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BRIEF REPORT

# A Cross-National Analysis of Measurement Invariance of the Satisfaction With Life Scale

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Measurement invariance of the Satisfaction With Life Scale (SWLS) was examined in probability samples of adults 50–79 years of age living in the United States, England, and Japan. Confirmatory factor analysis modeling was used to test for multigroup measurement invariance of a single-factor structure of the SWLS. Results support a single-factor structure of the SWLS across the 3 countries, with tests of measurement invariance of the SWLS supporting its configural invariance and metric invariance. These results suggest that the SWLS may be used as a single-factor measure of life satisfaction in the United States, England, and Japan, and that it is appropriate to compare correlates of the SWLS in middle-aged and older adults across these 3 countries. However, results provided evidence for only partial scalar invariance, with the intercept for SWLS Item 4 varying across countries. Cross-national comparisons of means revealed a lower mean at the latent variable level for the Japanese sample than for the other 2 samples. In addition, over and above the latent mean difference, the Japanese sample also manifested a significantly lower intercept on Item 4. Implications of the findings for research on cross-national comparisons of life satisfaction in European American and East Asian countries are discussed.

*Keywords:* life satisfaction, Satisfaction With Life Scale, measurement invariance, factorial invariance, cross-national

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Life satisfaction is viewed as a cognitive and global evaluation of the quality of one's life as a whole (Pavot & Diener, 1993). Understanding differences in life satisfaction is an important goal in and of itself, but also because life satisfaction is associated with social, occupational, and mental and physical health outcomes (for a review, see Pavot & Diener, 2008). In addition, life satisfaction has been identified as a way of assessing the quality of life of societies (Diener, 2000), and it is used in surveys in the United States for public health surveillance purposes and population estimates of well-being (e.g., Kobau, Sniezek, Zack, Lucas, & Burns, 2010).

Researchers have evaluated cross-national differences in means and correlates of life satisfaction, including cross-national comparisons between European American and East Asian countries (e.g., Diener, Suh, Smith, & Shao, 1995). Cross-national research (e.g., Diener, Suh, et al., 1995) has found that life satisfaction is higher for countries that are high in individualism, such as European American cultures, relative to countries that are low in individualism, such as East Asian cultures (Oyserman, Coon, & Kemmelmeier, 2002), and life satisfaction correlates positively with national ratings of individualism (e.g., Diener, Diener, & Diener, 1995).

In evaluating cross-national differences in life satisfaction, it is presumed that measurement of the construct is comparable across countries. However, because the meaning of items may differ for people from different countries, researchers first need to establish measurement invariance of measures of life satisfaction. Measurement invariance is defined as "the mathematical equality of corresponding measurement parameters for a given factorially defined construct (i.e., the loadings and intercepts of a construct's multiple manifest indicators) across two or more groups" (Little, 1997, p. 55). Without first establishing measurement invariance, it cannot be known whether differences across groups in means or correlates of life satisfaction are true differences or due to psychometric differences in item responses.

The most commonly used measure of life satisfaction is the Satisfaction With Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985). Although cross-national research has evaluated measurement invariance in models involving multiple measures including the SWLS (Caprara et al., 2012), and the extent to which a single-factor model fit the data from college students from 41 countries (Vittersø, Røysamb, & Diener, 2002), we know of only a few cross-national studies that have examined measurement invariance of the SWLS. One study found that four of the five SWLS items showed evidence of differential item functioning in

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comparisons between undergraduates from the United States and China (Oishi, 2006), and another study found nonequivalence in the SWLS between undergraduates from the United States and Brazil (Zanon, Bardagi, Layous, & Hutz, 2014). A study of adolescents from Argentina, Brazil, Chile, and Spain found evidence for factor invariance for a set of items taken from several measures of well-being, including four items from the SWLS (Casas et al., 2012). Finally, evidence of measurement invariance of the SWLS was obtained in a comparison of student groups but not between community groups from the United States and Russia (Tucker, Ozer, Lyubomirsky, & Boehm, 2006).

Although informative, prior research has generally focused on college students, who may not be representative of the general population. Furthermore, the assessment of life satisfaction in adolescents and young adults may differ from similar assessment in older adults, underscoring the need for research on measurement invariance in adults. Finally, because cultural factors such as individualism may contribute to cross-national differences in life satisfaction (Oyserman et al., 2002), research on measurement invariance is needed in countries that differ in individualism.

