An Extension of the Internal/External Frame of Reference Model: ©

A Response to Bong (1998)

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Abstract

Bong (1998) extended the internal/external frame of reference (I/E) model by attempting to operationalize the internal and external comparison processes that are central to the model and expanding the range of academic self-concept domains. Bong concluded that the "I/E failed to receive clear support" (p. 102) in relation to predictions that she derived from her extension of the original model. Our critical evaluation and reanalysis, however, reveals potential complications in the operationalization of the internal and external comparisons, the rationale for post hoc confirmatory factor analysis models and the use of correlated uniquenesses, and, thus, the original conclusions. The failure to appropriately operationalize the internal-external distinction based on the items used in the study meant that new tests of this distinction could not be pursued appropriately. The reanalysis, however, provided strong support for the original I/E model and a new extension to incorporate a wider range of academic domains consistent with Bong's original intent.

The Internal/External Frame Of Reference (I/E) Model (Marsh, 1986, 1990, 1993; Marsh, Byrne, & Shavelson, 1988) was developed to explain why math and verbal self-concepts are almost uncorrelated even though corresponding areas of academic achievement are substantially correlated (typically .5 to .8, depending on how achievement is measured). According to the I/E model, academic self-concept in a particular school subject is formed in relation to two comparison processes or frames of reference. The first is the typical external (social comparison) reference in which students compare their self-perceived performances in a particular school subject with the perceived performances of other students in the same school subject. If they perceive themselves to be better than other students then they have a high academic self-concept in relation to that domain. The second is an internal (ipsative-like) reference in which students compare their own performance in
one particular school subject with their own performances in other school subjects. An understanding of ipsative scores is important to understanding this second comparison process. A set of ipsative scores must sum to a constant for each student (a common example of ipsative scores are ranks). Thus, an increase in any one score must be accompanied by a decrease in the mean of the remaining scores (if the rank of any one score increases then the rank of some other score must fall). For this reason, the average correlation among a set of ipsative scores must be negative. Depending upon how these two processes are weighted, the joint operation of the two processes is consistent with the low correlations typically found between math and verbal self-concepts. It is, however, important to emphasize that support for the I/E model does not require that the correlation between math and verbal self-concepts be zero, but only that it be substantially less than the typically substantial correlation between math and verbal achievement.

*Insert Figure 1 About Here*

Stronger tests of the I/E model are possible when math and verbal achievements are related to math and verbal self-concepts (see Figure 1A). The external comparison process predicts that good math skills lead to higher math self-concept and that good verbal skills lead to higher verbal self-concept. According to the internal comparison process, however, good math skills should lead to lower verbal self-concept (once the positive effects of good verbal skills are controlled). The better I am at mathematics, the poorer I am at verbal subjects (relative to my good math skills). Similarly, better verbal skills should lead to lower math self-concept (once the positive effects of good math skills are controlled). In models used to test this prediction (Figure 1A), the paths leading from math achievement to math self-concept and from verbal achievement to verbal self-concept (the solid lines in Figure 1A) are predicted to be positive. However, the paths leading from math achievement to verbal self-concept and from verbal achievement to math self-concept (the dashed lines in Figure 1A) are predicted to be negative. Support for these predictions comes from a large body of research based on a variety of different self-concept measures and from a variety of different countries (Marsh, 1990; Marsh, Byrne, & Shavelson, 1988; Marsh & Craven, 1997) and for longitudinal data (Marsh & Yeung, in press). Despite the robustness of the findings, there is a need for further research extending the model and underlying theory in many directions. In this respect, the extensions of the I/E model proposed by Bong (1998) make a useful contribution to existing research.


Bong (1998) extended tests of the I/E model by attempting to make explicit the implicit distinction between the internal and external processes posited in the I/E model and extending the range of specific school subjects considered. In particular, she measured self-concepts in specific school subjects (English, Spanish, history, algebra, geometry, and chemistry) as well as the more global math and verbal domains that have been the primary focus of I/E research. (For present purposes we use the term "global" to refer to the first-order factors measured by these global math and global verbal items and reserve the terms higher- or second-order factors to those factors resulting from higher-order factor analyses). Using a 7-point response scale [1 = very poor, not true at all, ... 7 = very good, very true], students responded to two internal items [Compared to my ability to learn other subjects, my ability to learn (specific school subject) is; Compared to my grades in other school subjects, I usually get better grades in (specific school subject)] and two external items [Compared to the ability of my friends and classmates, my ability to learn (specific school subject) is; Compared with my friends and classmates, I usually get better grades in (specific school subject).] Bong's major conclusions were that: "The I/E model failed to receive clear support with (a) subject-specific self-efficacy and (b) frame specific self-concepts" (p. 102) [self-
concept responses designed to distinguish between the internal and external comparison processes].

We fully endorse the importance of Bong's intent to operationalize measures of the internal and external processes that have been implicit in previous I/E research and to extend the model to incorporate a wider range of more specific academic domains. We do, however, have a number of concerns about Bong's underlying assumptions, the success of her operationalization of the internal and external processes, the conduct of the CFAs, and, thus, her major conclusions.

