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Hierarchical Confirmatory Factor Analysis of the Myers-Briggs Type Indicator

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Confirmatory factor analyses were conducted on the Myers-Briggs Type Indicator using over 11,000 student and leadership-development raters, testing (a) a first-order factor model with additional secondary loadings, and (b) a hierarchical, second-order factor model. Results indicated that both strategies succeeded in providing some degree of improvement in model-fit.

The Myers-Briggs Type Indicator (MBTI) was created over fifty years ago using a process that fell somewhat outside the traditional academic model of psychological test development; its goal was to operationalize the "type"-based Jungian theory of personality (e.g., Briggs & Myers, 1976). Not surprisingly, the combination of a non-academic author, a "type" instead of "trait" philosophy of measurement, and a theoretical view of personality that at first glance appears to be far removed from the currently popular Five-Factor Model (FFM; e.g., McCrae & Costa, 1987) has led to the emergence of a number of vociferous critics (e.g., Pittenger, 1993) who charge that the MBTI lacks the status, measurement quality, and overall gravitas associated with traditional assessment instruments (e.g., MMPI, CPI, 16PF, NEO-PI).
However, the fact remains that in applied organizational and assessment settings the MBTI is extremely popular, as evidenced by the volume of research studies that have been devoted to it as well as the diversity of applied organizational functions to which it has been applied, which range from relatively uncontroversial uses such as career-counseling, self-development, and team-building through highly litigious tasks such as employee selection and placement (e.g., Briggs & Myers, 1976; Brown & Harvey, 1999; Hall & MacKinnon, 1969; Harvey, 1996; Hartzler & Hartzler, 1982; Myers & McCaulley, 1985; Sample & Hoffman, 1986).

In addition to research focused on the application of the MBTI to solve applied assessment problems, a number of studies of its psychometric properties have also been performed (e.g., Harvey & Murry, 1994; Harvey, Murry, & Markham, 1994; Harvey, Murry, & Stamoulis, 1995; Johnson & Saunders, 1990; Sipps, Alexander, & Freidt, 1985; Thompson & Borrello, 1986, 1989; Tischler, 1994; Tzeng, Outcalt, Boyer, Ware, & Landis, 1984). Somewhat surprisingly, given the intensity of criticisms offered by its detractors (e.g., Pittenger, 1993), a review and meta-analysis of a large number of reliability and validity studies (Harvey, 1996) concluded that in terms of these traditional psychometric criteria, the MBTI performed quite well, being clearly on a par with results obtained using more well-accepted personality tests.

With respect to its factor structure – the primary issue of concern in this study – several studies have sought to assess the latent dimensionality of the MBTI item pool. According to its developers, the MBTI measures four underlying bipolar dimensions of personality: introversion (I) versus extraversion (E); sensing (S) versus intuition (N); thinking (T) versus feeling (F); and perceiving (P) versus judging (J). Although developed from a typological Jungian theoretical perspective, research (e.g., McCrae & Costa, 1989) has shown that these scales converge quite well with four of the "Big Five" dimensions of personality (e.g., McCrae & Costa, 1987) – Extraversion, Openness, Agreeableness, and Conscientiousness, respectively – that have been the focus of considerable attention in terms of their effectiveness in selection and placement contexts (e.g., Schmit & Ryan, 1993; Tett, Jackson, Rothstein, & Reddon, 1994). Indeed, additional items contained in the MBTI can be used to form a scale that clearly measures the missing fifth factor from the Big Five typology – Neuroticism (e.g., Harvey, Murry, & Markham, 1995) – making the MBTI a viable candidate for assessing the Five-Factor Model as well.

However, despite the relatively large number of factor-analytic studies that have been performed – which includes several confirmatory factor analyses (e.g., Harvey et al., 1995; Johnson & Saunders, 1990; Thompson & Borrello, 1989) – significant unanswered questions still remain concerning the MBTI's factor structure. That is, although support for a priori 4-factor solution has been seen in large-sample exploratory studies, as well as in confirmatory studies that compared the 4-factor model against competing views of the instrument (e.g., Harvey et al., 1995), even the best-fitting 4-factor models that have been reported in past confirmatory factor analyses arguably leave significant room for improvement regarding model fit. For example, the model exhibiting the best level of fit in Harvey et al. (1995) – a four-factor oblique model based on the MBTI authors' hypothesized structure, in which each MBTI item loaded on one latent factor – produced a confirmatory factor analysis goodness of fit index (GFI) of .88; the Sipps et al. (1985) study reported a GFI of .74 for their best-fitting (oblique) 4-factor model.

Such levels of confirmatory model fit certainly lend some degree of credibility and plausibility to the hypothesized

4-factor structure, especially given the fact that the *competing* factor models specifying alternative dimensionalities tested in Harvey et al. (1995) were found to provide clearly inferior levels of fit in comparison to the a priori model. However, the fact remains that if conventional rules-of-thumb for interpreting GFI and similar model-fit statistics are applied (e.g., viewing fit indices in the .90's as desirable; see James, Mulaik, & Brett, 1992; Tucker & Lewis, 1973), one is left with the conclusion that the available research has yet to conclusively determine the answers to such basic questions as the number of factors that the MBTI measures, and the item makeup of each.

Our study attempted to address these questions by evaluating the degree to which two strategies for developing alternative factor models to represent the MBTI's latent structure might be successful in improving the fit of confirmatory factor analysis models, relative to the levels of fit seen in the best-fitting, a priori 4-factor model examined in earlier confirmatory studies. Ideally, one (or both) of these methods for developing new models of the MBTI's factor structure would be successful in increasing the levels of confirmatory factor analysis model-fit into the range generally viewed as desirable. Because it is clearly inappropriate to develop, then subsequently "confirm," a factor model using a single sample of respondents, we conducted our model-development versus model-testing analyses in separate samples of raters drawn from both student and "real world" populations of organizational employees.

The first strategy for developing alternative factor models focused on freeing-up additional factor loadings, using the a priori 4-factor pattern hypothesized by the MBTI's developers as the starting point. That is, after failing to find convincing levels of model fit (using conventional rules-of-thumb) in a confirmatory test of the 4-factor model, Harvey et al. (1995) conducted an additional round of exploratory factor analyses on the same dataset, which produced results that suggested that it might be beneficial to add a number of secondary factor loadings as a means to improve model fit. Although some test developers believe strongly in the doctrine of *independent-cluster structure* – i.e., that each item should load on one and only one latent factor – it is probably unreasonable to expect that an independent-cluster structure would obtain in an instrument like the MBTI, in which a relatively large number of items load on a relatively small number of latent factors (e.g., in the MBTI Form F/G scoring system, on average over 23 items are used to measure each of the four primary scales). Accordingly, we hypothesized that the addition of secondary loadings might be sufficient to produce appreciable improvements in confirmatory model-fit indices. Exploratory factor analysis results (using both the Harvey et al. sample, as well as a new sample of raters drawn from participants in leadership-development programs) were used to generate the secondary loading patterns, which were then tested using confirmatory factor analysis in a holdout sample of leadership-program raters.