The current study was conducted to test for measurement invariance of the SWLS in probability samples of middle-aged and older adults living in the United States, England, and Japan. Although we were interested in evaluating measurement invariance of the SWLS in countries that differ in individualism (Oyserman et al., 2002), we focused on these three countries because data on the SWLS were publically available rather than because we had specific hypotheses regarding each country.

# Method

## Participants

Because tests of measurement invariance between groups are sensitive to the sample sizes involved, it is preferable that the sample sizes be roughly equivalent in the groups that are compared (Brown, 2015, p. 251). Therefore, approximately equal-size samples were selected from each survey; the American sample was slightly smaller than the English and Japanese samples, which were identical in size. Furthermore, because the surveys differed in their proportions of men and women and age cutoffs, we selected an equal number of men and women between 50 and 79 years of age from each survey so that groups would be comparable on gender and age.

**Midlife Development in the United States (MIDUS).** The MIDUS is a probability survey of Americans who were 25 to 74 years of age at baseline (i.e., in 1995–1996). A subset of the general population sample ($N = 640$) completed the SWLS in 2004–2006 as part of the MIDUS II Biomarker Project (Ryff, Seeman, & Weinstein, 2010). There were 197 men and 218 women who met eligibility criteria for this study (i.e., 50–79 years of age and completed the SWLS); the 197 men and random sample of 197 women used in this study had a mean age of 61.4 years ($SD = 7.7$) and the marital status of the sample was 5% never married, 72% married or cohabiting, 1% separated, 14% divorced, and 8% widowed. The racial composition of the sample was 94% White, 2% Black, and 4% other. The 197 women selected for the study did not significantly differ from the remaining women on age or marital status.

**Midlife Development in Japan (MIDJA).** The MIDJA study is a probability sample of 1,027 noninstitutionalized, Japanese-speaking adults aged 30–79 years from the Tokyo metropolitan area. Data were collected in 2008 (Ryff et al., 2008). There were 300 men and 300 women who met eligibility criteria for this study, all of whom were included in this study. Participants had a mean age of 64.2 years ($SD = 8.4$) and the marital status of the sample was 8% never married, 74% married, 2% separated, 5% divorced, and 11% widowed.

**English Longitudinal Study of Ageing (ELSA).** The ELSA is a longitudinal probability survey of households in England in which at least one person was ≥50 years of age (Banks, Breeze, Lessof, & Nazroo, 2006). The current analyses were based on data from core members who participated in the second wave of data collection ($N = 8,780$), which was completed in 2004–2005. There were 3,157 men and 3,810 women who met eligibility criteria for this study; random samples of 300 men and 300 women were used in this study to match the sample size of the MIDJA. Participants had a mean age of 63.5 years ($SD = 7.8$) and the marital status of the sample was 5% never married, 73% married, 3% separated, 9% divorced, and 10% widowed. The 600 people selected for the study did not significantly differ from the remaining people on age or marital status.

## Measure

**SWLS (Diener et al., 1985).** The SWLS consists of five items that are rated on a 1-to-7 rating scale, with higher scores indicating greater life satisfaction. The scale has good psychometric properties, including established internal consistency, test–retest reliability, and construct validity (for reviews, see Pavot & Diener, 1993, 2008). For the MIDJA sample, the SWLS was translated and back-translated by native speakers.

## Analyses

Measurement invariance was tested within the framework of multigroup confirmatory factor analysis (CFA) modeling using procedures outlined by Byrne (2006) and Vandenberg and Lance (2000). Analyses were conducted using EQS 6.1 (Bentler, 2005), which includes estimation based on the Satorra–Bentler scaled $\chi^2$ (S-B$\chi^2$; Satorra & Bentler, 1988), permitting appropriate goodness-of-fit indices and standard errors for data that are nonnormally distributed. Prior to conducting this analysis, we examined multivariate normality through the Mardia (1970) multivariate kurtosis coefficient and normalized estimate of multivariate kurtosis. Mardia's normalized multivariate kurtosis estimates can be interpreted like $z$ scores, and Bentler and Wu (2002) suggest that normalized estimates >3 will lead to chi-square and standard error biases.

