

CAPICE Deliverable D3: Harmonized Phenotypes

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(July 16, 2018)

1 Introduction

At the moment the CAPICE ESRs are carrying out data analyses using mostly ASEBA or SDQ questionnaire data. Because different questionnaires are used, the phenotypes studied across research groups are not exactly the same. This is a pity since then conclusions are harder to draw based on our studies combined, and it also makes it harder to combine data, for example to increase statistical power or to make direct international comparisons.

To solve this problem we've come to a solution that makes it possible to use *harmonized phenotypes*. Harmonized phenotypes are phenotypes that measure the same trait using the same metric. For example, temperature measures in degrees Fahrenheit from the US and temperature measures in degrees Celcius from the Netherlands can be harmonized by expressing all measures into degrees Kelvin. Degrees Kelvin is in this case the common metric. A similar approach is presented here in this report: we provide a common metric for research groups that have ASEBA-based measures and SDQ-based measures.

We will first present a summary of the solution. Next we present the solution in more detail.

2 Summary of the solution

ESR Kratika Agarwal (University of Twente) has carried out an exploratory factor analysis using the RAINE data set from Australia. There we had data on 10-year-olds whose parents filled in both CBCL and SDQ questionnaires. Analysing all 145 CBCL and SDQ items at once, she identified a clear dimension for Emotional Problems, with high factor loadings for the five SDQ items constituting the Emotional Problems subscale, and a collection of 39 CBCL items clearly associated with emotional problems (see Table 1). In that same analysis, she also identified a clear dimension for the five SDQ items constituting the ADHD subscale, with a collection of 8 CBCL items. These particular subsets of items were further studied using Item Response Theory, more specifically the Generalized Partial Credit Model (GPCM, Muraki 1992). In the GPCM,

the probability of a certain response x on item j by person k , $P(x_{jk} = i)$ is modelled using a logistic function of both person parameter θ_k (i.e., the phenotype) and item parameters:

$$P(x_{jk} = i) | \theta_k, a_j, b_j, d_{j,1}, \dots, d_{j,m_j-1} = \frac{\exp(\sum_{i=0}^j a_j (\theta_k - b_j + d_{j,i}))}{\sum_{g=0}^{m_j-1} \exp(\sum_{i=0}^g a_j (\theta_k - b_j + d_{j,i}))}$$

where

m_j is the number of answer categories for item j

x_j is the response to item j

a_j is the item discrimination parameter

b_j is the overall item difficulty parameter

$d_{j,i}$ is the category i item difficulty parameter

θ_k is the score of person k on the latent dimension.

This model is identified when we set $d_{j,0} = 0$ for all items j , and setting

$$\sum_{i=1}^{m_j-1} d_{j,i} = 0.$$

First we describe the emotional problems dimension, next the ADHD dimension.

The psychometric analysis using the GPCM on the 5 SDQ Emotional Problems items and the associated 39 CBCL items confirmed a well-fitting one-dimensional construct. With this GPCM model calibrated using the Australian data, the common metric for this emotional problems dimension was defined.

To obtain harmonized phenotypes on this new metric for the CAPICE data sets, one could use the procedure followed by Van den Berg et al (2014) in the Genetics of Personality Consortium. In such a procedure applied to this project, all relevant model parameters of the GPCM model are used to estimate latent phenotypes for data sets where only SDQ data are available, or only CBCL data. In this approach, both the discrimination parameters and the difficulty parameters are used to express each measure in the common metric. It is based on Maximum Likelihood principles and is very similar to the estimation of factor scores in the case of factor analysis: conditional on the observed raw item scores and the factor model parameters (factor loadings and intercepts), the most likely value for the latent factor is determined. In the GPCM case, conditional on the observed raw item scores and the GPCM model parameters (discrimination parameters and difficulty parameters) the most likely value for the latent trait θ_k is determined. This approach requires either access to the item data by an analyst, or familiarity with item response theory (IRT) models with those researchers involved in working with the raw item data.