**Operationalization of Internal and External Self-concepts**

An implicit, untested assumption in the Bong (1998) study is that the internal and external processes posited in the I/E model are captured by Bong's new items. If these items do not represent these underlying processes, than any conclusions based on the results in relation to theoretical predictions may be inappropriate. Particularly important are tests of the construct validity of the Bong's internal self-concept scales as an adequate representation of the ipsative process posited in the I/E model. Two such tests are:

1. Ipsative scores, by definition, must sum to a constant so that an increase in any one score must be accompanied by an equal decrease in the remaining scores. Thus, it follows as a well-known mathematical necessity that the average correlation among a set of ipsative scores must be negative. The 15 correlations among the six internal scores for specific school subjects (Bong, 1998, Table 2, p. 106) are all positive, varying from .04 to .75 (mean $r = .266$). These results make it clear that the internal scales for specific subjects have not appropriately mirrored the ipsative internal-comparison process posited in the I/E model. It is, however, interesting to note that the correlations among the internal scores are less than the corresponding correlations among the external scores (mean $r = .380$) so that responses to these items may have captured some of the internal comparison process.

2. Because ipsative scores must sum to a constant, the mean ipsative score should not be correlated with any other variables. In the context of the present investigation, for example, the mean of the internal self-concept scores should be uncorrelated with the mean school grade and uncorrelated with the mean external score. Again, this test of the construct validity of the internal self-concept scores fails. The mean internal score (across the 6 specific school subjects) correlates .39 with the mean school grade and .81 with the mean external score.

In summary, responses to Bong's internal items fail these most basic tests of appropriately representing the ipsative process in the I/E model. Hence, any evaluation of the internal comparison process based on these responses must be viewed with caution and any claims that the results violate predictions based on the I/E model may be premature. It seems likely that students were not able to isolate the internal and the external frames of reference that were explicit in the ratings of specific school subjects. For example, the internal ratings that are such an important basis of Bong's research are likely to be influenced substantially by an external frame of reference (e.g., if I am a good student with a positive academic self-concept, I give higher ratings to all the internal items, whereas if I am a poor student with a poor academic self-concept I give lower ratings to all the internal items). Similarly, it is likely that the external ratings are also influenced to some extent by an internal frame of reference. Hence, a plausible counter-explanation for what Bong referred to as paradoxical results is that the internal and external scores were sufficiently confounded so that self-concept factors combining the internal and external scores behaved appropriately even though factors based on separate internal and external scores did not.
A Reanalysis of Bong (1998)

Our reanalysis is based on raw data provided by the author of the original study and the reader is referred to the original study (Bong, 1998) for a more detailed description of the sample, procedures, and methods. The simultaneous extension in two different directions (the separation of self-concept into internal and external scales, and the addition of self-concepts in specific subjects) makes it difficult to evaluate the original I/E model in relation to these extensions. The fact that the internal self-concepts in the specific subjects apparently do not capture ipsative nature of the internal comparison process posited in the I/E model complicates any evaluation of its extension to include additional academic domains. For example, even though every correlation among the six specific self-concept factors was positive (the average was supposed to be negative) there was a significantly negative correlation between the internal math and internal verbal scores (-.18) based on the global math and verbal self-concept ratings. This is important because these global domains more closely approximate those posited in the original I/E model. At least in this respect, these global math and verbal self-concept responses may provide better support for Bong's operationalization of the internal and external comparison processes than her self-concepts in specific school subjects. For these reasons, we begin with simpler models in three stages to evaluate: (1) the structure of self-concept based on the subject specific and global self-concepts (but not the achievement scores); (2) path models of the relations between global verbal and math self-concepts (but not specific self-concept ratings) and corresponding achievement scores; and (3) path models combining the achievement scores with global and specific components of self-concept.

Specific and Global Academic Self-concepts: The Construct Validity of Internal and External Self-concepts

Consistent with the strategy used by Bong (1998) we begin with a model of the internal and external components of the eight self-concept domains. We, however, consider a wider variety of models than presented by Bong and compare the results of the various models as a guide to interpreting the results. In all analyses we start with responses to individual items rather than the item-pair responses used by Bong. Our basis for this decision is that a critical feature in these analyses is to evaluate relations among the 16 self-concept factors representing the combination of the two comparison frames (internal and external) and the eight academic domains. Bong had only two items to represent each of these factors (at least 4 items would have been preferable, or even more given that these were new items attempting to measure new constructs).

