The general factor of psychopathology (p): Choosing among competing models and interpreting p

Caspi, Houts, Fisher, Danese, & Moffitt

Supplemental Information

Supplemental Table 1. Assessment of symptoms of mental disorders in the E-Risk cohort at age 18 years. Values in parentheses indicate variable names used in MPlus syntax (Supplemental Information, pp 20-27).

Symptom Scale	N	Mean	SD	Range	Symptoms	
ADHD (adhd18)	2061	5.79	4.29	0 - 18	• Make careless mistakes • Don't listen • Leave projects unfinished • Disorganized; difficulty organizing tasks that have many steps • Get borded quickly; can't concentrate / mind wanders; tune out when should focus • Lack self-discipline; put off tasks that require lots of effort • Misplace wallet, keys, mobile phone, paperwork. Lose things • Easily distracted/get sidetracked easily; can't resist temptation • Forgetful: forget appointments, forget to do errands, forget to return calls	• Feel fidgety or squirmy; feel very restlss • Don't enjoy doing quiet activities • Too loud or noisy • Talk too much • Always on the go, in a hurry, as if driven by a motor • Uncomfortable sitting still; need to get up and move. • Make "snap" decisions (too fast) • Difficulty waiting; impatient • Jump into projects without reading the instructions; impulsive/act without thinking about what might happen; interrupt, barge into others' conversations
Alcohol Dependence (alc18)	2063	1.13	1.68	0 - 11	• Tolerance • Withdrawal • Loss of control; used more than intended • Unable to cut down • Spent great deal of time using • Reduced or gave up activities	• Use despite social, psychological, physical problems • Use when hazardous • Interferes with responsibilities • Continued use despite objections • Cravings

Symptom Scale	N	Mean	SD	Range	Symptoms	
Cannabis Dependence (mar18)	2066	0.34	1.38	0 - 10	• Tolerance • Withdrawal • Loss of control; used more than intended • Unable to cut down • Spent great deal of time using	• Reduced or gave up activities • Use despite social, psychological, physical problems • Use when hazardous • Interferes with responsibilities • Continued use despite objections
Tobacco Dependence (smk18)	2062	0.67	1.62	0 - 10	• Number of cigarettes smoked per day (0-3 pts) • Length of time from waking to first cigarette (0-3 pts) • Smoke when sick	• Hard not to smoke in nonsmoking area • Hate to give up cigarette in morning / after hot drink / after meal / with alcohol / when craving • Smoke most in the morning
Conduct Disorder (cd18)	2053	2.12	2.28	0 - 13	• Bully/threaten • Initiates physical fights • Used a weapon • Physically cruel • Physically cruel to animals • Stolen while confronting victim • Destroyed others' property (no fire)	• Broken into car/property • Often lies to avoit obligations • Stolen without confronting victim • Stayed out late without permission • Run away from home • Skip school/college
Generalized Anxiety Disorder (gad18)	2066	1.13	2.15	0 - 7	• Restless, keyed up or on edge • Easily tired • Difficulty concentrating on what you were doing • More irritable than usual	• Trouble with falling or staying asleep, or waking up tired • Tense, sore or aching muscles • Any somatization (e.g., jumpy, sweating, dry mouth, nausea, trouble swallowing)

Symptom Scale	N	Mean	SD	Range	Symptoms	
Major Depression (mde18)	2063	1.81	2.97	0 - 9	• Depressed mood • Diminished interest • Weight or appetite change • Sleep problems • Psychomotor problems	• Fatigue • Feelings of worthlessness/guilt • Thought difficulties, lack of focus • Thoughts of death/suicide
Disordered Eating (eat18)	2064	0.45	0.88	0 - 5	• Made self sick by eating until uncomfortably full • Lost control over amount eaten • Lose more than one stone (3.6 kg or 14 lbs) in 3 month period	• Believe you're fat when others say you're too thin • Food dominated life
Post-traumatic stress disorder (PTSD18)	2064	1.37	3.32	0 - 17	• Remembering trauma over & over, or when you didn't want to • Having bad dreams or nightmares about trauma • Reexperiencing trauma event • Being in similar situations to trauma is upsetting/anxiety provoking • Heart pound/sweat/physically ill when reminded of trauma • Avoid talking about trauma • Stay away from certain people/places or activities to avoid being reminded of trauma • Struggle to remember important parts of trauma • Lose interest in activities that were important or enjoyable	• Begin to feel isolated or distant from other people • Find it more difficult to feel love for other people • More irritable or short-tempered • Having more trouble than usual falling asleep or staying asleep because of trauma • Feel there was no point in planning for the future • More trouble than usual keeping your mind on what you were doing • Become more concerned about danger or much more careful about things (e.g., checking to see who and what is around you) • Feel jumpy or get easily startled by ordinary noises or movements

Symptom Scale	N	Mean	SD	Range	Symptoms	
Psychosis Symptoms (psy18)	2063	0.04	0.31	0 - 7	• Thoughts can be read by another • Sent messages through radio or TV • Being followed or spied on • Heard voiced others cannot hear	• Felt under the control of special power • Read thoughts of another person • See something others cannot hear
Prodromal Symptoms A (prodA18)	2062	0.27	0.77	0 - 6	• More sensitive to lights or sounds • Can't trust anyone	• Food may be poisoned
Prodromal Symptoms B (prodB18)	2062	0.25	0.76	0 - 6	• People or places I know seem different • Thinking is unusual or frightening	• Have special abilities or powers beyond my natural talent

Note. We assessed the same 11 disorder/symptoms as in Schaefer et al. (2018): alcohol dependence, cannabis dependence, tobacco dependence, conduct disorder, attention-deficit hyperactivity disorder (ADHD), major depression, generalized anxiety disorder, post-traumatic stress disorder, disordered eating, psychosis symptoms, prodromal symptoms (we divided these into 2 parcels to allow proper identification of the confirmatory factor models). All symptoms were coded as 0 = absent, 1 = present except prodromal symptoms which study members endorsed on a 3-point (0, 1, 2) scale. Schaefer et al. (2018) treated symptom scales as ordinal; we treat them as continuous.

Supplemental Table 2. Correlations between mental-disorder symptom scales in the E-Risk cohort.

