DOCUMENT RESUME

ED 278 690 TM 870 107

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TITLE The Hierarchical Structure of Academic Self-Concept: The Marsh/Shavelson Model.
SPONS AGENCY Social Sciences and Humanities Research Council of Canada, Ottawa (Ontario).
PUB DATE 28 Nov 86
NOTE 20p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Aptitude; *Affective Measures; Correlation; Factor Analysis; *Factor Structure; Foreign Countries; Goodness of Fit; High Schools; *Models; Questionnaires; Research Methodology; Self Concept; *Self Concept Measures; Self Evaluation (Individuals)
IDENTIFIERS Affective Perception Inventory (Soares and Soares); Canada; Self Concept of Ability Scale (Brookover); Self Description Questionnaire

ABSTRACT

The purpose of the present investigation is to study the hierarchical structure of academic self-concept. The original Shavelson model posited specific facets of academic self-concept to define a single higher-order facet, but Marsh and Shavelson (1985) found the hierarchical structure to be more complicated. In a revised model they proposed that at least two higher-order academic facets--verbal/academic and math/academic--are required. In the present investigation approximately 1,000 Canadian high school students completed nine self-concept scales; the verbal, math, and school self-concept scales from three different instruments. Confirmatory factor analysis (CFA) provided support for all nine of these scales, and a hierarchical CFA was used to determine the number of higher-order factors needed to explain correlations among the nine first-order factors. The two higher-order academic factors posited by Marsh and Shavelson fit the data reasonably well and substantially better than the single higher-order factor proposed in the original Shavelson model. The math/academic and verbal/academic factors were nearly uncorrelated, and the contributions of scales from the three instruments to each higher-order factor were remarkably similar. In subsequent discussion the Marsh/Shavelson model was more clearly defined and directions for further research were examined. (Author/LMO)

The Hierarchical Structure of Academic Self-concept: The Marsh/Shavelson Model

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28 November, 1986

Running Head: Academic Self-concept

The authors gratefully acknowledge funding support from the Social Sciences and Humanities Research Council of Canada, and the cooperation of teachers and students of the Carleton Board of Education. We wish to acknowledge Jennifer Barnes, Raymond Debus, and Bengt Muthen for their comments on earlier drafts of this manuscript.

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The Hierarchical Structure of Academic Self-concept: The Marsh/Shavelson Model

Shavelson, Hubner and Stanton (1976) posited self-concept to be a multifaceted, hierarchical construct, and presented a possible representation of this hierarchical model in which general self-concept appeared at the apex and was divided into academic and nonacademic self-concepts. In this model self-concepts in particular academic content areas (e.g., mathematics and English) were posited to form a single higher-order facet of academic self-concept. According to this model the specific facets of academic self-concepts should be substantially correlated so that they can be incorporated into a single higher-order academic self-concept.

Marsh and Shavelson (1985; Shavelson & Marsh, 1986; also see Marsh & Hocevar, 1985) tested the Shavelson model with responses by preadolescent students to the Self Description Questionnaire (SDQ). Their findings generally supported the model, but the hierarchy proved to be more complicated than anticipated and led to a revision of the original model. In particular, Verbal self-concept (VSC) and Math self-concept (MSC) were nearly uncorrelated with each other, and did not combine with School self-concept (SSC) to form a single, second-order academic factor. Instead there were two second-order academic factors representing verbal/academic and math/academic self-concepts that were nearly uncorrelated. In subsequent research with late-adolescent responses to the SDQ III (Marsh, in press) VSC and MSC were again nearly uncorrelated to each other and could not be adequately explained by a single higher-order academic factor. The purpose of the present investigation is to test the generality of these findings that led to the revision of the Shavelson model with responses to other self-concept instruments.

Methods

The sample, procedures, and instrumentation are described in more detail by Byrne (1986; Byrne & Shavelson, 1986). Subjects were 516 males and 475 females who attended grades 11 or 12 in two coeducational high schools in the suburbs of Ottawa, Canada. VSC, MSC, and SSC were each measured by the SDQ III (Marsh, Barnes & Hocevar, 1985; Marsh & O'Niell, 1984; Marsh, Richards & Barnes, 1986), the Self-concept of Ability Scales (SCA; Brookover, 1962; Shavelson, et al., 1976; Shavelson & Bolus, 1982), and the Affective Perception Inventory (API; Soares & Soares, 1979). For purposes of the present investigation the 9 (3 VSC, 3 MSC, and 3 SSC) scales were represented by 27 subscales. The items designed to measure each of the 9 scales were randomly divided into three groups of items and the sum of responses to items comprising each subscale was computed. A correlation matrix derived from these 27 (9 x 3) subscales using listwise deletion for missing values was the basis of subsequent analyses. The correlation matrix was fit to models to be described and parameters were estimated with the commercially available LISREL V (Joreskog & Sorbom, 1981). The specification of the models in terms of LISREL V is described in more detail by Marsh and Hocevar (1985).