Since familiarity with item response theory is limited and the data from other research groups cannot be shared at the moment due to national and privacy laws, we proposed a work-around where we obtain harmonized phenotypes using weighted sum scores. In this approach, only the discrimination parameters are

used. Sums of raw item scores that are weighted by the respective discrimination parameters, correlate highly with estimated phenotypes using an IRT procedure directly. Technically, the weighted sum scores are the sufficient statistics for the estimated phenotypes in IRT models. There is therefore a deterministic relationship between the weighted sumscore and the most likely value for the latent phenotype θ_k . This approach allows researchers in other countries with access to the raw item data to construct their own harmonized phenotypes in a very easy and straightforward way.

Table 1: Factor loadings varimax solution. Factor 1 was identified as an emotional problems dimension, and Factor 2 was identified as an ADHD dimension.

	Factor1	Factor2	Factor3	Factor4
CBCL acts too young	0.19	0.14	0.19	0.43
CBCL allergy	0.17	0.04	-0.08	0.06
CBCL argues a lot	0.22	0.64	0.13	0.09
CBCL asthma	0.13	0.13	-0.04	0.02
CBCL behaves like opposite sex	0.14	0.09	0.01	0.07
CBCL bowels outside toilet	0.13	0.09	0.11	0.03
CBCL bragging	0.14	0.44	0.18	0.11
CBCL cant concentrate	0.19	0.31	0.22	0.67
CBCL obsessions	0.37	0.08	0.15	0.28
CBCL restless, hyperactive	0.13	0.43	0.14	0.46
CBCL too dependent	0.47	0.07	0.07	0.15
CBCL lonely	0.39	0.15	0.18	0.06
CBCL confused	0.37	0.04	0.20	0.34
CBCL cries a lot	0.37	0.21	0.10	0.07
CBCL cruel to animals	0.07	0.15	0.44	0.12
CBCL cruel, bully	0.10	0.42	0.46	0.01
CBCL day dreams	0.30	0.07	0.15	0.41
CBCL deliberate harm	0.00	0.07	0.41	0.07
CBCL demands attention	0.34	0.48	0.17	0.20
CBCL destroys own things	0.10	0.27	0.58	0.12
CBCL destroys others things	0.16	0.33	0.55	0.08
CBCL disobedient at home	0.13	0.66	0.20	0.07
CBCL disobedient at school	0.04	0.38	0.43	0.26
CBCL doesnt eat well	0.28	0.18	0.03	0.03
CBCL doesnt get along	0.32	0.26	0.34	0.19
CBCL doesnt feel guilty	0.11	0.48	0.33	0.06
CBCL easily jealous	0.38	0.43	0.09	0.00
CBCL eats or drinks pica	0.07	0.01	0.08	0.06
CBCL fears animals, situations	0.36	0.03	0.03	0.10
CBCL fears going to school	0.35	0.04	0.12	0.10
CBCL fears might do bad	0.34	0.00	0.12	0.08
CBCL fears has to be perfect	0.42	0.06	-0.03	-0.13