This decision to do analyses at the item level also has important implications for the appropriate inclusion of correlated uniquenesses to account for method effects due to the use of parallel worded items. Following from earlier discussion, all analyses in this investigation included correlated uniquenesses between items designed to measure different domains that have the same wording (e.g., the parallel worded items designed to measure internal and external self-concepts in different domains). In support of this decision, preliminary results consistently showed that such correlated uniquenesses were needed. For these reasons, we begin our analyses with 32x32 correlation matrix (8 domains x 2 comparison frames x 2 items) and focus on a priori models with correlated uniquenesses to account for method effects associated with the parallel wording of items.
Separate Internal And External Self-Concept Factors

Model 1 (Table 1) posits 16 first-order factors (8 domains x 2 comparison frames), each based on responses to two items. In Model 1 the factor loadings (not shown) were consistently high (.74 - .94, median = .89). The correlations among the 16 factors, however, cast some doubt on the appropriateness of Model 1. In particular, even though none of the estimated factor correlations is "out-of-range" (i.e., greater than 1.0), the matrix of factor correlations is nonpositive-definite. An inspection of the correlation matrix (Table 1) shows that correlations between the matching internal and external factors for the same domain are extremely high; 7 of 8 are .95 or higher (the one exception being the .89 correlation between the global internal and external verbal factors) and typically do not differ significantly from 1.0. Consistent with earlier observations, this suggests that students were unable to differentiate between internal and external comparison factors as operationalized in this study. This leads us to consider the corresponding 8-factor model in which four items from the same self-concept domain (two internal and two external) all loaded on the same factor.

Combined Internal And External Self-Concept Factors

Model 2 (Table 1) posits 8 self-concept (domain) factors, each based on responses to four (2 internal and 2 external) items. Factor loadings were again very high (.73 - .92, median = .88). Importantly, the matrix of factor correlations (Table 1) is fully proper. Consistent with the I/E model, the correlation between the global math and global verbal factor (r = .01) is close to zero. Although none of the other factor correlations is this low, the pattern of correlations is mostly reasonable. Thus, for example English self-concept correlates .03 to .13 with Algebra, Geometry, global math, and Chemistry (classified as "math" self-concepts by Bong). Whereas history is moderately correlated with these math self-concept factors (.16 to .35), it is more highly correlated with English (.55) and global verbal (.44) self-concepts. Similarly, algebra and geometry self-concepts are more highly correlated with the math self-concepts than the verbal self-concepts. Although chemistry is moderately correlated with some of the verbal self-concept factors, it is more highly correlated with the other math self-concept factors.

Spanish self-concept, however, is an important exception to this predictable pattern of results. Although Bong modeled Spanish as one of the verbal factors, Spanish self-concept is nearly uncorrelated with the other three verbal factors (.10 to .13) and is somewhat more highly correlated with the four math self-concepts (.22 to .27). Furthermore, inspection of correlations among grades in the different school subjects (Bong, 1998, Table 2, p. 106) shows a similar problem for Spanish achievement in that it is as highly correlated with algebra, geometry, and chemistry achievements (.28 to .32) as with English (.32) and history (.25) achievements. Although somewhat unexpected, this pattern of results is probably attributable to the fact that a majority of the students in this study were native Spanish speakers. For these students it may be reasonable that English and Spanish are seen as quite distinct and that they may feel more positively about subjects that are not so demanding of their possibly limited English skills. Although this pattern of results was not anticipated, we pursue it further in a subsequent extension of the I/E model.

Self-concept Models of Separate and Combined Internal and External Factors

The juxtaposition of the models positing separate (Model 1) and combined (Model 2) internal and external self-concept scales is central to our reanalysis. These results clearly show that students are not able to differentiate between the internal and external factors (factor correlations approach 1.0) and that these two components can be collapsed into a single
factor for each of the domains (the TLI is the same for Models 1 and 2). These results undermine conclusions based on the assumption that these internal and external self-concept scores fully and adequately reflect the internal and external comparison processes in the I/E model. These initial results also provide support for the a priori prediction that correlated uniquenesses are needed to control for method effects associated with items having parallel wording. (Because all subsequent models are based on relations among the same self-concept factors considered in Models 1 and 2 and because the results based on these comparisons generalize to the subsequent models, we do not discuss further the results of models without correlated uniquenesses.)

Global Math and Global Verbal Self-concept: Their Relation to Achievement

Because most I/E research has focused on global math and verbal self-concept measures, we begin by considering models of only these responses. In order to have multiple indicators of each of the four self-concept scales (internal and external scales for the Math and verbal domains), analyses are conducted with individual items. In order to have multiple indicators of the math and verbal achievement factors we used algebra and geometry grades to represent math achievement and English and history grades to represent verbal achievement. Although the use of history to represent verbal achievement is not entirely satisfactory, Bong's results show that history achievement is more highly correlated with English ($r = .52$) than either of the mathematics achievements (.28 and .25 respectively) and this correlation is slightly higher than the correlation between the two mathematics subjects (.52 vs. .46).

In Model 4 (Table 2), self-concept factors combining the internal and external items for each domain are posited. Model 4 is well defined in that all factor loadings are substantial, the solution is fully proper, and the fit is reasonable (TLI = .92). Importantly, results again provide strong support for the original I/E model. In particular, the correlation between verbal and math self-concept is close to zero ($r = .02$), math achievement has a positive effect on math self-concept but a negative effect on verbal self-concept, and verbal achievement has a positive effect on verbal self-concept but a negative effect on math self-concept. In summary, the results of these models provide very good support for the original I/E model.