The second strategy for improving model-fit levels involved the estimation of a *hierarchical*, second-order factor model for the MBTI. In contrast to previous confirmatory item-level factor analyses of the MBTI that estimated only first-order latent factors (e.g., Harvey et al., 1995; Sipps et al., 1985) for the 94-item Form F item pool, we explored the possibility that a model that estimated (a) a number of first-order *subfactors* (or facets) of each of the four primary MBTI dimensions, as well as (b) four *second-order* factors to represent the primary MBTI scales on which the first-order facets would load, could produce higher levels of model fit. Support for the view that a hierarchical approach might be necessary can be found in the results of Johnson and Saunders (1990), who conducted a factor analysis that attempted to group the subscales formed by the Type Differentiation Indicator (TDI) scoring system (Saunders, 1986) for the 290-item MBTI Form J into the four primary MBTI dimensions; their results suggested that the TDI subscales could indeed be grouped into the predicted 4-factor structure. Although Johnson and Saunders only studied subscale-level *composite scores* for each of these facets (i.e., they did not include actual item-level data in their confirmatory analysis), their results imply that it may be necessary to model both the overall 4-factor structure of the MBTI, as well as the subfactors or facets of each of those four domains, in order to achieve acceptable levels of model fit when performing confirmatory factor analysis using item-level MBTI data.

Method

Participants

The MBTI responses that were analyzed in this study were obtained from two archival sources. To perform the exploratory "model-building" factor analyses needed to identify the secondary factor loadings for the 4-factor first-order models, and the higher-dimensionality first-order portions of the hierarchical factor model (i.e., the subfactors of each of the four MBTI item pools), we studied (a) a sample of 2,639 raters composed of individuals (primarily undergraduate students) used in the Harvey et al. (1995) and Harvey and Murry (1994) studies, keeping only respondents with no missing data across the 94 items from Form F that are scored to produce the four main scales; and (b) one-half (N = 4,313) of a sample of raters who participated in leadership development programs held by the Center for Creative Leadership (CCL), again using only profiles with no missing item responses across the four primary MBTI scales.

For the confirmatory analyses, the holdout sample (N = 4,244) of CCL raters was used to test the new factor models. Although subjects from the Harvey et al. (1995) and Harvey and Murry (1994) studies were re-used during the "model-building" stage of our study, we did not view this as constituting a problem, given that these raters were used only to *develop* (and not to *test*) the new factor models, and because we additionally used a second, independent sample (the first half of the CCL database) as a basis for generating new factor models to be tested in the confirmatory analyses. None of the raters in the CCL samples were previously used to either develop or test confirmatory factor models of the MBTI.

Materials and Models

Form F of the MBTI was used, which contains 166 multiple-choice items. Of these 166 items, 95 items make up the four dimension scores under the Form F/G scoring system. Ninety-four items were analyzed in the present study; item 68 was omitted because it allows raters the option of selecting more than one response alternative. Because we could not rely on the TDI scoring system (Saunders, 1986) used by Johnson and Saunders (1990) in order to develop our hypothesized hierarchical model (i.e., because many of the items that are scored in Form J to produce the TDI facet scales are not present in the shorter, and more widely used, Forms F/G), we relied on exploratory factor analyses of the Form F item pools (conducted separately in each of the four main scales) to generate the first-order subfactors. Given the demographic dissimilarities in the student versus CCL samples, the similarity of exploratory models derived in the different samples was of interest.

Procedure

For the exploratory analyses, data were analyzed using SAS version 8; exploratory factor analyses were performed using PROC FACTOR, with oblique Harris-Kaiser rotation (power = 0.5) and squared multiple correlations as communality estimates. The rotated 4-factor pattern was then examined for additional (secondary) item loadings. For the hierarchical models, subfactors were identified by examining solutions suggested by scree plots of eigenvalues, using the criterion of interpretability and robustness (i.e., having a reasonable number of items for each factor) to define the final facet scales selected for the model-building.

For the confirmatory factor models, PROC CALIS was used on the item variance-covariance matrix; the GFI, adjusted GFI, root mean square residual (RMSR), Bentler's comparative fit index (CFI), and James, Mulaik, and Brett's parsimonious normed fit index (NFI) were used to quantify model fit. In addition to the alternative models developed here, we also evaluated the fit of the a priori 4-factor models (i.e., the orthogonal and oblique independent-cluster structure models from Harvey et al., 1995) in order to provide a basis of comparison to the earlier results.

Results

Model Building

Figures 1-5 present the scree plots for the overall 94-item pools, and each of the four major scales analyzed separately; Table 1 summarizes the exploratory factor analysis results. As in previous studies, the scree plots for the full 94-item pool (Figure 1) are quite clear in indicating that these MBTI items function as indicators of four primary latent constructs. Likewise, the factor analyses performed in the four separate item pools (Figures 2-5) are equally clear in indicating that each pool is dominated by a single underlying latent trait (e.g., considering the size of the first eigenvalue, and the ratios of first to second eigenvalues). Interestingly, given the presumably significant demographic and motivational differences in existence between the student versus CCL samples, the results in Figures 1-5 are strikingly similar in terms of the eigenvalue patterns they reveal.

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Insert Figures 1-5 and Table 1 about here

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With respect to finding secondary factor loadings that could be added to the a priori 4-factor solution in an attempt to improve model fit, the rotated factor loadings in Table 1 for the entire 94-item factor analyses reveal remarkably similar patterns of findings in the student versus CCL samples. Some sample-based differences were observed, however, leading us to examine two types of models with secondary loadings: a model with an additional 29 secondary-loading items from the student sample, and one with 27 additional loadings based on the CCL sample (a cutoff of approximately .15 and higher was used to identify the non-predicted secondary loadings). Of the four MBTI scales, secondary loadings were more numerous in the SN and JP domains, and it is typically quite easy to explain why these items exhibit secondary loadings (e.g., item DN64, which deals with preferring to analyze unsolved problems, loads on both the "intuitive" pole of the SN scale as well the "thinking" pole of the TF factor).