We first needed to establish a well-fitting baseline model. Existing factor analytic studies have shown that the SWLS is represented by a single-factor solution (for reviews, see Pavot & Diener, 1993, 2008). Consequently, we conducted a CFA evaluating a single-factor structure of the SWLS in each sample. Consistent with other cross-national studies of measurement invariance of the SWLS (e.g., Zanon et al., 2014), the loading of Item 1 was fixed at 1.00 for purposes of model identification and latent variable scaling. Once a baseline model was identified, we tested the equivalence of this model across samples by imposing a series of increasingly stringent between-groups constraints, described below.

Our first model specified *configural invariance* (Vandenberg & Lance, 2000), meaning that the same factor structure (i.e., same pattern of fixed and free factor loadings) was estimated simultaneously in all three groups but no between-groups constraints were placed on parameter estimates. Given support for the configural model, we proceeded to test Model 2, in which we forced equal factor loadings across groups. *Metric invariance* or *weak factorial invariance* (Meredith & Teresi, 2006; Vandenberg & Lance, 2000) in the sense of a common factor structure and loadings is met if this model does not result in a deterioration of fit compared with the configural model. Model 3 added the additional constraint of equal item intercepts in the three groups. In one group, that latent variable mean was fixed at zero (for identification purposes) and in the other two groups the latent means were estimated. This model, known as *scalar invariance* or *strong factorial invariance* (Meredith & Teresi, 2006; Vandenberg & Lance, 2000), implies that any mean differences between the groups are due to mean differences in the latent underlying construct rather than to mean differences varying from item to item. If the obtained results did not support Model 2 or Model 3, we then tested for partial measurement invariance (Byrne, Shavelson, & Muthén, 1989) by successive removal of constraints on factor loadings (for Model 2) or item intercepts (for Model 3) based on examination of modification indices until the revised model did not differ from the previously tested model using the criteria described below.

We used several indices for evaluating model fit. First, we used the S-B$\chi^2$ because it incorporates a scaling correction for the $\chi^2$ when distributional assumptions are violated. Similar to the $\chi^2$ statistic, use of the S-B$\chi^2$ is sensitive to sample size. Consequently, we also evaluated model fit with the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA) and its 90% confidence interval (CI). CFI values $\geq$.95, SRMR values $\leq$.08, and RMSEA values $\leq$.06 are viewed as evidence for a well-fitting model (Hu & Bentler, 1999), with CFI values of .92–.94 and RMSEA values $\leq$.08 considered as indicators of reasonable model fit (Byrne, 2008). For CFI and RMSEA, we report the robust versions (i.e., $^*$CFI and $^*$RMSEA, based on the S-B$\chi^2$).

The various models we tested can be seen as nested under each other, in the sense that as more between-groups restrictions are included, the models are hierarchically nested. Nested models can be compared in pairs by calculating the differences in their overall $\chi^2$ values and the related degrees of freedom; the $\chi^2$-difference value ($\Delta\chi^2$) is distributed as $\chi^2$, with the degrees of freedom equal to the difference in degrees of freedom ($\Delta df$). Historically, if the $\Delta\chi^2$ value is significant, it suggests that the constraints in the more restrictive model do not hold and therefore the two models are not equivalent across groups; similar comparisons can be made based on the S-B$\chi^2$, except that a correction to this difference value is needed because it is not distributed as $\chi^2$ (Satorra & Bentler, 2001). However, the use of the $\Delta\chi^2$ has come under criticism because it is highly sensitive to sample size. Consequently, researchers have based decisions of invariance on alternative criteria. Cheung and Rensvold (2002) suggested that $\Delta$CFI should not exceed $-.01$, and Chen (2007) recommended that measurement invariance should be rejected when $\Delta\text{CFI} \leq -.01$ and when $\Delta\text{RMSEA} \geq .015$. For comparisons between all nested models we report the appropriately scaled $\Delta\chi^2$ value ($\Delta$S-B$\chi^2$, based on the Satorra & Bentler, 2001, correction) and its degrees of freedom. However, we relied on the two measures of relative fit ($\Delta$CFI and $\Delta$RMSEA) and we adopted Cheung and Rensvold's (2002) and Chen's (2007) cutoff values for rejecting measurement invariance, using the robust versions of these measures.