Subject Specific and Global Self-concepts and their Relation to Achievement

For purposes of models summarized in Table 3, we added self-concept scales for four specific school subjects (English, history, algebra, and geometry) corresponding to the four achievement scores considered in Table 2 (see earlier discussion). For now we have excluded the Spanish domain that seems to be qualitatively different from the other "verbal" domains and chemistry (but we include these domains in subsequent analyses). The models are like those considered in Table 2 in that we begin with responses to individual items, posit two achievement factors (verbal and mathematics), and compare the results of two sets of models - one with separate internal and external self-concept factors for each domain and one with the internal and external items from the same domain combined to form a single factor. Again, only the most important parameters for evaluating predictions of the I/E model are presented (Table 3); correlations among factors and the path coefficients relating the achievement factors to each of the self-concept factors.

Insert Table 2 About Here

Insert Table 3 About Here
Combined Internal and External Self-concept Factors

Model 6 (Table 3) posits a single self-concept factor for each of the six domains, combining the internal and external items from the same domain into a single factor. Model 6 provides clear support for the original I/E model. Correlations among English, history, and verbal self-concept factors (.44 to .70) and among the algebra, geometry, and math self-concept factors (.69 to .80) are all substantial. In contrast, the correlations between these two sets of factor (.01 to .28) are much smaller. The smallest factor correlation (.01) is the near-zero correlation between the global math and global verbal self-concept factors. Path coefficients from verbal achievement are large and substantial for English, history, and verbal self-concepts (.34 to .61), but negative for algebra, geometry, and math self-concepts (-.21 to -.34). In contrast, the paths from math achievement are negative for English, history, and verbal self-concepts (-.13 to -.24), but substantial and positive for algebra, geometry, and math self-concepts (.68 to .82).

Higher-order Factor Model of the Combined Internal and External Self-concept Factors

Following Bong (1998) we next consider a higher-order factor model (Model 7, Table 4) that follows from the first-order factor model (Model 6) just considered. More specifically, Model 7 posits that relations between achievement factors and self-concept responses can be explained in terms of a higher-order verbal self-concept (incorporating the English, history, and verbal first-order factors) and a higher-order math self-concept (incorporating the algebra, geometry, and math first-order factors). Four indicators, combining the internal and external items from the same domain into a single factor, defined each of the six first-order factors. The higher-order factors are well defined in that higher-order factor loadings relating English, history, and verbal (first-order) factors to the higher-order verbal factor (Table 4) are all substantial as are the higher-order factor loadings relating the algebra, geometry, and math (first-order) factors to the higher-order math self-concept factor. This model was proper and provides a reasonable fit to the data (TLI = .93).

Model 7 is important because it provides a direct test of the original I/E model based on the extended set of academic domains including both internal and external self-concept responses and including both the subject specific and global first-order factors. Consistent with the I/E model, verbal achievement has a positive effect on the higher-order verbal self-concept but a negative effect on the higher-order math self-concept (Table 5, Figure 2). Also consistent with a priori predictions, math achievement has a negative effect on the higher-order verbal self-concept but a positive effect on the higher-order math self-concept. It is also important to note that the correlation between the higher-order math and verbal self-concepts is small and substantially smaller than the correlation between the two achievement factors (.16 vs. .52, Table 4).

Although the $\chi^2$ is better for Model 6 than for Model 7 (see Tables 3 and 4), the TLI that takes into account the improved parsimony of model 6 (it has 16 fewer estimated parameters than Model 7) is the same for both models (.93). Whereas Model 7 may be preferable to Model 6 because of its parsimony and provision of direct tests of the I/E model, the interpretations of the two models are very similar.

Extension of the I/E Model to Include Spanish

In the final set of results, we expand models of the relations of achievement to global and specific self-concepts by including the Spanish and chemistry domains. Whereas chemistry
may be less "mathematical" than algebra and geometry, its incorporation into the model as an additional math factor caused no major difficulties. Earlier analyses, however, suggest that the incorporation of Spanish into the model is more problematic. In particular, Spanish (both self-concept and achievement) seems very distinct from the other academic domains. Although Bong did not deal directly with this problem, we chose an alternative strategy to represent extensions of the I/E model to incorporate a wider variety of academic domains - one that we feel is more consistent with Bong's original intent than the strategy that she actually pursued. In particular, whereas most tests of the I/E model are based on verbal and math domains, this is not inherent to the logic of the I/E model (e.g., Marsh & Craven's, 1997, metaphoric extension of the I/E model to physical self-concept based on yet to be devised tennis and golf self-concept scales).

