DOCUMENT RESUME

ED 481 343 TM 035 284

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TITLE A Multi-Cultural Comparison of the Factor Structure of the MIDAS for Adults/College Students.

PUB DATE 2003-04-00

NOTE 22p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, April 21-25, 2003).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE EDRS Price MF01/PC01 Plus Postage.

DESCRIPTORS *College Students; *Cross Cultural Studies; *Cultural Differences; Factor Analysis; *Factor Structure; Foreign Countries; Higher Education; *Intelligence Tests; *Multiple Intelligences

IDENTIFIERS Canada; Chile; Singapore; South Korea; Taiwan; United Kingdom; United States

ABSTRACT

The Multiple Intelligences Developmental Assessment Scales (MIDAS) instrument was developed to measure eight constructs of intelligence. The 119-item MIDAS provides scores for 26 subscales in addition to the 8 major scales. Using the 26 subscales, a factor structure was developed on half of a U.S. sample of college students (n=834), while the second half was compared to six samples of college students and young adults from Canada (n=203), Chile (n=202), Korea (South Korea; n=200)), Singapore (n=284), Taiwan (n=203), and the United Kingdom (n=190). Multi-sample confirmatory factor analysis was used to investigate the fit of the imposed model as parameters were progressively relaxed. The seven groups were found to differ little even when the factor structure constraints were fully relaxed. A pairwise comparison between the U.S. sample and each of the remaining six groups found that the factor structure was common in the most relevant aspects for the Canadian and United Kingdom samples, but some differences were found for the remaining groups. The group showing the least in common with the U.S. factor structure was Korea. The overall results are supportive of multiple intelligences being viewed as abilities that are influenced by cultural content. (Contains 1 figure, 8 tables, and 20 references.) (Author/SLD)

# A Multi-Cultural Comparison of the Factor Structure of the MIDAS for Adults/College Students



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Poster presented at the annual meeting of the American Educational Research Association, Chicago, IL. April, 2003

## Abstract

The Multiple Intelligences Developmental Assessment Scales (MIDAS) was developed to measure eight constructs of intelligence. The 119 item MIDAS provides scores for 26 subscales in addition to the eight major scales. Using the 26 subscales, a factor structure was developed on one half of a United States sample of college students while the second half of the sample was compared to six samples of college students and young adults from Canada, Chile, Korea, Singapore, Taiwan, and the United Kingdom. Multi-sample confirmatory factor analysis (MCFA) was used to investigate the fit of the imposed model as parameters were progressively relaxed. The seven groups were found to differ even when the factor structure constraints were fully relaxed. A pairwise comparison between the US sample and each of the remaining six groups found that the factor structure was common in the most relevant aspects for the Canadian and UK samples, but some differences were found for the remaining groups. The group showing the least in common with the US factor structure was Korea. The overall results are supportive of multiple intelligences being viewed as abilities that are influenced by the cultural context.


## Introduction

One of psychology's most eminent and resilient contributions to western culture has been the assessment of intelligence (Binet, 1916; Spearman, 1927; Wechsler, 1958). Intelligence tests, however, have come under regular criticism as inadequate and flawed measures. Beyond the most recent challenges to their claims for universal objectivity, a fundamental source of criticism is the narrow scope of the intelligence quotient (I.Q.) and its limited ability to give a true picture of human intellectual prowess (Gardner, 1983; Gould, 1981; Sternberg, 1982). Over the years, a

number of alternative theories of intelligence have been offered (Guilford, 1967; Sternberg, 1982; Thurstone, 1938) but none have enjoyed wide acceptance or use in education, research, or clinical psychology. The I.Q. owes much of its popularity to its simplistic, intuitive appeal, and its match to prevailing social assumptions and a particularly westernized perspective on the nature of the human mind (Gould, 1981).

An alternative to the unitary concept of general intelligence was proposed by Howard Gardner in his book, Frames of Mind (1983). Gardner suggested that it was better to conceptualize intelligence as comprised of seven distinct yet complementary constructs: linguistic, logical-mathematical, musical, spatial, kinesthetic, interpersonal, and intrapersonal. An eight construct, naturalistic, was proposed later (Gardner,1993). These constructs, or intelligences, were defined as abilities that permit an individual to solve a problem or create a product that is valued within one or more cultural settings. In other words, Gardner's definition of intelligence and intellectual ability was not context free. This more holistic view of intellectual functioning was embraced in a multiple intelligence (MI) assessment, which describes a learner's intellectual propensities across a range of endeavors. MI theory holds the promise that individuals have the potential to be successful and perform with intelligence in non-academic activities (e.g., kinesthetic, musical).

