**Co-development of general psychopathology and high-risk personality traits during adolescence**

Supplementary methods and results

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# Supplementary methods

## Participants

**Table M1.** Participant demographic information and follow up rates

|  |  |  |
| --- | --- | --- |
|  |   | **Cohort** |
|   | **Overall**, N = 2,083*1* | **CSC**, N = 1,556*1* | **CAP**, N = 527*1* |
| **Age (years)** | 13.49 (0.44) | 13.50 (0.47) | 13.45 (0.36) |
| (Missing) | 2 | 0 | 2 |
| **Sex** |  |  |  |
| Male | 691 / 2,081 (33%) | 517 / 1,556 (33%) | 174 / 525 (33%) |
| Female | 1,390 / 2,081 (67%) | 1,039 / 1,556 (67%) | 351 / 525 (67%) |
| (Missing) | 2 | 0 | 2 |
| **School type** |  |  |  |
| Public | 493 / 2,083 (24%) | 398 / 1,556 (26%) | 95 / 527 (18%) |
| Private | 713 / 2,083 (34%) | 520 / 1,556 (33%) | 193 / 527 (37%) |
| Catholic | 877 / 2,083 (42%) | 638 / 1,556 (41%) | 239 / 527 (45%) |
| **Country of birth** |  |  |  |
| Australia | 1,745 / 2,073 (84%) | 1,278 / 1,549 (83%) | 467 / 524 (89%) |
| Other English-speaking country | 120 / 2,073 (5.8%) | 86 / 1,549 (5.6%) | 34 / 524 (6.5%) |
| Non-English-speaking country | 208 / 2,073 (10%) | 185 / 1,549 (12%) | 23 / 524 (4.4%) |
| (Missing) | 10 | 7 | 3 |
| **Follow up** |  |  |  |
| Baseline | 2,083 / 2,083 (100%) | 1,556 / 1,556 (100%) | 527 / 527 (100%) |
| 12-month  | 1,799 / 2,083 (86%) | 1,327 / 1,556 (85%) | 472 / 527 (90%) |
| 24-month | 1,674 / 2,083 (80%) | 1,227 / 1,556 (79%) | 447 / 527 (85%) |
| 30-month  | 1,078 / 1,556 (69%) | 1,078 / 1,556 (69%) | 0 / 0 (0%) |
| 36-month  | 407 / 527 (77%) | 0 / 0 (0%) | 407 / 527 (77%) |
| 30- / 36-month | 1,485 / 2,083 (71%) | 1,078 / 1,556 (69%) | 407 / 527 (77%) |
| *Note.  1*Mean (SD); n / N (%)  |

## Measures

**Table M2.** Item wording and corresponding lower-order factors for indicators of psychopathology.

|  |  |  |
| --- | --- | --- |
| **Lower-order factor** | **Item**  | **Description** |
| Alcohol use/harms | AUC2 | How often do you have 5+ std drinks in the past 6 mths? |
| Alcohol use/harms | AUC3 | In the past 6 mths, how many std drinks on a typical day? |
| Alcohol use/harms | AH1 | Got into fights, acted bad, or did mean things. |
| Alcohol use/harms | AH2 | Caused shame or embarrassment to someone. |
| Alcohol use/harms | AH3 | Neglected my responsibilities. |
| Alcohol use/harms | AH4 | Felt that I need more alcohol than I used to in order to get the same effect. |
| Alcohol use/harms | AH5 | Noticed a change in my personality. |
| Alcohol use/harms | AH6 | Tried to cut down or quit drinking. |
| Alcohol use/harms | AH7 | Suddenly found myself in a place that I could not remember getting to. |
| Alcohol use/harms | AH8 | Felt I was going crazy. |
| Conduct/inattention | SD2 | I am restless. I cannot stay still for long. |
| Conduct/inattention | SD5 | I get very angry and often lose my temper. |
| Conduct/inattention | SD10 | I am constantly fidgeting or squirming. |
| Conduct/inattention | SD12 | I fight a lot. I can make other people do what I want. |
| Conduct/inattention | SD15 | I am easily distracted. I find it difficult to concentrate. |
| Conduct/inattention | SD18 | I am often accused of lying or cheating. |
| Conduct/inattention | SD22 | I take things that are not mine from home, school or elsewhere. |
| Distress | SD3 | I get a lot of headaches, stomach-aches, or sickness. |
| Distress | SD13 | I am often unhappy, down-hearted, or tearful. |
| Distress | K62R | … hopeless? |
| Distress | K64R | … so depressed that nothing could cheer you up? |
| Distress | K65R | … that everything was an effort? |
| Distress | K66R | … worthless? |
| Fear | K61R | …nervous? |
| Fear | K63R | … restless or fidgety? |
| Fear | SD8 | I worry a lot. |
| Fear | SD16 | I am nervous in new situations. I easily lose confidence. |
| Fear | SD24 | I have many fears. I am easily scared. |

*Note*. SD = items from Strengths and Difficulties Questionnaire; AH = Alcohol Harms, items from Rutgers Alcohol Problem Index (RAPI); K6 = Kessler 6 Plus scale (K6+); AUC = Alcohol use, AUDIT-C items. AH items prefaced with “*In the past 6 months how many times have you experienced the following as a consequence of drinking alcohol*”. K6 items prefaced with “*In the last 4 weeks, about how often did you feel”*

## Analytic Plan

Figure S1 depicts the overarching analytic procedure, from measurement invariance assessment via moderated factor analysis (MNLFA) to the primary analyses using latent curve models with structured residuals (LCM-SR). Each step in the procedure is described in further detail below.

**Figure S1 High level summary of data analytic approach**



## Measurement invariance

Moderated nonlinear factor analysis (MNLFA) was used to examine the measurement invariance of the psychopathology dimensions. MNLFA simultaneously assesses differential item functioning (DIF) and measurement invariance across multiple grouping variables (which can be either categorical or continuous), and ultimately aims to generate factor scores that have been corrected for measurement bias and can be used in subsequent analyses (Bauer, 2017; Curran, McGinley, et al., 2014). Building on the multiple groups and multiple-indicators-multiple-causes (MIMIC) approaches to measurement invariance, MNLFA evaluates DIF and mean and variance impact effects through moderation effects on model parameters in a sequential, iterative model building process. In the present study, the effects of age, sex, and cohort (i.e., CAP or CSC) were examined.

Drawing on the general procedures outlined by Bauer (2017) and Gottfredson et al. (2019), we conducted the analyses in four broad steps. Details of each step are described below.

**Table M3. Moderated nonlinear factor analysis sequential model building process**

|  |  |
| --- | --- |
| **Step** | **Description** |
| **Step 1.** Draw cross-sectional calibration sample | We drew a cross-sectional calibration sample with one randomly selected observation per participant using the aMNLFA.sample function from the aMNLFA package. The use of a calibration sample strategy is necessary to preserve the assumption of independence, which is directly violated by longitudinal data (Curran, McGinley, et al., 2014). Different calibration samples were drawn for psychopathology and personality analyses. |
| **Step 2.** Fit MNLFA models separately for each lower-order psychopathology factor | MNLFA models were fit separately for each lower order factor (from the higher-order model of psychopathology; and each personality subscale of the SURPS), adopting the divide and conquer approach recommended by Bauer (2017). This step is comprised of the following sub-steps: * 2a. Estimated mean and variance impact models and examine impact effects (threshold to retain non-invariance effects is p < 0.1).
* 2b. Estimated and examined DIF effects (threshold to retain non-invariance terms is p < .05)
* 2c. Test all marginally significant terms in a single model and removed any remaining non-invariant terms, adjusting for Type 1 errors. For mean and variance impact terms, these were retained if p was less than .05, for DIF terms (loadings & intercepts) we applied a Benjamin-Hochberg correction. DIF terms where p values were lower than the BH correction were retained.
* 2d. Estimated final model and obtain parameter values.
 |
| **Step 3.** Evaluate factor score quality | The quality of the adjusted factor scores derived from the MNLFA procedure were assessed by examining how closely they correlated with scores from a model with no non-invariance terms. A high correlation (e.g., r > .9) suggests that the model is invariant. |
| **Step 4A.** Combine parameter estimates from univariate models and estimate higher-order model of psychopathology with full longitudinal data  | Using the parameter values (i.e., SVALUES) from the final univariate models for each lower-order factor, we estimated a higher-order model of psychopathology and extracted factor scores to be used in subsequent analyses |
| **Repeat Steps 1 – 3** for each high-risk personality trait | As described above. |
| **Step 4B**. Combine parameter estimates from univariate models and estimate correlated factors model of high-risk personality traits with full longitudinal data | The parameter values from the final univariate models for each personality trait were combined and we estimated a correlated factors model and extracted adjusted factor scores to be used in subsequent analyses |