In order to incorporate the Spanish domain, we extend the I/E model (as operationalized in Models 6 and 7) to include three domains: verbal (English, history, and verbal), math (algebra, geometry, math, and chemistry); and Spanish (Spanish by itself). Based on the logic of the I/E model, to the extent that Spanish serves as an additional basis of comparison for different school subjects, the effect of Spanish Achievement should be positive on Spanish self-concept but negative on verbal and math self-concept factors and the effects of math and verbal Achievement on Spanish self-concept should be negative. Also, to the extent that other school subjects serve as a basis of comparison for Spanish, the effects of achievement in other school subjects on Spanish self-concept should be negative.

First-order Factor Model

Model 8 (Table 5) posits three achievement factors (verbal, Spanish, and math) and eight self-concept factors. It differs from Model 6 in that chemistry achievement is added to the math achievement factor, Spanish achievement is added as a separate achievement factor, and chemistry and Spanish self-concept factors are added as separate self-concept factors. Model 8 was well defined in that all factor loadings were substantial for achievement factors (.62 to .90, Mdn = .70) and self-concept factors (.72 to .92, Mdn = .87), the fit to the data is reasonable (TLI = .93), and the model is fully proper (i.e., there were no nonpositive-definite matrices). The most critical parameter estimates for evaluating the I/E model are the correlations among the factors and the path coefficients leading from the three achievement factors to the eight self-concept factors (Table 5). Consistent with the original I/E model (and Model 6), verbal achievement has a substantial positive effect on the three verbal self-concept factors and a smaller negative effect on the four math self-concept factors, whereas math achievement has substantial positive effects on the four math self-concept factors and smaller negative effects on the three verbal self-concept factors. The critical new parameters, however, are those involving the Spanish domain. Consistent with the logic of our extension of the I/E model to incorporate Spanish, Spanish achievement has a substantial positive effect on Spanish self-concept and small negative effects on all the remaining verbal and math self-concept factors, whereas the effects of verbal achievement and math achievement on Spanish self-concept are negative.

Model 9 (see Figure 2) is similar to Model 8 except that it posits that the eight self-concept factors and their relations to achievement can be explained in terms of three higher-order self-concept factors (verbal, math, and Spanish). Critical parameter estimates for Model 9 (Table 5) are higher-order factor loadings relating first-order factors to higher-order factors, factor correlations, and path coefficients leading from the three achievement factors to the three higher-order self-concept factors. The higher-order factors are well defined in that all higher-order factor loadings (Table 5, Figure 2) are substantial. Of particular relevance are the path coefficients. These provide very strong support for the original I/E model and its
extension to include Spanish: (a) the effects of verbal achievement are substantially positive for verbal self-concept and negative for the math and Spanish self-concept, (b) the effects of Spanish achievement are substantially positive for Spanish self-concept and negative for math and verbal self-concepts, and (c) the effects of math achievement are substantially positive for math self-concept and negative for verbal and Spanish self-concepts.

Finally, it is useful to compare results for Models 8 and 9. Model 9 is more parsimonious, representing the eight first-order self-concept factors with three higher-order factors (and requiring 33 fewer parameter estimates). It does not, however, fit the data as well although the TLI that penalizes a lack of parsimony is nearly the same (.93 for Model 8, .92 for Model 9). In summary, both Models 8 and 9 provide good support for the predictions from the original I/E model and our extension to incorporate a wider range of academic domains - particularly Spanish.

Summary and Discussion

Bong (1998) proposed two new extensions of the I/E model. First and, perhaps, most importantly, she attempted to operationalize the critical distinction between internal and external comparison processes that is implicit in the I/E model. Second, she extended the range of specific academic domains to include more than the global verbal and math constructs that have been the basis of most I/E research. Although these are important areas for further research, there were potential complications with the operationalization of the constructs, the logic of the new tests, the reported SEMs, and, thus, the conclusions based on the research.

In contrast to her conclusions, our reanalysis found very strong support for the original I/E model. This support was particularly strong for analyses of the global math and global verbal self-concept responses, but was clearly evident for responses to the extended range of academic domains as well. Hence, this extension of the I/E model appears to have been successful.

The most problematic aspect of the original Bong study, perhaps, was the attempted operationalization of the internal and external comparison processes. In particular, the internal comparison items failed to capture the ipsative process that is at the heart of the I/E model. For example, correlations between internal and external comparison factors for the same domain were so very high, mostly .95 or more, that there was little evidence that student responses to these items were able to differentiate between these two aspects of self-concept. Based on our reanalysis, a more appropriate conclusion for this study is that all predictions from the original I/E model were supported and the failure to appropriately operationalize the internal and external comparison processes meant that some interesting new predictions based on Bong’s extension of the I/E model could not be tested appropriately. An important direction for further research is to evaluate broadly the construct validity of the internal and external comparison processes that have not been adequately operationalized in previous research or in the Bong (1998) study that attempted to achieve this goal.