Although MI theory has been welcomed by many educators, wider acceptance and use has been limited by the lack of a practical, reliable, and valid method of assessment. Gardner's (1983; 1993) broad definition of intelligence and his complex descriptions of the multiple intelligences made it difficult to create psychometrically sound methods of measurement. Indeed,

Gardner (1998) challenged the basic assumption that intellectual prowess can be measured via paper-and-pencil, multiple-choice type tests.

The Multiple Intelligences Developmental Assessment Scales (MIDAS) attempted to measure Gardner's eight constructs of intelligence with an objective, psychometrically sound instrument. An 106 item form for use with adolescents and adults was developed (originally titled the HAPI) and found to have generally favorable psychometric properties with regards to factor structure, internal consistency, test-retest reliability, and concurrent validity (Shearer & Jones, 1994). Currently, the MIDAS measures eight constructs and consists of 119 items. The current version was also found to have high internal consistency for each of the eight scales with Cronbach Alpha coefficients ranging from .85 to .90, although the factor structure was only partially confirmed (Wiswell, Hardy, & Reio, 2001; Yoong, 2000).

Although originally developed for an United States (US) audience, the MIDAS has developed an international presence, and has been translated into several languages (Shearer, personal communication, July, 2002). The proposed question for this study was the extent to which the eight scales of the MIDAS were consistent across cultures as compared to the possible impact of cultural context on the measurement of MI. Samples of college-aged students from Canada, Chile, Korea, Singapore, Taiwan, and the United Kingdom (UK) were compared to a sample of US college students using multi-sample confirmatory factor analysis (MCFA) as a method to explore cultural bias.

## Method

The MIDAS had been previous administered to High School or college students using the English version for the US (n=834), Canada (n=203), Singapore (n=284), Taiwan (n=203), and UK students (n=190), and translated into the appropriate language for students in Chile (n=202) and Korea (n=200). The Singapore and UK further had the Teen-MIDAS versions while the other groups had the adult version. All versions of the MIDAS had the same number of items with identical scoring procedures to construct the scales. The modifications were made to add clarity to items or have items describe activities that were similar in context to the original but more relevant to the culture or age group. Demographic variable were not available for all groups, but the samples can be generally described as young adults attending high school or college.

As illustrated by Keith, Fugate, DeGraff, Diamond, Shadrach, and Stevens (1995), MCFA has the advantage of providing a direct comparison of two or more covariance matrices and can assess the degree of equivalence of the factor structure. MCFA is hierarchical in execution, progressing from the most restrictive to least restrictive model that is common across the samples. The most restrictive model is defined as having equal covariance matrices across all groups. If a good fit results at this stage, as indicated by various measures of goodness of fit (Bollen, 1989; Browne & Cudeck, 1993), further analysis of the factor structure is not needed since all factor structures that would result would be indistinguishable across groups.

If the covariances are found to differ across groups, the next step is to test the fit of the factor structure across the groups with all parameters invariant (Keith et al., 1995). Then the constraints on the unique and error variances are removed, while keeping other parameters

constrained. The change in the chi square statistic that results from reducing these constraints can then be tested for statistical significance. In addition to the change in chi square there are many fit statistics that can be examined. For this study, the relative chi-square (CMIN/DF; Carmines & McIver, 1981), Goodness of Fit Index (GFI; Bollen, 1989), Adjusted Goodness of Fit Index (AGFI; Bollen, 1989), Normed Fit Index (NFI; Bentler & Bonett, 1980), Tucker-Lewis coefficient (TLI; Bollen, 1989), Comparative Fit Index (CFI; Bentler, 1990), Parsimonious CFI (PCFI; Arbuckle & Wothke, 1999), and the Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1993) were reported for each stage.

The model constraints continue to be systematically removed, factor variance, then factor correlations, and finally factor loadings, with the change in fit evaluated at each stage. Assuming differences in fit are found at the stages, some levels have more implications for the use of the MIDAS in different cultures than others. For example, differences in unique, error, and factor variances are not expected to be similar unless the samples were randomly drawn from the same population (Marsh, 1993). Differences in factor correlations and factor loadings, however, have more severe implications for the interpretation of the MIDAS scales when used by other cultures.