## Latent curve models with structured residuals

The co-development of general psychopathology and high-risk personality traits were examined using latent curve models with structured residuals (LCM-SR). Analyses were conducted in three broad steps, as depicted in Figure S1, based on the procedure described by Curran and colleagues (Curran, Howard, et al., 2014) and Wellman and colleagues (Wellman et al., 2020).

In the first step we examined three univariate between-person models for each construct to determine the optimal growth form (i.e., intercept only vs. intercept + linear slope vs. intercept + linear + quadratic slope). The intercept only model included mean and variance of the intercept factor and residual variances for each of the measurement points that were allowed to vary over time. This model was then expanded to include linear and non-linear growth terms. The best fitting model was selected for subsequent analyses.

In the second step, we examined univariate within-person models by expanding the best-fitting model from step 1 to include autoregression parameters among residuals and tested the inclusion of equality constraints of the autoregressions (i.e., autoregression parameters constrained to equality vs. freely estimated). This approach helps determine how best to represent the autoregressive parameters and provides an indication of whether the effect is consistent overtime. If the autoregressive parameters constrained to equality are found to improve overall fit, this would suggest that the effect is consistent over time. In contrast, if estimating autoregressive parameters freely improves overall fit, this can indicate that the size and significance of an effect may fluctuate overtime. Within the context of LCM-SR, autoregressive parameters reflect time-point specific deviations from individual-specific mean levels and growth curve (Curran, Howard, et al., 2014; Mund et al., 2021). For example, within-person deviations in psychopathology at time point T might predict within-person deviations from the person-specific trajectory of psychopathology at the subsequent time point T+1, such that an adolescent experiencing heightened levels in psychopathology at T might continue to experience heightened levels of psychopathology at T+1. Statistically significant autoregressive effects indicate that deviations from the person-specific curve are enduring, whereas non-significant autoregressive effects indicate that individuals tend to fall back to their typical person-specific trajectory in between assessments (Falkenström et al., 2022).

In the third step, cross-lags were introduced sequentially in a series of bivariate models to examine cross-construct relations at the latent factor and time-specific residual levels and test equality constraints on the cross-lagged regressions. First a base bivariate model that combines the best fitting univariate models for general psychopathology and a personality trait of interest from the previous step was estimated. In this model the intercept and slope for each construct were allowed to covary within and across constructs. Time-specific residuals were allowed to covary between constructs, and these covariances were constrained to be equal across time for time two, three and four. The autoregressive components among the structured residuals for each construct were retained (i.e., best fitting structure from Step 2 was incorporated into the model). We then introduced regressions of the residuals and evaluated each side of the reciprocal effects separately. Specifically, we first introduced the regression of the structured residual of general psychopathology onto the relevant personality trait (while holding the regression of the structured residual of the personality trait onto the structured residual of general psychopathology to zero). We compared a model with the regression estimates freely estimated with another constraining these estimates to equality over time. We then removed these regressions and introduced the regression of structured residual of the personality trait onto the structured residual of general psychopathology.

The optimal parameter constraints for each direction of influence were then combined, and an unconditional bivariate model was estimated. This model was then expanded to include sex and age at baseline as time invariant covariates by regressing the slope and intercept factors onto the covariates. This allowed us to control for the influence of sex and age at baseline in the interpretation of our final models. As with the autoregressive parameters, the cross-lag effects in an LCM-SR reflect the degree to which deviations from an individual’s typical level of general psychopathology can be predicted from the individuals prior deviation from their expected score on personality (Curran, Howard, et al., 2014). Recently published guidelines for interpreting cross-lagged effects recommend .03 (small effect), .07 (medium effect) and .13 (large effect) can be used as benchmark values for CLMP and RI-CLPM models (Orth et al., 2022). Given the interpretation of the within-person parameters of the RI-CLPM are similar to the LCM-SR (Mund et al., 2021), we have applied the same guidelines when interpreting the cross-lagged effects in the present study (these are likely conservative thresholds due to the additional variance captured in the between-person components of the LCM-SR).

As described in the main text, goodness-of-fit for all models was assessed using root mean square error of approximation (RMSEA), comparative fit index (CFI) and Tucker-Lewis index (TLI)t, where RMSEA values < 0.06, and CFI and TLI values > .95 indicate acceptable fit (Brown, 2014). Models were also compared using the information criteria, including the Akaike information criterion (AIC), Bayesian information criterion (BIC), and the sample-size adjusted BIC (aBIC), where lower values indicate superior fit (Raftery, 1995). Changes in model fit between nested models were also formally evaluated with the likelihood ratio test using a scaled difference chi-square. If there was no statistically significant improvement in model fit, the best fitting model was determined based on overall fit, parsimony and theoretical basis for components.

**Table M4. Summary of iterative model building process for latent curve models with structured residuals (LCM-SR)**

|  |  |
| --- | --- |
| **Step/Model** | **Description** |
| **Step 1. Unconditional univariate between-person models to identify optimal shape of growth** |
| Random intercept only  | * Mean and variance of the intercept factor
* Residual variances for each repeated measure (freely estimated over time)
 |
| Random intercept + linear slope  | * Mean and variance of the intercept and linear slope factors
* Residual variances for each repeated measure (freely estimated over time)
* Intercept & slope covariance
 |
| Random intercept + linear slope + quadratic slope | * Mean and variance of the intercept and linear and quadratic slope factors
* Residual variances for each repeated measure (freely estimated over time)
* Intercept & slope covariances
 |
| Model evaluation* Assess overall fit
* Test linear vs. quadratic growth with nested chi-square difference test
* Retain growth parameters that result in significant improvement in model fit
 |
| **Step 2. Unconditional univariate within-person models to test inclusion of autoregressive paths** |
| Autoregressive parameters (equal) | Best fitting model from Step 1 +* Add autoregressive path among the time-specific residuals
* Constrain AR paths to be **held equal across time**
 |
| Autoregressive parameters (free) | Best fitting model from Step 1 +* Add autoregressive path among the time-specific residuals
* Allow AR paths to **be freely estimated across time**
 |
| Model evaluation* Test inclusion of free vs. constrained AR paths with nested chi-square difference test
* Retain autoregressive path that results in significant improvement in model fit
* If there is no statistically significant improvement in model fit, the best fitting model is determined based on overall fit, parsimony and theoretical basis for components
 |
| *Repeat Steps 1 and 2 for each construct* |
| **Step 3. Estimate bivariate LCM-SR models to test inclusion of cross-lag parameters and covariates**  |
| Bivariate LCM-SR (no cross-lags) | * Combine two univariate LCMs into single bivariate LCM (e.g., P and NT)
* Allow the latent factors from each univariate model to covary with each other
* Allow the time-specific residuals to covary between the two constructs, and constrain to equality from T2 to T4
* Include AR paths among the structured residuals identified in step 2, but did not include any prospective paths between two constructs (i.e., no cross-lag effects were estimated)
 |
| Bivariate LCM-SR (P on SURPS cross-lags, equal) | * Bivariate LCM-SR +
* Cross-lag paths from P to SURPS trait
* Constrain cross-lag paths to be equal across time
* Assess improvement in model fit with chi-square differences test (compare with bivariate LCM-SR without cross-lags)
 |
| Bivariate LCM-SR (P on SURPS cross-lags, free) | * Bivariate LCM-SR +
* Cross-lag paths from P to SURPS trait
* Allow cross-lag paths to be freely estimated across time
* Assess improvement in model fit with chi-square differences test (compare with bivariate LCM-SR without cross-lags; and bivariate LCM-SR with P on SURPS cross-lags held equal)
 |
| Bivariate LCM-SR (SURPS on P cross-lags, equal) | * Bivariate LCM-SR +
* Remove P on SURPS cross-lags
* Cross-lag paths from SURPS trait to P
* Constrain cross-lag paths to be equal across time
* Assess improvement in model fit with chi-square differences test (compare with bivariate LCM-SR without cross-lags)
 |
| Bivariate LCM-SR (SURPS on P cross-lags, free) | * Bivariate LCM-SR +
* Cross-lag paths from P to SURPS trait
* Allow cross-lag paths to be freely estimated across time
* Assess improvement in model fit with chi-square differences test (compare with bivariate LCM-SR without cross-lags; and bivariate LCM-SR with SURPS on P cross-lags held equal)
 |
| Model evaluation * Retain cross-lag paths that results in significant improvement in model fit.
* If there is no statistically significant improvement in model fit, the best fitting model is determined based on overall fit, parsimony and theoretical basis for components
 |
| Full unconditional LCM-SR | * Bivariate LCM-SR + best-fitting P on SURPS and SURPS on P cross-lag structures
* Examine model results and overall fit
 |
| Final conditional LCM-SR | * Bivariate LCM-SR + best-fitting P on SURPS and SURPS on P cross-lag structures
* Regress latent curve and intercept factors on baseline age and sex
* Examine model results and overall fit
 |
| *Repeat Step 3 for each P and SURPS pairing (i.e., P and NT, P and AS, P and IMP, P and SS).** Answer research questions using the results from this model, assessing the significance of the autoregressive and reciprocal paths between constructs as well as the variation sin the magnitude of the reciprocal relation over time
 |