CBCL feels unloved	0.31	0.36	0.29	-0.05
CBCL feels others out to get	0.39	0.25	0.31	0.09
CBCL feels worthless	0.46	0.12	0.22	0.17
CBCL accident prone	0.26	0.17	0.07	0.19
CBCL gets in fights	0.14	0.29	0.52	0.07
CBCL gets teased a lot	0.34	0.25	0.28	0.29
CBCL hangs out with trouble	0.08	0.32	0.38	0.17
CBCL hears voices not there	0.25	0.04	0.23	0.08
CBCL impulsive	0.16	0.49	0.23	0.40
CBCL loner	0.35	-0.03	0.23	0.15
CBCL lying or cheating	0.14	0.49	0.31	0.11
CBCL bites fingernails	0.12	0.06	0.05	0.03
CBCL nervous or tense	0.54	0.11	0.08	0.14
CBCL nervous movements	0.16	0.03	0.19	0.21
CBCL nightmares	0.35	0.08	0.04	-0.01
CBCL not liked by other kids	0.33	0.20	0.34	0.23
CBCL constipated	0.26	0.06	-0.01	0.01
CBCL too fearful or anxious	0.59	-0.01	0.08	0.14
CBCL feels dizzy	0.30	0.05	0.06	0.03
CBCL feels too guilty	0.42	-0.02	0.12	0.07
CBCL overeating	0.18	0.11	0.05	0.06
CBCL overtired	0.42	0.12	0.13	0.09
CBCL overweight	0.12	0.04	0.05	-0.03
CBCL no cause aches/pains	0.32	0.18	0.02	-0.05
CBCL no cause headaches	0.27	0.17	0.04	0.02
CBCL no cause nausea	0.37	0.12	0.04	-0.00
CBCL no cause eye problems	0.11	0.05	0.04	0.01
CBCL no cause skin problems	0.22	0.09	-0.01	0.02
CBCL no cause stomachaches	0.36	0.10	-0.01	-0.02
CBCL no cause vomiting	0.19	0.07	0.00	0.03
CBCL no cause other symptoms	-0.02	-0.04	0.02	0.06
CBCL attacks people	0.17	0.30	0.51	0.04
CBCL picks nose, etc	0.15	0.19	0.20	0.15
CBCL plays sex parts in public	0.03	0.01	0.33	0.14
CBCL plays sex parts too much	0.02	-0.00	0.26	0.13
CBCL poor school work	0.17	0.22	0.27	0.47
CBCL poorly coordinated	0.27	0.05	0.09	0.37
CBCL likes older kids	0.29	0.29	0.17	0.01
CBCL likes younger kids	0.27	0.20	0.15	0.22
CBCL refuses to talk	0.26	0.12	0.35	-0.01
CBCL compulsive behaviour	0.19	0.11	0.25	0.15
CBCL runs away from home	0.09	0.17	0.47	-0.05
CBCL screams a lot	0.27	0.43	0.31	0.01
CBCL secretive	0.37	0.12	0.27	0.01
CBCL sees things not there	0.23	-0.01	0.24	0.09
CBCL self-conscious	0.50	0.14	0.02	0.01

CBCL sets fires	-0.03	0.08	0.38	0.05
CBCL sexual problems	0.12	0.03	0.30	0.04
CBCL showing off	0.10	0.48	0.16	0.15
CBCL shy or timid	0.44	-0.03	-0.00	0.01
CBCL sleeps less than most	0.26	0.13	0.11	0.11
CBCL sleeps more than most	0.10	0.04	0.11	0.08
CBCL plays with bowel motions	0.03	0.04	0.21	0.05
CBCL speech problem	0.12	-0.03	0.07	0.29
CBCL stares blankly	0.30	-0.00	0.27	0.22
CBCL steals at home	0.09	0.18	0.43	-0.00
CBCL steals outside home	0.05	0.08	0.36	0.06
CBCL stores things up	0.28	0.14	0.07	0.11
CBCL strange behaviour	0.18	-0.01	0.31	0.17
CBCL strange ideas	0.25	0.01	0.25	0.14
CBCL stubborn, sullen	0.32	0.53	0.19	-0.03
CBCL sudden change in mood	0.39	0.41	0.24	0.03
CBCL sulks a lot	0.39	0.42	0.10	0.00
CBCL suspicious	0.28	0.20	0.25	-0.07
CBCL obscene language	0.13	0.37	0.39	-0.01
CBCL talks about killing self	0.19	0.12	0.46	0.06
CBCL talks/walks in sleep	0.12	0.12	0.05	0.03
CBCL talks too much	0.28	0.40	0.03	0.16
CBCL teases a lot	0.13	0.47	0.21	-0.00
CBCL temper tantrums	0.27	0.59	0.23	0.07
CBCL thinks sex too much	0.12	0.07	0.31	0.06
CBCL threatens people	0.14	0.22	0.52	0.04
CBCL thumb-sucking	0.06	0.09	-0.01	0.03
CBCL overly neat/clean	0.25	-0.00	0.02	-0.00
CBCL trouble sleeping	0.30	0.07	0.15	0.14
CBCL skips school	0.16	0.03	0.08	0.02
CBCL lacks energy/slow	0.38	0.02	0.09	0.11
CBCL unhappy/depressed	0.49	0.19	0.30	0.03
CBCL unusually loud	0.22	0.46	0.23	0.13
CBCL uses alcohol or drugs	-0.04	0.04	0.06	0.05
CBCL vandalism	0.01	0.14	0.52	0.04
CBCL wets self during day	0.04	0.02	0.03	0.02
CBCL wets the bed	0.00	0.06	0.18	0.04
CBCL whining	0.33	0.38	0.08	0.09
CBCL wants to be other sex	0.03	0.11	0.02	0.01
CBCL withdrawn	0.36	-0.01	0.28	0.18
CBCL worries	0.61	0.07	0.11	0.02
CBCL any other problems	0.09	0.04	0.04	0.08
SDQ considerate of others	0.03	-0.38	-0.22	-0.06
SDQ restless	0.07	0.43	0.04	0.50
SDQ complains of illness	0.39	0.16	-0.00	0.03
SDQ shares well	-0.00	-0.26	-0.15	-0.05