## Results

The first step was to find a factor structure model that would fit the normative data sample. The US sample was randomly split into two groups: the first sample was used to find a fitting factor structure and the second used in the multi-cultural comparison. Rather than use 119 items, a simpler approach was taken using the 26 subscales (referred to as "cluster scales") provided by the MIDAS. These scales are formed from groups of items, which taken together,

form the eight major scales. The first exploratory model had each subscale loading on its major scale with all major scales intercorrelated. As shown by Table 1, this model was an improvement over the independence model, but did not provide a sufficient fit of the data. With the aid of the modification indices provided by the AMOS software (Arbuckle & Wothke, 1999), a revised model was developed that provided a better fit while still attempting to maintain the general structure of the theoretical factor structure. Additional paths were drawn for the Kinesthetic, Logical-Mathematical, Spatial, Linguistic, and Interpersonal scales, ten error covariance paths were added, and several nonsignificant factor correlations paths were removed. Some examples of added paths were the subscale of Art Design was shared by the Kinesthetic, Spatial, and Interpersonal scales, the subscale Calculations was shared by the Logical-Mathematical and Intrapersonal scales, and the error terms for Composition and Expression were allowed to covary. The final model can be seen in Figure 1, with its fit statistics in Table 1. Although the fit of the final model was still not ideal, it was a large improvement over the first model ($\chi^2$=2,346.34, df=6, $p<.001$) and still provided the eight theoretical constructs. It should be noted that the original MIDAS structure was based on the items while this model was derived from the subscales.

Before applying the model shown in Figure 1 to a confirmatory US sample and the data sets from the other countries, a test of the covariance matrix similarity was made. The data from Canada (n=203), Chile (n=202), Korea (n=200), Singapore (n=284), Taiwan (n=203), United Kingdom (UK; n=190), and the US (n=417) were compared in a model consisting of only the observed variables, their variances, and covariances. The covariances were found to be different

($\chi^2$=3,690.32, df=2,106, p<.001), indicating that potential differences could occur in the factor structures.

As shown in Table 2, the model was progressively allowed to vary across the seven groups. The fifth step, allowing all parameters to vary, could not be assessed because a solution could not be found that would converge. In the four steps that were done, some of the fit statistics, such as RMSEA and relative chi square, consistently indicated a good fit of the data to the model across the all steps. Others, such as the NFI, TLI, and CFI, indicated that the fit was marginal. The chi square, GFI, and AGFI indicated a very poor fit of the data. The change in chi square across the steps was always highly significant, indicating that the proposed factor structure was too restrictive across the data sets.

Next, each group was compared against the US sample in a pairwise manner to see what patterns may emerge. As shown in Tables 3 through 8, the closeness of fit varied by country. The Canadian and UK samples (Tables 3 and 8) showed improvement in fit from the most restrictive model when error variances and covariances were permitted to vary while all other parameters remained constrained. For theses two samples, further relaxing of the structure resulted in very little improvement in model fit. The change in chi square was statistically significant for movement from Step 1 to Step 2, but the remaining steps were either nonsignificant or at p>.01.

The Korean sample appeared to have the least in common with the US derived factor structure. The change in chi square across the steps were all highly significant, and the remaining fit statistics at each step were less supportive of model fit as compared to the other paired comparisons. The remaining samples, Chile, Singapore, and Taiwan, fit better with the US sample that Korea, but not as well as Canada and the UK. With Chile, there was a slight

improvement in fit until the fourth step when error variances and covariances, factor variances, and factor correlations but not factor loadings were allowed to vary. Relaxing the last parameters did not result in a significant change in chi square or an improvement in the other fit statistics. For the Singapore sample, the change in chi square was significant between the steps, but the overall fit was better than the Korean sample. The Taiwan sample showed improvement in fit as the parameter restrictions were lifted, but step four (freeing the factor correlations) did not result in a significant change in chi square. In the next step, allowing the factor loading to vary did produce an improvement, however.

## Discussion

The factor structure would appear to not be invariant across all groups. There are some groups, Canada and the UK, that differ from the US sample on parts of the factor structure that are not as crucial (error variances and covariances) to the overall structure, which would indicate that the interpretation of the MIDAS would be most similar for these groups. The Korea sample, however, had the most differences and may suggest that the factor structures for the US and Korea groups are the farthest apart and have the most potential for cultural bias in the interpretation of MIDAS results. It is interesting to note, however, that some of the fit statistics for the groups the furthest apart (Korea and the US) were actually better than those for fitting the original US sample to the base model (Tables 5 and 1, respectively).