*Note*. P = general psychopathology, NT = negative thinking, AS = anxiety sensitivity, IMP = impulsivity, SS = sensation seeking, SURPS = Substance Use Risk Profile Scale

**Supplementary Results**

**Table S1. Intraclass Correlation Coefficients (ICC)**

|  |  |
| --- | --- |
| **Variable** | **ICC** |
| IMP\_T3 | 0.016 |
| SS\_T1 | 0.019 |
| SS\_T0 | 0.020 |
| P\_T0 | 0.021 |
| P\_T3 | 0.024 |
| AS\_T3 | 0.027 |
| IMP\_T2 | 0.027 |
| IMP\_T0 | 0.028 |
| IMP\_T1 | 0.028 |
| SS\_T2 | 0.029 |
| AS\_T2 | 0.034 |
| P\_T1 | 0.034 |
| P\_T2 | 0.034 |
| AS\_T1 | 0.035 |
| NT\_T0 | 0.037 |
| SS\_T3 | 0.038 |
| AS\_T0 | 0.043 |
| NT\_T1 | 0.049 |
| NT\_T2 | 0.064 |
| NT\_T3 | 0.080 |

**Table S2. Logistic regressions comparing baseline characteristic analyses between participants who were absent for all follow-ups vs participants present at any follow-ups**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Any follow-ups | No follow-ups | OR (95% CI) |
| **General Psychopathology** | Mean (SD) | 0.0 (0.8) | 0.3 (0.9) | 1.19 (0.90-1.58, p=0.225) |
| **Negative Thinking** | Mean (SD) | -0.2 (0.8) | 0.1 (0.9) | **1.37 (1.01-1.85, p=0.044)** |
| **Anxiety Sensitivity** | Mean (SD) | -0.1 (0.6) | 0.0 (0.6) | 0.99 (0.69-1.43, p=0.973) |
| **Impulsivity** | Mean (SD) | 0.3 (0.9) | 0.5 (0.9) | 1.14 (0.88-1.49, p=0.323) |
| **Sensation Seeking** | Mean (SD) | -0.0 (0.6) | -0.0 (0.6) | 0.97 (0.68-1.37, p=0.863) |
| **Sex** | Female | 1167 (92.3) | 97 (7.7) | - |
|  | Male | 567 (92.8) | 44 (7.2) | 0.90 (0.59-1.36, p=0.621) |
| **Cohort** | CSC | 1427 (91.7) | 129 (8.3) | - |
|  | CAP | 496 (94.1) | 31 (5.9) | 0.73 (0.47-1.12, p=0.161) |

**Table S3. Logistic regressions comparing Cohort x baseline variable interactions between participants who were absent for all follow-ups vs participants present at any follow-ups, and participants who present for all follow-ups vs participants absent at any follow-ups**

|  |  |
| --- | --- |
| **Cohort, Baseline variable** | **OR (95% CI),** **Any follow-ups (vs. 0 follow-ups)** |
| General Psychopathology, CAP | 0.92 (0.55-1.56, p=0.767) |
| Negative Thinking, CAP | 1.23 (0.65-2.32, p=0.525) |
| Anxiety Sensitivity, CAP | 0.89 (0.31-2.55, p=0.835) |
| Impulsivity, CAP  | 1.38 (0.77-2.42, p=0.271) |
| Sensation Seeking, CAP | 0.91 (0.38-2.14, p=0.825) |
| Male, CAP | 0.96 (0.37-2.34, p=0.936) |

**Table S4. Logistic regressions comparing Sex x baseline variable interactions between participants who were absent for all follow-ups vs participants present at any follow-ups, and participants who present for all follow-ups vs participants absent at any follow-ups**

|  |  |
| --- | --- |
| **Sex x Baseline variable** | **OR (95% CI),** **Any follow-ups (vs. 0 follow-ups)** |
| General Psychopathology, Male | 0.84 (0.54-1.32, p=0.449) |
| Negative Thinking, Male | 1.17 (0.73-1.87, p=0.519) |
| Anxiety Sensitivity, Male | 0.76 (0.39-1.51, p=0.430) |
| Impulsivity, Male | 0.82 (0.53-1.28, p=0.384) |
| Sensation Seeking, Male | 0.70 (0.37-1.33, p=0.267) |

## Measurement Invariance

**DIF parameters.** Factor loading non-invariance was observed for 5 items in the psychopathology models, and 4 items in the personality models. Females were less likely to respond to report symptoms of SD16 (DIF estimate = -0.438, ‘I am nervous in new situations. I easily lose confidence’), and more likely to report symptoms of K63R (‘… restless or fidgety?’), S13 (‘I am often unhappy, down-hearted, or tearful’; DIF estimates = 0.501 and 0.303, respectively). Older adolescents were less likely to endorse symptoms of K62R (‘… hopeless?’), K64R (‘… so depressed that nothing could cheer you up?’; DIF estimates = -0.194 and -0.397, respectively). Students in the CSC study were more likely to endorse AH5 (‘Noticed a change in my personality.’), AH7 (‘Suddenly found myself in a place that I could not remember getting to.’) and SD15 (‘I am easily distracted. I find it difficult to concentrate.’; DIF estimates = 9.828, 3.924 and 0.040, respectively). Regarding personality items, females were less likely to report SURPS17 (‘I feel that Im a failure.’; DIF estimate = -0.583), older adolescents were less likely to report SURPS6 (‘I enjoy new and exciting experiences even if they are unconventional (out of the ordinary).’; DIF estimate = -0.237), and participants in the CAP study were less likely to report SURPS13R (‘I feel proud of my accomplishments (achievements).’) and SURPS20R (‘I feel pleasant.’; DIF estimates = -0.213 and -0.096, respectively). All other psychopathology and personality items exhibited intercept and factor loading invariance across age, sex, and study.