	ADHD	Alc	Cann	Tob	CD	GAD	MDE	Eat	PTSD	Psych	Prod A
Alcohol Dependence	0.30										
Cannabis Dependence	0.22	0.19									
Tobacco Dependence	0.22	0.19	0.38								
Conduct Disorder	0.43	0.37	0.40	0.32							
Generalized Anxiety Disorder	0.26	0.13	0.08	0.08	0.14						
Major Depressive Episode	0.34	0.26	0.17	0.19	0.24	0.46					
Eating Disorder	0.28	0.20	0.09	0.15	0.17	0.27	0.35				
Post-Traumatic Stress Disorder	0.19	0.12	0.08	0.17	0.15	0.24	0.34	0.22			
Psychosis Symptoms	0.13	0.04	0.11	0.09	0.11	0.17	0.17	0.14	0.16		
Prodromal Symptoms A	0.27	0.10	0.19	0.15	0.21	0.30	0.34	0.26	0.35	0.35	
Prodromal Symptoms B	0.27	0.17	0.22	0.12	0.25	0.30	0.34	0.21	0.27	0.29	0.50

Note. The shading indicates strength of association, with darker shading indicating stronger correlations. Higher correlations between some disorders (but not others) support the construction of latent factor scores representing the externalizing, internalizing, and thought disorder spectra, whereas the positive correlations between all symptom scales support the construction of a higher-order factor of general psychopathology (which we label "p"). ADHD = attention-deficit hyperactivity disorder; Alc = alcohol dependence; Cann = cannabis dependence; Tob = tobacco dependence; CD = conduct disorder; GAD = generalized anxiety disorder; MDE = major depressive episode; Eat = eating disorder; PTSD = post-traumatic stress disorder; Psych = psychosis symptoms; Prod A = prodromal symptoms (A).

Supplemental Table 3. Comparing models of the structure of psychopathology: Traditional fit statistics, standardized factor loadings and factor correlations (**Panel A**).

	Correlated-Factors			One-Factor	Higher-Order Factor				Bi-Factor (Orthogonal p-free)			
Model Fit Statistics												
Chi-Square	232.26			648.61	232.26				172.97			
Degrees of freedom	51			54	51				42			
Akaike Information Criteria	85787.17			86615.04	85787.17				85660.95			
Bayesian Information Criteria (BIC)	86006.87			86817.85	86006.87				85931.35			
Sample Adjusted BIC	85882.97			86703.47	85882.97				85778.85			
RMSEA (90% CI)	0.04 (0.04 – 0.05)			0.07 (0.07 – 0.08)	0.04 (0.04 – 0.05)				0.04 (0.03 – 0.05)			
Comparative Fit Index	0.92			0.75	0.92				0.94			
Tucker-Lewis Index	0.90			0.69	0.90				0.91			
SRMR	0.04			0.07	0.04				0.03			
Standardized Factor Loadings	Ext	Int	ThD	p	p	Ext	Int	ThD	p	Ext	Int	ThD
ADHD	0.60			0.55	0.60				0.50	0.32		
Alcohol Dependence	0.48			0.38	0.48				0.32	0.35		
Cannabis Dependence	0.51			0.38	0.51				0.25	0.47		
Tobacco Dependence	0.47			0.36	0.47				0.27	0.38		
Conduct Disorder	0.72			0.50	0.72				0.37	0.68		
Generalized Anxiety Disorder		0.58		0.50		0.58		0.50			*0.23*	
Major Depressive Episode		0.74		0.63		0.74		0.65			*0.58*	
Eating Disorder		0.48		0.45		0.48		0.47			*0.08*	
Post-Traumatic Stress Disorder		0.48		0.45		0.48		0.49			*0.04*	
Psychosis Symptoms			0.43	0.34			0.43	0.28				0.37
Prodromal Symptoms A			0.74	0.59			0.74	0.56				0.51
Prodromal Symptoms B			0.69	0.58			0.69	0.54				0.39
Externalizing					0.61							
Internalizing					0.88							
Thought Disorder					0.79							
Factor Determinacy	0.86	0.87	0.86	0.89	0.83	0.86	0.87	0.86	0.85	0.78	0.67	0.65
Factor Correlations												
Externalizing									0.00			
Internalizing	0.54								0.00	0.00		
Thought Disorder	0.48	0.69							0.00	0.00	0.00	

Supplemental Table 3, Continued. Comparing models of the structure of psychopathology: Traditional fit statistics, standardized factor loadings and factor correlations (**Panel B**).

	Bi-Factor (Oblique p-free)				Bi-Factor (–p-free Ext)			Bi-Factor (–p-free Int)			Bi-Factor (–p-free ThD)		
Model Fit Statistics													
Chi-Square	111.90				345.69			181.26			208.09		
Degrees of freedom	39				47			46			45		
Akaike Information Criteria	85574.16				85996.31			85688.61			85750.68		
Bayesian Information Criteria (BIC)	85861.46				86238.54			85936.48			86004.18		
Sample Adjusted BIC	85699.43				86101.93			85796.68			85861.21		
RMSEA (90% CI)	0.03 (0.02 – 0.04)				0.06 (0.05 – 0.06)			0.04 (0.03 – 0.04)			0.04 (0.04 – 0.05)		
Comparative Fit Index	0.97				0.87			0.94			0.93		
Tucker-Lewis Index	0.95				0.82			0.92			0.90		
SRMR	0.03				0.06			0.04			0.04		
Standardized Factor Loadings	p	Ext	Int	ThD	p	Int	ThD	p	Ext	ThD	p	Ext	Int
ADHD	0.69	*-0.08*			0.61			0.48	0.35		0.43	0.38	
Alcohol Dependence	0.50	*0.01*			0.47			0.31	0.36		0.24	0.40	
Cannabis Dependence	0.39	0.70			0.49			0.23	0.48		0.27	0.45	
Tobacco Dependence	0.38	0.32			0.45			0.25	0.39		0.23	0.40	
Conduct Disorder	0.64	*0.22*			0.66			0.34	0.69		0.34	0.69	
Generalized Anxiety Disorder	0.31		0.53		0.32	0.50		0.58			0.43		0.38
Major Depressive Episode	0.47		0.55		0.49	0.61		0.72			0.51		0.63
Eating Disorder	0.36		0.32		0.36	0.30		0.49			0.37		0.26
Post-Traumatic Stress Disorder	0.28		0.40		0.32	0.30		0.48			0.44		0.18
Psychosis Symptoms	0.16			0.42	0.21		0.40	0.26		0.38	0.42		
Prodromal Symptoms A	0.33			0.69	0.42		0.63	0.53		0.55	0.72		
Prodromal Symptoms B	0.37			0.55	0.44		0.49	0.50		0.43	0.67		
Factor Determinacy	0.85	0.76	0.75	0.79	0.87	0.74	0.75	0.87	0.79	0.69	0.87	0.80	0.73
Factor Correlations													
Externalizing	0.00							0.00			0.00		
Internalizing	0.00	*-0.10*			0.00			0.00			0.00	0.00	
Thought Disorder	0.00	*0.13*	0.58		0.00	0.00		0.00	0.00				