Regarding the analyses designed to identify subfactors/facets of each of the four main MBTI scales, the results in Figures 2-5 and Table 1 again reveal highly similar results in the two samples; based on interpretability and parsimony, we chose 3-factor EI, 2-factor SN, 2-factor TF, and 3-factor JP solutions for both samples. Although interpretatively similar subfactors are seen in the student versus CCL samples, some differences are present (see Table 1); consequently, separate confirmatory models were estimated in the holdout CCL sample based on the specific derivation sample (i.e., CCL versus student) that was used to generate the model.

Model Testing

Table 2 summarizes the model-fit statistics for the confirmatory models that were estimated in the CCL holdout sample based on the above exploratory factor analysis results. Models 1 and 2 (a priori 4-factor without secondary loadings) were estimated in order to provide comparability to the Harvey et al. (1995) results; interestingly, the orthogonal 4-factor a priori model fit appreciably better in this sample than in the Harvey et al. (1995) student-based sample, whereas the oblique model fit slightly worse (earlier GFIs = .77 and .88, respectively).

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Insert Table 2 about here

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In terms of the ability of the strategy of adding secondary loadings to improve model fit, the results in Table 2 indicate that, relative to models 1-2, models 3-4 and 5-6 were somewhat successful; however, the magnitude of improvement is modest (e.g., GFIs of approximately .88 versus .85), and as in the earlier confirmatory MBTI factor analyses, none of the fit indices reach the .90-and-above range that many researchers deem indicative of adequate fit. As with the a priori 4-factor results (models 1-2), the addition of oblique factors produced only a slight improvement in model fit relative to the orthogonal model (consistent with earlier factor analyses of the MBTI, only the SN and JP scales demonstrate appreciable levels of factor correlation: e.g., r = .39 in models 5-6, and r = .51 in model 2).

Regarding the second strategy of taking a hierarchical approach to improving model fit, models 7-8 represent a fully oblique (at the first-order factor level) representation of the subfactor-based models developed using the student and CCL (derivation) samples, whereas models 9-10 represent the more restricted (hierarchical) case in which the first-order (subscale) MBTI factors are grouped to form the four second-order MBTI domains. In this type of analysis, the fully oblique first-order facet models (7-8) can be interpreted as providing the best possible level of fit for any hierarchical MBTI model that is based on the linkages of MBTI items to first-order factors depicted in Table 1 (barring model modifications that we would consider unacceptable, such as allowing correlated unique factors); thus, the main issues concern the degree to which (a) the fit of the models with four second-order factors (9-10) is degraded relative to the corresponding models 7-8, and (b) the fit of the hierarchical models is comparable to the fit produced by augmenting the first-order 4-factor model with secondary loadings.

As the results in Table 2 indicate, although the fully-oblique first-order facet models (7-8) produce the highest levels of model fit attained by any of our confirmatory factor solutions, and the restricted second-order 4-factor models (9-10) produce fit levels that are quite comparable to those produced by the fully-oblique first-order facet models (7-8), the fact remains that all of our alternative models produce fit indices that are generally quite similar to one another (although they all provide some degree of improvement over the a priori 4-factor model), and none achieve the .90-and-higher levels that are commonly viewed as denoting adequate fit.

Discussion

The results reported above indicate that our two-pronged strategy for using exploratory, model-building methods to produce alternative confirmatory factor models having increased levels of fit was, at least numerically, successful; furthermore, our findings clearly supported the view that the 94-item Form F/G MBTI item pool is dominated by the 4-factor structure predicted by the instrument's authors (which, as was noted earlier, also matches up well with the four non-Neuroticism factors of the Big Five taxonomy). The fact that this a priori factor structure was yet again recovered via exploratory means and found to fit reasonably well using confirmatory analysis, in a sample of "real world" managerial employees that is arguably quite different from the college-student based samples that have been seen in earlier confirmatory and exploratory factor analyses, speaks directly to the robustness and generalizability of past claims of support for the predicted 4-factor MBTI latent structure.

However, none of our confirmatory factor models succeeded in breaking the magical ".90 barrier" of fit, despite the fact that we aggressively sought out alternative models (using both the secondary-loadings and hierarchical factor structure strategies), derived the alternative models using both student and "real world" samples, and tested them using confirmatory analysis in an independent holdout sample. Although additional research is needed to provide a definitive answer to this question, we hypothesize that this situation may well represent a case in which confirmatory model-fit indices computed for models involving large numbers of items, and relatively small numbers of factors, simply fail to provide a "practically useful" measure of model fit. That is, the models we tested possessed a very large number of overidentifying restrictions (i.e., degrees of freedom produced by the fact that many parameters, such as factor loadings or correlations between unique factors that could potentially have been estimated as free parameters, were instead fixed to zero), which provided us with tremendous power to reject the implicit null hypothesis that *zero differences* exist between the variance/covariance matrix being analyzed, versus the variance/covariance matrix implied by the estimated model parameters.

In essence, rather than being rewarded for following the highly desirable practice of using a large number of indicators to estimate each of the latent personality constructs (i.e., each Form F/G MBTI scale contains in excess of 20 items), we were instead effectively punished by having extremely high power to detect what may well turn out, in practice, to be relatively trivial areas of model lack-of-fit. Accordingly, even though our results, and those of previous exploratory studies, indicate that a very clear latent structure underlies these 94 MBTI items, it may not be possible (short of resorting to questionable post-hoc "model improvement" strategies based on confirmatory model modification indices that rely on adding conceptually unappealing free parameters such as unique factor correlations or correlations between unique and common factors) to break the ".90 barrier" when item pools as large as those contained in the MBTI are examined. Further research using Monte Carlo methods to study the degree to which samples produced on the basis of "known true" factor solutions having high ratios of items-to-factors are able to produce model-fit indices that satisfy rules-of-thumb developed using models that typically have relatively few indicators per construct will be needed to resolve this question.

In sum, although the MBTI is very widely used in organizations, with literally millions of administrations being given annually (e.g., Moore, 1987; Suplee, 1991), the criticisms of it that have been offered by its vocal detractors (e.g., Pittenger, 1993) have led some psychologists to view it as being of lower psychometric quality in comparison to more recent tests based on the FFM (e.g., McCrae & Costa, 1987). In contrast, we find the findings reported above – especially when viewed in the context of previous confirmatory factor analytic research on the MBTI, and meta-analytic reviews of MBTI reliability and validity studies (Harvey, 1996) – to provide a very firm empirical foundation that can be used to justify the use of the MBTI as a personality assessment device in applied organizational settings.