**Latent factor mean impact parameters.** Latent factor mean differences were observed for alcohol use/harms, conduct/inattention, and negative thinking latent factors. Older adolescents reported higher scores on the alcohol use/harms, conduct/inattention, and negative thinking latent factors (0.647, 0.111, 0.115, respectively). Students from the CAP study reported higher scores on the conduct/inattention and impulsivity latent factors (0.448 and 0.247, respectively). All other latent factor mean differences were not statistically significant.

**Latent factor variance impact parameters.** Latent factor variance differences were observed for fear, alcohol use/harms, conduct/inattention, and all personality factors. Age was significantly and positively related to fear, alcohol use/harms, conduct/inattention, and all personality factor variances (variance estimates = 0.462, 0.419 and 0.254, respectively), such that older adolescents had greater variability in fear, conduct/inattention and sensation seeking. Sex was significantly and positively related to alcohol, conduct/inattention, impulsivity, and negative thinking factor variances, such that males had greater variability in alcohol use/harms, conduct/inattention, impulsivity, and negative thinking factor variances (variance estimates = 0.135, 0.525, 0.536 and 0.452, respectively). Study was significantly related to alcohol use/harms, impulsivity, sensation seeking, anxiety sensitivity and negative thinking factor variances, such that participants in the CAP study had greater variability in alcohol use/harms (variance estimate = 0.347) and lower variability in all personality factor variances (impulsivity = -0.615, sensation seeking = -0.576, anxiety sensitivity = -0.869, and negative thinking = -0.624). No other latent factor variance differences were statistically significant.

**Scoring model**

Below is the scoring model used to estimate general psychopathology factor scores.

INPUT INSTRUCTIONS

 TITLE: Higher Order final MNLFA

 DATA: FILE = long\_psych\_binary\_sept.csv;

 VARIABLE:

 NAMES = id study school time agecent ageclean sex

 auditc1 auditc2 auditc3 ah1c ah2c ah3c ah4c ah5c ah6c ah7c ah8c

 sd2 sd3 sd5 sd8 sd10 sd12 sd13 sd15 sd16 sd18 sd22 sd24

 k61r k62r k63r k64r k65r k66r new\_id;

 MISSING=.;

 !

 !

 !

 USEVARIABLES= sd16 sd24 k61r k63r sd3 sd8 sd13 k62r k64r k65r

 k66r auditc2 auditc3 ah2c ah3c ah5c ah6c ah7c ah8c sd2 sd5 sd10 sd12 sd15 sd18

 sd22 agecent sex study ;

 CATEGORICAL= sd16 sd24 k61r k63r sd3 sd8 sd13 k62r k64r k65r

 k66r auditc2 auditc3 ah2c ah3c ah5c ah6c ah7c ah8c sd2 sd5 sd10 sd12 sd15 sd18

 sd22 ;

 !

 CONSTRAINT = agecent sex study;

 AUXILIARY= school time ageclean;

 !IDVARIABLE = id;

 CLUSTER = new\_id;

 ANALYSIS:

 TYPE=COMPLEX;

 ESTIMATOR=MLR;

 ALGORITHM=INTEGRATION;

 INTEGRATION=MONTECARLO;

 LINK=LOGIT;

 PROCESSORS=8;

 MODEL:

 FEAR BY sd16\*(l\_1)

 sd24@1.242

 k61r@3.088

 k63r\*(l\_2);

 [SD16$1@-1.143

 SD24$1@0.535

 K61R$1@-2.736

 K63R$1@-0.435];

 DIST BY sd3@1.329

 sd8@1.578

 sd13\*(l\_3)

 k62r\*(l\_4)

 k64r\*(l\_5)

 k65r @2.038

 k66r @4.321;

 [SD3$1@0.687

 SD8$1@-0.094

 SD13$1@2.097

 K62R$1@0.246

 K64R$1@1.964

 K65R$1@-0.856

 K66R$1@1.53];

 ALC BY auditc2 @3.606

 auditc3 @3.184

 ah2c @3.408

 ah3c @3.796

 ah5c\*(l\_6)

 ah6c @3.876

 ah7c\*(l\_7)

 ah8c @3.973;

 [AUDITC2$1@7.7

 AUDITC3$1@5.532

 AH2C$1@8.641

 AH3C$1@8.77

 AH5C$1@26.52

 AH6C$1@10.43

 AH7C$1@14.446

 AH8C$1@10.777];

 CON BY sd2 @2.074

 sd5 @0.961

 sd10 @2.564

 sd12 @1.224

 sd15\*(l\_8)

 sd18 @1.068

 sd22 @1.247;

 [SD2$1@1.004

 SD5$1@1.057

 SD10$1@2.349

 SD12$1@2.789

 SD15$1@0.31

 SD18$1@2.19

 SD22$1@3.385];

 [FEAR@0 DIST@0 ALC@0 CON@0];

 FEAR (v\_fear);

 !DIST (v\_dist);

 ALC (v\_alc);

 CON (v\_con);

 ! HIGHER ORDER MODEL

 P BY DIST\* CON ALC FEAR;

 P@1;

 ! Moderation of factor means

 ALC ON AGECENT@0.647;

 CON ON AGECENT@0.111;

 CON ON STUDY@0.448;

 ! FEAR DIF items

 SD16 ON sex@-0.438;

 K63R ON sex@0.501;

 ! DIST DIF items

 SD13 ON SEX@0.303;

 K62R ON AGECENT@-0.194;

 K64R ON AGECENT@-0.397;

 ! ALC DIF items

 AH5C ON STUDY@9.828;

 AH7C ON STUDY@3.924;

 ! CON DIF items

 SD15 ON STUDY@0.04;

 MODEL CONSTRAINT:

 ! moderation of factor variances

 v\_fear=1\*exp(0.462\*agecent+0);

 !v\_dist=1\*exp(0);

 v\_alc=1\*exp(0.135\*sex+0.347\*study+0);

 v\_con=1\*exp(0.419\*agecent+ 0.525\*sex+ 0);

 ! moderation of factor loadings

 l\_1=1.82 -0.369\*sex;!SD16

 l\_2=0.433 +1.272\*sex; !k63r

 l\_3=3.534 -0.809\*sex; !SD13

 l\_4=4.185 +0.765\*agecent; !K62R

 l\_5=4.505 +1.216\*agecent; !K64R

 l\_6=10.425 -3.983\*study; !AH5C

 l\_7=5.247 -1.514\*study; !AH7C

 l\_8=1.765 -0.336\*study; !SD15

 OUTPUT: tech1; svalues;

 SAVEDATA: SAVE=FSCORES; FILE="scores\_HO\_0906.dat";

Below is the scoring model used to estimate personality factor scores.

INPUT INSTRUCTIONS

 TITLE: Estimate SURPS factor scores

 DATA: FILE = "long\_surps\_0902.csv";

 VARIABLE:

 NAMES = new\_id timepoint school ageclean surps1r surps2 surps3 surps4r surps5

 surps6 surps7r surps8 surps9 surps10 surps11 surps12 surps13r surps14

 surps15 surps16 surps17 surps18 surps19 surps20r surps21 surps22 surps23r

 agecent sex study;

 MISSING=.;

 USEVARIABLES = surps1r surps2 surps3 surps4r surps5 surps6

 surps7r surps8 surps9 surps10 surps11 surps12 surps13r surps14 surps15 surps16

 surps17 surps18 surps19 surps20r surps21 surps22 surps23r agecent sex study;

 AUXILIARY = timepoint ageclean school;

 CATEGORICAL= surps1r surps2 surps3 surps4r surps5 surps6

 surps7r surps8 surps9 surps10 surps11 surps12 surps13r surps14 surps15 surps16

 surps17 surps18 surps19 surps20r surps21 surps22 surps23r ;

 !