## Results

Means, standard deviations, skewness, and kurtosis for SWLS item and total scores are presented in Table 1. Mardia's multivariate kurtosis coefficient and its normalized estimate, respectively, were 11.40 and 13.52 for the MIDUS II, 24.58 and 35.99 for the ELSA, and 18.47 and 27.03 for the MIDJA. The substantial multivariate kurtosis supports the use of robust statistics.

We first sought to establish a well-fitting baseline model through conducting a CFA in each sample, evaluating a single-factor structure of the SWLS. Testing of this single-factor model yielded a good fit to the data in the MIDUS II, S-B$\chi^2(5) = 10.19$, $p = .07$, $^*\text{CFI} = .993$, SRMR = .017, $^*\text{RMSEA} = .051$, 90% CI [.000, .097], and a reasonable fit in the ELSA, S-B$\chi^2(5) = 20.35$, $p = .001$, $^*\text{CFI} = .984$, SRMR = .019, $^*\text{RMSEA} = .072$, 90% CI [.041, .105], and the MIDJA, S-B$\chi^2(5) = 17.19$, $p = .004$, $^*\text{CFI} = .990$, SRMR = .026, $^*\text{RMSEA} = .064$, 90% CI [.032, .098]. Consistent with a single-factor structure, the SWLS demonstrated good internal consistency in the MIDUS II ($\alpha = .85$), ELSA ($\alpha = .86$), and MIDJA ($\alpha = .84$) samples.

Measurement invariance was hierarchically tested on the single-factor model; results from these analyses are presented in Table 2. Results from the tests of Model 1, which tested for configural invariance, suggest a well-fitting model, with $^*$CFI, SRMR, and $^*$RMSEA values falling within recommended values. These results support the presence of a single-factor model across groups. Results for Model 2, which tested for metric invariance, suggest a well-fitting model, with $^*$CFI, SRMR, and $^*$RMSEA values falling within recommended values. Although the $\Delta$S-B$\chi^2$ was statistically significant, the $\Delta^*$CFI and $\Delta^*$RMSEA were below the recommended values for rejecting measurement invariance. Because this model constraints equal factor loadings across groups, these results suggest that the SWLS items tap the same latent construct across the three groups. Results for Model 3, which tested for scalar invariance, indicate that as a function of the additional constraints of item intercepts, there was substantial deterioration in model fit, with the S-B$\chi^2$ showing a large and highly significant increase in value. In addition, the $^*$RMSEA exceeded the cutoff for a well-fitting model and the $\Delta^*$RMSEA exceeded Chen's (2007) cutoff for rejecting measurement invariance. The Lagrange multiplier test statistic suggested that item intercepts for Item 4 were not invariant. Thus, we released the constraints on these item intercepts. Although the increase in S-B$\chi^2$ relative to Model 2 was still significant, relaxing these constraints resulted in $^*$CFI, SRMR, and $^*$RMSEA values that suggested a well-fitting model and $\Delta^*$CFI and $\Delta^*$RMSEA values that were below cutoffs for rejecting invariance (see Model 3a in Table 2). The estimated intercept for Item 4 was lower in the MIDJA sample (4.94) relative to the ELSA sample (5.38) or the MIDUS II sample (5.47). In addition, because the mean of the latent factor was constrained at zero for one group (i.e., the American sample) for identification purposes and estimated in the other two groups, the mean differences in the latent

Table 1
*Item Means, Standard Deviations, and Intercorrelations Presented Separately by Sample*