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Table 1

Factor Loading Patterns

		Separate-Pool Results										Overall Pool Results							
Item	Label	EI			SN		TF		JP			Student				CCL			
		1	2	3	1	2	1	2	1	2	3	TF	SN	JP	EI	TF	SN	JP	EI
DI6	in grp rather talk to known-well people	SC										0.07	-0.03	-0.04	0.51	0.03	-0.08	0.02	0.49
DI15	usually keep feelings to self			SC								-0.13	-0.09	0.08	0.42	-0.14	-0.04	-0.00	0.43
DI19	sometimes bored at parties	SC										-0.01	0.06	-0.12	0.46	-0.00	0.05	-0.03	0.47
DI25	meeting strangers takes effort	SC										0.06	-0.05	0.02	0.56	0.03	-0.01	0.05	0.54
DI33	am hard to get to know			SC								-0.12	0.05	0.06	0.52	-0.14	0.10	0.04	0.55
DI41	one of last to hear goings on		S	C								-0.02	0.02	-0.01	0.32	-0.04	-0.01	-0.01	0.34
DI47	Embarrassed think about it days later	SC										0.11	-0.08	-0.04	0.27	0.06	-0.10	-0.03	0.22
DI50	usually quite and reserved	SC										0.01	0.00	-0.01	0.74	0.00	-0.00	-0.01	0.71
DI58	have deep friends w/very few ppl	SC										0.10	0.09	-0.07	0.33	0.01	0.08	0.00	0.35
DI66	are less enthusiastic than average			SC								-0.12	-0.12	0.07	0.41	-0.04	-0.18	0.01	0.38
DI77	theater > party		SC									-0.04	0.19	-0.21	0.32	0.05	0.17	-0.11	0.33
DI87	reserved > talkative		SC									-0.17	-0.00	-0.05	0.53	-0.10	-0.06	-0.04	0.48
DI92	quiet > hearty		SC									-0.04	0.01	-0.04	0.44	0.04	-0.08	-0.04	0.45
DI95	write > speak		SC									0.02	0.11	-0.09	0.36	0.01	0.07	-0.09	0.34
DI106	calm > lively		SC									-0.06	-0.08	-0.08	0.44	0.06	-0.18	-0.07	0.43
DI116	detached > sociable		SC									-0.13	0.04	0.05	0.41	-0.13	0.01	0.02	0.36
DI126	have lot to say to only some	SC										0.03	-0.03	0.03	0.57	0.03	-0.05	0.05	0.58
DI129	not interested in follow fashion		SC									-0.07	0.04	-0.00	0.22	-0.05	-0.09	0.00	0.18
DI134	help others have fun at party	S	C									0.03	-0.06	0.01	0.48	0.00	-0.00	0.02	0.49
DI138	tell my interests only after time			SC								-0.05	0.02	0.03	0.44	-0.01	0.02	-0.01	0.47
DI148	get introduced > intro others	SC										0.04	-0.05	0.05	0.56	0.00	-0.04	0.03	0.51
DI160	tell feelings only w/special reason			SC								-0.16	-0.03	0.14	0.34	-0.09	-0.01	0.04	0.37
					1	2													

DN2	get along w/ imaginative > realistic				S	C						0.09	0.45	0.15	-0.04	0.10	0.47	0.15	-0.05
DN11	invent ways of your own for doing things				C	S						-0.22	0.41	0.10	-0.03	-0.15	0.39	0.15	-0.05
DN17	enjoy odd/origial ways of writing					SC						-0.03	0.48	-0.04	0.05	0.02	0.43	0.02	-0.01
DN37	admire original>conventional ppl				SC							0.05	0.32	0.08	-0.03	-0.01	0.36	0.07	-0.06
DN53	annoyed at people not liking theory					SC						-0.17	0.30	-0.07	0.05	-0.07	0.34	-0.02	0.01
DN64	pref. analyzing unsolved problems				C	S						-0.27	0.37	-0.04	0.04	-0.22	0.32	0.03	0.00
DN70	higher praise=vision>common sense				SC							0.01	0.43	0.00	0.04	-0.00	0.46	-0.04	-0.04
DN73	imaginative > matter-of-fact				SC							0.19	0.48	0.06	-0.03	0.12	0.48	0.00	-0.05
DN76	theory > certainty					SC						-0.04	0.46	0.09	0.02	-0.04	0.55	0.10	0.05
DN78	invent > build				SC							0.00	0.50	0.02	-0.01	-0.03	0.48	0.02	0.01
DN88	concept > statement				SC							-0.02	0.51	0.01	0.03	-0.01	0.53	0.03	-0.00
DN90	design > production				SC							0.07	0.43	0.02	-0.00	0.06	0.51	-0.01	0.05
DN98	fascinating > sensible				SC							0.16	0.42	0.11	-0.04	0.11	0.50	0.07	-0.04
DN102	ideas > facts				SC							0.20	0.53	0.04	-0.04	0.16	0.57	0.03	-0.03
DN104	abstract > concrete				S	C						0.10	0.54	0.17	0.00	0.09	0.59	0.13	-0.00
DN107	create > make				SC							0.04	0.56	-0.03	-0.02	0.02	0.55	-0.05	-0.04
DN112	spire > foundation				S	C						0.00	0.30	0.15	-0.00	0.07	0.35	0.12	-0.01
DN115	theory > experience					SC						-0.08	0.18	0.06	0.08	-0.09	0.34	0.07	0.06
DN117	symbol > sign				S	C						0.12	0.40	-0.00	0.00	0.09	0.41	-0.00	0.05
DN119	figurative > literal				S	C						0.14	0.47	0.10	-0.03	0.13	0.44	0.12	-0.04
DN121	change > accept				C	S						-0.22	0.35	0.10	-0.06	-0.30	0.36	0.09	-0.10
DN128	pref teach theory > fact					SC						-0.02	0.54	0.05	0.00	-0.02	0.61	0.07	0.01
DN140	see possibilties > adjust to facts				SC							0.04	0.25	-0.12	-0.04	-0.01	0.34	-0.04	-0.10
DN145	ingenious > practical				SC							0.00	0.51	0.10	-0.00	-0.01	0.55	0.09	0.01
DN149	friend w/ideas > feet on ground				SC							0.02	0.38	0.12	-0.07	-0.04	0.43	0.11	-0.07
DN165	prefer original > conventional				SC							-0.04	0.38	0.17	-0.12	-0.05	0.41	0.12	-0.14
							1	2											
DF4	more careful about feelings > rights						SC					0.40	-0.04	-0.03	-0.02	0.38	-0.05	-0.02	-0.04