 CONSTRAINT= agecent sex study ;

 !IDVARIABLE = id;

 CLUSTER = new\_id;

 ANALYSIS:

 TYPE=COMPLEX;

 ESTIMATOR=MLR;

 ALGORITHM=INTEGRATION;

 INTEGRATION=MONTECARLO;

 LINK=LOGIT;

 PROCESSORS=8;

 MODEL:

 ! IMPULSIVITY

 imp BY surps2 @2.201;

 imp BY surps5 @2.018;

 imp BY surps11 @3.48;

 imp BY surps15 @2.226;

 imp BY surps22 @1.342;

 [SURPS2$1@-1.774];

 [SURPS2$2@1.874];

 [SURPS2$3@5.102];

 [SURPS5$1@-1.451];

 [SURPS5$2@1.917];

 [SURPS5$3@4.81];

 [SURPS11$1@-1.724];

 [SURPS11$2@3.154];

 [SURPS11$3@7.157];

 [SURPS15$1@-1.398];

 [SURPS15$2@1.762];

 [SURPS15$3@4.761];

 [SURPS22$1@-0.619];

 [SURPS22$2@1.907];

 [SURPS22$3@4.146];

 ! SENSATION SEEKING

 ss BY surps3 @3.203;

 ss BY surps6\*(l\_2);

 ss BY surps9 @3.29;

 ss BY surps12 @2.149;

 ss BY surps16 @0.985;

 ss BY surps19 @1.976;

 SURPS6 ON AGECENT@-0.237;

 [SURPS3$1@-2.652];

 [SURPS3$2@-1.132];

 [SURPS3$3@1.045];

 [SURPS6$1@-4.393];

 [SURPS6$2@-2.337];

 [SURPS6$3@1.381];

 [SURPS9$1@-3.733];

 [SURPS9$2@-1.145];

 [SURPS9$3@2.769];

 [SURPS12$1@-2.147];

 [SURPS12$2@-0.449];

 [SURPS12$3@1.485];

 [SURPS16$1@-0.619];

 [SURPS16$2@1.086];

 [SURPS16$3@2.938];

 [SURPS19$1@-2.176];

 [SURPS19$2@-0.561];

 [SURPS19$3@1.583];

 !ANXIETY SENSITIVITY

 as BY surps8 @2.922;

 as BY surps10 @3.495;

 as BY surps14 @3.058;

 as BY surps18 @3.917;

 as BY surps21 @3.101;

 [SURPS8$1@-2.236];

 [SURPS8$2@-0.069];

 [SURPS8$3@2.722];

 [SURPS10$1@-1.793];

 [SURPS10$2@1.061];

 [SURPS10$3@3.824];

 [SURPS14$1@-2.432];

 [SURPS14$2@-0.041];

 [SURPS14$3@2.742];

 [SURPS18$1@-1.886];

 [SURPS18$2@1.485];

 [SURPS18$3@5.017];

 [SURPS21$1@-1.845];

 [SURPS21$2@1.089];

 [SURPS21$3@3.836];

 !NEGATIVE THINKING

 nt BY surps1r @2.937;

 nt BY surps4r @3.11;

 nt BY surps7r @3.286;

 nt BY surps13r\*(l\_4);

 nt BY surps17\*(l\_5);

 nt BY surps20r\*(l\_6);

 nt BY surps23r @3.389;

 SURPS13R ON STUDY@-0.213;

 SURPS17 ON SEX@-0.583;

 SURPS20R ON STUDY@-0.096;

 [SURPS1R$1@-1.622];

 [SURPS1R$2@2.967];

 [SURPS1R$3@4.791];

 [SURPS4R$1@-0.886];

 [SURPS4R$2@3.293];

 [SURPS4R$3@5.613];

 [SURPS7R$1@-1.46];

 [SURPS7R$2@3.354];

 [SURPS7R$3@5.743];

 [SURPS13R$1@-1.363];

 [SURPS13R$2@3.074];

 [SURPS13R$3@5.125];

 [SURPS17$1@-1.112];

 [SURPS17$2@0.923];

 [SURPS17$3@2.751];

 [SURPS20R$1@-2.47];

 [SURPS20R$2@3.105];

 [SURPS20R$3@5.787];

 [SURPS23R$1@-1.362];

 [SURPS23R$2@3.105];

 [SURPS23R$3@5.392];

 [ imp@0 ];

 [ ss@0 ];

 [ as@0 ];

 [ NT@0 ];

 !factor variances

 imp(v\_imp);

 ss(v\_ss);

 as(v\_as);

 nt(v\_nt);

 !Moderation of factor means

 imp ON STUDY@0.247;

 nt ON AGECENT@0.115;

MODEL CONSTRAINT:

 ! Moderation of factor variances

 v\_imp=1\*exp(0.536\*sex +

 (-0.615\*study) +

 0);

 v\_ss=1\*exp(0.254\*agecent +

 (-0.576\*study) +

 0);

 v\_as=1\*exp((-0.869\*study) +

 0);

 v\_nt=1\*exp(0.452\*sex +

 (-0.624\*study) +

 0);

 ! Moderation of factor loadings

 l\_2=2.983 + 0.357\*agecent;

 l\_4=3.724 -0.62\*study;

 l\_5=2.749 -1.062\*sex;

 l\_6=3.691 -0.309\*study;

 OUTPUT: tech1; svalues;

 SAVEDATA: SAVE=FSCORES; FILE="scores\_surps\_0902.dat";

**Table S5 Correlation between MNLFA adjusted factor scores and unadjusted factor scores**

|  |  |
| --- | --- |
| Construct | r |
| Fear | 0.99\*\*\* |
| Distress | 1.00\*\*\* |
| Alcohol | 0.94\*\*\* |
| Conduct | 0.99\*\*\* |
| AS | 1.00\*\*\* |
| NT | 1.00\*\*\* |
| IMP | 1.00\*\*\* |
| SS | 1.00\*\*\* |

 \*\*\* p <.001.

## Preliminary unconditional univariate and bivariate latent curve models with structured residuals

A summary of the model fit and nested model comparisons is provided in Table S6. Below we briefly summarise key decisions and outcomes.

### Unconditional univariate between-person models

For all constructs, a model with a random intercept and linear slope fit the data well. Quadratic slope models were also examined for each construct; however, there were negative variances present in all of these. Inspection of the mean observed scores at each time point also indicated that a linear model may be more suitable for the data. Therefore, quadratic slope models were excluded from subsequent analyses.

### Unconditional univariate within-person models

Next, the intercept and linear growth curve models were expanded to include autoregressive effects between time-adjacent structured residuals to determine the stability of each construct over time. For general psychopathology, allowing the autoregressive parameters to be freely estimated appeared to fit the data better (Model 17) as determined via examining model fit indices. A negative residual variance was detected at T4; however, this issue did not appear in subsequent bivariate models. Thus, Model 17 was retained.

For negative thinking, there was no statistically significant difference between the freely estimated versus constrained models, however inspection of the model fit indices suggests that the constrained model was a slightly better fit. Further, the constrained model improved fit over the base intercept and linear slope model. For each of the remaining personality constructs, the inclusion of autoregressive parameters did not improve fit according to the chi-square differences test compared to the base intercept + linear slope models. Given that this also indicates that the inclusion of the autoregressive parameters does not degrade model fit, these were retained in subsequent analyses (Curran, Howard, et al., 2014). The chi-square differences test comparing freely estimated versus constrained autoregressive parameters were also non-significant, however the fit indices overall indicated the constrained models fit slightly better. Thus, for all personality constructs the models with autoregressive parameters constrained to equality were selected for subsequent analyses.

## Unconditional bivariate models

Univariate models for each personality construct and general psychopathology were combined into unconditional bivariate models without cross-lagged parameters between constructs for each of the personality and general psychopathology models (Models 27, 34, 43 and 50). These models all had acceptable fit and were then expanded to test the inclusion of bidirectional cross-lags.