SDQ temper tantrums	0.21	0.53	0.17	0.12
SDQ solitary, plays alone	0.26	-0.06	0.14	0.19
SDQ generally obedient	-0.01	-0.46	-0.17	-0.13
SDQ often seems worried	0.54	0.04	0.08	0.10
SDQ helpful of others in need	0.06	-0.17	-0.17	-0.06
SDQ constantly fidgeting	0.13	0.33	0.08	0.49
SDQ at least one good friend	-0.10	-0.08	-0.20	-0.13
SDQ often fights/bullies	0.07	0.38	0.41	0.09
SDQ often unhappy/tearful	0.39	0.12	0.19	0.10
SDQ generally liked by kids	-0.17	-0.19	-0.30	-0.24
SDQ easily distracted	0.11	0.28	0.10	0.71
SDQ nervous or clingy	0.44	0.00	0.01	0.18
SDQ kind to younger kids	-0.06	-0.19	-0.23	-0.06
SDQ often lies/cheats	0.05	0.43	0.28	0.12
SDQ picked on/bullied	0.27	0.15	0.23	0.25
SDQ volunteers to help others	0.07	-0.18	-0.06	-0.08
SDQ thinks before acting	0.01	-0.33	-0.12	-0.42
SDQ steals	0.01	0.17	0.32	0.05
SDQ relates better to adults than kids	0.24	0.13	0.12	0.16
SDQ many fears easily scared	0.52	-0.03	0.02	0.15
SDQ sees tasks thru end, good att span	-0.02	-0.30	-0.12	-0.58

Figure 1 shows the deterministic relationship between the weighted sumscore and the estimated latent phenotype. The estimated latent phenotype is the score that would be obtained when using the approach as followed by Van den Berg et al. (2014), using the expected a-posteriori estimate. The weighted sum score is the score that would be obtained using the solution presented here. It is a clear one-to-one relationship. The one-to-one relationship illustrates that once you know the weighted sumscore, you have 'sufficient' information to know what the latent phenotype is. The correlation between the weighted sumscore and the estimated phenotype equals 0.91 for the emotional problems as measured in the Raine data.

Therefore, if research groups with SDQ data use a weighted sum score for their five emotional problems subscale items, and the research groups with CBCL data also use a weighted sum score of a set of 39 CBLC items, we know we have harmonized phenotypes for Emotional Problems. This should work as long as the populations studied are not too far away from the age of 10, as the IRT model was calibrated on a sample of ten-year-olds. In Table 2 we present the weights that should be used to compute weighted sums for emotional problems.