| | | | | | Intercorrelations | | | |
|---|---|---|---|---|---|---|---|---|
| Sample | Mean | *SD* | Skewness | Kurtosis | Item 1 | Item 2 | Item 3 | Item 4 |
| MIDUS II | | | | | | | | |
| Item 1 | 4.80 | 1.52 | −0.78 | −0.21 | | | | |
| Item 2 | 4.89 | 1.56 | −0.79 | −0.24 | .76*** | | | |
| Item 3 | 5.26 | 1.45 | −1.05 | 0.51 | .72*** | .79*** | | |
| Item 4 | 5.47 | 1.37 | −1.23 | 1.12 | .65*** | .63*** | .66*** | |
| Item 5 | 4.16 | 1.77 | −0.13 | −1.17 | .54*** | .50*** | .50*** | .46*** |
| Total | 24.58 | 6.37 | −0.74 | 0.21 | | | | |
| ELSA | | | | | | | | |
| Item 1 | 5.17 | 1.33 | −1.12 | 0.87 | | | | |
| Item 2 | 5.21 | 1.42 | −1.22 | 0.98 | .77*** | | | |
| Item 3 | 5.50 | 1.31 | −1.48 | 1.99 | .76*** | .83*** | | |
| Item 4 | 5.65 | 1.32 | −1.60 | 2.48 | .72*** | .69*** | .75*** | |
| Item 5 | 4.75 | 1.76 | −0.59 | −0.85 | .56*** | .54*** | .60*** | .57*** |
| Total | 26.27 | 6.11 | −1.14 | 0.94 | | | | |
| MIDJA | | | | | | | | |
| Item 1 | 4.06 | 1.35 | −0.25 | −0.04 | | | | |
| Item 2 | 4.19 | 1.36 | −0.36 | 0.04 | .85*** | | | |
| Item 3 | 4.53 | 1.43 | −0.61 | 0.11 | .75*** | .79*** | | |
| Item 4 | 4.34 | 1.36 | −0.33 | −0.12 | .69*** | .69*** | .66*** | |
| Item 5 | 3.78 | 1.54 | −0.04 | −0.58 | .41*** | .39*** | .42*** | .43*** |
| Total | 20.90 | 5.81 | −0.30 | 0.25 | | | | |

*Note*. MIDUS II = Midlife Development in the United States; ELSA = English Longitudinal Study of Ageing; MIDJA = Midlife Development in Japan.
*** $p < .001$.

means across the three samples can be compared. The latent factor mean for the English sample was estimated as .318, a value that is significantly higher than the mean of zero for the American sample ($Z = 3.73$), whereas the mean for the Japanese sample was estimated as −.702, a value that is significantly lower than the mean of zero for the American sample ($Z = -8.25$).

Because the MIDJA used a translated version of the SWLS, it is possible that the translated measure contributed to the nonequivalence obtained in the multigroup CFA. Therefore, we conducted three separate analyses for pairwise comparisons between the MIDUS II and ELSA, MIDUS II and MIDJA, and ELSA and MIDJA. Results of these analyses, presented in the online Supplementary Materials, provided evidence for (a) configural, metric, and scalar invariance for the comparisons between the MIDUS II and ELSA; (b) configural, metric, and partial scalar invariance for the comparisons between the MIDUS II and MIDJA; and (c) configural, metric, and partial scalar invariance for the comparisons between the ELSA and MIDJA. Because comparisons between the MIDUS II and ELSA yielded scalar invariance, whereas comparisons between the MIDJA and the two other samples yielded only partial scalar invariance, results of the multigroup analyses may be due, at least in part, to the translated version of the SWLS used in the MIDJA.

## Discussion

Results from the CFA testing multigroup measurement invariance of the SWLS in probability samples of middle-aged and older adults from the United States, England, and Japan supported a single-factor solution in each of the three countries. Furthermore, results indicated that the configural model (Model 1) was supported, which confirms that a similar latent factor was present in

Table 2
*Goodness-of-Fit Statistics for Tests of Measurement Invariance of a Single-Factor Model of the Satisfaction With Life Scale*

| Model number and description | S-B$\chi^2$ (*df*) | *CFI | SRMR | *RMSEA | *RMSEA 90% CI | ΔS-B$\chi^2$ (*df*) | Δ*CFI | Δ*RMSEA |
|---|---|---|---|---|---|---|---|---|
| 1. Configural | 49.01*** (15) | .988 | .021 | .065 | [.045, .086] | — | — | — |
| 2. Factor loadings invariant | 78.89*** (23) | .981 | .065 | .068 | [.052, .084] | 30.49*** (8) | −.007 | .003 |
| 3. Factor loadings and item intercepts invariant | 165.11*** (31) | .983 | .074 | .090 | [.077, .104] | 113.98*** (8) | .002 | .022 |
| 3a. Factor loadings and item intercepts invariant[a] | 102.43*** (29) | .984 | .066 | .069 | [.055, .084] | 24.85*** (6) | .003 | .001 |

*Note*. S-B$\chi^2$ = Satorra–Bentler scaled $\chi^2$; *df* = degrees of freedom; *CFI = robust comparative fit index; SRMR = standardized root mean square residual; *RMSEA = robust root mean square error of approximation; CI = confidence interval.
[a] Item intercepts for Item 4 were not constrained.
*** $p < .001$.

the three countries. Thus, it appears that adults from the United States, England, and Japan conceptualize life satisfaction similarly, as reflected by a single factor.