The application of CFA and its advantages over exploratory factor analysis are well documented, and these advantages are especially important for examining hierarchical structures (Marsh, 1985; in press; Marsh & Hocevar, 1985). In the present investigation an initial first-order model was posited to test the a priori structure of 9 academic self-concept factors and to examine the correlations among these factors. This first-order model had a simple structure in that each of the nine posited factors corresponded to one of the nine self-concept scales, and only the three measured variables designed to infer each scale were allowed to load on the corresponding factor. A well-defined first-order factor structure is a prerequisite to testing higher-order structures because subsequent higher-order models are based on it and its goodness of fit is the upper limit for the goodness of fit of higher-order models. Hence, the rationale, parameter estimates, and fit of the first-order factor structure should be examined carefully in HCFA studies.

The purpose of HCFA is to explain covariation among the first-order factors with one or more higher-order factors. Because higher-order models and the corresponding first-order model are nested, the higher-order model cannot fit the data any better than the first-order model. Since the number of parameters needed to estimate the higher-order factors is less than the number of covariances among first-order factors, the higher-order model is supported so long as: a) the parameter estimates are defensible in relation to the a priori substantive model, b) the fit is reasonable and not substantially poorer than the first-order model, and c) technical requirements are met (e.g., the model is identified and there are no Heywood cases). In the present investigation alternative HCFA models posited one (general academic), two (verbal/academic and math/academic), or three (verbal, math, and school) higher-order factors to account for covariation among the nine first-order factors.

In CFA there are not well-established guidelines for testing goodness of fit, but the general approach is to: a) examine parameters in relation to substantive issues; b) evaluate overall goodness of fit in terms of statistical significance and in comparison to alternative models; and c) evaluate subjective indicators of fit such as the Tucker Lewis Index (TLI) and Bentler Bonett Index (BBI) and to compare values from alternative models (Bentler & Bonett, 1980). Goodness of fit is evaluated, in part, with an overall X^2 test. A nonsignificant X^2 indicates that the model fits the data, but there are problems in inferring support for a model from support for the null hypothesis. Furthermore, when the sample size is large, the X^2 test is extremely powerful and will nearly always be statistically significant. Hence, most practical applications of CFA require a subjective evaluation of whether a statistically significant X^2 is small enough to constitute an adequate fit (see Bentler & Bonett, 1980; Long, 1983; Joreskog & Sorbom, 1981). However, subjective indicators of fit are also affected by sample size. Marsh, Balla and McDonald (1986) demonstrated that sample size had a substantial effect on most goodness-of-fit indicators typically used in CFA research as well as on the chi-square test statistic. Of the commonly used indicators, only the TLI was relatively independent of sample size in their study based on actual and simulated data.

Cudeck and Browne (1983) noted that hypothesized models are best regarded as approximations of reality rather than exact statements of truth so that any model can be rejected if the sample size is large enough. From this perspective they argue that it is preferable to depart from the unrealistic assumption of the hypothesis testing approach that any model will exactly fit the data. Cudeck and Browne, as well as other researchers (e.g., Marsh, in press), suggest that the inclusion of additional "garbage" parameters to improve the fit may be counterproductive unless the parameters can be replicated and given a substantive interpretation. Because of the problems in assessing fit when the sample size is large as in the present investigation, the comparison of TLIs for competing substantive models will be emphasized here.