DF26	value sentiment > logic						SC					0.57	0.03	0.06	-0.02	0.50	0.00	0.11	-0.05
DF29	higher compliment: feeling>reasonable						SC					0.45	0.15	0.05	-0.06	0.42	0.15	0.02	-0.07
DF72	warm-hearted > firm-minded							SC				0.55	0.08	-0.02	-0.02	0.52	0.06	-0.00	-0.03
DF79	sympathize > analyze						SC					0.56	-0.07	0.05	-0.01	0.52	-0.07	0.08	-0.05
DF81	blessings > benefits						SC					0.38	0.06	-0.04	0.00	0.39	0.09	-0.07	0.02
DF84	uncritical > critical							SC				0.37	0.00	0.09	-0.00	0.36	-0.07	-0.00	-0.02
DF86	touching > convincing						SC					0.63	0.04	-0.00	0.00	0.58	0.06	0.05	0.02
DF89	soft > hard							SC				0.51	0.06	-0.06	0.05	0.53	0.04	-0.02	0.04
DF91	forgive > tolerate							SC				0.39	0.10	-0.09	-0.06	0.26	0.07	-0.08	-0.07
DF93	who > what						C	S				0.34	-0.01	0.03	-0.10	0.31	0.05	0.02	-0.17
DF100	devoted > determined						SC					0.42	0.04	-0.01	0.05	0.45	0.01	-0.07	0.03
DF103	compassion > foresight						SC					0.60	-0.09	0.01	-0.01	0.54	-0.07	0.01	-0.02
DF105	mercy > justice						SC					0.36	0.12	0.05	0.02	0.38	0.16	-0.02	0.02
DF108	trustful > wary							SC				0.22	0.10	-0.08	-0.09	0.19	0.05	-0.06	-0.10
DF111	gentle > firm							SC				0.58	0.03	-0.01	0.03	0.55	0.04	0.00	0.07
DF114	feeling > thinking						SC					0.65	0.03	0.04	-0.05	0.62	0.01	0.04	-0.04
DF120	peacemaker > judge							SC				0.39	0.12	-0.01	-0.04	0.38	0.06	-0.03	-0.01
DF122	agree>discuss						SC					0.19	-0.25	0.02	0.07	0.15	-0.23	-0.02	0.06
DF133	worse to not have enough warmth							SC				0.33	0.09	-0.09	-0.00	0.27	0.09	-0.07	-0.10
DF147	work under kind > fair						SC					0.25	-0.06	0.10	0.00	0.19	0.00	0.01	0.02
DF154	heart rule head > head rule heart						SC					0.44	0.03	0.08	-0.09	0.45	0.01	0.12	-0.07
DF158	worse to be unsympathetic > unreasonable						SC					0.37	-0.01	0.01	0.00	0.30	0.01	-0.00	-0.01
									1	2	3								
DP1	following schedule cramps me										SC	-0.07	0.07	0.55	0.03	-0.04	0.11	0.53	0.00
DP9	cant tell well about Saturday								SC			0.06	-0.01	0.44	0.06	0.02	0.08	0.33	0.08
DP13	prefer doing things at last minute								SC			-0.01	-0.02	0.50	-0.05	-0.03	0.02	0.51	-0.05
DP20	hard to adapt to routine										SC	-0.20	0.21	0.34	-0.08	-0.21	0.25	0.32	-0.13
DP27	prefer free to do what looks fun								C	S		0.00	0.04	0.50	-0.00	-0.02	0.05	0.54	0.04
DP35	plunge in to new projects w/o plan								SC			0.06	-0.11	0.48	0.06	0.11	-0.13	0.45	0.01

DP42	at best dealing with unexpected										SC	-0.19	0.20	0.42	-0.11	-0.14	0.19	0.40	-0.11
DP49	daily routine painful even when neces										SC	-0.12	0.09	0.47	0.01	-0.09	0.08	0.44	-0.02
DP55	prefer just going to planning trip								C	S		-0.01	0.08	0.54	-0.01	0.02	0.04	0.55	0.03
DP60	making weekend list not appealing								C		S	-0.09	-0.03	0.54	0.08	-0.00	0.02	0.49	0.07
DP74	spontaneous > systematic									SC		0.21	0.20	0.46	-0.10	0.23	0.18	0.38	-0.13
DP85	unplanned > scheduled									SC		0.05	0.12	0.66	-0.03	0.12	0.15	0.58	0.00
DP94	impulse > decision									SC		0.21	0.16	0.45	-0.08	0.27	0.10	0.32	-0.04
DP97	leisurely > punctual									SC		0.20	0.09	0.41	0.00	0.25	0.17	0.32	0.04
DP99	changing > permanent									S	C	-0.02	0.32	0.26	-0.11	-0.09	0.32	0.15	-0.15
DP109	easy-going > orderly									SC		0.26	0.10	0.35	-0.07	0.29	0.10	0.34	-0.03
DP113	quick > careful										SC	-0.07	0.05	0.30	-0.11	-0.14	0.14	0.27	-0.17
DP118	casual > systematic									SC		0.30	0.11	0.43	-0.04	0.33	0.05	0.39	-0.04
DP124	routine parts of day=boring										SC	-0.04	0.08	0.28	0.04	-0.15	0.12	0.27	-0.02
DP132	find details as go along a job								SC			-0.00	-0.02	0.56	0.06	0.04	-0.03	0.56	0.00
DP142	ext speed at end job > early start								SC			0.04	-0.05	0.45	0.01	0.01	0.03	0.46	0.01
DP151	in planned sits unpleas tb tied down								C		S	-0.03	0.04	0.50	0.03	-0.02	0.07	0.46	0.07
DP153	often forget small things								SC			-0.01	-0.02	0.36	0.11	0.01	0.00	0.34	0.10

Note. Separate Pool results are based on exploratory factor analyses in each of the four main MBTI item pools, conducted separately; 'S' = item loading estimated using the factor results for the student sample, 'C' = item loading estimated using the factor results from the CCL derivation sample. Overall Pool results are based on analysis of all 94 MBTI items. Highlighted items in the overall results were estimated as free primary and secondary factor loadings.