Note. RMSEA = root mean square error of approximation; CI = Confidence Interval; SRMR = standardized root mean square residual; ADHD = attention deficit hyperactivity disorder; Ext = Externalizing; Int = Internalizing; ThD = Thought Disorder. *Italics* = p > 0.05.

Supplemental Table 4. Ancillary factor-level fit statistics for the models of psychopathology.

	p-factor							p-free Factors																	
								Externalizing						Internalizing						Thought Disorders					
	OF	HO	OR	OB	-Ext	-Int	-ThD	CF	HO	OR	OB	-Int	-ThD	CF	HO	OR	OB	-Ext	-ThD	CF	HO	OR	OB	-Ext	-Int
ω / ω_S	.78	.85	.82	.81	.81	.83	.81	.69	.76	.70	.74	.76	.69	.66	.78	.68	.66	.66	.67	.66	.76	.66	.66	.66	.66
ω_H / ω_{HS}	--	.52	.64	.62	.68	.63	.63	--	.55	.44	.13	.54	.49	--	.44	.11	.41	.38	.27	--	.47	.30	.52	.44	.35
Relative ω	--	.62	.79	.76	.84	.76	.78	--	.73	.63	.17	.71	.70	--	.57	.16	.62	.57	.40	--	.62	.46	.79	.67	.53
H Index	.80	.76	.77	.76	.77	.79	.79	.72	.72	.61	.54	.93	.63	.70	.70	.37	.53	.53	.48	.70	.70	.41	.61	.54	.45
ECV	1.0	.37	.55	.48	.61	.53	.58	.38	.24	.24	.14	.33	.27	.33	.21	.09	.18	.20	.15	.29	.19	.12	.20	.20	.14

Note. OF = One-Factor; HO = Higher-Order; CF = Correlated-Factors; OR = Bi-Factor (Orthogonal p-free); OB = Bi-Factor (Oblique p-free); -Ext = Bi-Factor (-p-free Externalizing); -Int = Bi-Factor (-p-free Internalizing); -ThD = Bi-Factor (-p-free Thought Disorders). ω_H / ω_{HS} and Relative ω could not be calculated for the One-Factor Model because it had no p-free factors and the Correlated-Factors Model because it did not estimate p.

ECV = Explained Common Variance.

Supplemental Table 5. Correlations and factor congruencies between first-order dimensions of psychopathology, and 'p' and p-free factors from different models.

	Correlated-Factors			General Factor p-factor							p-free Factors Externalizing					p-free Factors Internalizing					p-free Factors Thought Disorders				
	Ext	Int	ThD	OF	HO	OR	OB	-Ext	-Int	-ThD	HO	OR	OB	-Int	-ThD	HO	OR	OB	-Ext	-ThD	HO	OR	OB	-Ext	-Int
Correlated-Factors																									
Ext	--			.58	.50	.49	.79	.77	.46	.44	1.0	.84	.62	.98	.99	.67	.10	.12	.08	.23	.61	.10	.19	.06	.14
Int	.67	--		.61	.66	.68	.48	.48	.73	.57	.67	.12	.02	.13	.20	1.0	.84	.99	.99	.96	.83	.20	.60	.40	.20
ThD	.62	.83	--	.54	.56	.53	.35	.41	.49	.69	.61	.11	.13	.15	.09	.83	.13	.66	.40	.17	1.0	.99	1.0	1.0	.99
General Factor 'p'																									
OF	.84	.94	.90	--	.99	.99	.95	.96	.98	.98	.58	.56	.33	.56	.57	.61	.50	.60	.60	.58	.54	.53	.53	.53	.53
HO	.75	.97	.92	.99	--	.99	.91	.99	.99	.98	--	.49	.31	.49	.50	--	.56	.66	.65	.64	--	.56	.56	.56	.56
OR	.74	.98	.88	.98	.99	--	.92	.93	1.00	.98	.49	--	.24	.47	.47	.68	--	.68	.67	.46	.53	--	.53	.52	.52
OB	.97	.73	.62	.87	.79	.80	--	.99	.90	.87	.79	.76	--	.76	.77	.48	.41	--	.47	.46	.35	.34	--	.34	.34
-Ext	.99	.77	.71	.92	.85	.84	.98	--	.91	.90	.77	.75	.46	.76	.76	.48	.40	.47	--	.46	.41	.40	.41	--	.40
-Int	.69	.99	.83	.95	.98	.99	.77	.79	--	.96	.46	.43	.22	--	.44	.73	.61	.73	.72	.70	.49	.48	.49	.49	--
-ThD	.66	.87	.99	.94	.95	.93	.69	.76	.88	--	.44	.42	.25	.42	--	.57	.45	.57	.56	--	.69	.68	.69	.69	.68
p-free Factors																									
Externalizing																									
OR	.80	.12	.11	.36	.23	.19	.68	.69	.14	.15	.80	--	.70	1.0	1.0	--	--	--	--	--	--	--	--	--	--
OB	.37	.02	.13	.17	.11	.03	.17	.32	-.01	.11	.37	.53	--	.70	.66	--	--	--	--	--	--	--	--	--	--
-Int	.81	.13	.15	.38	.25	.21	.69	.70	.14	.18	.81	1.0	.53	--	1.0	--	--	--	--	--	--	--	--	--	--
-ThD	.83	.20	.09	.40	.28	.25	.74	.72	.21	.14	.83	.98	.45	.97	--	--	--	--	--	--	--	--	--	--	--
Internalizing																									
OR	.10	.52	.13	.28	.37	.36	.17	.16	.48	.14	.10	-.16	-.13	-.20	-.05	.52	--	.83	.89	.95	--	--	--	--	--
OB	.12	.81	.66	.60	.72	.72	.20	.26	.78	.67	.12	-.44	-.22	-.44	-.37	.81	.56	--	.99	.95	--	--	--	--	--
-Ext	.08	.75	.40	.48	.59	.61	.19	.19	.72	.43	.08	-.41	-.28	-.44	-.29	.75	.80	.92	--	.99	--	--	--	--	--
-ThD	.23	.66	.17	.41	.49	.51	.32	.29	.63	.22	.23	-.10	-.18	-.15	.05	.66	.93	.65	.88	--	--	--	--	--	--
Thought Disorders																									
OR	.10	.20	.70	.34	.36	.30	.04	.17	.21	.62	.10	-.11	.16	-.06	-.24	.20	-.31	.26	-.10	-.44	.70	--	1.0	1.0	1.0
OB	.19	.60	.88	.61	.68	.63	.18	.31	.59	.83	.19	-.25	.09	-.22	-.32	.60	.06	.70	.39	.01	.88	.86	--	1.0	1.0
-Ext	.06	.40	.79	.45	.51	.46	.05	.17	.40	.73	.06	-.32	.00	-.27	-.41	.40	-.11	.55	.21	-.20	.79	.94	.96	--	1.0
-Int	.14	.20	.71	.36	.38	.31	.09	.21	.21	.64	.14	-.06	.18	-.01	-.20	.20	-.36	.23	-.15	-.48	.71	1.0	.84	.93	--