Results and Discussion

The First-Order Factor Model

VSC, MSC, and SSC were measured with three different self-concept instruments, and the purpose of the first-order factor model (Model 1) was to test the ability of a nine-factor model to explain these responses. Support for the posited first-order model is also prerequisite for subsequent HCFAs. For Model 1 every factor loading (Table 1) and every factor variance is large and statistically significant. Factor correlations vary from -.01 to .94 but those between matching factors from different instruments are highest (.65 to .94, Md = .78), those between SSC and the other two academic facets are intermediate (.39 to .65, Md = .49), and those between VSC and MSC are lowest (-.01 to .14, Md=.05). This pattern of correlations provides support for the construct validity of the self-concept responses, the lack of correlation between VSC and MSC, and the hierarchical model posited by Marsh and Shavelson (1985). The X^2 for the first-order factor model (Table 2) is large, due in part to the large sample size, but the TLI (.93) suggests that the fit is reasonable. In summary there is good support for the first-order model.

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The Higher-Order Factor Models

A series of HCFA models was posited to explain the 36 correlations among the nine first-order factors. Model 2, the simplest, posits a single higher-order factor; a general academic self-concept defined by all nine first-order factors. Model 3 posits two higher-order factors; math/academic defined by the MSC and SSC factors and verbal/academic defined by the VSC and SSC scales. Model 4 posits three higher-order factors defined by the VSC, MSC and SSC scales respectively. The higher-order models differ substantially in their ability to fit the data (Table 2). Whereas Model 2 provides a relatively poorer fit (TLI = .80), Models 3 and 4 differ only modestly in their ability to fit the data (TLIs=.90 and .91 respectively). Inspection of the higher-order factor loadings (Table 3) shows that the general academic factor in Model 2 is really a math/academic factor since the VSC factors have only small loadings on the single higher-order factor. Higher-order factor loadings and factor correlations for both Models 3 and 4 (Table 3) support the interpretation of the posited factors. In Model 3 both higher-order factors are well defined, but the correlation between these math/academic and verbal/academic factors is not significantly different from zero. In Model 4 the higher-order school factor is significantly correlated with both the math and verbal factors, but the correlation between the higher-order math and verbal factors is not statistically significant. Model 4 provides a slightly better fit to the data than Model 3 but the difference is small and complicated by the fact that the two models are not nested so that a test of the statistical significance of the difference is precluded. The major focus of the present investigation is on the relative ability of one general academic ability factor (Model 2) and two higher-order factors (Model 3) to explain correlations among the first-order factors. For this comparison Model 3 is clearly superior.

Models 3A and 3B (Table 3) place further restrictions on Model 3 in order to test additional substantive issues. In Model 3A the correlation between the two higher-order factors, verbal/academic and math/academic self-concepts, was fixed to be zero. Consistent with the nonsignificant correlation in Model 3, the fit of Model 3A does not differ significantly from Model 3. In Model 3B the higher-order factor loadings of the first-order factors representing the same self-concept facet were constrained to be equal. That is, the contribution of scales from each of the three self-concept instruments was required to be the same for a given second-order factor. For example, the three VSC factors based on responses to the SDQ III, the API, and the SCA were constrained so that each had the same factor loading on the higher-order verbal/academic factor. Because the goodness of fit for Model 3B does not differ significantly from Model 3A, there is strong support for the generality of the self-concepts measured by the three different instruments.

<u>Summary</u>

The Shavelson model posited academic self-concept to be multifaceted. This contention was supported in that VSC, MSC and SSC were consistently differentiated in responses to three different self-concept instruments. The Shavelson model proposed that specific facets of academic self-concept could be explained by one higher-order facet of academic self-concept, but the results of the present investigation suggest that the hierarchy is more complicated. Consistent with the revision proposed by Marsh and Shavelson (1985), two second-order academic facets -- math/academic and verbal/academic -- were required instead of just one. This was necessary because of the lack of correlation between Math and Verbal self-concepts. Since the earlier study was based on responses to SDQ instruments, the results of the present investigation based on responses to the SDQ III, the API, and the SCA support the generality of the earlier finding.

The Marsh/Shavelson Model: Current Status and Future Directions

Existing support for the Marsh/Shavelson model is based primarily on demonstrating apparent problems with the original Shavelson model, but this is a weak basis of support. The revised model has not been specified in sufficient detail nor has appropriate research been conducted to adequately evaluate it. Hence it is important to more fully define the model and directions of future research. Figures 1A and 1B show possible representations of the academic portion of self-concept as posited by Shavelson et al. (1A) and by Marsh and Shavelson (1B). A more general discussion of the Shavelson model is presented elsewhere (Marsh & Shavelson, 1985; Shavelson & Bolus, 1982; Shavelson et al., 1976) and discussion here will focus on the structure of academic self-concept. The primary distinction between Figures 1A and 1B is the hypothesis of just one general facet of academic self-concept in Figure 1A compared to two hierarchical facets in Figure 1B. There are, however, other issues that require further consideration and additional research.