The variation across groups and the patterns in the pairwise comparisons would suggest that cultural context does matter. The samples that were the closest to the US sample in factor structure fit were also the most culturally similar: Canada and the UK. The Korean sample, the

most different, used a version of the MIDAS that has had the most extensive alteration to items in its translation. This may indicate that culturally, the items as written for an US audience had the most difficulty fitting into the context of Korean experience. Taken as a whole, these results suggested that although there are some stable features to the MI constructs, there is also a cultural context at work. This is supportive of Gardner's (1993) view of intelligences as abilities that are understood within a cultural setting. Those cultural settings that are most similar should result in the most similar MI constructs, while cultures with less common experiences would produce variations in the MI themes.

The factor structure used for this study attempted to maintain the eight constructs. Other studies examining the factor structure have had mixed success in confirming this factor structure in the MIDAS (Wiswell, Hardy, & Reio, 2001; Yoong, 2000). For example, Yoong (2000) found the Kinesthetic scale did not emerge because its items loaded on other scales. Wiswell, Hardy, and Reio (2001) also described problems confirming the Kinesthetic scale, plus noticed discrepancies for the Intrapersonal, Logical-Mathematical, and Spatial scales. In the base model for this study, these same scales were altered with additional paths, and the Kinesthetic construct was the most altered. The factor structure that was being fitted by this study had the eight constructs, but the possibility exists that other models may have been better fits for the US as well as the other data. In future investigations, examination of other structures could be attempted. For example, the correlations among the factors would suggest higher order or hierarchical structures might be likely. Alternatively, the factor structure from the item level, rather than the subscales or cluster scores, could be investigated.

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Table 1

Fit of Base Model to US sample (n=417)

| Models | $\chi^2$ | df | $\chi^2$/df | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|
| Independence | 7892.28 | 325 | 24.28 | .29 | .23 | | | | | .24 |
| Initial Model | 3439.70 | 272 | 12.65 | .63 | .52 | .56 | .50 | .58 | .49 | .17 |
| Final Model | 1093.36 | 266 | 4.11 | .83 | .77 | .86 | .87 | .89 | .73 | .09 |

Table 2

Comparison of the Fit of the Factor Model Across All Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 6,830.49 | 2,373 | 2.88 | | | | .77 | .76 | .78 | .85 | .84 | .88 | .03 |
| Error variances and covariances vary | 6,198.65 | 2,169 | 2.86 | 631.84 | 204 | <.001 | .78 | .76 | .80 | .85 | .86 | .82 | .03 |
| Error variances and covariances and factor variances vary | 6,038.35 | 2,127 | 2.84 | 160.30 | 42 | <.001 | .79 | .76 | .80 | .85 | .86 | .81 | .03 |
| Error and Factor variances and covariances vary | 5,870.91 | 2,037 | 2.88 | 167.44 | 90 | <.001 | .79 | .75 | .81 | .85 | .87 | .76 | .03 |

Note: Factor loadings were invariant

Table 3

Comparison of the Fit of the Factor Model for the US and Canada Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 1,824.04 | 618 | 2.95 | | | | .82 | .79 | .83 | .87 | .88 | .83 | .06 |
| Error variances and covariances vary | 1,761.08 | 584 | 3.02 | 62.96 | 34 | .002 | .82 | .79 | .83 | .87 | .88 | .79 | .06 |
| Error variances and covariances and factor variances vary | 1,749.27 | 577 | 3.03 | 11.81 | 7 | .101 | .82 | .78 | .83 | .87 | .88 | .78 | .06 |
| Error and Factor variances and covariances vary | 1,724.44 | 562 | 3.07 | 24.83 | 15 | .052 | .83 | .78 | .84 | .86 | .88 | .76 | .06 |
| All parameters can vary | 1,677.78 | 532 | 3.15 | 46.67 | 30 | .027 | .83 | .77 | .85 | .86 | .89 | .73 | .06 |