As an example of how it works, suppose that we have data from one child with the following item scores on the five SDQ items for Emotional Problems: 0, 1, 2, 1, and 1, see Table 3. For each item, we have a different weight. For each item we therefore weigh the observed item score with the respective weight by multiplying the item with the weight. The weighted item scores are in the last

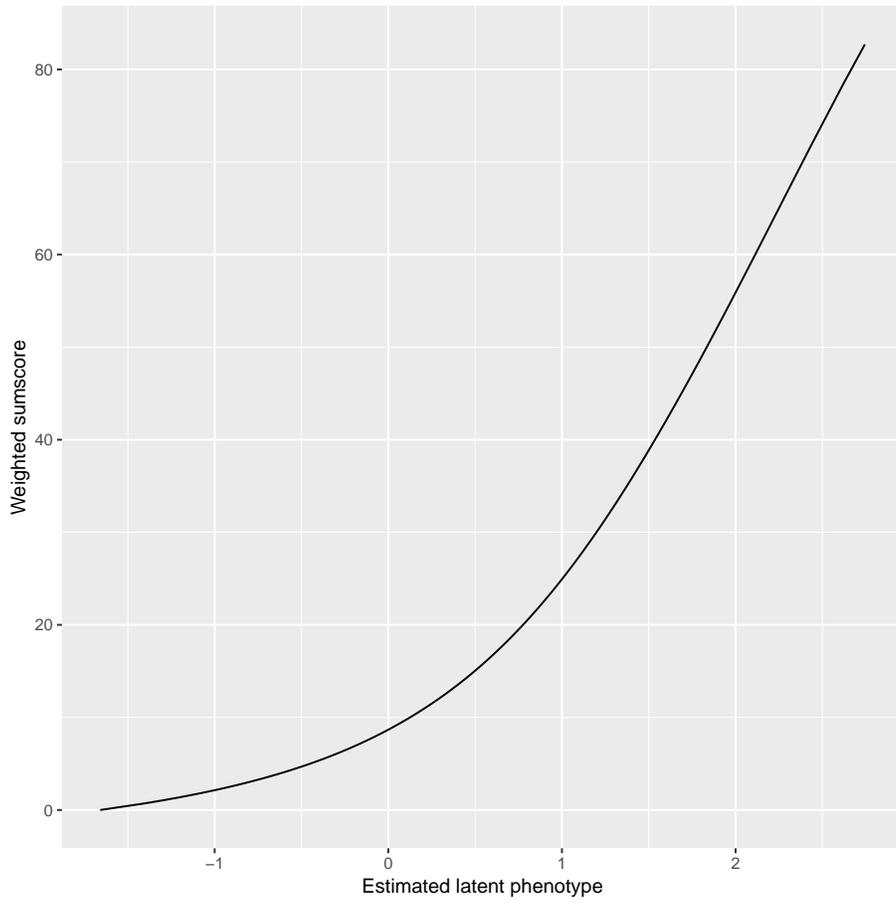


Figure 1: The nonlinear but deterministic relationship between the estimated latent phenotype and the weighted sumscore.

column. The weighted sum score is simply the sum of these weighted scores: $0+1.37+2.88+0.92+1.11 = 6.28$. If one happens to have only CBCL item scores, one uses the CBCL weights to compute the weighted sum scores. This procedure can then be carried out for all individuals for which harmonized phenotypes are needed.

The same psychometric analyses was done for the ADHD dimension. The analysis showed a selection of 8 CBCL items and 5 SDQ items that together form a scale of ADHD. Table 4 shows the weights for the ADHD items.

3 Detailed description of the methodology

The participants for the Western Australian Pregnancy Cohort (the Raine project), used in this study were children aged 10. A detailed methodology for the Raine study is described by (Newnham et al., 1993). All analyses were carried out using R.

As an initial analysis, we performed an exploratory factor analysis with no rotation using all 145 CBCL and SDQ items combined. We found the eigen values and looked at the scree plot. It suggested a scree at factor 4. Next, we performed an exploratory factor analysis where we used a varimax rotation with four dimensions. Here we used varimax so that we could have more interpretable clusters of factors. From this solution, we got the factor loadings (see Figure 1). We identified which factors could be interpreted as internalising problems or ADHD-type of problems, the main phenotypes for the CAPICE project. We identified two dimensions that seemed relevant for CAPICE (factor 1 and factor 4, see Table 1). The first factor showed high factor loadings for the five SDQ items that form the SDQ Emotional Problems subscale. A large set of CBCL items with high factor loadings on that factor also related to emotional problems. We therefore interpreted this factor as Emotional Problems, as a subform of internalising problem behaviour. The fourth factor showed high factor loadings for the five SDQ items that form the SDQ ADHD subscale. A set of CBCL items with high factor loadings on that factor also related to attention and hyperactivity. We therefore interpreted this factor as ADHD.