The Lack of Correlation Between Verbal/academic and Math/academic Factors

The Marsh/Shavelson model (Figure 1B) requires the higher-order factors to be sufficiently uncorrelated so that they can be differentiated and cannot be collapsed into a single higher-order dimension as in Figure 1A. However, a growing body of research, including the present investigation, suggests that these two higher-order self-concepts are uncorrelated. Furthermore, this lack of correlation has important implications for how facets of academic self-concept relate to corresponding areas of academic achievement. For example, math achievement contributes substantially to MSC, but once the effect of verbal achievement has been controlled the contribution of math achievement to VSC is negative. Similarly, once the effect of math achievement has been controlled the contribution of verbal achievement to MSC is negative. Because empirical and theoretical supoort for this aspect of the model have been described in detail elsewhere (e.g., Marsh, 1986b) they will not be reviewed further.

The lack of correlation between MSC and VSC, and the corresponding need for two higher-order academic facets is the strongest basis of support for Figure 1B. Nevertheless, this support comes primarily from correlational studies based on responses to highly structured instruments collected at a single point in time. Further research is needed that examines these relations: a) in experimental or quasi-experimental designs (though we are generally suspicious of "one-shot" laboratory manipulations that claim to alter self-concept); b) longitudinally using powerful covariance structure modeling (e.g., Byrne, 1986; Shavelson & Bolus, 1982); and c) with data collection procedures that allow subjects to form their own structure as with the repertory grid technique (e.g., Bannister & Mair, 1968) instead of imposing on them the structure implicit in the design of the self-concept instrument.

The Range of Specific Academic Facets

The specific facets of academic self-concept in Figure 1B were chosen to broadly represent academic subjects studied by students in most Western countries. It should be emphasized that these specific academic facets are not exhaustive in that other school subjects may be important for some students. Similarly, it may be that some of the school subjects in Figure 1B are not relevant to all students (e.g., not all students study a foreign language). Each of the specific facets of academic self-concept may be defined by even more specific components as indicated by the lines leading to each specific facet. For example, Math self-concept may have subcomponents related to algebra, geometry, and calculus, whereas English self-concept may have subcomponents related to literature, composition, and grammar.

The model in Figure 1B requires the specific academic facets to be well defined and differentiable from each other. Based on research with MSC and VSC we further contend that these specific facets of academic self-concept will be more clearly differentiated than the corresponding academic achievements. The specific facets in Figure 1B are ordered from relatively pure measures of verbal/academic self-concept to relatively pure measures of math/academic self-concept. Consistent with this ordering, specific factors on either end of the continuum are posited to load on only one higher-order factor whereas those in the middle load on both.

SSC is a different kind of construct than the more specific facets in Figure 1B in that it is much broader. Its inclusion is justified because it marks the midpoint of our continuum and also because it has traditionally been the only indicator of academic self-concept (see discussion below). The results reported here suggest that most of the reliable variance in SSC can be incorporated into the two hierarchical facets but that there is also a small amount of unique variance that cannot. This unique variance might represent the influence of social aspects of school (e.g., peer relations, extra-curricular activities, etc.). Support for this suggestion comes from the finding that self-concepts of Peer Relations tend to be more highly correlated with SSC than with either MSC or VSC in SDQ research. The unique variance in SSC may also represent the influence of other courses (e.g., art, music, physical education, industrial arts, home economics, etc.) that cannot be explained by the two hierarchical facets.

In contrast to the wide array of academic self-concepts posited in Figure 1B, tests of the model have been limited primarily to MSC, VSC, and SSC. The lack of correlation between MSC and VSC justifies the need for more than one higher-order facet of academic self-concept, but there are logical and technical problems in trying to define two higher-order factors on the basis of only three lower-order factors. More importantly, while the empirical findings indicate that at least two higher-order factors are necessary, there is weak support for the claim that two are sufficient. Adequate tests of the model require a much broader array of specific academic self-concepts than has been considered in existing research. The original Shavelson model posited a single higher-order academic self-concept but subsequent research showed academic self-concept to be more differentiated than anticipated. A similar fate may befall the Marsh/Shavelson model when it has been more fully tested.