Note. Below diagonal = Correlations between extracted factor scores; above diagonal = factor congruencies. Factor congruency values > .95 = "considered equal"; values between 0.85-0.94 = "fair similarity" (Lorenzo-Seva & ten Berg, 2006). Ext = Externalizing; Int = Internalizing; ThD = Thought Disorders; OF = One-Factor; HO = Higher-Order; OR = Bi-Factor (Orthogonal p-free); OB = Bi-Factor (Oblique p-free); -Ext = Bi-Factor (-p-free Externalizing); -Int = Bi-Factor (-p-free Internalizing); -ThD = Bi-Factor (-p-free Thought Disorders).

Supplemental Table 6. Genetic and environmental influences on psychopathology.

	r_{MZ}	r_{DZ}	A^2 (95% CI)	C^2 (95% CI)	E^2 (95% CI)
Correlated-Factors					
Externalizing	0.58	0.35	0.47 (0.29 – 0.66)	0.11 (0.00 – 0.28)	0.42 (0.37 – 0.47)
Internalizing	0.51	0.23	0.51 (0.43 – 0.58)	0.00 (0.00 – 0.00)	0.50 (0.44 – 0.55)
Thought Disorders	0.38	0.17	0.38 (0.30 – 0.46)	0.00 (0.00 – 0.00)	0.63 (0.56 – 0.69)
General Factor ('p')					
One-Factor	0.53	0.27	0.51 (0.31 – 0.72)	0.01 (0.00 – 0.19)	0.48 (0.42 – 0.53)
Higher-Order	0.51	0.24	0.51 (0.43 – 0.58)	0.00 (0.00 – 0.00)	0.50 (0.44 – 0.55)
Bi-Factor (Orthogonal p-free)	0.51	0.23	0.51 (0.43 – 0.58)	0.00 (0.00 – 0.00)	0.50 (0.44 – 0.55)
Bi-Factor (Oblique p-free)	0.54	0.29	0.51 (0.31 – 0.71)	0.03 (0.00 – 0.21)	0.46 (0.41 – 0.51)
Bi-Factor (-p-free Externalizing)	0.57	0.33	0.49 (0.30 – 0.68)	0.08 (0.00 – 0.25)	0.43 (0.38 – 0.48)
Bi-Factor (-p-free Internalizing)	0.51	0.22	0.51 (0.43 – 0.58)	0.00 (0.00 – 0.00)	0.50 (0.44 – 0.55)
Bi-Factor (-p-free Thought Disorders)	0.42	0.19	0.42 (0.34 – 0.49)	0.00 (0.00 – 0.00)	0.59 (0.52 – 0.65)
p-free Factors					
Externalizing					
Bi-Factor (Orthogonal p-free)	0.57	0.35	0.45 (0.27 – 0.64)	0.12 (0.00 – 0.29)	0.43 (0.38 – 0.48)
Bi-Factor (Oblique p-free)	0.48	0.09	0.46 (0.38 – 0.54)	0.00 (0.00 – 0.00)	0.55 (0.49 – 0.61)
Bi-Factor (-p-free Internalizing)	0.57	0.35	0.44 (0.25 – 0.62)	0.13 (0.00 – 0.30)	0.43 (0.38 – 0.48)
Bi-Factor (-p-free Thought Disorders)	0.57	0.34	0.45 (0.27 – 0.64)	0.12 (0.00 – 0.28)	0.43 (0.38 – 0.48)
Internalizing					
Bi-Factor (Orthogonal p-free)	0.13	-0.01	0.11 (0.03 – 0.19)	0.00 (0.00 – 0.00)	0.89 (0.80 – 0.98)
Bi-Factor (Oblique p-free)	0.45	0.19	0.44 (0.37 – 0.52)	0.00 (0.00 – 0.00)	0.56 (0.50 – 0.62)
Bi-Factor (-p-free Externalizing)	0.40	0.13	0.38 (0.30 – 0.46)	0.00 (0.00 – 0.00)	0.62 (0.56 – 0.69)
Bi-Factor (-p-free Thought Disorders)	0.26	0.04	0.23 (0.15 – 0.31)	0.00 (0.00 – 0.00)	0.76 (0.69 – 0.85)
Thought Disorders					
Bi-Factor (Orthogonal p-free)	0.13	0.02	0.11 (0.03 – 0.19)	0.00 (0.00 – 0.00)	0.89 (0.80 – 0.98)
Bi-Factor (Oblique p-free)	0.30	0.11	0.29 (0.21 – 0.36)	0.00 (0.00 – 0.00)	0.72 (0.64 – 0.79)
Bi-Factor (-p-free Externalizing)	0.22	0.06	0.20 (0.12 – 0.28)	0.00 (0.00 – 0.00)	0.80 (0.72 – 0.89)
Bi-Factor (-p-free Internalizing)	0.12	0.02	0.11 (0.03 – 0.19)	0.00 (0.00 – 0.00)	0.89 (0.80 – 0.99)

