Personal Style Inventory Item Revision: Confirmatory Factor Analysis

This research was a team effort of Enzo Valenzi and myself. I'm deeply grateful to Enzo for his years of statistical contributions to the development of the PSI.

Abstract

This study was designed to revise the six scales of the Personal Style Inventory: Planning, Analysis, Control, Vision, Insight, and Sharing. Fifteen items for each scale were evaluated using the confirmatory factor analysis procedure of structural equation modeling as implemented in LISREL 8. Each item pool contained the original five items for each scale plus ten items constructed to supplement the original five. Using a convenience sample of 322 subjects, a revised set of five items was chosen from the 15 item pool for each scale.

Several fit measures were examined to determine the adequacy of the model with the revised scales. Measurement model factor loadings were used to evaluate validity and reliability. A test-retest analysis of a 46 subject subsample, coefficient alphas, construct reliabilities, chi-square differences, model ϕ values, and confidence intervals were used to assess reliability, internal consistency, and discriminant validity. It was concluded that the revised scales were a significant improvement over the existing scales.

Introduction

It is well known that people differ in their relative preferences for rational and intuitive ways of dealing with situations. Measurement of personal style frequently is used in personnel development for individual counseling and in group training programs to assess participants' preferences on relevant attributes. Recently, assessment of the *intuitive dimension* of personal style has emerged as a significant theme in management development. A compelling case for the world-wide implications of this emerging emphasis appears in the report of a study of intuition in management (Parikh, Neubauer, & Lank, 1994). In a nine-nation survey of senior managers, they found that 54% were guided equally by intuition and rationality while 8% said they were guided more by intuition (p. 63). The Personal Style Inventory (PSI) (Taggart & Hausladen, 1993) provides an effective and efficient assessment of preferences for rational/intuitive styles.

An early assessment tool designed to help individuals understand their preferences for rational/intuitive styles was published as the Human Information Processing (HIP) Survey (Taggart & Torrance, 1984). The three scales provide scores for an individual's left-dominant (rational), right-dominant (intuitive), and integrated (rational/intuitive) behavior preferences. The PSI evolved as a second-generation measure from extensive field experience with the survey. An idea pool of 500 behavioral items was generated and sorted into six scales (Taggart & Valenzi, 1990).

This pool was used to express preferences for an original set of 90 items grouped into 15 paired items for each of three paired scales. Factor analysis was used to select five items for each scale. In subsequent analysis, the original coefficient alphas were found to be less than desired for some scales. So we wrote 60 more items to evaluate along with the original items to select a revised set of 30 with improved psychometric properties.

The Original PSI

The PSI includes 30 items to assess six information processing modes classified as either a rational or an intuitive style. Responses are based on a six-point rating of frequency anchored by 1 (never) and 6 (always). Adverbial anchors for the numerical scale were selected based on a magnitude estimation scale procedure (Bass, Cascio, & O'Conner, 1974). The scales are paired on three "how do you" themes with contrasting yet complementary rational and intuitive styles for each. This framework presents individuals with a more detailed assessment of their rational/intuitive preferences than the earlier HIP Survey:

How do you prepare for the future?

Rational PLANNING by developing proposals or
Intuitive VISION by generating scenarios

How do you solve problems?

Rational ANALYSIS as a specialist or
Intuitive INSIGHT as a generalist

How do you approach work?

Rational CONTROL procedure oriented or
Intuitive SHARING people centered

The PSI is part of a self-administering, self-scoring, and self-interpreting education and training package. Limiting each scale to five items facilitates the real-time scoring and reporting of assessment results in training programs. This design feature will be retained for the revised PSI scales derived from this study. For this reason, the new scales are limited to five items although a better fitting model might be obtained with a different number of items. In sum, this study sought to identify six revised PSI scales that have five items and acceptable, improved psychometric properties.

Psychometric Properties

Due to the non-ipsative scoring, individuals completing the PSI can have any pattern of scores across the six scales. Even though the paired scales suggest complementary modes, people do not necessarily score low on one scale if they score high on the other, e.g. low on Planning if they are high on Vision. Sometimes a respondent will score relatively high or low on both scales of a pair.