Specifically, we added the regression of the residual for general psychopathology on the residual for each personality construct, first constraining these to equality (Models 28, 35, 42 and 51), and then allowing them to be freely estimated (Models 29, 36, 43 and 52). For all constructs, results of the chi-square differences test indicated that these regressions did not improve or degrade model fit, nor was there a difference between the constrained vs. unconstrained models. Inspection of model fit indices indicated that the constrained models (Models 28, 35, 42 and 51) fit the data marginally better and were thus retained for all constructs. We then removed these regressions and repeated the process for the regression of residual personality on residual general psychopathology. There was again no indication that the inclusion of these regressions improved, or degraded model fit, nor was there a difference between the constrained (Models 30, 37, 46, 53) and unconstrained models (Models 31, 38, 47, 54). Thus, the constrained models were retained (Models 30, 37, 46, 53). Both sets of regressions were then combined into unconditional bivariate models with general psychopathology (Models 32, 39, 48, 55) and these fit the data well. However, a negative residual variance was detected for the slope of anxiety sensitivity (Models 39). Therefore, the slope factor for anxiety sensitivity was removed (Models 41), which fit the data well.

**Table S6. Summary of model fit and comparison of nested models from latent curve models with structured residuals**

| **Model** |  |  | **Model fit indices** |  |  |  |  |  |  | **χ2 Difference Test for Nested Models Based on Loglikelihood** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **N** | **χ2 (df)** | **BIC** | **AIC** | **aBIC** | **CFI** | **TLI** | **RMESEA (90% CI)** | **χ2 Δ (df)** | **Models Compared** |
| **Step 1: Unconditional univariate between-person models** |  |  |  |  |  |  |  |  |  |  |
|  | **General psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 1 Intercept only | 2078 | 203.937 (8)\*\*\* | 16480.28 | 16446.45 | 16461.22 | 0.848 | 0.886 | 0.109 (0.096-0.122) |  |  |
|  |  | **2 Intercept + linear slope** | **2078** | **52.189 (5)\*\*\*** | **16331.9** | **16281.15** | **16303.31** | **0.963** | **0.956** | **0.067 (0.052-0.085)** | **148.3228 (3)\*\*\*** | **2 vs 1** |
|  |  | 3 Intercept + linear + quadratic slope | 2078 | 20.208 (2)\*\*\* | 16318.65 | 16250.98 | 16280.52 | 0.986 | 0.958 | 0.066 (0.042-0.094) |  |  |
|  | **Negative Thinking** |  |  |  |  |  |  |  |  |  |  |
|  |  | 4 Intercept only | 2051 | 247.031 (8)\*\*\* | 15180.97 | 15147.21 | 15161.91 | 0.712 | 0.784 | 0.121 (0.108-0.134) |  |  |
|  |  | **5 Intercept + linear slope** | **2051** | **10.241 (5)** | **14872.25** | **14821.61** | **14843.65** | **0.994** | **0.992** | **0.023 (0.000-0.042)** | **239.1303 (3)\*\*\*** | **5 vs 4** |
|  |  | 6 Intercept + linear + quadratic slope | 2051 | 4.083 (2) | 14886.36 | 14818.85 | 14848.24 | 0.997 | 0.992 | 0.023 (0.000-0.054) |  |  |
|  | **Anxiety Sensitivity** |  |  |  |  |  |  |  |  |  |  |
|  |  | 7 Intercept only | 2051 | 38.502 (8)\*\*\* | 11949.67 | 11915.91 | 11930.61 | 0.921 | 0.941 | 0.043 (0.030-0.057) |  |  |
|  |  | **8 Intercept + linear slope** | **2051** | **3.296 (5)** | **11917.34** | **11866.71** | **11888.75** | **1** | **1** | **0.000 (0.000-0.025)** | **32.3201 (3)\*\*\*** | **8 vs 7** |
|  |  | 9 Intercept + linear + quadratic slope | 2051 | 2.931 (2) | 11939.7 | 11872.18 | 11901.57 | 0.998 | 0.993 | 0.015 (0.000-0.049) |  |  |
|  | **Impulsivity** |  |  |  |  |  |  |  |  |  |  |
|  |  | 10 Intercept only | 2051 | 44.569 (8)\*\*\* | 16809.38 | 16775.63 | 16790.32 | 0.935 | 0.951 | 0.047 (0.034-0.061) |  |  |
|  |  | **11 Intercept + linear slope** | **2051** | **8.112 (5)** | **16779.32** | **16728.68** | **16750.72** | **0.994** | **0.993** | **0.017 (0.000-0.038)** | **33.3178 (3)\*\*\*** | **11 vs 10** |
|  |  | 12 Intercept + linear + quadratic slope | 2051 | 4.051 (2) | 16796.66 | 16729.15 | 16758.53 | 0.996 | 0.989 | 0.022 (0.000-0.054) |  |  |
|  | **Sensation Seeking** |  |  |  |  |  |  |  |  |  |  |
|  |  | 13 Intercept only | 2051 | 69.259 (8)\*\*\* | 12696.16 | 12662.41 | 12677.1 | 0.884 | 0.913 | 0.061 (0.048-0.075) |  |  |
|  |  | **14 Intercept + linear slope** | **2051** | **3.608 (5)** | **12605.55** | **12554.91** | **12576.95** | **1** | **1** | **0.000 (0.000-0.026)** | **60.7874 (3)\*\*\*** | **14 vs 13** |
|  |  | 15 Intercept + linear + quadratic slope | 2051 | 0.959 (2) | 12624.17 | 12556.66 | 12586.05 | 1 | 1 | 0.000 (0.000-0.035) |  |  |
| **Step 2: Unconditional univariate within-person models** |  |  |  |  |  |  |  |  |  |  |
|  | **General Psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 16 Model 2 + autoregressive parameters (equal) | 2078 | 23.844 (4)\*\*\* | 16306.02 | 16249.63 | 16274.25 | 0.985 | 0.977 | 0.049 (0.031-0.069) | 45.3223 (1)\*\*\* | 16 vs 2 |
|  |  | **17 Model 2 + autoregressive parameters (free)** | **2078** | **4.336 (2)** | **16301.6** | **16233.93** | **16263.47** | **0.998** | **0.995** | **0.024 (0.000-0.055)** | **19.3232 (2)\*\*\*** | **17 vs 16** |
|  |  | 18 Model 2 + autoregressive parameters (free, modified) | 2078 | 4.257 (3) | 16294.06 | 16232.03 | 16259.12 | 0.999 | 0.998 | 0.014 (0.000-0.042) |  |  |
|  | **Negative Thinking** |  |  |  |  |  |  |  |  |  |  |
|  |  | **19 Model 5 + autoregressive parameters (equal)** | **2051** | **4.791 (4)** | **14871.6** | **14815.34** | **14839.83** | **0.999** | **0.999** | **0.010 (0.000-0.036)** | **4.3396 (1)\*** | **19 vs 5** |
|  |  | 20 Model 5 + autoregressive parameters (free) | 2051 | 0.559 (2) | 14881.25 | 14813.74 | 14843.13 | 1 | 1 | 0.000 (0.000-0.030) | 3.5666 (2) | 20 vs 19 |
|  | **Anxiety Sensitivity** |  |  |  |  |  |  |  |  |  |  |
|  |  | **21 Model 8 + autoregressive parameters (equal)** | **2051** | **2.046 (4)** | **11922.82** | **11866.56** | **11891.05** | **1** | **1** | **0.000 (0.000-0.024)** | **1.0352 (1)** | **21 vs 8** |
|  |  | 22 Model 8 + autoregressive parameters (free) | 2051 | 2.076 (2) | 11937.41 | 11869.9 | 11899.29 | 1 | 0.999 | 0.004 (0.000-0.044) | 0.3982 (2) | 22 vs 21 |
|  | **Impulsivity** |  |  |  |  |  |  |  |  |  |  |