In addition, there was support for metric invariance (Model 2), which indicates that the factor structure of the scale was equivalent across groups, suggesting that participants from the three countries attributed the same meaning to the latent construct measured by the SWLS. Because metric invariance was obtained, associations between the SWLS and other variables can be compared across middle-aged and older adults from the United States, England, and Japan, because one unit of change in one group equals one unit of change in another.

However, results only partially supported Model 3, which tested for scalar equivalence by also constraining item intercepts to be equal. Evidence for scalar invariance is necessary to establish that mean differences between groups are due to differences in the latent underlying construct rather than to differences varying from item to item. Results suggest that item intercepts for Item 4 ("So far I have gotten the important things I want in life") were not invariant; people from Japan with the same value on the latent factor scored lower on this item than people from England or the United States. Similarly, other cross-national studies have found evidence of noninvariance for Item 4 (e.g., Oishi, 2006; Zanon et al., 2014). In comparison with other SWLS items, which focus on the present, Item 4 involves an implicit reference to the past. It may be that people from Japan are less likely to attain important things they want in their lives (i.e., differences in intercepts may reflect real differences in life satisfaction) or the difference may reflect a cultural difference in the meaning or interpretation of this item. For example, people from East Asia may not evaluate their personal accomplishments as positively as people from European American countries because doing so seems too self-enhancing and not socially desirable (Oishi, 2006). Furthermore, the SWLS was translated and back-translated for the MIDJA and the translation of the Japanese version could be a source of bias. Because the SWLS has only partial scalar invariance, comparisons of SWLS mean differences confound mean differences at the level of the latent variable with item-specific differences, which may result from measurement artifacts. Our results do suggest, however, that mean comparisons can be made at the latent level once Item 4 is allowed to have its own intercept.

In interpreting the results, it is important to consider the strengths and limitations of the study. Strengths include the use of probability samples of adults from three countries. As results were based on only three countries, additional research is needed to evaluate measurement invariance of the SWLS in other countries that differ in level of individualism. In addition, it is possible that participants in the three surveys differed in ways other than individualism, which could have contributed to the results. Furthermore, we examined only measurement invariance, and future research is needed to evaluate potential slope or intercept biases of the association between the SWLS and other measures of subjective well-being and constructs such as individualism. Finally, the use of back-translation has been criticized (e.g., Geisinger, 1994), and it would be useful in the future for researchers to follow guidelines advanced by the International Test Commission for adapting measures for cross-cultural research (cf. Hambleton, 2001).

In conclusion, results from the study suggest that (a) middle-aged and older participants from the United States, England, and Japan evaluate life satisfaction along a single dimension; (b) correlates of the SWLS can be compared across these countries; and (c) mean comparisons can be made between the United Sates and England, but cross-national comparisons of means on the SWLS for Japan should be interpreted with caution, as differences in means cannot be solely attributed to life satisfaction, but rather may be confounded with differences across countries in how participants respond to particular items (particularly Item 4) in the SWLS.

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## Correction to Carleton, Gosselin, and Asmundson (2010)

In the article "The Intolerance of Uncertainty Index: Replication and Extension With an English Sample" by R. Nicholas Carleton, Patrick Gosselin, and Gordon J. G. Asmundson (*Psychological Assessment*, 2010, Vol. 22, No. 2, pp. 396–406. http://dx.doi.org/10.1037/a0019230), the Factor loading of the First sample in Table 2 should have begun with Item 2 and the final value in that table should not exist. Factor 1 should be associated with Items 2, 5, 6, 7, 9, 11, 13, 17, 21, and 30; Factor 2 should be associated with Items 3, 14, 19, 23, and 29; and Factor 3 should be associated with Items 4, 10, 18, 24, and 27.

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