Analyzing differences between parent- and self-report measures with a latent space approach

S1 Table

Syndrome	Question
AB	3. Argues a lot
AB	16. Cruelty, bullying, or meanness to others
AB	19. Demands a lot of attention
AB	20. Destroys his/her own things
AB	21. Destroys things belonging to his/her family or others
AB	22. Disobedient at home
AB	23. Disobedient at school
AB	37. Gets in many fights
AB	57. Physically attacks people
AB	68. Screams a lot
AB	86. Stubborn, sullen, or irritable
AB	87. Sudden changes in mood or feelings
AB	89. Suspicious
AB	94. Teases a lot
AB	95. Temper tantrums or hot temper
AB	97. Threatens people
AB	104. Unusually loud
AD	14. Cries a lot
AD	29. Fears certain animals, situations, or places, other than school
AD	30. Fears going to school
AD	31. Fears he/she might think or do something bad
AD	32. Feels he/she has to be perfect
AD	33. Feels or complains that no one loves him/her

AD	35. Feels worthless or inferior
AD	45. Nervous, highstrung, or tense
AD	50. Too fearful or anxious
AD	52. Feels too guilty
AD	71. Self-conscious or easily embarrassed
AD	91. Talks about killing self
AD	112. Worries
AP	1. Acts too young for his/her age
AP	4. Fails to finish things he/she starts
AP	8. Can't concentrate, can't pay attention for long
AP	10. Can't sit still, restless or hyperactive
AP	13. Confused or seems to be in a fog
AP	17. Daydreams or gets lost in his/her thoughts
AP	41. Impulsive or acts without thinking
AP	61. Poor school work
AP	78. Inattentive or easily distracted
RBB	2. Drinks alcohol without parents' approval
RBB	26. Doesn't seem to feel guilty after misbehaving
RBB	28. Breaks rules at home, school, or elsewhere
RBB	39. Hangs around with others who get in trouble
RBB	43. Lying or cheating
RBB	63. Prefers being with older kids
RBB	67. Runs away from home
RBB	72. Sets fires
RBB	81. Steals at home
RBB	82. Steals outside the home
RBB	90. Swearing or obscene language
RBB	96. Thinks about sex too much
RBB	99. Smokes, chews, or sniffs tobacco
RBB	101. Truancy, skips school
RBB	105. Uses drugs for nonmedical purposes (don't include alcohol or tobacco)

SC	47. Nightmares
SC	51. Feels dizzy or lightheaded
SC	54. Overtired without good reason
SC	56A. Aches or pains (not stomach or headaches)
SC	56B. Headaches
SC	56C. Nausea, feels sick
SC	56D.A. Problems with eyes (not if corrected by glasses
SC	56E. Rashes or other skin problems
SC	56F. Stomachaches
SC	56G. Vomiting, throwing up
SP	11. Clings to adults or too dependent
SP	12. Complains of loneliness
SP	25. Doesn't get along well with other kids
SP	27. Easily jealous
SP	34. Feels others are out to get him/her
SP	36. Gets hurt a lot, accident-prone
SP	38. Gets teased a lot
SP	48. Not liked by other kids
SP	62. Poorly coordinated or clumsy
SP	64. Prefers being with younger kids
SP	79. Speech problem
TP	9. Can't get his/her mind off certain thoughts; obsessions
TP	18. Deliberately harms self or attempts suicide
TP	40. Hears sounds or voices that aren't there
TP	46. Nervous movements or twitching
TP	58. Picks nose, skin, or other parts of body
TP	66. Repeats certain acts over and over; compulsions
TP	70. Sees things that aren't there
TP	76. Sleeps less than most kids
TP	83. Stores up too many things he/she doesn't need
TP	84. Strange behavior

TP	85. Strange ideas
TP	100. Trouble sleeping
WD	5. There is very little he/she enjoys
WD	42. Would rather be along than with others
WD	65. Refuses to talk
WD	69. Secretive, keeps things to self
WD	75. Too shy or timid
WD	102. Underactive, slow moving, or lacks energy
WD	103. Unhappy, sad, or depressed
WD	111. Withdrawn, doesn't get inolved with others
.	6. Bowel movements outside toilet
.	7. Bragging, boasting
.	15. Cruel to animals
.	24. Doesn't eat well
.	44. Bites fingernails
.	49. Constipated, doesn't move bowels
.	53. Overeating
.	55. Overweight
.	59. Plays with own sex parts in public
.	60. Plays with own sex parts too much
.	73. Sexual problems
.	74. Showing off or clowning
.	77. Sleeps more than most kids during day and/or night
.	80. Stares blankly
.	88. Sulks a lot
.	92. Talks or walks in sleep
.	93. Talks too much
.	98. Thumb-sucking
.	106. Vandalism
.	107. Wets self during the day
.	108. Wets the bed

.	109. Whining
.	110. Wishes to be of opposite sex

Table 1. Item's syndrome membership, the items without syndrome are denoted as '.'