Table 4

Comparison of the Fit of the Factor Model for the US and Chile Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 2,078.56 | 618 | 3.36 | | | | .80 | .77 | .82 | .86 | .86 | .82 | .06 |
| Error variances and covariances vary | 1,938.54 | 584 | 3.32 | 140.02 | 34 | <.001 | .81 | .77 | .83 | .86 | .87 | .78 | .06 |
| Error variances and covariances and factor variances vary | 1,890.88 | 577 | 3.28 | 47.66 | 7 | <.001 | .81 | .77 | .83 | .86 | .88 | .78 | .06 |
| Error and Factor variances and covariances vary | 1,859.44 | 562 | 3.31 | 31.44 | 15 | .008 | .81 | .76 | .83 | .86 | .88 | .76 | .06 |
| All parameters can vary | 1,816.70 | 532 | 3.42 | 42.74 | 30 | .062 | .81 | .75 | .84 | .86 | .88 | .72 | .06 |

Table 5

Comparison of the Fit of the Factor Model for the US and Korea Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 2,272.94 | 618 | 3.68 | | | | .79 | .76 | .80 | .83 | .84 | .80 | .07 |
| Error variances and covariances vary | 2,133.39 | 584 | 3.65 | 139.55 | 34 | <.001 | .79 | .75 | .81 | .84 | .85 | .77 | .07 |
| Error variances and covariances and factor variances vary | 2,070.59 | 577 | 3.59 | 62.80 | 7 | <.001 | .80 | .75 | .81 | .84 | .86 | .76 | .07 |
| Error and Factor variances and covariances vary | 2,023.82 | 562 | 3.60 | 46.77 | 15 | <.001 | .80 | .75 | .82 | .84 | .86 | .74 | .07 |
| All parameters can vary | 1953.16 | 532 | 3.67 | 70.66 | 30 | <.001 | .80 | .74 | .83 | .84 | .87 | .71 | .07 |

Table 6

Comparison of the Fit of the Factor Model for the US and Singapore Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 2,185.27 | 618 | 3.54 | | | | .81 | .78 | .83 | .87 | .87 | .83 | .06 |
| Error variances and covariances vary | 2,098.13 | 584 | 3.59 | 87.14 | 34 | <.001 | .82 | .78 | .84 | .87 | .88 | .80 | .06 |
| Error variances and covariances and factor variances vary | 2,074.18 | 577 | 3.60 | 23.95 | 7 | .001 | .82 | .78 | .84 | .87 | .88 | .78 | .06 |
| Error and Factor variances and covariances vary | 2,038.58 | 562 | 3.63 | 35.60 | 15 | .002 | .82 | .78 | .85 | .86 | .88 | .76 | .06 |
| All parameters can vary | 1,978.65 | 532 | 3.72 | 59.93 | 30 | .001 | .83 | .77 | .85 | .86 | .89 | .73 | .06 |