Further even though the three rational style and three intuitive style scales suggest doing things from related perspectives, people do not necessarily score in the same direction on all three scales in either style. Thus even though behaviorally the constructs are conceptually distinct, empirically they may be correlated. This presents a special challenge for scale assessment. We do not expect discriminant validity to be as robust as would be the case with ipsatively scored and more conceptually distinct constructs.

In writing the item pool for the original PSI, we used statements in the pairs that were the converse of each other. Some of these ended up in the final items for each scale. This imbedded an ipsitive bias even thought the scales *per se* were non-ipsitive. For instance, if a person responded with a strong preference for the Logic item, "When solving problems, I prefer to use accepted approaches rather than using hunches and first impressions," then they would respond with a low preference for the Insight item, "When solving problems, I rely on hunches and first impressions, rather than accepted approaches." As a result, we predicted negative correlations between factors across the rational and intuitive styles of the original model. In creating items for the revised PSI, we avoided this ipsitive bias in writing the items. For this reason, we do not expect negative correlations between pairs of factors as was the case with the original PSI.

Method

To provide a basis for revising the six scales, ten new items were written for each scale. The content of the original five items guided the wording of the new items. The original five plus the ten new items were assembled into a 90 item (15 items for each of six scales) PSI Research Survey. Using factor analysis and structural equation modeling, five items were chosen from the 15 item pool to represent the revised scales of the survey. Then using confirmatory factor analysis, estimates for several models using the new items were compared with estimates for a model with the original five items. In addition test-retest reliability, coefficient alphas, construct reliability, chi-square differences, and confidence intervals were used to perform reliability, internal consistency, and discriminant validity analyses.

Subjects

The PSI Research Survey of 90 items was administered to 322 undergraduate and graduate business students in a large urban commuter university. A retest administration was given to a subsample of 46 subjects. The two assessments for the subsample were administered at the beginning and near the end of a 15 week semester. The sample consisted of 164 women and 155 men (3 missing values) and the subsample consisted of 27 women and 19 men. The mean age of the sample was 25.5 years (*SD*=5.6) and the mean age of the subsample was 24.3 years (*SD*=5.9). Some students were engaged in full-time career oriented work. Others worked at least part-time while completing their business degree. For this reason, the subjects were more representative of business professionals than typical undergraduate student samples.

Analysis

Subject's responses to the PSI Research Survey were analyzed with the PRELIS 2 and LISREL 8 software using the SIMPLIS command language (Joreskog & Sorbom, 1993, 1996a, 1996b) for structural equation modeling. Because there were no missing scale values for any of the samples, neither listwise nor pairwise deletion was necessary. For each scale, the fifteen items were the observed indicator variables with one latent factor. These responses were input into

PRELIS 2 to create a covariance matrix which was input to LISREL 8 to evaluate model estimates using maximum likelihood estimation.

Seven measures of model fit are reported: χ^2, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), Bentler-Bonnet normed fit index (NFI), Tucker-Lewis non-normed fit index (NNFI), and root mean square error of approximation (RMSEA). For the index measures, values above .90 are considered indicative of good model fit. Traditionally χ^2, GFI and AGFI have been reported. Additionally, the CFI, NFI, NNFI, and RMSEA indices are included because they are less sensitive to sampling characteristics and they take sample size and degrees of freedom into account. Browne and Cudek (1993) suggest that values of RMSEA that are equal to or less than .08 are indicative of reasonable model fit.

Model Specification

In the model specification phase, the 90 items were subjected to principal components analysis limited to six factors using SPSS (1990). The highest loadings for Analysis and Control items clustered on the first factor, Insight and Vision on the second, Planning on the third, and Sharing on the fourth. No scale had significant clusters of high loads on the last two factors. A 60 item model was derived from the ten highest loadings for each scale. Then a six-factor LISREL model was used to select five items per scale. Successive runs were made to select one variable for removal after each run using the modification indices for adding a path or adding an error covariance. Since these variables were responsible for the largest residuals, their removal yielded the best overall improvement in fit measures for the final 30 item model.