S2 Table

	CBCL				YSR			
	F1	F2	F3	F4	F1	F2	F3	F4
Q01			-.439					.356
Q02		.748			.309	.505	.304	
Q03				.762		.510		
Q04			-.464					
Q05	-.488				.426			
Q06				.376				
Q07				.475		.359		
Q08			-.828			.323		.314
Q09	-.342		-.313		.316		-.315	
Q10			-.381	.415			-.328	
Q11	-.344	-.329						
Q12	-.447				.677			
Q13	-.318		-.601		.548			
Q14	-.562				.495			
Q15			-.365		.353			
Q16				.718		.613		
Q17			-.571		.309			
Q18	-.443	.301			.447			
Q19				.756				
Q20				.509		.360		
Q21				.594		.509	-.319	
Q22				.699		.708		
Q23				.627		.794		
Q24					.352			

Q25				.544			-.309
Q26				.622		.380	
Q27				.607	.556		
Q28		.395		.623		.785	
Q29	-.440						
Q30	-.498				.557		
Q31	-.397				.454		
Q32	-.414				.498		
Q33	-.385			.565	.538		
Q34				.616	.389		
Q35	-.524				.740		
Q36	-.345						-.362
Q37				.638		.502	-.415
Q38				.388			-.381
Q39		.355		.388		.548	
Q40	-.404						-.696
Q41			-.430	.505		.358	
Q42	-.472				.433		
Q43		.403		.372		.563	
Q44							
Q45	-.526				.750		
Q46					.359		-.373
Q47	-.334						-.322
Q48				.507		.308	-.370
Q49	-.373						
Q50	-.714				.839		
Q51	-.568				.417		
Q52	-.651				.624		
Q53							
Q54	-.444				.463		
Q55							

Q56A	-.348						-.456	
Q56B	-.396						-.522	
Q56C	-.594						-.487	
Q56D							-.367	
Q56E	-.319						-.418	
Q56F	-.480						-.525	
Q56G	-.357						-.667	
Q57				.617		.546	-.359	
Q58			-.313					
Q59			-.869					.590
Q60			-.621					.428
Q61		.327	-.314			.414		
Q62			-.423		.339			
Q63						.316		
Q64			-.422					
Q65	-.358						-.353	
Q66			-.395				-.306	
Q67		.463		.356		.467		
Q68				.599				
Q69	-.393	.424			.400			
Q70	-.368		-.360				-.656	
Q71	-.484				.669			
Q72		.313	-.443	.325		.584		
Q73		.323						
Q74			-.344	.489		.435		.451
Q75	-.503				.511			
Q76								
Q77	-.401	.355						
Q78			-.798					.370
Q79			-.448				-.356	
Q80			-.459					.369

Q81		.400				.551		
Q82		.518	-.370			.732		
Q83								
Q84			-.341				-.316	
Q85			-.369		.366			
Q86				.520		.363		
Q87	-.470			.396	.377			
Q88	-.470			.407				.610
Q89				.481				
Q90				.458		.568		
Q91	-.350			.530	.576			
Q92								.527
Q93		-.344		.609				.426
Q94				.649		.663		
Q95				.687		.442		
Q96			-.337	.346		.471		
Q97				.750		.701		
Q98	.334			.310				.511
Q99		.831				.749		
Q100	-.301				.357		-.353	
Q101		.681				.563		
Q102	-.497				.560			
Q103	-.680				.720			
Q104				.573			-.345	.427
Q105		.862				.746		
Q106		.374	-.335	.392				.525
Q107			-.408					.762
Q108								.393
Q109				.554				.720
Q110	-.552				.427			
Q111	-.530							

Q112	-.550	.826

Table 2. Factor structures for CBCL and YSR. Loadings smaller than 0.3 are suppressed. For the first 2 factors, two data shows similar patterns: the first large factor covers most items of the AD syndrome (an internalizing syndrome), and the second large factor covers most items of the RBB syndrome, an externalizing syndrome. However, the third factor loaded on AP, SP, and TP syndromes in CBCL, while in YSR it is loaded on SC and WD syndromes. The fourth factor is loaded on the items with no syndrome membership in YSR, while in CBCL this factor is loaded on most of the AB syndrome.