The most important new feature of the present investigation, consistent with the intent of the original Bong (1998) study, is the extension of the I/E model to include a wider range of academic domains. Bong attempted to incorporate a variety of specific academic domains under the higher-order math and verbal factors. Consistent with the growing evidence for the extreme content specificity of academic self-concept, this attempt was not particularly successful. As emphasized here, for example, the attempt to incorporate Spanish as a verbal domain was problematic, a point recognized by Bong when she fit some supplemental models that excluded Spanish. It is, however, important to emphasize that
there is nothing inherent in the I/E model that requires researchers to limit consideration to
global math and global verbal domains or, for that matter, to limit tests of the I/E model to
different facets of academic self-concept. Although nearly all I/E research has been in the
academic arena and considered only global math and verbal domains, it is important for
future research to extend tests of the model along the lines demonstrated here.

In the present investigation, for example, the Spanish domain did not fit very well into either
the higher-order verbal or math factors. However, when we included Spanish as a separate
domain, the model fit much better and there was good support for the extended I/E model in
which more than just two domains are posited. In particular, consistent with this extension of
the original model, the effects of math and verbal achievement on Spanish self-concept were
negative as were the effects of Spanish achievement on math and verbal self-concepts,
whereas the effect of Spanish achievement on Spanish self-concept was strongly positive.
Although this extension is different from the original I/E model, the extension and the results
are clearly consistent with the logic of the I/E model. These findings also make sense and
have potentially important applicability to practice, suggesting that self-concepts in native
and nonnative languages may be very distinct, particularly when mode of instruction is not in
the native language. Thus, not only were Spanish and English self-concept uncorrelated (r =
.01), but Spanish self-concept was more highly correlated to self-concepts in algebra (.21)
and geometry (.23) domains in which potential limitations in English may not be so
important. Although beyond the scope of the present investigation, the results should form
the basis of further research examining the juxtaposition of self-concepts in English and
other languages for native and non-native speakers and how these vary with language of
instruction (or equivalent patterns in non-English speaking countries). More generally, the
extended model also provides a basis for pursuing tests of the I/E model for a more diverse
set of core academic domains like those considered here, noncore academic domains, and
other nonacademic domains as well.
References


Table 1

Confirmatory Factor Analysis Models of Global and Specific Self-concepts: Separate (Model 1) and Combined (Model 3) Internal and External Self-concept Factors

Model 1: 16 Separate Self-concept Factors

Factors IEng XEng IHis XHis IVrb XVrb ISpn XSpn IAlg XAlg IGeo XGeo IMth XMth IChm XChm

IEng 1.00

XEng .97 1.00

IHIS .49 .56 1.00

XHis .49 .63 .95 1.00

IVrb .68 .63 .44 .39 1.00

XVrb .65 .72 .43 .43 .89 1.00

ISpn .07 .13 .11 .10 .15 .12 1.00

XSpn .05 .16 .13 .19 .08 .13 .96 1.00

IAlg .01 .17 .18 .28 -.01 .15 .22 .29 1.00

XAlg .04 .24 .21 .37 -.01 .17 .22 .31 .95 1.00
IGeo .01 .14 .11 .24 .09 .18 .20 .27 .77 .79 1.00
XGeo .05 .24 .15 .33 .05 .22 .20 .26 .72 .82 .95 1.00
IMth -.06 .08 .07 .19 -.19 .07 .15 .23 .76 .77 .66 .64 1.00
XMth -.01 .11 .10 .22 -.14 .09 .18 .27 .75 .79 .69 .70 .95 1.00
ICHm .08 .17 .24 .35 .20 .26 .14 .21 .51 .55 .66 .63 .43 .51 1.00
XChm .07 .22 .26 .42 .17 .28 .18 .30 .52 .61 .64 .68 .46 .53 .95 1.00

Model 2: 8 Combined Self-concept Factors

Variable TEng THis TVrb TSpn TAlg TGeo TMth TChm
TEng 1.00
THis .55 1.00
TVrb .70 .44 1.00
TSpn .10 .13 .12 1.00
TAlg .12 .28 .11 .27 1.00
TGeo .11 .23 .16 .24 .80 1.00
TMth .03 .16 .01 .22 .79 .69 1.00
TChm .13 .35 .24 .22 .57 .67 .51 1.00

Note. Factor correlations for two models are presented. Model 1 posits 16 factors consisting of all combinations of the two frames (I = Internal, X = external) and 8 domains (Vrb = Verbal, Spn = Spanish, Mth = Math, Eng = English, His = history, Alg = algebra, Geo = geometry, Chm = Chemistry). Model 2 posits only the eight domain factors (referred to as T = Total factors to indicate that internal and external items are associate with a single factor). Model 1 with correlated uniquenesses ($\chi^2 = 443.44, df = 232$ RNI = .98 TLI = .96) fits better than the corresponding model with no correlated uniquenesses ($\chi^2 = 1706.78, df = 344$ RNI = .89 TLI = .84), but the matrix of correlations for both models was improper (nonpositive-definite). Model 2 with correlated uniquenesses ($\chi^2 = 688.22, df = 324$ RNI = .97, TLI = .95) also fit better than the alternative Model 2 with no correlated uniquenesses ($\chi^2 = 2689.32, df = 426$ RNI = .82 TLI = .79), but the matrix of correlations for both models was fully proper (i.e. neither was nonpositive-definite).
Table 2