The Theoretical and Empirical Role of General Academic Self-concept

There is ambiguity in the role and definition of general academic self-concept that resembles issues in the definition of general self-concept (see Marsh, 1986a). Historically, to the extent that academic and nonacademic self-concept were even distinguished, a general academic self-concept was emphasized instead of specific academic facets. Specific facets of academic self-concept were relegated a relatively minor role except in research that focused on particular areas of academic achievement. Even here, researchers typically considered only one specific facet of academic self-concept. Because of the increased emphasis on specific facets of academic self-concept and because of the demonstration that specific academic self-concepts cannot be adequately explained in terms of a single construct, the role of general academic self-concept is unclear.

Marsh (1986a) described five operational definitions of general self-concept that can be applied to general academic self-concept: (a) a hierarchical general academic self-concept such as appears at the apex of Figure 1A; (b) SSC-like scales that are relatively unidimensional, relatively content free, and typically can be reworded so as to apply to specific academic facets; (c) an aggregate academic self-concept based on a collection of academic-related items that typically confound specific and general components; (d) a discrepancy general academic self-concept based on the difference between ratings of specific facets (actual ratings) and ideal ratings; and (e) a weighted average general academic self-concept in which specific facets are weighted according to their salience, value or importance. Shavelson et al. (Figure 1A) posited a hierarchical general academic self-concept and did not consider other definitions of general academic self-concept. Whereas a single hierarhical factor is apparently inadequate, the two hierarchical facets posited in Figure 1B may suffice. Figure 1B has the further advantage of incorporating both the SSC scale and hierarchical factors into the same theoretical model. According to this formulation, SSC reflects roughly equal portions of math/academic and verbal/academic self-concept, and, perhaps, an unique component. The aggregate form of general academic self-concept is theoretically and empirically weak, and its continued use is not recommended. Although the discrepancy and weighted average approaches have been used to define general self-concept, technical problems hinder their application and their empirical support is apparently weak. Furthermore, they apparently have not been examined in academic self-concept research.

There is no clear agreement about how general academic self-concept should be defined, but a more basic consideration is whether it is a useful construct. Existing research suggests that general academic self-concept, no matter how it is defined, cannot adequately reflect the diversity of specific academic facets. If the role of academic self-concept research is to better understand the complexity of the self in an academic context, to predict academic behaviors and accomplishments, to provide outcome measures for academic interventions, and to relate academic self-concept to other constructs, then the specific facets of academic self-concept are more useful than a general facet. Even when the logical emphasis of research is on one specific component of academic self-concept (e.g., MSC), the inclusion of other academic facets (e.g., VSC) in the same study may be theoretically valuable and provide an effective control for some types of response bias. For these reasons we recommend tha academic self-concept research should emphasize multiple specific facets rather than a single general facet of academic self-concept. From this perspective, undue emphasis on alternative theoretical and operational definitions of general academic self-concept may be counterproductive.

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Table 1

Parameter Estimates for the First-order Factor Structure (Model 1)

Measured Variables	First-order Factor Loadings For: SDQ Verb	SDQ Math	SDQ Schl	API Verb	API Math	API Schl	SCA Verb	SCA Math	SCA Schl	Error/ Unique- ness
SDQ Verb 1	.77	0	0	0	0	0	0	0	0	.41
SDQ Verb 2	.76	0	0	0	0	0	0	0	0	.42
SDQ Verb 3	.67	0	0	0	0	0	0	0	0	.55
SDQ Math 1	0	.93	0	0	0	0	0	0	0	.13
SDQ Math 2	0	.92	0	0	0	0	0	0	0	.16
SDQ Math 3	0	.87	0	0	0	0	0	0	0	.24
SDQ Schl 1	0	0	.82	0	0	0	0	0	0	.33
SDQ Schl 2	0	0	.88	0	0	0	0	0	0	.22
SDQ Schl 3	0	0	.88	0	0	0	0	0	0	.23
API Verb 1	0	0	0	.82	0	0	0	0	0	.33
API Verb 2	0	0	0	.78	0	0	0	0	0	.38
API Verb 3	0	0	0	.79	0	0	0	0	0	.37
API Math 1	0	0	0	0	.95	0	0	0	0	.10
API Math 2	0	0	0	0	.87	0	0	0	0	.25
API Math 3	0	0	0	0	.89	0	0	0	0	.21
API Schl 1	0	0	0	0	0	.86	0	0	0	.25
API Schl 2	0	0	0	0	0	.69	0	0	0	.53
API Schl 3	0	0	0	0	0	.65	0	0	0	.58
SCA Verb 1	0	0	0	0	0	0	.80	0	0	.37
SCA Verb 2	0	0	0	0	0	0	.93	0	0	.14
SCA Verb 3	0	0	0	0	0	0	.83	0	0	.31
SCA Math 1	0	0	0	0	0	0	0	.95	0	.10
SCA Math 2	0	0	0	0	0	0	0	.96	0	.08
SCA Math 3	0	0	0	0	0	0	0	.87	0	.25
SCA Schl 1	0	0	0	0	0	0	0	0	.81	.35
SCA Schl 2	0	0	0	0	0	0	0	0	.89	.20
SCA Schl 3	0	0	0	0	0	0	0	0	.78	.40