|  |  | **23 Model 11 + autoregressive parameters (equal)** | **2051** | **6.593 (4)** | **16784.02** | **16727.76** | **16752.25** | **0.995** | **0.993** | **0.018 (0.000-0.041)** | **1.5559 (1)** | **23 vs 11** |
|  |  | 24 Model 11 + autoregressive parameters (free) | 2051 | 2.350 (2) | 16793.67 | 16726.16 | 16755.55 | 0.999 | 0.998 | 0.009 (0.000-0.046) | 3.9576 (2) | 22 vs 23 |
|  | **Sensation Seeking** |  |  |  |  |  |  |  |  |  |  |
|  |  | **25 Model 14 + autoregressive parameters (equal)** | **2051** | **4.281 (4)** | **12613.08** | **12556.82** | **12581.31** | **0.999** | **0.999** | **0.006 (0.000-0.034)** | **0.0359 (1)** | **25 vs 14** |
|  |  | 26 Model 14 + autoregressive parameters (free) | 2051 | 1.000 (2) | 12623.5 | 12555.99 | 12585.38 | 1 | 1 | 0.000 (0.000-0.036) | 2.7923 (2) | 26 vs 25 |
| **Step 3. Bivariate models** |  |  |  |  |  |  |  |  |  |  |
|  | **Negative Thinking x General Psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 27 Bivariate LCM-SR (no cross-lags) | 2078 | 42.851 (16)\*\*\* | 30016.2 | 29858.3 | 29927.24 | 0.991 | 0.984 | 0.028 (0.018-0.039) |  |  |
|  |  | **28 Bivariate LCM-SR (P on NT lags, equal)** | **2078** | **42.029 (15)\*\*\*** | **30022.63** | **29859.1** | **29930.5** | **0.991** | **0.983** | **0.029 (0.019-0.040)** |  |  |
|  |  | 29 Bivariate LCM-SR (P on NT lags, free) | 2078 | 41.428 (13)\*\*\* | 30035.6 | 29860.79 | 29937.12 | 0.99 | 0.979 | 0.032 (0.022-0.044) | 1.5247 (2) | 29 vs 28 |
|  |  | **30 Bivariate LCM-SR (NT on P lags, equal)** | **2078** | **39.443 (15)\*\*\*** | **30020.1** | **29856.56** | **29927.96** | **0.992** | **0.985** | **0.028 (0.018-0.039)** |  |  |
|  |  | 31 Bivariate LCM-SR (NT on P lags, free) | 2078 | 40.721 (13)\*\*\* | 30023.89 | 29849.08 | 29925.4 | 0.991 | 0.98 | 0.032 (0.021-0.043) | 3.3945 (2) | 31 vs 30 |
|  |  | 32 Full unconditional LCM-SR | 2078 | 35.117 (14)\*\* | 30021.43 | 29852.25 | 29926.12 | 0.993 | 0.986 | 0.027 (0.016-0.038) |  |  |
|  |  | **33 Final conditional LCM-SR** | **2067** | **63.153 (26)\*\*\*** | **29835.75** | **29599.13** | **29702.31** | **0.99** | **0.98** | **0.026 (0.018-0.035)** |  |  |
|  | **Anxiety Sensitivity x General Psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 34 Bivariate LCM-SR (no cross-lags) | 2078 | 33.640 (16)\*\* | 27728.29 | 27570.4 | 27639.34 | 0.992 | 0.985 | 0.023 (0.012-0.034) |  |  |
|  |  | **35 Bivariate LCM-SR (P on AS lags, equal)** | **2078** | **32.344 (15)\*\*** | **27734.08** | **27570.55** | **27641.95** | **0.992** | **0.985** | **0.024 (0.012-0.035)** |  |  |
|  |  | 36 Bivariate LCM-SR (P on AS lags, free) | 2078 | 28.668 (13)\*\* | 27743.97 | 27569.15 | 27645.48 | 0.993 | 0.984 | 0.024 (0.012-0.036) | 3.7518 (2) | 35 vs 36 |
|  |  | **37 Bivariate LCM-SR (AS on P lags, equal)** | **2078** | **33.099 (15)\*\*** | **27734.78** | **27571.24** | **27642.64** | **0.991** | **0.984** | **0.024 (0.013-0.035)** |  |  |
|  |  | 38 Bivariate LCM-SR (AS on P lags, free) | 2078 | 31.169 (13)\*\* | 27745.13 | 27570.31 | 27646.64 | 0.991 | 0.982 | 0.026 (0.014-0.038) | 2.7511 (2) | 38 vs 37 |
|  |  | 39 Full unconditional LCM-SR | 2078 | 28.910 (14)\* | 27736.76 | 27567.59 | 27641.45 | 0.993 | 0.986 | 0.023 (0.011-0.034) |  |  |
|  |  | 40 Full conditional LCM-SR | 2067 | 41.054 (22)\*\* | 27626.81 | 27412.72 | 27506.08 | 0.992 | 0.985 | 0.020 (0.010-0.030) |  |  |
|  |  | 41 Final unconditional LCM-SR (no AS slope) | 2078 | 52.318 (19)\*\*\* | 27730.35 | 27589.37 | 27650.92 | 0.984 | 0.977 | 0.029 (0.020-0.039) |  |  |
|  |  | **42 Final conditional LCM-SR (no AS slope)** | **2067** | **73.899 (34)\*\*\*** | **27551.84** | **27360.29** | **27443.82** | **0.985** | **0.977** | **0.024 (0.016-0.031)** |  |  |
|  | **Impulsivity x General Psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 43 Bivariate LCM-SR (no cross-lags) | 2078 | 38.839 (16)\*\* | 32561.39 | 32403.49 | 32472.43 | 0.991 | 0.984 | 0.026 (0.016-0.037) |  |  |
|  |  | **44 Bivariate LCM-SR (P on IMP lags, equal)** | **2078** | **37.894 (15)\*\*\*** | **32567.1** | **32403.56** | **32474.97** | **0.991** | **0.982** | **0.027 (0.016-0.038)** |  |  |
|  |  | 45 Bivariate LCM-SR (P on IMP lags, free) | 2078 | 37.245 (13)\*\*\* | 32580.93 | 32406.11 | 32482.44 | 0.99 | 0.979 | 0.030 (0.019-0.041) | 1.0964 (2) | 44 vs 45 |
|  |  | **46 Bivariate LCM-SR (IMP on P lags, equal)** | **2078** | **37.570 (15)\*\*** | **32567.01** | **32403.47** | **32474.87** | **0.991** | **0.983** | **0.027 (0.016-0.038)** |  |  |
|  |  | 47 Bivariate LCM-SR (IMP on P lags, free) | 2078 | 35.537 (13)\*\*\* | 32577.58 | 32402.76 | 32479.09 | 0.991 | 0.98 | 0.029 (0.018-0.040) | 2.897 (2) | 47 vs 46 |
|  |  | 48 Full unconditional LCM-SR | 2078 | 32.892 (14)\*\* | 32568.36 | 32399.18 | 32473.05 | 0.992 | 0.985 | 0.025 (0.014-0.037) |  |  |
|  |  | **49 Final conditional LCM-SR** | **2067** | **58.952 (26)\*\*\*** | **32411.48** | **32174.86** | **32278.05** | **0.989** | **0.978** | **0.025 (0.016-0.033)** |  |  |
|  | **Sensation Seeking x General Psychopathology** |  |  |  |  |  |  |  |  |  |  |
|  |  | 50 Bivariate LCM-SR (no cross-lags) | 2078 | 18.402 (16) | 28946.47 | 28788.57 | 28857.51 | 0.999 | 0.998 | 0.008 (0.000-0.023) |  |  |
|  |  | **51 Bivariate LCM-SR (P on SS lags, equal)** | **2078** | **18.421 (15)** | **28954.11** | **28790.57** | **28861.97** | **0.998** | **0.997** | **0.010 (0.000-0.024)** |  |  |
|  |  | 52 Bivariate LCM-SR (P on SS lags, free) | 2078 | 18.081 (13) | 28968.49 | 28793.67 | 28870 | 0.997 | 0.995 | 0.014 (0.000-0.028) | 0.6057 (2) | 52 vs 51 |
|  |  | **53 Bivariate LCM-SR (SS on P lags, equal)** | **2078** | **18.148 (15)** | **28953.43** | **28789.89** | **28861.29** | **0.998** | **0.997** | **0.010 (0.000-0.024)** |  |  |
|  |  | 54 Bivariate LCM-SR (SS on P lags, free) | 2078 | 13.401 (13) | 28961.81 | 28786.99 | 28863.32 | 1 | 1 | 0.004 (0.000-0.022) | 4.2075 (2) | 54 vs 53 |
|  |  | 55 Final unconditional LCM-SR | 2078 | 18.150 (14) | 28960.83 | 28791.65 | 28865.51 | 0.998 | 0.996 | 0.012 (0.000-0.026) |  |  |
|   |  | **56 Final conditional LCM-SR** | **2067** | **44.655 (26)\*** | **28858.23** | **28621.6** | **28724.79** | **0.993** | **0.985** | **0.019 (0.009-0.028)** |   |   |