Table 7

Comparison of the Fit of the Factor Model for the US and Taiwan Groups

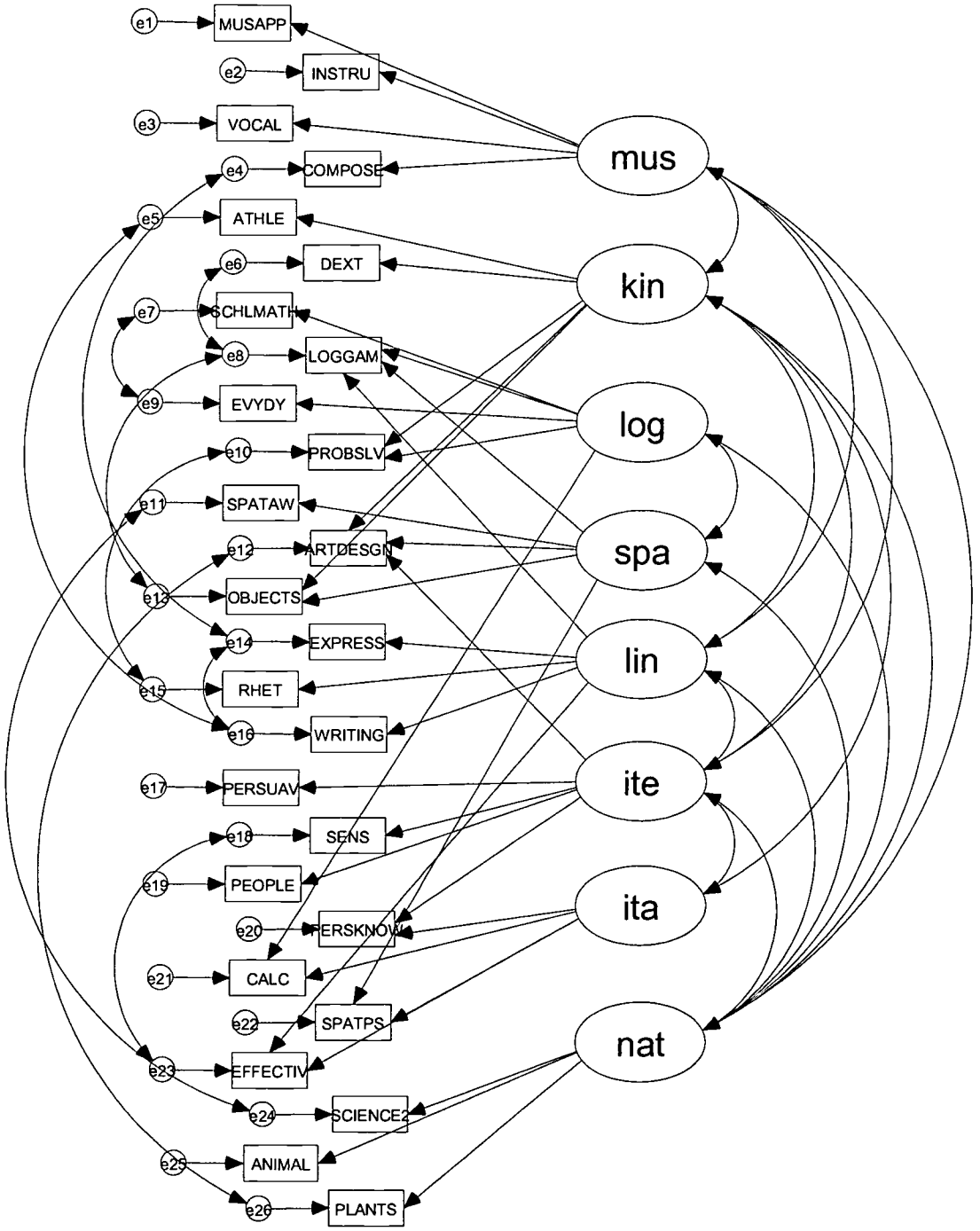
| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 1,955.10 | 618 | 3.16 | | | | .81 | .79 | .82 | .87 | .87 | .83 | .06 |
| Error variances and covariances vary | 1,815.82 | 584 | 3.11 | 139.28 | 34 | <.001 | .82 | .79 | .84 | .87 | .88 | .79 | .06 |
| Error variances and covariances and factor variances vary | 1,747.27 | 577 | 3.03 | 68.55 | 7 | <.001 | .83 | .79 | .84 | .87 | .89 | .79 | .06 |
| Error and Factor variances and covariances vary | 1,731.19 | 562 | 3.08 | 16.08 | 15 | .38 | .83 | .78 | .85 | .87 | .89 | .77 | .06 |
| All parameters can vary | 1,664.28 | 532 | 3.13 | 66.91 | 30 | <.001 | .83 | .78 | .86 | .87 | .90 | .73 | .06 |

Table 8

Comparison of the Fit of the Factor Model for the US and UK Groups

| Models | $\chi^2$ | df | $\chi^2$/df | $\Delta\chi^2$ | df | p | GFI | AGFI | NFI | TLI | CFI | PCFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All parameters invariant | 2,013.15 | 618 | 3.26 | | | | .80 | .78 | .82 | .86 | .87 | .82 | .06 |
| Error variances and covariances vary | 1,946.34 | 584 | 3.33 | 66.81 | 34 | <.001 | .81 | .77 | .83 | .86 | .87 | .78 | .06 |
| Error variances and covariances and factor variances vary | 1,936.58 | 577 | 3.36 | 9.76 | 7 | .20 | .81 | .77 | .83 | .85 | .87 | .77 | .06 |
| Error and Factor variances and covariances vary | 1,921.74 | 562 | 3.42 | 14.84 | 15 | .46 | .81 | .76 | .83 | .85 | .87 | .75 | .06 |
| All parameters can vary | 1,872.07 | 532 | 3.52 | 49.67 | 30 | .01 | .81 | .75 | .84 | .85 | .88 | .72 | .06 |

Figure 1: Base model



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