From these two factors, we selected the items with a factor loading of at least 0.3, positive or negative, on either Factor 1 or Factor 4.

3.1 Emotional Problems

With the selection of items with a loading of at least 0.3 (positive or negative) on Factor 1 (emotional problems scale), we carried out an Item response theory (IRT) analysis to investigate the psychometric quality of the Emotional Problems scale. The selection consisted of 39 CBCL items and 5 SDQ items. We used the *mirt* package to estimate the discrimination and difficulty parameters and looked at the item fit. We used the Generalized Partial Credit Model (GPCM, Muraki, 1992). The discrimination parameters (weights) and item fit statistics are presented in Table 5. The item fit statistics look good and there

are no strange very large or very small discrimination parameters. We conclude that these 44 items form a nice scale that can be used as a common metric for CBCL and SDQ items related to emotional problems.

3.2 ADHD

We also carried out the analysis for the selection of 8 CBCL and 5 SDQ items that showed factor loadings of at least 0.3 (positive or negative) on the fourth dimension of the factor analysis, see Table 1. This dimension was interpreted as an ADHD dimension. Two items had negative factor loadings: item number 12 (SDQ thinks before acting) and item number 13 (SDQ good attention span). We reverse-coded these items and carried out an IRT analysis on these 13 items to investigate the psychometric quality of the scale, again using the GPCM. We looked at the discrimination and difficulty parameters. The parameters showed two items with very large discrimination (SDQ easily distracted and CBCL can't concentrate), see Table 6. It could be that due to a close semantic link between these two concentration-related items, the scale becomes dominated by these two, leading to a bad-fitting model. That was indeed the case: see Table 6 shows 3 misfitting items out of 13, which is more than you'd expect testing each chi-square statistic at a significance level of 0.05 under the null-hypotheses of no item misfit.

We therefore fitted the GPCM again without the SDQ easily distracted item and inspected the parameters and model fit again. Table 7 shows that this set of items forms a well-fitting scale. Note that the weights (discrimination parameters) are barely affected by omitting one item.

We also looked at the ADHD scale including the SDQ easily distracted item but leaving out the CBCL can't concentrate item. Table 8 shows a good fit, with only one misfitting item out of 12, which you would more or less expect with 12 tests at a significance level of 0.05.

Given these results for the ADHD subset of SDQ and CBCL items, we see that this scale is somewhat dominated by the two concentration items, one from the CBCL and one from the SDQ. We also see that the weights of the items are hardly affected by omitting one of these items. This is suggestive of local independence which is an important assumption of the GPCM. We therefore conclude that these two concentration items do not form a separate subscale from the other ones, so that they can be used together with the other items. Note moreover that the two items are in separate questionnaires, so that researchers with only CBCL data only have the can't concentrate item, and researchers with only SDQ data only have the easily distracted items.

The weights across the three ADHD psychometric analyses were very similar. In order to find a set of weights for the harmonization, we therefore arbitrarily chose to use the weights for all items based on the analysis without the SDQ item easily distracted (Table 7), with the weight for the SDQ item easily distracted the weight based on the analysis without the CBCL can't concentrate item (Table 8). These weights are presented in Table 4.

