657	0	0	0	0	0	0	0	561						
8	0	0	0	555	0	0	0	0	0	0	103	0	697					
9	0	0	0	-632	0	0	0	0	0	0	0	0	0	603				
10	0	0	0	0	693	0	0	0	0	0	073	0	0	0	515			
11	0	0	0	0	-697	0	0	0	0	0	0	114	0	0	0	513		
12	0	0	0	0	544	0	0	0	0	0	0	0	219	0	0	0	719	
13	0	0	0	0	-561	0	0	0	0	0	0	0	0	172	0	0	0	686

Path Coefficients (BETA)

	Sex	MACH	EACH	MAnx	EAnx
Sex	0				
MAch	-046	0			
EAch	-027	0	0		
MAnx	078	-490	285	0	
EAnx	-141	114	-480	0	0

Factor Variance/Covariances (PSI)

	Sex	MACH	EACH	MAnx	EAnx
Sex	1				
MAch	0	998			
EAch	0	833	999		
MAnx	0	0	0	903	
EAnx	0	0	0	-033	880

Note. See Table 1 for definition of variables. All coefficients are presented in standardized form to facilitate interpretation. Three digit coefficients represent values between +1 and -1 presented without decimal points, whereas values of 0 or 1 represent coefficients fixed by the design of the model (factor loadings of 0) or the nature of the variable (e.g., sex is a single-item factor assumed to be measured without error). All parameter estimates are statistically significant except the path leading from sex to English achievement (in Beta) and the correlation between the MAnx and EAnx residual variances (in PSI). The LISREL design matrices used to fit the model are LAMBDA (factor loadings), THETA (error/uniqueness and correlated uniquenesses), BETA (path coefficients) and PSI (factor variances, factor residuals, and correlated factor residuals).

Appendix I

Correlation Matrix Used In Analysis and a Description of the Variables

	Correlations												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	-.042	1.000											
3	-.041	.678	1.000										
4	-.035	.647	.495	1.000									
5	-.013	.668	.523	.713	1.000								
6	.050	-.184	-.159	-.080	-.105	1.000							
7	-.065	.147	.124	.053	.083	-.435	1.000						
8	.100	-.070	-.058	.001	-.021	.473	-.386	1.000					
9	-.044	.166	.149	.058	.089	-.425	.425	-.315	1.000				
10	-.117	-.143	-.101	-.172	-.183	.068	-.024	-.001	.004	1.000			
11	.105	.157	.110	.182	.202	-.475	.123	.006	-.002	-.475	1.000		
12	-.015	-.068	-.046	-.102	-.105	.375	-.388	.182	.072	.375	-.388	1.000	
13	.068	.132	.093	.158	.166	-.401	.395	-.260	.158	-.401	.395	-.260	1.000
Mn	1.503	10.16	2.541	8.673	6.828	1.304	1.690	1.325	1.692	1.236	1.716	1.279	1.697
SD	0.500	7.683	2.733	5.300	4.758	0.460	0.463	0.468	0.462	0.425	0.451	0.448	0.459

Description of the Variables (HSB variable labels in parentheses) and the construct it defines (see Figure 2)

1 Sex	(SEX)	Sex (1=male, 2=female)
2 Math Ach	(YBMTH1FS)	Sophomore Math Part 1 Formula Score
3 Math Ach	(YBMTH2FS)	Sophomore Math Part 2 Formula Score
4 Verbal Ach	(YBVOCBFS)	Sophomore Vocabulary Formula Score
5 Verbal Ach	(YBREADFS)	Sophomore Reading Formula Score
6 Math Anx	(YB035E)	I am usually at ease in mathematics class (1=true, 2=false)
7 Math Anx	(YB035F)	Doing mathematics assignments makes me feel tense (1=true, 2=
8 Math Anx	(YB035G)	Mathematics class does not scare me (1=true, 2=false)
9 Math Anx	(YB035H)	I dread mathematics class (1=true, 2=false)
10 Verbal Anx	(YB035A)	I am usually at ease in English class (1=true, 2=false)
11 Verbal Anx	(YB035B)	Doing English assignments makes me feel tense (1=true, 2=false
12 Verbal Anx	(YB035C)	English class does not scare me (1=true, 2=false)
13 Verbal Anx	(YB035D)	I dread English class (1=true, 2=false)

Note. The variables are numbered 1 to 13 and these numbers correspond to the 13 measured variables shown in Figure 1. The variable label names used to identify each of these variables on the HSB data file (see NCES, 1986) are also presented (in brackets).

FIGURE CAPTIONS

Figure 1. The structural parameter estimates for Models 1 and 3. The 13 numbered boxes refer to the 13 measured variables (see Appendix 1) and the five latent constructs are indicated by circles. Except for sex all the constructs have at least two indicators (i.e., the circles are associated with two or more boxes) and correlated uniquenesses are posited between some of these indicators in Model 3 (the double-headed arrows connecting the boxes). Path coefficients (the single-headed arrows going from left to right) represent relations between latent constructs. Correlated residuals (the double-headed arrows connecting the circles) are posited between math and English achievement, and between math and English anxiety. The LISREL design matrices used to define these models and all the corresponding parameter estimates are presented in Tables 2 and 3.