Note. r_{MZ} = correlation between monozygotic twins; r_{DZ} = correlation between dizygotic twins; A^2 = additive genetic variation; C^2 = common (shared) environmental variation; E^2 = specific (non-shared) environmental variation + measurement error.

Supplemental Table 7. Relationships (standardized β with 95% Confidence Intervals) between first-order factors and 'p' extracted from various models and the nomological net (cf. Figure 1). Model 1 shows associations between each p-factor and the nomological network; Model 2 shows associations between each p-factor and the nomological network after adjusting for the contribution of the three first-order factors in the Correlated Factors Model. All models controlled for sex.

Relationship with:	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
Correlated-Factors							
Externalizing	.16 (.11, .22)	-.16 (-.21, -.11)	-.11 (-.16, -.06)	.34 (.29, .39)	.19 (.13, .25)	.46 (.41, .51)	.11 (.05, .18)
Internalizing	.19 (.13, .24)	-.12 (-.17, -.07)	-.07 (-.11, -.02)	.22 (.18, .27)	.17 (.11, .23)	.50 (.45, .56)	.09 (.03, .16)
Thought Disorders	.15 (.09, .21)	-.13 (-.18, -.08)	-.10 (-.15, -.06)	.22 (.17, .27)	.15 (.08, .21)	.43 (.36, .50)	.07 (.01, .14)
Model 1, p from:							
One Factor	.19 (.13, .24)	-.15 (-.20, -.11)	-.11 (-.16, -.11)	.30 (.25, .35)	.19 (.13, .25)	.52 (.46, .57)	.11 (.04, .18)
Higher-Order	.19 (.13, .24)	-.14 (-.19, -.09)	-.09 (-.14, -.09)	.26 (.21, .31)	.18 (.12, .24)	.51 (.46, .57)	.10 (.03, .17)
Bi-Factor (Orthogonal p-free)	.18 (.13, .24)	-.14 (-.19, -.09)	-.10 (-.14, -.10)	.27 (.22, .32)	.18 (.12, .24)	.52 (.46, .57)	.10 (.03, .17)
Bi-Factor (Oblique p-free)	.17 (.11, .22)	-.15 (-.20, -.10)	-.11 (-.16, -.11)	.36 (.31, .41)	.18 (.12, .23)	.46 (.41, .50)	.09 (.03, .16)
Bi-Factor (-p-free Externalizing)	.17 (.12, .23)	-.17 (-.22, -.12)	-.12 (-.17, -.12)	.35 (.30, .40)	.20 (.14, .25)	.49 (.44, .54)	.12 (.05, .19)
Bi-Factor (-p-free Internalizing)	.19 (.13, .24)	-.13 (-.18, -.08)	-.07 (-.12, -.08)	.24 (.20, .29)	.17 (.11, .23)	.50 (.45, .56)	.09 (.02, .16)
Bi-Factor (-p-free Thought Disorders)	.16 (.10, .22)	-.14 (-.19, -.09)	-.11 (-.16, -.11)	.25 (.20, .30)	.16 (.09, .22)	.46 (.40, .53)	.09 (.02, .15)
Model 2, p from:							
One Factor	-.002 (-.006, .001)	-.001 (-.004, .002)	-.004 (-.007, -.001)	.007 (.003, .011)	.000 (-.003, .004)	-.001 (-.005, .003)	.004 (.000, .008)
Higher-Order	.000 (.000, .000)	.000 (.000, .000)	.000 (.000, .000)	.000 (.000, .000)	.000 (.000, .000)	.000 (.000, .000)	.000 (.000, .000)
Bi-Factor (Orthogonal p-free)	-.005 (-.012, .002)	-.004 (-.011, .003)	-.012 (-.018, -.005)	.018 (.010, .025)	-.004 (-.011, .003)	.007 (-.001, .016)	.001 (-.006, .009)
Bi-Factor (Oblique p-free)	-.005 (-.016, .006)	.009 (-.002, .019)	-.009 (-.020, .001)	.031 (.019, .043)	-.013 (-.024, -.001)	-.019 (-.033, -.006)	-.019 (-.033, -.006)
Bi-Factor (-p-free Externalizing)	-.001 (-.005, .002)	-.004 (-.007, .000)	-.005 (-.008, -.002)	.008 (.005, .012)	-.001 (-.005, .002)	-.002 (-.006, .002)	.002 (-.002, .006)
Bi-Factor (-p-free Internalizing)	-.002 (-.007, .002)	.002 (-.003, .006)	-.005 (-.010, -.001)	.013 (.008, .018)	-.005 (-.010, .000)	-.006 (-.012, -.001)	-.004 (-.010, .000)
Bi-Factor (-p-free Thought Disorders)	-.003 (-.008, .001)	-.002 (-.006, .002)	-.007 (-.012, -.003)	.008 (.003, .013)	.000 (-.004, .004)	.007 (.002, .012)	.003 (-.001, .008)

Supplemental Table 8. Relationships (standardized β with 95% Confidence Intervals) between first-order factors and p-free factors extracted from various models and the nomological net (cf. Figure 2).