4 References

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Table 2: Weights for Emotional Problems items to be used for harmonization.

	weight
CBCL obsessions	1.05
CBCL too dependent	1.42
CBCL lonely	1.42
CBCL confused	1.76
CBCL cries a lot	1.45
CBCL demands attention	1.26
CBCL doesnt get along	1.83
CBCL easily jealous	1.30
CBCL fears animals, situations	0.87
CBCL fears going to school	1.55
CBCL fears might do bad	1.18
CBCL fears has to be perfect	0.84
CBCL feels unloved	1.35
CBCL feels others out to get	2.09
CBCL feels worthless	2.12
CBCL gets teased a lot	1.46
CBCL loner	1.06
CBCL nervous or tense	1.64
CBCL nightmares	0.79
CBCL not liked by other kids	2.12
CBCL too fearful or anxious	1.98
CBCL feels dizzy	1.19
CBCL feels too guilty	1.81
CBCL overtired	1.29
CBCL no cause aches/pains	0.72
CBCL no cause nausea	0.91
CBCL no cause stomachaches	0.73
CBCL secretive	1.26
CBCL self-conscious	1.17
CBCL shy or timid	0.83
CBCL stubborn, sullen	1.28
CBCL sudden change in mood	1.63
CBCL sulks a lot	1.53
CBCL trouble sleeping	0.91
CBCL lacks energy/slow	1.40
CBCL unhappy/depressed	2.54
CBCL whining	1.19
CBCL withdrawn	2.00
CBCL worries	1.76
SDQ complains of illness	0.69
SDQ often seems worried	1.37
SDQ often unhappy/tearful	1.44
SDQ nervous or clingy	0.92
SDQ many fears easi scared	1.11

Table 3: Example computing the weighted sum score for one individual.

	weight	score	weight.1
SDQ complains of illness	0.69	0	0.00
SDQ often seems worried	1.37	1	1.37
SDQ often unhappy/tearful	1.44	2	2.88
SDQ nervous or clingy	0.92	1	0.92
SDQ many fears easi scared	1.11	1	1.11

Table 4: Weights for ADHD items to be used for harmonization. Note that the last two items should be reverse-coded, see text.

	weight
CBCL acts too young	1.32
CBCL cant concentrate	3.33
CBCL restless, hyperactive	2.07
CBCL confused	1.59
CBCL day dreams	0.98
CBCL impulsive	1.88
CBCL poor school work	1.70
CBCL poorly coordinated	1.14
SDQ restless	1.61
SDQ constantly fidgeting	1.56
SDQ easily distracted	2.75
SDQ thinks before acting	1.35
SDQ sees tasks thru end, good att span	1.70

Table 5: Discrimination parameters (weight) and item fit statistics for the Emotional Problems scale.

	weight	X-square	df	p
CBCL obsessions	1.05	77.88	67	0.17
CBCL too dependent	1.42	29.16	38	0.85
CBCL lonely	1.42	43.41	38	0.25
CBCL confused	1.76	28.32	37	0.85
CBCL cries a lot	1.45	36.88	38	0.52
CBCL demands attention	1.26	72.21	63	0.20
CBCL doesnt get along	1.83	37.62	38	0.49
CBCL easily jealous	1.30	59.42	62	0.57
CBCL fears animals, situations	0.87	58.81	51	0.21
CBCL fears going to school	1.55	39.58	37	0.36
CBCL fears might do bad	1.18	38.50	38	0.45
CBCL fears has to be perfect	0.84	62.04	56	0.27
CBCL feels unloved	1.35	50.01	38	0.09
CBCL feels others out to get	2.09	48.85	37	0.09
CBCL feels worthless	2.12	42.35	36	0.22
CBCL gets teased a lot	1.46	45.80	58	0.88
CBCL loner	1.06	45.97	38	0.18
CBCL nervous or tense	1.64	28.69	43	0.95
CBCL nightmares	0.79	48.83	38	0.11
CBCL not liked by other kids	2.12	40.49	37	0.32
CBCL too fearful or anxious	1.98	45.89	37	0.15
CBCL feels dizzy	1.19	34.98	35	0.47
CBCL feels too guilty	1.81	25.43	35	0.88
CBCL overtired	1.29	27.08	37	0.88
CBCL no cause aches/pains	0.72	38.18	47	0.82
CBCL no cause nausea	0.91	43.13	38	0.26
CBCL no cause stomachaches	0.73	36.94	38	0.52
CBCL secretive	1.26	41.40	37	0.28
CBCL self-conscious	1.17	53.80	59	0.67
CBCL shy or timid	0.83	43.83	54	0.84
CBCL stubborn, sullen	1.28	72.92	57	0.08
CBCL sudden change in mood	1.63	51.55	51	0.45
CBCL sulks a lot	1.53	46.42	49	0.58
CBCL trouble sleeping	0.91	42.47	40	0.37
CBCL lacks energy/slow	1.40	52.29	38	0.06
CBCL unhappy/depressed	2.54	34.00	33	0.42
CBCL whining	1.19	37.48	37	0.45
CBCL withdrawn	2.00	25.77	35	0.87
CBCL worries	1.76	56.14	41	0.06
SDQ complains of illness	0.69	77.90	64	0.11
SDQ often seems worried	1.37	79.71	60	0.05
SDQ often unhappy/tearful	1.44	30.01	38	0.82
SDQ nervous or clingy	0.92	66.64	69	0.56
SDQ many fears easi scared	1.11	44.72	56	0.86