Table 2
Fit Indices for the CFA Models

Model	Sample Used to Derive Model	GFI	AGFI	RMSR	CFI	Parsimonious NFI
1. 4-factor orthogonal WITHOUT secondary loadings	--	.849	.843	.016	.729	.680
2. 4-factor oblique WITHOUT secondary loadings	--	.854	.847	.011	.746	.694
3. 4-factor orthogonal WITH secondary loadings	Student	.877	.871	.014	.773	.715
4. " "	CCL	.879	.872	.013	.775	.718
5. 4-factor oblique WITH secondary loadings	Student	.881	.875	.010	.784	.725
6. " "	CCL	.882	.875	.010	.785	.726
7. Fully oblique first-order factors of hierarchical model	Student	.886	.880	.010	.802	.740
8. " "	CCL	.886	.880	.010	.802	.740
9. Hierarchical model with 4 second-orders	Student	.875	.869	.011	.784	.727
10. " "	CCL	.876	.870	.011	.787	.731

Note. GFI = Goodness of Fit Index; AGFI = GFI Adjusted for Degrees of Freedom;

RMR = Root Mean Square Residual; CFI = Comparative Fit Index; Parsimonious NFI = Normed Fit Index

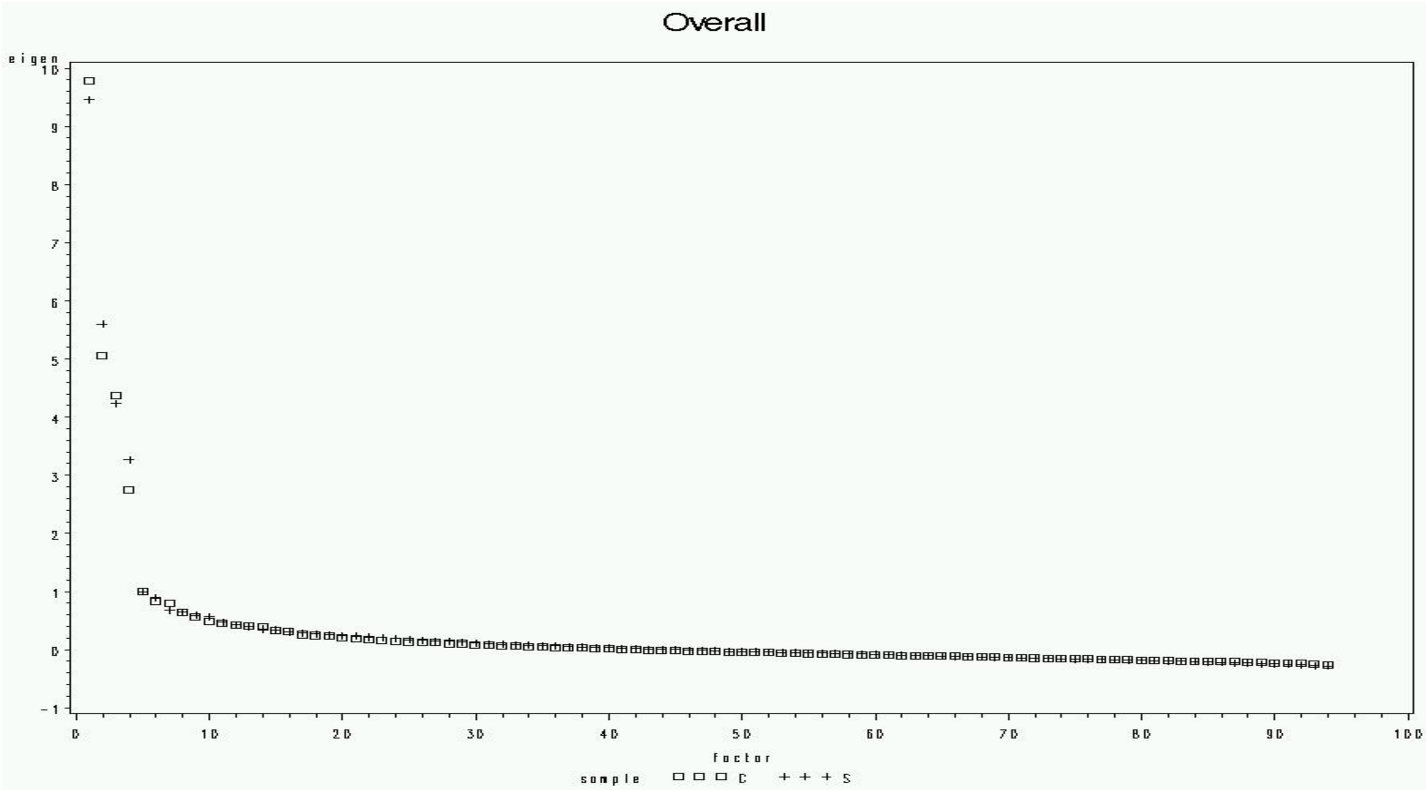

Figure 1. Scree plot of eigenvalues for all MBTI items (CCL sample = plus, student sample = square).