Factor:	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
Externalizing from:							
Correlated-Factors	.16 (.11, .22)	-.16 (-.21, -.11)	-.11 (-.16, -.06)	.34 (.29, .39)	.19 (.13, .25)	.46 (.41, .51)	.11 (.05, .18)
Correlated-Factors (adjusted)[a]	.04 (.00, .07)	-.07 (-.11, -.04)	-.06 (-.10, -.03)	.19 (.16, .23)	.07 (.03, .12)	.15 (.10, .19)	.05 (.01, .10)
Bi-Factor (Orthogonal p-free)	.08 (.03, .13)	-.11 (-.16, -.06)	-.08 (-.12, -.03)	.25 (.20, .30)	.12 (.07, .18)	.22 (.17, .28)	.08 (.02, .14)
Bi-Factor (Oblique p-free)	.03 (-.02, .09)	-.08 (-.13, -.04)	-.04 (-.09, -.00)	.05 (-.01, .10)	.08 (.02, .14)	.08 (.02, .14)	.10 (.04, .16)
Bi-Factor (-p-free Internalizing)	.08 (.02, .13)	-.12 (-.17, -.07)	-.09 (-.13, -.04)	.26 (.21, .31)	.13 (.07, .18)	.13 (.18, .28)	.08 (.02, .14)
Bi-Factor (-p-free Thought Disorders)	.09 (.04, .15)	-.11 (-.16, -.06)	-.07 (-.12, -.02)	.26 (.21, .31)	.13 (.07, .19)	.26 (.20, .31)	.08 (.02, .14)
Internalizing from:							
Correlated-Factors	.19 (.13, .24)	-.12 (-.17, -.07)	-.07 (-.11, -.02)	.22 (.18, .27)	.17 (.11, .23)	.50 (.45, .56)	.09 (.03, .16)
Correlated-Factors (adjusted)[b]	.04 (.02, .07)	.01 (-.02, .03)	.04 (.01, .06)	-.02 (-.05, .00)	.02 (.00, .05)	.12 (.09, .15)	.01 (-.02, .04)
Bi-Factor (Orthogonal p-free)	.12 (.07, .17)	.00 (-.04, .04)	.06 (.01, .10)	.00 (-.05, .05)	.06 (.01, .10)	.15 (.10, .20)	.01 (-.05, .06)
Bi-Factor (Oblique p-free)	.13 (.07, .18)	-.04 (-.09, .01)	.00 (-.04, .05)	.02 (-.03, .07)	.09 (.02, .15)	.33 (.27, .39)	.04 (-.02, .10)
Bi-Factor (-p-free Externalizing)	.12 (.07, .18)	-.01 (-.06, .03)	.04 (-.01, .09)	.00 (-.04, .05)	.07 (.02, .13)	.27 (.22, .32)	.02 (-.03, .08)
Bi-Factor (-p-free Thought Disorders)	.13 (.09, .18)	-.02 (-.07, .02)	.05 (.00, .09)	.05 (.00, .10)	.09 (.04, .13)	.25 (.20, .30)	.03 (-.02, .09)
Thought Disorders from:							
Correlated-Factors	.15 (.09, .21)	-.13 (-.18, -.08)	-.10 (-.15, -.06)	.22 (.17, .27)	.15 (.08, .21)	.43 (.36, .50)	.07 (.01, .14)
Correlated-Factors (adjusted)[c]	-.01 (-.04, .02)	-.02 (-.05, .00)	-.04 (-.07, -.02)	.02 (-.01, .05)	.00 (-.03, .03)	.00 (-.03, .04)	-.01 (-.04, .03)
Bi-Factor (Orthogonal p-free)	.02 (-.03, .08)	-.05 (-.10, -.01)	-.08 (-.12, -.03)	.05 (.00, .10)	.03 (-.03, .10)	.10 (.03, .18)	.01 (-.05, .07)
Bi-Factor (Oblique p-free)	.09 (.03, .15)	-.08 (-.13, -.03)	-.07 (-.11, -.02)	.06 (.01, .12)	.08 (.01, .15)	.27 (.20, .35)	.04 (-.02, .11)
Bi-Factor (-p-free Externalizing)	.05 (-.01, .10)	-.05 (-.10, .00)	-.07 (-.11, -.02)	.04 (-.01, .09)	.04 (-.03, .11)	.17 (.10, .24)	.01 (-.06, .07)
Bi-Factor (-p-free Internalizing)	.02 (-.03, .08)	-.07 (-.11, -.02)	-.09 (-.14, -.04)	.07 (.02, .12)	.04 (-.02, .10)	.12 (.05, .19)	.02 (-.05, .08)

Note. All models controlled for sex. [a] Adjusted for Internalizing and Thought Disorders; [b] Adjusted for Externalizing and Thought Disorders; [c] Adjusted for Externalizing and Internalizing.

Supplemental Table 9. Sensitivity analyses: Are the nomological-network results similar whether they are estimated using raw scores, extracted factor scores or structural equation modeling? Results shown are standardized β with 95% Confidence Intervals. Panel A presents results about the nomological network with p from various models. Panel B presents results about the nomological network and Externalizing Disorders from various models. Panel C presents results about the nomological network and Internalizing Disorders from various models. Panel D presents results about the nomological network and Thought Disorders from various models.