In addition to this approach, we used several other specification strategies to arrive at a final set of 30 items synthesizing the results of each. One alternative strategy started with 90 items and used LISREL modification indices directly to select 30 items. In yet another approach, we mixed item deletion with the addition of positive error covariances. In all, we explored five alternative strategies for selecting 30 items from 90. One third of the items did not show up in any one of the specification methods while six items appeared in all five. Once the clearly unacceptable items were dropped from consideration and the clearly acceptable items were retained, model estimates were relatively insensitive to which items were used to complete five items for each scale. With this insight, we identified an item composite model that yielded the largest measurement model factor loadings from all five specification strategies.

Results

The 30 items chosen in the composite specification phase were used in six models to determine measures of fit. Values of seven measures of fit for the six models are summarized in Table 1 on the next page: χ^2, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), Bentler-Bonnet normed fit index (NFI), Tucker-Lewis non-normed fit index (NNFI), and root mean square error of approximation (RMSEA).

Table 1
Model Evaluation

Model	χ2	*df*	GFI	AGFI	CFI	NFI	NNFI	RMSEA
One-factor null [a]	3427.34***	405	.46	.38	.50	.47	.46	.150
Six-factor revised [a]	1059.39***	390	.82	.79	.89	.88	.89	.073
Six-factor revised [b]	754.22***	371	.87	.84	.94	.88	.93	.057
Four-factor revised [b]	1153.28***	380	.80	.75	.87	.82	.85	.080
Two-factor revised [b]	2010.83***	385	.65	.57	.73	.69	.69	.110
Six-factor original [b]	1221.77***	371	.81	.76	.80	.74	.76	.085

[a] without error covariances.

[b] with positive error covariances

***$p < .001$.

Model Evaluation

For a baseline, a null model with all items in a single factor was evaluated. Then we assessed a six-factor model that did not include added parameters. Given the theoretical prediction of item associations, only covariances with positive coefficients were considered.

Then we evaluated a six-factor model with 19 positive error covariances whose modification indices were greater than the LISREL default value of 7.882. This yielded a χ^2 value of 754.22 and goodness of fit measures that ranged from a low of .84 to a high of .94 with a RMSEA of .057.

Using the same error covariance terms, both a four-factor and two-factor version of the model were evaluated. The four-factor model combined Planning and Analysis into a single factor for the rational style and Vision and Insight for the intuitive style with Control and Sharing remaining as individual factors. The two-factor model combined Planning, Analysis, and Control into a single rational factor and Vision, Insight, and Sharing into a single intuitive factor.

Since five items for each scale from the original version of the PSI were included in the PSI Research Survey, model estimates were obtained using these items to compare with the revised model. The measurement model factor loadings and r^2s for the revised model tabulated in Table 2 on the next page were used to provide an initial assessment of validity and reliability. The factor loadings ranged from a low of .52 for Insight 10 to a high of .87 for Sharing 11.

Table 2

Measurement Model Factor Loadings

Item	Loading	r^2	Item	Loading	r^2	Item	Loading	r^2
P03	.69	.48	A07	.75	.56	C07	.71	.51
P06	.76	.59	A08	.73	.53	C08	.78	.62
P08	.76	.57	A09	.76	.58	C10	.81	.65
P09	.79	.63	A11	.82	.67	C11	.68	.46
P15	.67	.45	A15	.74	.54	C13	.71	.50
V06	.80	.64	I03	.67	.45	S09	.80	.64
V07	.81	.66	I06	.54	.29	S11	.87	.75
V08	.84	.71	I08	.79	.63	S12	.85	.73
V09	.76	.58	I10	.52	.27	S13	.73	.54
V10	.81	.71	I14	.62	.40	S14	.69	.47

Internal Consistency and Dimensionality

The test-retest correlations for the 46 case subsample ranged from .58 to .75 across the six scales, all significant at the $p < .01$ level. These are included in the first column of Table 3. To assess internal consistency for each five-item scale, coefficient alphas were computed. These values ranged from .74 to .90. In addition to coefficient alpha, internal consistency was assessed by two measures suggested by Fornell and Larcker (1981). Construct reliability (ρ_ε) is a measure analogous to coefficient alpha (Fornell & Larcker, 1981, Equation 10) and average variance extracted ($\rho_{vc(\eta)}$), which estimates the amount of variance captured by a construct's measure relative to random measurement error. Estimates of $\rho_{vc(\eta)}$ above .50 provide further evidence of internal consistency (Fornell & Larcker, 1981, Equation 11). The values of ρ_ε ranged from .78 to .90 with 5 of 6 reliabilities greater than .80 as shown in Table 3 on the next page. Only one estimate of $\rho_{vc(\eta)}$ was less than .50. This was .42 for Insight.