Factor Correlations

SDQ Verb	---								
SDQ Math	-.01	---							
SDQ Schl	.47	.49	---						
API Verb	.87	.00	.51	---					
API Math	.06	.94	.51	.14	---				
API Schl	.45	.42	.76	.55	.51	---			
SCA Verb	.65	.05	.52	.75	.10	.45	---		
SCA Math	.02	.87	.46	.03	.86	.45	.14	---	
SCA Schl	.39	.53	.78	.43	.56	.68	.64	.65	---

Note. Factor loadings and factor correlations are presented in standardized form to facilitate interpretation. Each of the nine sets of subscales represents the sum of responses to a third of the items in the corresponding self-concept scale.

[a] Verb=Verbal; Math=Math; Schl=School; SDQ=Self Description Questionnaire; API=Affective Perceptions Inventory; SCA=Self Concept of Ability.

Table 2

Goodness of Fit Indicators for All CFA Models

Model	X^2	df	BBI	TLI
0	19784	351	0	0
1	1390	288	.93	.93
1A	6714	324	.66	.64
2	3792	315	.81	.80
3	1972	311	.90	.90
4	1841	312	.91	.91
3A	1975	312	.90	.90
3B	1991	320	.90	.91

Note. The null model (Model 0) is of no substantive interest, but is used in the definition of the Bentler Bonett Index (BBI) and the Tucker Lewis Index (TLI). Models 1 and 1A each posited 9 first-order factors and no higher-order factors, but differed in that correlations among the nine factors were freely estimated in Model 1 but fixed to be zero in Model 1A. One, two and three higher-order factors were posited to explain correlations among first-order factors in Models 2, 3 and 4 respectively (see Table 3). In Model 3A the correlation between the two higher-order factors was fixed to be zero, and in Model 3B the same content factors from the different instruments were required to have the same factor loading on each of the higher-order factors (see Table 3).

Table 3

Second-Order Factor Loadings and Correlations in Five Hierarchical Models

First[a] order factor	Model 2	Model 3		Model 4			Model 3A		Model 3B[b]	
	General Academic	Verb/ Acad	Math/ Acad	Verb	Math	Schl	Verb/ Acad	Math/ Acad	Verb/ Acad	Math/ Acad
	Factor Loadings of First-order Factors on Second-order Factors									
SDQ										
Verb	.10	.82	0	.87	0	0	.82	0	.83	0
Math	.95	0	.97	0	.97	0	0	.97	0	.97
Schl	.56	.61	.49	0	0	.88	.62	.50	.61	.53
API										
Verb	.13	.89	0	.95	0	0	.89	0	.88	0
Math	.96	0	.96	0	.96	0	0	.96	0	.96
Schl	.54	.60	.46	0	0	.82	.61	.47	.58	.50
SCA										
Verb	.16	.83	0	.80	0	0	.83	0	.83	0
Math	.90	0	.90	0	.90	0	0	.90	0	.91
Schl	.64	.58	.57	0	0	.88	.59	.59	.63	.55
	Correlations Among Second-Order Factors									
1[c]	1.0	1.0		1.0			1.0		1.0	
2		.07	---	.07	---		0	---	0	---
3				.64	.62	---				

Note. The five hierarchical models are summarized in Table 2. The parameter estimates are presented in standardized form to facilitate intepretations. All estimated parameters were statistically significant except for correlations between the math/academic and verbal/academic factors (Model 3) and between the math and verbal factors (Model 4). A description of the design matrices used to estimate these parameters is presented by Marsh and Hocevar (1985).