*Notes*. NT = Negative Thinking; AS = Anxiety Sensitivity; IMP = Impulsivity; SS = Sensation Seeking; P = General Psychopathology

\*p<.05, \*\*P<.01, \*\*\*p<.001

**Table S7. Standardized residual variances from preliminary univariate latent growth models**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **p** |
| P 13 | 0.404 | 0.029 | <.001 |
| P 14 | 0.497 | 0.017 | <.001 |
| P 15 | 0.444 | 0.018 | <.001 |
| P 16 | 0.259 | 0.030 | <.001 |
| AS 13 | 0.607 | 0.045 | <.001 |
| AS 14 | 0.628 | 0.026 | <.001 |
| AS 15 | 0.605 | 0.027 | <.001 |
| AS 16 | 0.428 | 0.055 | <.001 |
| NT 13 | 0.326 | 0.036 | <.001 |
| NT 14 | 0.473 | 0.020 | <.001 |
| NT 15 | 0.459 | 0.022 | <.001 |
| NT 16 | 0.228 | 0.038 | <.001 |
| SS 13 | 0.350 | 0.041 | <.001 |
| SS 14 | 0.530 | 0.024 | <.001 |
| SS 15 | 0.505 | 0.027 | <.001 |
| SS 16 | 0.319 | 0.052 | <.001 |
| IMP 13 | 0.469 | 0.039 | <.001 |
| IMP 14 | 0.550 | 0.024 | <.001 |
| IMP 15 | 0.543 | 0.026 | <.001 |
| IMP 16 | 0.396 | 0.049 | <.001 |

*Notes*. SE = standard error; NT = Negative Thinking; AS = Anxiety Sensitivity; IMP = Impulsivity; SS = Sensation Seeking; P = General Psychopathology

**Table S8. Means and variances for observed variables included in LCM-SR models**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **N** | **Mean** | **Variance** |
| P\_T0 | 2067 | 0.034 | 0.659 |
| P\_T1 | 1783 | 0.023 | 0.837 |
| P\_T2 | 1642 | 0.029 | 0.893 |
| P\_T3 | 1454 | 0.093 | 0.882 |
| IMP\_T0 | 1927 | 0.281 | 0.79 |
| IMP\_T1 | 1744 | 0.243 | 0.889 |
| IMP\_T2 | 1571 | 0.205 | 0.928 |
| IMP\_T3 | 1424 | 0.221 | 0.901 |
| SS\_T0 | 1927 | -0.005 | 0.377 |
| SS\_T1 | 1744 | 0.006 | 0.5 |
| SS\_T2 | 1571 | -0.007 | 0.538 |
| SS\_T3 | 1424 | 0.015 | 0.565 |
| AS\_T0 | 1927 | -0.059 | 0.348 |
| AS\_T1 | 1744 | -0.042 | 0.391 |
| AS\_T2 | 1571 | -0.041 | 0.451 |
| AS\_T3 | 1424 | -0.004 | 0.424 |
| NT\_T0 | 1927 | -0.2 | 0.633 |
| NT\_T1 | 1744 | -0.123 | 0.727 |
| NT\_T2 | 1571 | -0.034 | 0.764 |
| NT\_T3 | 1424 | 0.035 | 0.725 |

**Table S9. Summary of Missing Data Patterns**

Note. X = not missing

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Missing Data Pattern** | **Frequency** | **AGE\_T0** | **SEX\_T0** | **P\_T0** | **P\_T1** | **P\_T2** | **P\_T3** | **IMP\_T0** | **IMP\_T1** | **IMP\_T2** | **IMP\_T3** | **SS\_T0** | **SS\_T1** | **SS\_T2** | **SS\_T3** | **AS\_T0** | **AS\_T1** | **AS\_T2** | **AS\_T3** | **NT\_T0** | **NT\_T1** | **NT\_T2** | **NT\_T3** |
| 1 | 1126 | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 2 | 20 | x | x | x | x | x | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  |
| 3 | 26 | x | x | x | x | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x |
| 4 | 2 | x | x | x | x | x | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  |
| 5 | 14 | x | x | x | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x |
| 6 | 2 | x | x | x | x | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  |
| 7 | 2 | x | x | x | x | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x |
| 8 | 61 | x | x | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |
| 9 | 2 | x | x | x | x | x | x |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |
| 10 | 1 | x | x | x | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |
| 11 | 2 | x | x | x | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |
| 12 | 1 | x | x | x | x | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |
| 13 | 1 | x | x | x | x | x | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | 5 | x | x | x | x | x |  | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 15 | 206 | x | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  |
| 16 | 25 | x | x | x | x | x |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  |
| 17 | 4 | x | x | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  |
| 18 | 1 | x | x | x | x | x |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  |
| 19 | 11 | x | x | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |
| 20 | 3 | x | x | x | x | x |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 21 | 1 | x | x | x | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |
| 22 | 70 | x | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x |
| 23 | 2 | x | x | x | x |  | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  |
| 24 | 4 | x | x | x | x |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x |
| 25 | 3 | x | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |
| 26 | 1 | x | x | x | x |  | x |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 27 | 1 | x | x | x | x |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |
| 28 | 1 | x | x | x | x |  |  | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x |
| 29 | 155 | x | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  |
| 30 | 6 | x | x | x | x |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  |
| 31 | 12 | x | x | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 32 | 2 | x | x | x | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 33 | 1 | x | x | x |  | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 34 | 77 | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x |
| 35 | 2 | x | x | x |  | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  |
| 36 | 4 | x | x | x |  | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x |
| 37 | 1 | x | x | x |  | x | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  |
| 38 | 10 | x | x | x |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |
| 39 | 1 | x | x | x |  | x | x |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |
| 40 | 1 | x | x | x |  | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  |
| 41 | 18 | x | x | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  |
| 42 | 2 | x | x | x |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |
| 43 | 2 | x | x | x |  | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 44 | 10 | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x |
| 45 | 1 | x | x | x |  |  | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  |
| 46 | 1 | x | x | x |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |
| 47 | 1 | x | x | x |  |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  |
| 48 | 140 | x | x | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  |
| 49 | 22 | x | x | x |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 50 | 1 |  |  |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |  | x | x | x |
| 51 | 1 |  |  |  | x | x | x |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 52 | 1 |  |  |  | x | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |
| 53 | 2 |  |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |  | x | x |  |
| 54 | 1 |  |  |  | x | x |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 55 | 1 |  |  |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |  | x |
| 56 | 3 |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |  | x |  |  |
| 57 | 1 |   |   |   |   | x | x |   |   | x | x |   |   | x | x |   |   | x | x |   |   | x | x |

**Figure S2. Pairwise complete observation Pearson correlation coefficients between general psychopathology and personality**

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Note. All correlations were statistically significant.

**Supplementary references**

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