Path Models Relating Verbal and Math Achievement to Global Verbal and Math Self-concepts: Separate (Model 3) and Combined (Model 4) Internal and External Self-concept Factors

Model 4: Combined Int & Ext Factors

Path Coeff Factor Correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>AVrb</th>
<th>AMth</th>
<th>AVrb</th>
<th>AMth</th>
<th>Vrb</th>
<th>Mth</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVrb</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMth</td>
<td>0</td>
<td>0</td>
<td>.54</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vrb</td>
<td>.36</td>
<td>-.13</td>
<td>.29</td>
<td>.06</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mth</td>
<td>-.37</td>
<td>.75</td>
<td>.03</td>
<td>.55</td>
<td>.02</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. Vrb = Verbal, Mth = Math, A = Achievement, I = Internal self-concept scores, X = external self-concept scores. For each latent construct there are two indicators. All parameter estimates are presented in completely standardized form. Parameters with values 0 and 1 were fixed. Presented are two solutions, one with six factors (with separate factors for each of the two -- internal and external -- frames) and one with four factors (with internal and external responses representing the same domain collapsed into a single factor). Goodness of fit is reasonable for Model 3 ($\chi^2 = 109.86, df = 35$, RNI = .97, TLI = .95) and Model 4 ($\chi^2 = 161.20, df = 44$, RNI = .95, TLI = .92) and both solutions were fully proper.

Table 3

Path Models Relating Verbal and Math Achievement to Combined Internal and External Self-concept Factors (Model 6)

Model 6: Combined Int & Ext Factors

Variable Path Coeff Factor Correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>AVrb AMth AVrb AMth Eng His Vrb Alg Geo Mth</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVrb</td>
<td>.00  .00  1.00</td>
</tr>
<tr>
<td>AMth</td>
<td>.00  .00  .53  1.00</td>
</tr>
<tr>
<td>Eng</td>
<td>.47  -.24  .35  .02  1.00</td>
</tr>
<tr>
<td>His</td>
<td>.61  -.21  .49  .11  .55  1.00</td>
</tr>
</tbody>
</table>
Vrb .34 -.13 .27 .05 .70 .44 1.00
Alg -.30 .82 .14 .66 .12 .28 .11 1.00
Geo -.21 .68 .15 .57 .11 .23 .16 .80 1.00
Mth -.34 .72 .04 .54 .03 .16 .01 .79 .69 1.00

Note. A = Achievement, Vrb = Verbal, Mth = Math, Eng = English, His = history, Alg = algebra, Geo = geometry. Presented are path coefficients leading from the two achievement factors to the academic self-concept factors and correlations among all the factors (in completely standardized form). Goodness of fit is reasonable for Model 6 ($c^2 = 732.42$, df = 262, RNI = .95, TLI = .93).

Table 4
Path Model Relating Verbal and Math Achievement to Higher-Order (HO) Verbal and Math Self-concepts (Model 7)

<table>
<thead>
<tr>
<th>Variable</th>
<th>HO Factors</th>
<th>Path Coeff</th>
<th>Factor Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOVrb</td>
<td>HOMth AVrb AMth AVrb AMth Eng His Vrb Alg Geo Mth HOVrb HOMth</td>
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<td></td>
</tr>
<tr>
<td>Second-order Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVrb</td>
<td>.00 .00 .00 .00 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMth</td>
<td>.00 .00 .00 .52 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eng</td>
<td>.91 .00 .00 .41 .04 1.00</td>
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<td></td>
</tr>
<tr>
<td>His</td>
<td>.63 .00 .00 .28 .03 .57 1.00</td>
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<td></td>
</tr>
<tr>
<td>Vrb</td>
<td>.75 .00 .00 .34 .04 .68 .47 1.00</td>
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</tr>
<tr>
<td>Alg</td>
<td>.00 .96 .00 .08 .66 .14 .10 .12 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geo</td>
<td>.00 .83 .00 .00 .07 .57 .12 .08 .10 .80 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mth</td>
<td>.00 .82 .00 .00 .07 .57 .12 .08 .10 .79 .68 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOVrb</td>
<td>.00 .00 .58 -.25 .45 .05 .91 .63 .75 .16 .13 .13 1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOMth</td>
<td>.00 .00 -.37 .88 .09 .69 .15 .10 .12 .96 .83 .82 .16 1.00</td>
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<td></td>
</tr>
</tbody>
</table>

Note. A = Achievement, Vrb = Verbal, Mth = Math, Eng = English, His = history, Alg = algebra, Geo = geometry, HO = higher-order. Presented are higher-order factor loadings relating first-order self-concept factors to the higher-order verbal and math self-concept factors, path coefficients leading from the two achievement factors to the two higher-order self-concept factors, and correlations among all first-order and second-order factors (in
completely standardized form). The internal and external factors for each domain are combined to form a single first-order factor for each domain. Goodness of fit is reasonable ($\chi^2 = 792.73$, df = 278, RNI = .95, TLI = .93) and the solution was fully proper.