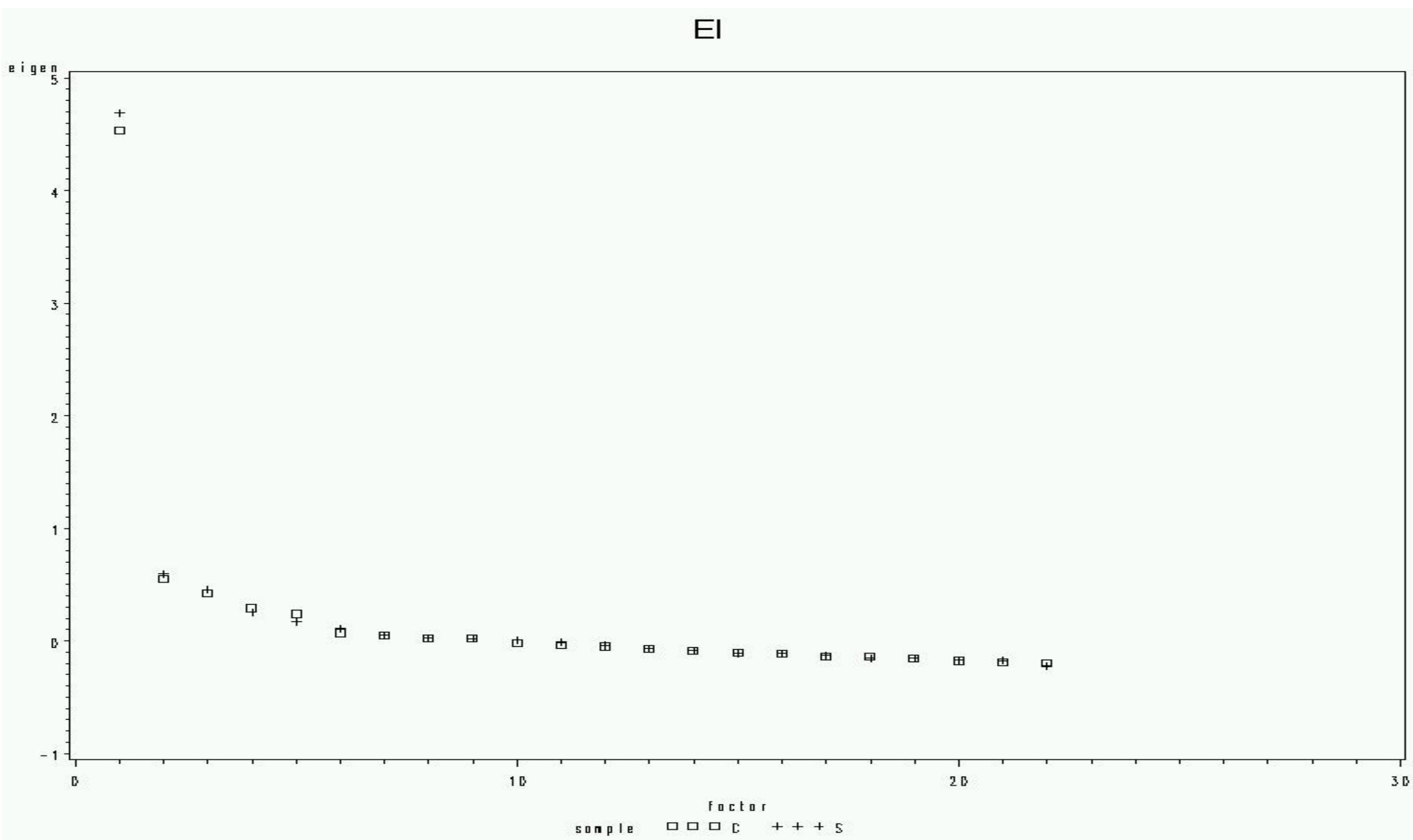

Figure 2. Scree plot of eigenvalues for EI items (CCL sample = plus, student sample = square).

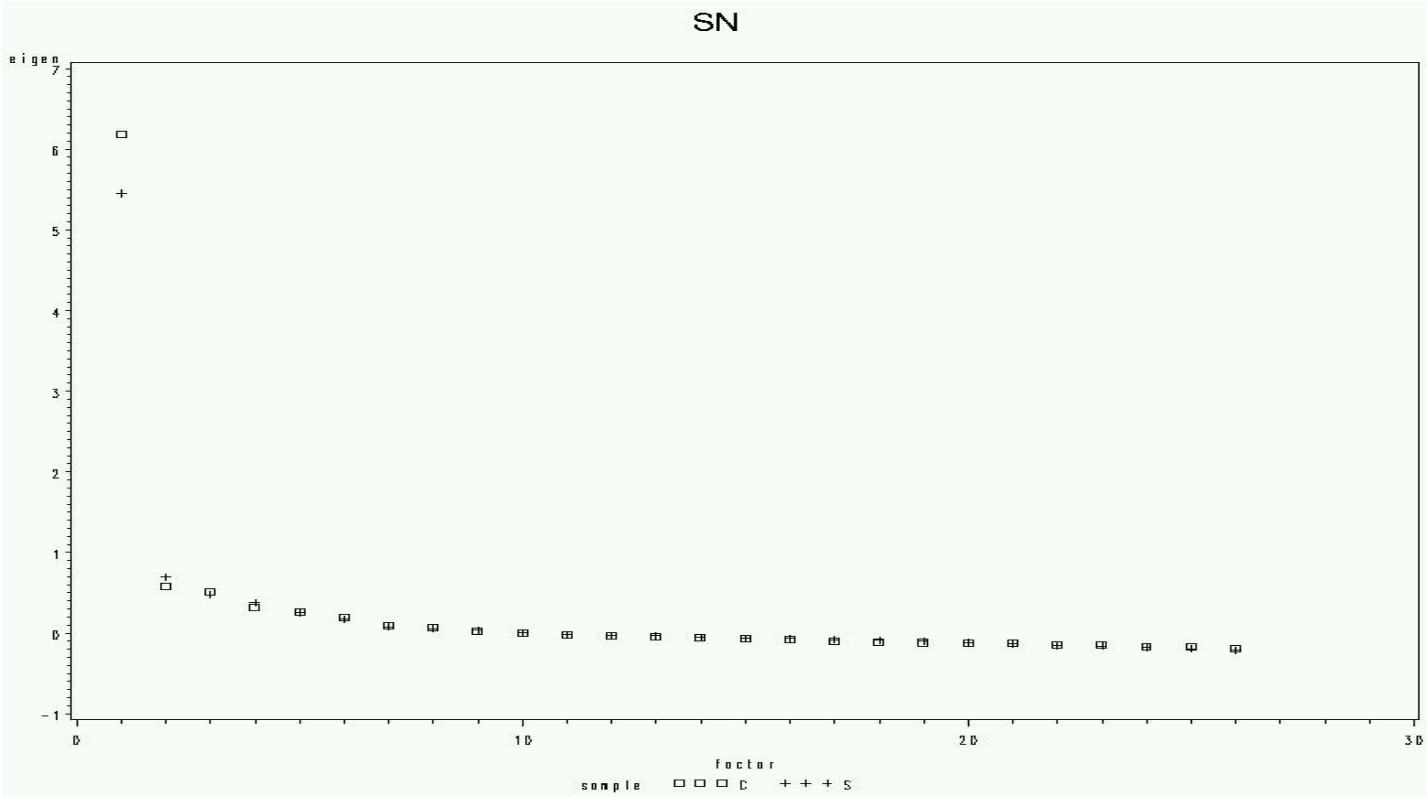

Figure 3. Scree plot of eigenvalues for SN items (CCL sample = plus, student sample = square).