Panel A	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
p-from:							
Raw Score	.19 (.14, .25)	-.15 (-.20, -.10)	-.09 (-.14, -.04)	.30 (.25, .34)	.19 (.13, .25)	.52 (.47, .57)	.12 (.05, .19)
One-Factor							
Factor Score Regression	.19 (.13, .24)	-.15 (-.20, -.11)	-.11 (-.16, -.11)	.30 (.25, .35)	.19 (.13, .25)	.52 (.46, .57)	.11 (.04, .18)
Structural Equation Modeling	.21 (.15, .27)	-.18 (-.23, -.12)	-.12 (-.18, -.07)	.34 (.29, .40)	.22 (.15, .28)	.59 (.54, .64)	.13 (.05, .21)
Higher-Order							
Factor Score Regression	.19 (.13, .24)	-.14 (-.19, -.09)	-.09 (-.14, -.09)	.26 (.21, .31)	.18 (.12, .24)	.51 (.46, .57)	.10 (.03, .17)
Structural Equation Modeling	.23 (.16, .29)	-.17 (-.23, -.11)	-.11 (-.18, -.04)	.33 (.26, .40)	.22 (.15, .29)	.62 (.57, .68)	.12 (.04, .21)
Bi-Factor (Orthogonal p-free)							
Factor Score Regression	.18 (.13, .24)	-.14 (-.19, -.09)	-.10 (-.14, -.10)	.27 (.22, .32)	.18 (.12, .24)	.52 (.46, .57)	.10 (.03, .17)
Structural Equation Modeling	.18 (.08, .27)	-.19 (-.32, -.06)	-.23 (-.43, -.03)	.64 (.52, .76)	Did not converge	.58 (.32, .85)	-.39 (-.93, .15)
Bi-Factor (Oblique p-free)							
Factor Score Regression	.17 (.11, .22)	-.15 (-.20, -.10)	-.11 (-.16, -.11)	.36 (.31, .41)	.18 (.12, .23)	.46 (.41, .50)	.09 (.03, .16)
Structural Equation Modeling	.16 (.09, .23)	-.13 (-.29, .03)	Did not converge	.46 (.39, .52)	.17 (.04, .29)	Did not converge	-.24 (-.42, -.05)
Bi-Factor (-p-free Externalizing)							
Factor Score Regression	.17 (.12, .23)	-.17 (-.22, -.12)	-.12 (-.17, -.12)	.35 (.30, .40)	.20 (.14, .25)	.49 (.44, .54)	.12 (.05, .19)
Structural Equation Modeling	.17 (.11, .24)	-.19 (-.26, -.13)	-.14 (-.20, -.08)	.43 (.37, .49)	.22 (.15, .29)	.48 (.42, .54)	.14 (.05, .23)
Bi-Factor (-p-free Internalizing)							
Factor Score Regression	.19 (.13, .24)	-.13 (-.18, -.08)	-.07 (-.12, -.08)	.24 (.20, .29)	.17 (.11, .23)	.50 (.45, .56)	.09 (.02, .16)
Structural Equation Modeling	.21 (.15, .27)	-.12 (-.18, -.06)	-.06 (-.12, .00)	.23 (.17, .29)	.18 (.11, .25)	.56 (.50, .62)	.10 (.02, .19)
Bi-Factor (-p-free Thought Disorders)							
Factor Score Regression	.16 (.10, .22)	-.14 (-.19, -.09)	-.11 (-.16, -.11)	.25 (.20, .30)	.16 (.09, .22)	.46 (.40, .53)	.09 (.02, .15)
Structural Equation Modeling	.14 (.08, .21)	-.15 (-.21, -.09)	-.15 (-.21, -.10)	.25 (.18, .31)	.15 (.07, .23)	.43 (.36, .51)	.08 (-.02, .18)

| Panel B	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
Externalizing from:							
Raw Score	.14 (.09, .20)	-.16 (-.21, -.11)	-.12 (-.17, -.07)	.35 (.30, .40)	.18 (.12, .23)	.40 (.35, .45)	.12 (.06, .19)
Correlated Factors (CF)							
Factor Score Regression	.16 (.11, .22)	-.16 (-.21, -.11)	-.11 (-.16, -.06)	.34 (.29, .39)	.19 (.13, .25)	.46 (.41, .51)	.11 (.05, .18)
Structural Equation Modeling	.17 (.10, .23)	-.18 (-.24, -.12)	-.13 (-.19, -.07)	.40 (.34, .46)	.21 (.14, .28)	.47 (.42, .52)	.14 (.05, .22)
p-free models							
Adjusted Raw Score[a]	.07 (.02, .12)	-.11 (-.16, -.07)	-.09 (-.14, -.05)	.28 (.23, .32)	.11 (.06, .16)	.24 (.19, .30)	.09 (.03, .14)
Adjusted CF Factor Score Regression[a]	.04 (.00, .07)	-.07 (-.11, -.04)	-.06 (-.10, -.03)	.19 (.16, .23)	.07 (.03, .12)	.15 (.10, .19)	.05 (.01, .10)
Bi-Factor (Orthogonal p-free)							
Factor Score Regression	.08 (.03, .13)	-.11 (-.16, -.06)	-.08 (-.12, -.03)	.25 (.20, .30)	.12 (.07, .18)	.22 (.17, .28)	.08 (.02, .14)
Structural Equation Modeling	.06 (-.02, .14)	-.07 (-.18, .05)	.03 (-.13, .19)	-.07 (.26, .12)	Did not converge	.22 (-.01, .45)	.47 (.07, .87)
Bi-Factor (Oblique p-free)							
Factor Score Regression	.03 (-.02, .09)	-.08 (-.13, -.04)	-.04 (-.09, -.00)	.05 (-.01, .10)	.08 (.02, .14)	.08 (.02, .14)	.10 (.04, .16)
Structural Equation Modeling	.05 (-.07, .17)	-.16 (-.35, .03)	Did not converge	-.01 (-.38, .38)	.13 (-.07, .32)	Did not converge	.27 (.14, .40)
Bi-Factor (-p-free Internalizing)							
Factor Score Regression	.08 (.02, .13)	-.12 (-.17, -.07)	-.09 (-.13, -.04)	.26 (.21, .31)	.13 (.07, .18)	.13 (.18, .28)	.08 (.02, .14)
Structural Equation Modeling	.05 (-.02, .12)	-.12 (-.19, -.04)	-.09 (-.16, -.03)	.29 (.22, .36)	.11 (.04, .19)	.23 (.15, .32)	.07 (-.02, .16)
Bi-Factor (-p-free Thought Disorders)							
Factor Score Regression	.09 (.04, .15)	-.11 (-.16, -.06)	-.07 (-.12, -.02)	.26 (.21, .31)	.13 (.07, .19)	.26 (.20, .31)	.08 (.02, .14)
Structural Equation Modeling	.10 (.03, .17)	-.11 (-.18, -.03)	-.04 (-.10, .03)	.30 (.22, .38)	.15 (.06, .23)	.34 (.27, .41)	.10 (-.02, .23)