Table 5

Path Model Relating Verbal, Spanish, and Math Achievement to Higher-Order (HO) Verbal, Spanish, and Math Self-concepts

<table>
<thead>
<tr>
<th>HO Factors</th>
<th>Path Coeff</th>
<th>Factor Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVrb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSpn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVrb</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>AMth</td>
<td>.00</td>
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<td>ASpn</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Eng</td>
<td>.90</td>
<td>.00</td>
</tr>
<tr>
<td>His</td>
<td>.63</td>
<td>.00</td>
</tr>
<tr>
<td>Vrb</td>
<td>.75</td>
<td>.00</td>
</tr>
<tr>
<td>Spn</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Alg</td>
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<tr>
<td>Geo</td>
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<tr>
<td>Mth</td>
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<tr>
<td>HVrb</td>
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<td>HSpn</td>
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<td>.00</td>
</tr>
<tr>
<td>HMth</td>
<td>.00</td>
<td>.00</td>
</tr>
</tbody>
</table>

Higher-order Model 9

| AVrb | .00 .00 .00 .00 .00 .00 1.00 |
| AMth | .00 .00 .00 .00 .00 .44 1.00 |
| ASpn | .00 .00 .00 .00 .00 .60 .50 1.00 |
| Eng | .90 .00 .00 .00 .00 .41 .02 .07 1.00 |
| His | .63 .00 .00 .00 .00 .29 .01 .05 .57 1.00 |
| Vrb | .75 .00 .00 .00 .00 .34 .01 .06 .67 .47 1.00 |
| Spn | .00 1.00 .00 .00 .00 -.07 .60 .09 .12 .08 .10 1.00 |
| Alg | .00 .00 .92 .00 .00 .11 .21 .61 .15 .10 .12 .26 1.00 |
| Geo | .00 .00 .88 .00 .00 .10 .20 .59 .14 .10 .12 .25 .80 1.00 |
| Mth | .00 .00 .82 .00 .00 .10 .19 .55 .13 .09 .11 .23 .75 .72 1.00 |
| Chm | .00 .00 .68 .00 .00 .08 .16 .45 .11 .08 .09 .19 .62 .59 .56 1.00 |
| HVrb | .00 .00 .00 .66 -.15 -.24 .45 .02 .08 .90 .63 .75 .13 .16 .15 .12 1.00 |
| HSpn | .00 .00 .00 -.37 .81 -.09 -.07 .60 .09 .12 .08 .10 1.00 .26 .25 .23 .19 .13 1.00 |
| HMth | .00 .00 .00 -.43 -.05 .95 .12 .23 .67 .16 .11 .13 .28 .92 .88 .82 .68 .18 .28 1.00 |

First-order Model 8

| AVrb | .00 .00 .00 1.00 |
| AMth | .00 .00 .43 1.00 |
| ASpn | .00 .63 .50 1.00 |
Eng .58 -.10 -.28 .36 .01 .04 1.00
His .67 -.09 -.23 .49 .08 .15 .55 1.00
Vrb .37 -.11 -.07 .28 .01 .10 .70 .44 1.00
Spn -.36 .80 -.08 -.07 .60 .09 .10 .13 .12 1.00
Alg -.39 -.07 .88 .13 .21 .60 .12 .28 .11 .27 1.00
Geo -.36 -.04 .84 .15 .23 .60 .11 .23 .16 .24 .80 1.00
Mth -.43 -.08 .81 .04 .14 .50 .03 .16 .01 .22 .79 .70 1.00
Chm -.19 -.05 .71 .24 .23 .57 .13 .35 .24 .22 .57 .67 .51 1.00

Note. A = Achievement, Vrb = Verbal, Mth = Math, Eng = English, His = history, Spn = Spanish, Alg = algebra, Geo = geometry, Chm = Chemistry, HO = higher-order. Parameter estimates presented for both models are correlations among all factors and path coefficients relating achievement factors to self-concept factors (in completely standardized form) and for Model 9 are higher-order factor loadings relating first-order self-concept factors to the higher-order self-concept factors. Goodness of fit is reasonable for the first-order ($c^2 = 1174.50,$ $df = 499,$ RNI = .95, TLI = .93) and higher-order ($c^2 = 1316.45,$ $df = 532,$ RNI = .94 , TLI = .92 ) solutions, both of which are fully proper.

Figure 1. Predictions based on the traditional I/E model (1A) and the extended I/E model (1B) that incorporates separate internal and external components of each academic self-concept domain.
Figure 2. Higher-order factor model. Eight first-order academic self-concept factors define three higher-order academic self-concept factors that are related to three academic achievement factors. For each domain (Verbal, Spanish, Math), the path from the achievement factor to the matching academic self-concept factor is positive, whereas the paths to the nonmatching self-concept factors are negative.