[a] Verb=Verbal; Math=Math; Schl = School; SDQ = Self Description Questionnaire; API = Affective Perceptions Inventory; SCA = Self Concept of Ability. [b] Matching factors from the three self-concept instruments were constrained to have the same factor loadings for a given second-order factor in the unstandardized form. When the factor loadings were standardized, however, the factor loadings varied somewhat. [c] The number of second-order factors varies between 1 and 3 depending on the model.

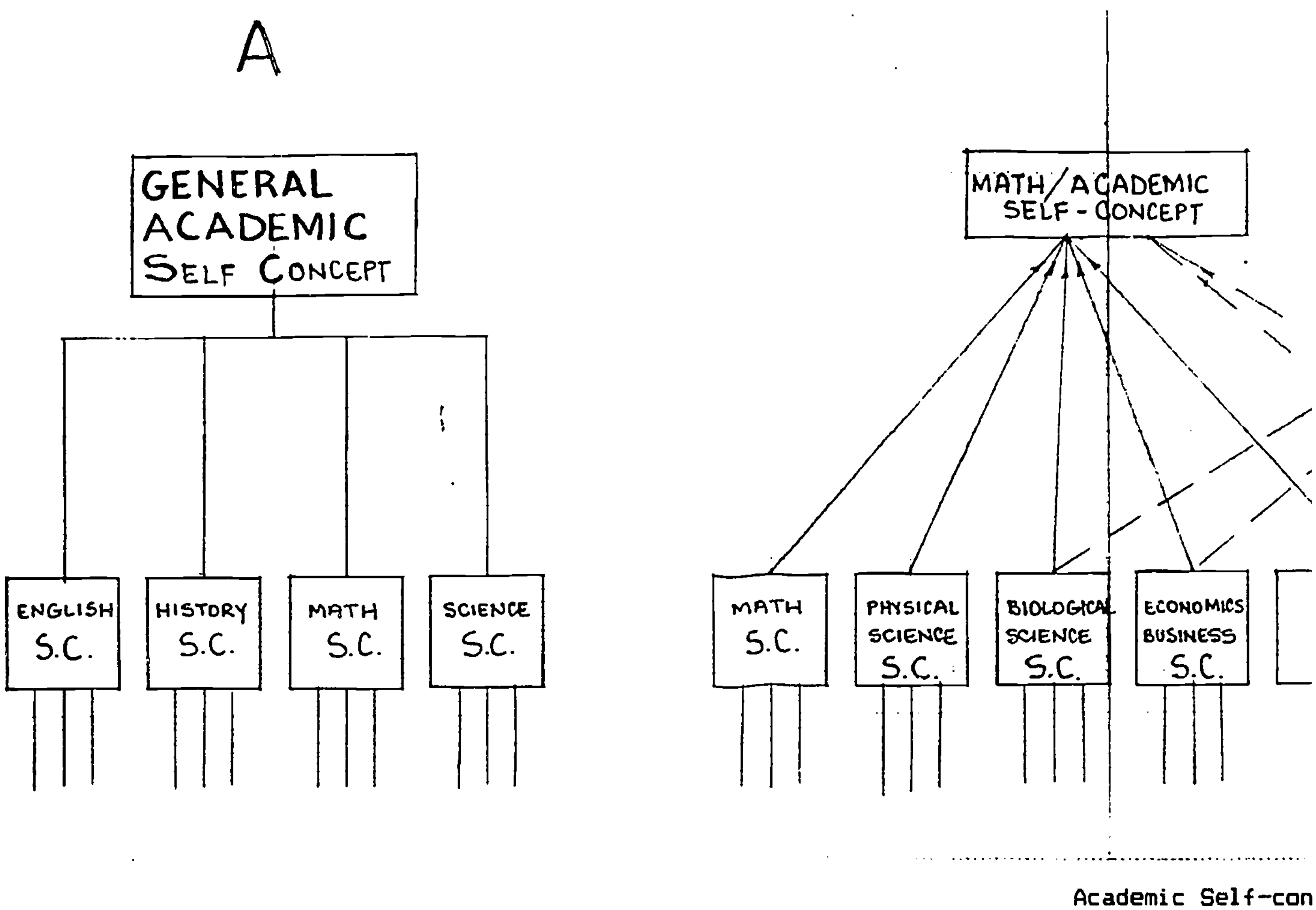

Figure Captions

Figure 1. The academic portion of the Shavelson m

Marsh/Shavelson revision (B).