Discriminant Validity

Several tests were performed to assess the discriminant validity of the constructs. First, chi-square difference tests were done between pairs of models as recommended by Anderson & Gerbing (1988) and Bollen (1989) as shown in Table 4 two pages forward. If the fit of each successive model is better than the fit of the less constrained model or the original six-factor model, evidence of discriminant validity exists. By this test, four comparisons supported discriminant validity. To maintain the overall alpha level at .05 for the family of tests, individual chi-square tests were done at the .013 alpha level. The individual alpha level was computed with a formula given by Finn (1974), $\alpha_0 = 1 - (1-\alpha_i)^t$, where α_0 is the overall significance level, α_i is the individual alpha level for each significance test, and t is the number of tests performed.

Table 3

Measures of Reliability and Internal Consistency

Scale	Retest *r*	α	ρ_ξ	$\rho_{vc(\_)}$
Planning	.74**	.84	.85	.54
Analysis	.75**	.85	.87	.58
Control	.72**	.85	.87	.57
Vision	.58**	.90	.90	.65
Insight	.60**	.74	.78	.42
Sharing	.68**	.86	.89	.62

$^{**}p < .01$.

Second, a method recommended by Anderson & Gerbing (1988) was used. For each pair of constructs in the model, the correlation between the two constructs was examined. If the constructs are distinct, the correlation between them should be less than one. This was tested by constructing the 95% confidence interval about the LISREL generated correlation, ϕ, shown in Table 5 on the next page. If the two constructs are distinct, the confidence interval should not include one and the null hypothesis that the correlation is one can be rejected at the 5% level of confidence. Of the 15 95% intervals constructed, all excluded one indicating that empirically each pair of constructs is distinct. A third test of discriminant validity was done by comparing the square of the parameter estimate, ϕ^2, between the two constructs to their average variance extracted. If the former is less than the latter, discriminant validity is supported (Fornell & Larcker, 1981). By this criterion 13 of 15 tests passed.

Discussion

The present work was undertaken to improve the psychometric properties of an existing instrument while retaining the practical advantages of its administration, scoring, and feedback in workshops. It is important to demonstrate that the revised version is an improvement over the original. Previous study of the PSI (Taggart & Valenzi, 1990) used a traditional scale development strategy while the present study used structural equation modeling. This represents a significant step forward in addressing the measurement problems inherent in these types of scales. Overall, the results support the reliability and convergent validity of the revised scales. And although results were not as positive for the tests of discriminant validity, they were deemed acceptable.

Table 4

Chi-Square Difference Tests

Model	$\chi 2$	*df*	Model	$\chi 2$	*df*	Differences	
						$\chi 2$	*df*
One-factor null [a]	3427.34***	405	Two-factor revised [b]	2010.83***	385	1416.51***	20
Two-factor revised [b]	2010.83***	385	Six-factor original [b]	1221.77***	371	789.06***	14
Six-factor original [b]	1221.77***	371	Four-factor revised [b]	1153.28***	380	68.49***	9
Four-factor revised [b]	1153.28***	380	Six-factor revised [b]	754.22***	371	399.06***	9

[a] without error covariances added.

[b] with positive error covariances added.

***$p < .001$.

Table 5

Measures of Discriminant Validity

Scale	Planning			Analysis			Control			Vision			Insight		
	ϕ	*SE*	95% Int	ϕ	*SE*	95% Int	ϕ	*SE*	95% Int	ϕ	*SE*	95% Int	ϕ	*SE*	95% Int
Analysis	.81*	.03	.75 - .87												
Control	.66*	.04	.58 - .74	.81*	.03	.75 - .87									
Vision	.30*	.06	.18 - .42	.36*	.06	.24 - .48	.04*	.06	(-.08) - .16						
Insight	.69*	.04	.61 - .77	.76*	.04	.68 - .84	.42*	.06	.30 - .66	.65*	.04	.57 - .73			
Sharing	.38*	.06	.50 - .26	.39*	.05	.29 - .49	.40*	.06	.28 - .52	.25*	.06	.13 - .37	.50*	.05	.40 - .60

* $p < .05$.