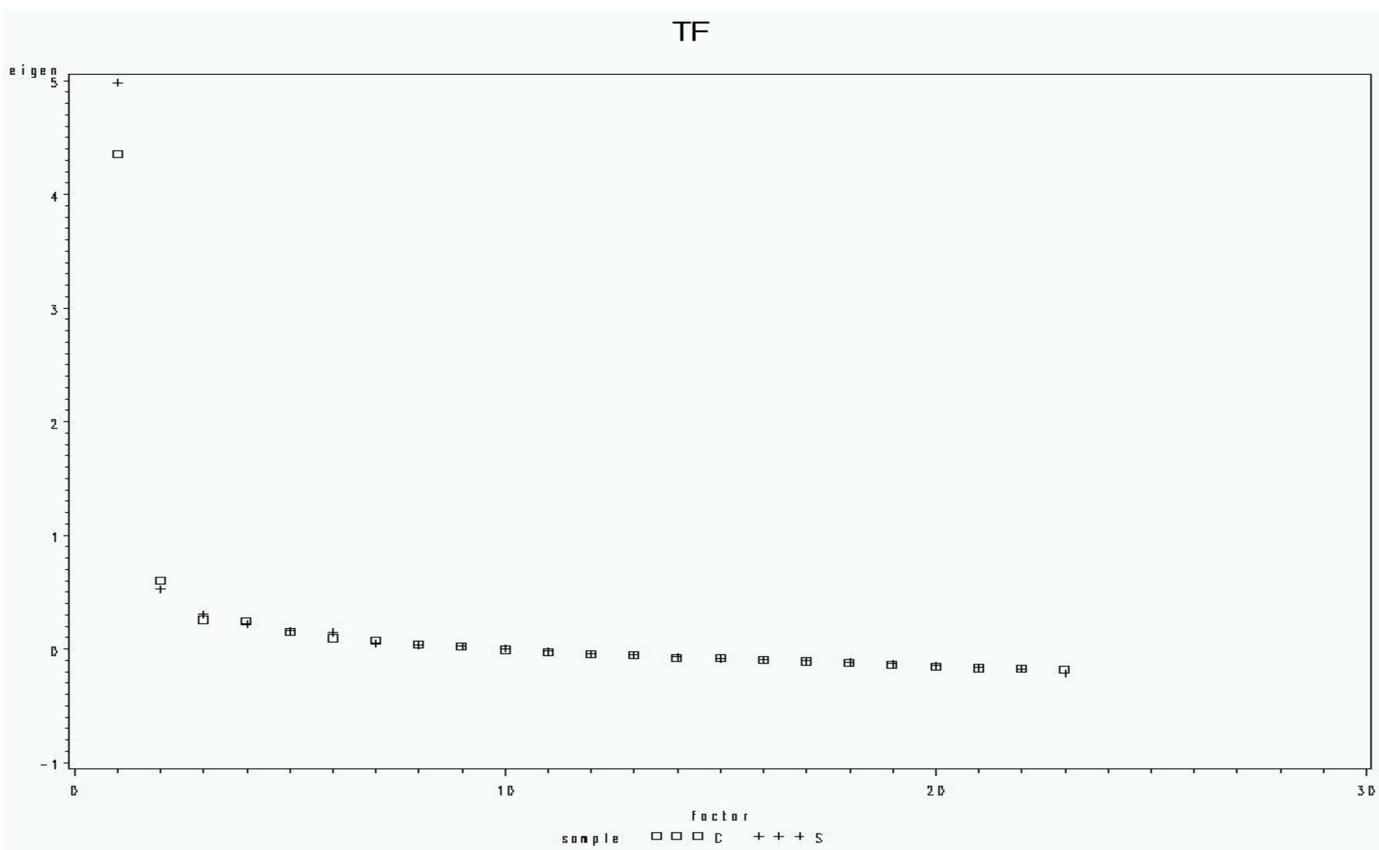

Figure 4. Scree plot of eigenvalues for TF items (CCL sample = plus, student sample = square).

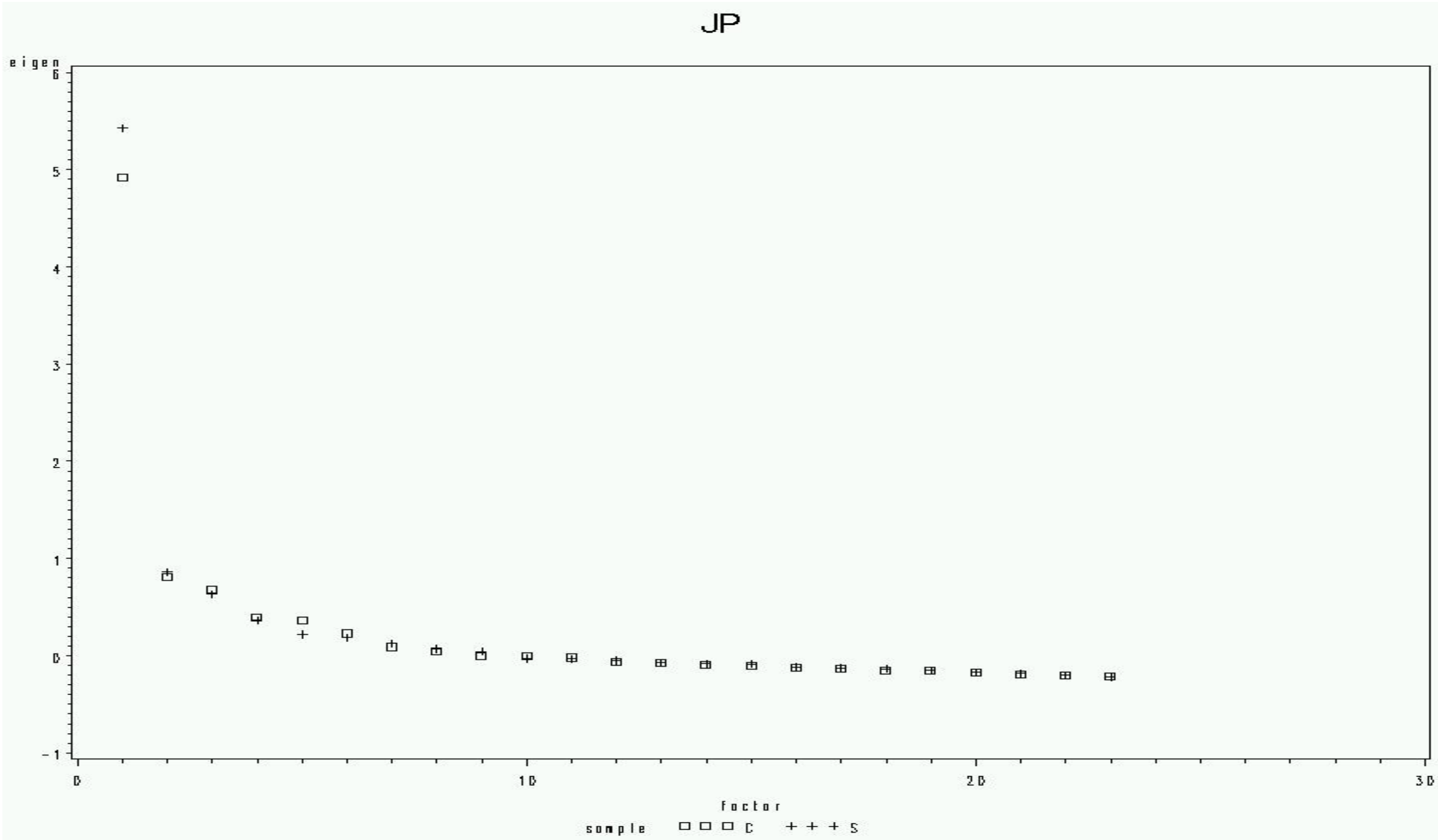

Figure 5. Scree plot of eigenvalues for JP items (CCL sample = plus, student sample = square)