Table 6: Discrimination parameters (weights) for all 13 ADHD items, together with chi-square fit statistics.

	weight	X-square	df	p
CBCL acts too young	1.31	19.25	30.00	0.93
CBCL cant concentrate	3.61	19.59	20.00	0.48
CBCL restless, hyperactive	1.81	45.16	27.00	0.02
CBCL confused	1.62	28.99	23.00	0.18
CBCL day dreams	1.04	30.29	34.00	0.65
CBCL impulsive	1.71	43.72	27.00	0.02
CBCL poor school work	1.70	25.56	28.00	0.60
CBCL poorly coordinated	1.14	34.27	28.00	0.19
SDQ restless	1.57	44.80	28.00	0.02
SDQ constantly fidgeting	1.53	39.61	29.00	0.09
SDQ easily distracted	2.96	20.00	21.00	0.52
SDQ thinks before acting	1.35	26.37	26.00	0.44
SDQ sees tasks thru end, good att span	1.89	16.04	24.00	0.89

Table 7: Discrimination parameters for ADHD items without SDQ Easily distracted item, together with chi-square fit statistics.

	weight	X-square	df	p
CBCL acts too young	1.32	22.28	28.00	0.77
CBCL cant concentrate	3.33	23.13	20.00	0.28
CBCL restless, hyperactive	2.07	35.15	24.00	0.07
CBCL confused	1.59	26.60	22.00	0.23
CBCL day dreams	0.98	27.96	30.00	0.57
CBCL impulsive	1.88	23.87	24.00	0.47
CBCL poor school work	1.70	19.06	26.00	0.83
CBCL poorly coordinated	1.14	29.43	27.00	0.34
SDQ restless	1.61	36.96	25.00	0.06
SDQ constantly fidgeting	1.56	26.99	26.00	0.41
SDQ thinks before acting	1.35	30.96	24.00	0.16
SDQ sees tasks thru end, good att span	1.70	23.62	23.00	0.43

Table 8: Discrimination parameters for ADHD items without CBCL can't concentrate item, together with chi-square fit statistics.

	weight	X-square	df	p
CBCL acts too young	1.25	26.69	27.00	0.48
CBCL cant concentrate	1.93	31.86	24.00	0.13
CBCL restless, hyperactive	1.53	32.42	21.00	0.05
CBCL confused	0.95	22.44	30.00	0.84
CBCL day dreams	1.76	31.25	25.00	0.18
CBCL impulsive	1.54	26.59	26.00	0.43
CBCL poor school work	1.09	27.89	24.00	0.26
CBCL poorly coordinated	1.78	51.69	25.00	0.00
SDQ restless	1.72	31.98	25.00	0.16
SDQ constantly fidgeting	2.75	16.63	19.00	0.62
SDQ thinks before acting	1.39	21.40	23.00	0.56
SDQ sees tasks thru end, good att span	1.80	13.74	23.00	0.93