Measures of Fit

Of the seven fit measures reported, three were used to evaluate the models: NFI, NNFI, and RMSEA. Using these criteria, for the six-factor revised model without added parameters, the NFI of .88, NNFI of .89, and the .073 value for RMSEA were marginally acceptable. The six-factor model with positive error covariances was improved with an NFI of .88, NNFI of .93, and RMSEA of .057. None of the fit measures for the four-factor model, two-factor model and the six-factor original were acceptable. The results for the six-factor model with positive error covariances establish the acceptability of the revised PSI model. Additional evidence for the acceptability of the new items is found in the factor loadings. Factor loadings were weakest for Insight with a range of .52 to .79 and strongest for Vision with a range of .76 to .84. Thus the superiority of the construct validity of the new items is supported.

Coefficient Alphas

Table 3 shows that 5 of the six coefficient alphas for the revised model were equal to or above .80 and all are above .70 the minimum recommended by Nunnally (1978). With respect to average variance extracted, only one measure of average variance extracted was less than .50 indicating that the variance due to measurement error was less than the variance captured by the construct (Fornell & Larcker, 1981). Therefore the validity of the individual indicators as well as the constructs were supported.

Coefficient alphas for this study were also compared with those of the original PSI study (Taggart & Valenzi, 1990). The lowest alpha in that study was .53 for the Control scale and ranged from .63 to .83 for the other scales. The coefficient alphas also were compared to data from a subsequent study which obtained .35 for Control and from .64 to .73 for the remaining scales (Taggart & Valenzi, 1996). Across all scales, the present coefficient alphas were more acceptable than for the two previous studies.

Validity and Reliability

The chi-square difference test was supportive of discriminant validity for the revised model where all tests were significant. Support also for discriminant validity for the new scales was provided by the confidence interval test. For the revised model, all tests supported discriminant validity. Results for the test recommended by Fornell and Larcker (1981) comparing average variance extracted by constructs to the square of their correlation were supportive for the revised model where only 13 of 15 tests were positive.

Construct Correlations

One explanation for why the revised model failed to demonstrate robust discriminant validity is that it required tests of constructs within the same general factor represented by the rational and intuitive styles. The item contrasts between general factors and item similarities within a style do not translate into clear predictions for low correlations. Large correlations between constructs within the same general factor can be accounted for in part by the non-ipsative scoring. Since an individual can score all highs or all lows or any combination for the six scales, good predictions can only be made for subsamples such as a rationally dominant accountant or intuitively dominant artist group. Most subjects score a pattern of moderate scores across all six scales. Also those who score low or high on some scales also tend to score low or high respectively on the other scales. In part these scoring patterns explain the associations between constructs.

Since some individuals have strong preferences for either the rational or the intuitive orientation, these patterns could be assessed by selecting subjects who scored either one standard deviation above or below the mean for each scale separately. If calculated for this subsample, the correlations between constructs would moderate substantially. In addition, ipsative scoring would improve discriminant validity. But ipsative scoring is not consistent with the design philosophy of the PSI since this would occur at the expense of face validity. In field experience, respondents consistently state that the PSI profile fairly represents their perception of their rational and intuitive style.

Summary

Overall, the revised scales are an improvement over the original scales with respect to model robustness, reliability, internal consistency, and convergent validity. The new scales also demonstrated satisfactory test-retest reliability over a 15-week interval, an assessment that had not been done on the original scales. Because the PSI is frequently used in a workshop setting for training purposes, a readministration to evaluate change may be done making the assessment of test-retest reliability necessary. A subsequent study is needed to validate these results in a comparable sample.

Our results indicate a need to improve further discriminant validity, especially within the general rational and intuitive constructs. This will be difficult because the items within these general constructs show the degree of natural correlation discussed above. Since the sample was drawn from an urban university business school dominated by evening classes, a significant number of subjects were members of the target population. The majority were working at least part-time while preparing for advanced careers in business. A follow up study using the new items will be conducted with a larger sample that is even more representative of the PSI population than our convenience sample.

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