S1 Appendix

The likelihood part of the LSIRM is based on conditional independence, given the latent position of item and respondent. The data likelihood of item-response data with respondent $k = 1, .., N$ and item $i = 1, .., P$ can be defined as (Eq. 4). All model coefficient is estimated by the Bayesian approach so that the inference will be based on posterior samples. The priors of $\beta_i, \theta_k, \boldsymbol{w_i}$ and $\boldsymbol{z_k}$ are set to be multivariate normal distribution (MVN) with mean 0, and the priors for the variance parameters of random effect θ_k, $k = 1, .., N$ are set to be conjugate inverse-Gamma distribution.

$$
\begin{aligned}
\beta_i|\tau_\beta^2 &\sim N(0, \tau_\beta^2), \tau_\beta^2 > 0 \\
\theta_k|\sigma^2 &\sim N(0, \sigma^2), \sigma^2 > 0 \\
\sigma^2 &\sim \text{Inv-Gamma}(a_\sigma, b_\sigma), a_\sigma > 0, b_\sigma > 0 \\
\boldsymbol{w_i} &\sim \text{MVN}_d(\boldsymbol{0}, \boldsymbol{I_d}) \\
\boldsymbol{z_k} &\sim \text{MVN}_d(\boldsymbol{0}, \boldsymbol{I_d}).
\end{aligned}
$$

With this prior and data likelihood, the posterior kernel can be expressed as below.

$$
\begin{aligned}
\pi(\beta, \theta, \sigma^2, Z, W|Y) \propto & P(Y|\beta, \theta, \sigma^2, Z, W)\pi(\beta, \theta, \sigma^2, Z, W) \\
\propto & \left[\prod_{k=1}^{N}\prod_{i=1}^{P} P(r_{k,i}|\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k})\right] \\
& \left[\prod_{i=1}^{P}\pi(\beta_i)\prod_{k=1}^{N}\pi(\theta_j|\sigma^2)\pi(\sigma^2)\prod_{i=1}^{P}\pi(\boldsymbol{w_i})\prod_{k=1}^{P}\pi(\boldsymbol{z_k})\right].
\end{aligned}
$$

This posterior kernel cannot be expressed with standard distribution, so the exact posterior density cannot be calculated and Gibbs sampler is used to sample each

parameter sequentially from their conditional density.

All the Bayesian inferences are made through these posterior samples. For example, the posterior distribution of $\mathbb{P}(y_{ki} = 1)$ can be easily evaluated by the logistic formula described above, with the posterior samples of $\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k}$

$$\begin{aligned}
\pi(\beta_i) &\propto \left[\prod_{k=1}^{N}\prod_{i=1}^{P} P(r_{k,i}|\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k})\right] \times \left[N_{\beta_i}(0, \tau_\beta^2)\right] \\
\pi(\theta_k) &\propto \left[\prod_{k=1}^{N}\prod_{i=1}^{P} P(r_{k,i}|\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k})\right] \times \left[N_{\theta_k}(0, \sigma^2)\right] \\
\pi(\boldsymbol{z_k}) &\propto \left[\prod_{k=1}^{N}\prod_{i=1}^{P} P(r_{k,i}|\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k})\right] \times \left[\mathrm{MVN}_{d,\boldsymbol{z_k}}(\boldsymbol{0}, \boldsymbol{I_d})\right] \\
\pi(\boldsymbol{w_i}) &\propto \left[\prod_{k=1}^{N}\prod_{i=1}^{P} P(r_{k,i}|\beta_i, \theta_k, \boldsymbol{w_i}, \boldsymbol{z_k})\right] \times \left[\mathrm{MVN}_{d,\boldsymbol{w_i}}(\boldsymbol{0}, \boldsymbol{I_d})\right] \\
\pi(\sigma^2) &\propto \text{Inv-Gamma}\left(\left(\frac{N}{2} + a_\sigma\right), \frac{1}{2}\sum_{k=1}^{N}\theta_k^2 + b_\sigma\right).
\end{aligned}$$

Specifically, because each conditional kernel may not be expressed as a standard distribution form, Metropolis-Hastings within Gibbs sampler is used. Furthermore, for the generalized case with missing data, the imputed value for non-respondent $(k \times i)$ pair can be sampled with the logistic formula at the start of each Gibbs sampler steps.