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Panel C	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
<u>Internalizing from:</u>							
Raw Score	.17 (.12, .23)	-.09 (-.14, -.04)	-.03 (-.08, .02)	.16 (.11, .21)	.15 (.09, .21)	.46 (.41, .51)	.08 (.02, .14)
Correlated Factors (CF)							
Factor Score Regression	.19 (.13, .24)	-.12 (-.17, -.07)	-.07 (-.11, -.02)	.22 (.18, .27)	.17 (.11, .23)	.50 (.45, .56)	.09 (.03, .16)
Structural Equation Modeling	.21 (.15, .27)	-.12 (-.17, -.06)	-.04 (-.10, .02)	.20 (.14, .26)	.19 (.12, .25)	.57 (.51, .63)	.10 (.02, .18)
p-free models							
Adjusted Raw Score[b]	.09 (.05, .13)	.00 (-.04, .05)	.05 (.01, .08)	-.01 (-.06, .03)	.05 (.01, .10)	.27 (.22, .32)	.02 (-.03, .07)
Adjusted CF Factor Score Regression[b]	.04 (.02, .07)	.01 (-.02, .03)	.04 (.01, .06)	-.02 (-.05, .00)	.02 (.00, .05)	.12 (.09, .15)	.01 (-.02, .04)
Bi-Factor (Orthogonal p-free)							
Factor Score Regression	.12 (.07, .17)	.00 (-.04, .04)	.06 (.01, .10)	.00 (-.05, .05)	.06 (.01, .10)	.15 (.10, .20)	.01 (-.05, .06)
Structural Equation Modeling	.06 (-.20, .33)	.19 (-.14, .52)	.39 (.07, .70)	-.96 (-1.23, -.69)	Did not converge	-.39 (-.61, -.18)	.70 (.25, 1.16)
Bi-Factor (Oblique p-free)							
Factor Score Regression	.13 (.07, .18)	-.04 (-.09, .01)	.00 (-.04, .05)	.02 (-.03, .07)	.09 (.02, .15)	.33 (.27, .39)	.04 (-.02, .10)
Structural Equation Modeling	.14 (.06, .21)	-.03 (-.17, .11)	Did not converge	-.16 (-.28, -.05)	.10 (-.03, .22)	Did not converge	.25 (.15, .35)
Bi-Factor (-p-free Externalizing)							
Factor Score Regression	.12 (.07, .18)	-.01 (-.06, .03)	.04 (-.01, .09)	.00 (-.04, .05)	.07 (.02, .13)	.27 (.22, .32)	.02 (-.03, .08)
Structural Equation Modeling	.13 (.05, .20)	.04 (-.04, .12)	.09 (.01, .16)	-.17 (-.28, -.06)	.04 (-.04, .13)	.38 (.28, .49)	.00 (-.09, .08)
Bi-Factor (-p-free Thought Disorders)							
Factor Score Regression	.13 (.09, .18)	-.02 (-.07, .02)	.05 (.00, .09)	.05 (.00, .10)	.09 (.04, .13)	.25 (.20, .30)	.03 (-.02, .09)
Structural Equation Modeling	.17 (.10, .24)	.02 (-.07, .11)	.14 (.05, .22)	.02 (-.08, .13)	.10 (.02, .18)	.41 (.26, .57)	.05 (-.07, .17)

| Panel D	Family History	Childhood SES	IQ (age 5)	Low Self-Control	Childhood Maltreatment	Adolescent Victimization	suPAR
Thought Disorders from:							
Raw Score	.12 (.06, .17)	-.11 (-.16, -.06)	-.10 (-.14, -.05)	.18 (.12, .23)	.12 (.05, .19)	.33 (.26, .41)	.06 (-.01, .12)
Correlated Factors (CF)							
Factor Score Regression	.15 (.09, .21)	-.13 (-.18, -.08)	-.10 (-.15, -.06)	.22 (.17, .27)	.15 (.08, .21)	.43 (.36, .50)	.07 (.01, .14)
Structural Equation Modeling	.14 (.08, .20)	-.14 (-.19, -.08)	-.13 (-.18, -.07)	.22 (.16, .27)	.14 (.06, .21)	.42 (.35, .48)	.07 (-.02, .15)
p-free models							
Adjusted Raw Score[c]	.02 (-.02, .06)	-.04 (-.08, .00)	-.07 (-.11, -.03)	.06 (.01, .11)	.03 (-.03, .08)	.10 (.04, .16)	.01 (-.04, .06)
Ajusted CF Factor Score Regression[c]	-.01 (-.04, .02)	-.02 (-.05, .00)	-.04 (-.07, -.02)	.02 (-.01, .05)	.00 (-.03, .03)	.00 (-.03, .04)	-.01 (-.04, .03)
Bi-Factor (Orthogonal p-free)							
Factor Score Regression	.02 (-.03, .08)	-.05 (-.10, -.01)	-.08 (-.12, -.03)	.05 (.00, .10)	.03 (-.03, .10)	.10 (.03, .18)	.01 (-.05, .07)
Structural Equation Modeling	.00 (-.10, .11)	.02 (-.15, .19)	.09 (-.19, .37)	-.47 (-.68, -.26)	Did not converge	-.04 (-.71, .62)	.49 (-.09, 1.07)
Bi-Factor (Oblique p-free)							
Factor Score Regression	.09 (.03, .15)	-.08 (-.13, -.03)	-.07 (-.11, -.02)	.06 (.01, .12)	.08 (.01, .15)	.27 (.20, .35)	.04 (-.02, .11)
Structural Equation Modeling	.08 (.01, .15)	-.09 (-.19, .02)	Did not converge	.01 (-.09, .11)	.07 (-.04, .18)	Did not converge	.13 (.03, .23)
Bi-Factor (-p-free Externalizing)							
Factor Score Regression	.05 (-.01, .10)	-.05 (-.10, .00)	-.07 (-.11, -.02)	.04 (-.01, .09)	.04 (-.03, .11)	.17 (.10, .24)	.01 (-.06, .07)
Structural Equation Modeling	.05 (-.03, .12)	-.03 (-.10, .05)	-.06 (-.12, .01)	-.07 (-.18, .03)	.01 (-.09, .11)	.23 (.13, .33)	-.01 (-.10, .08)
Bi-Factor (-p-free Internalizing)							
Factor Score Regression	.02 (-.03, .08)	-.07 (-.11, -.02)	-.09 (-.14, -.04)	.07 (.02, .12)	.04 (-.02, .10)	.12 (.05, .19)	.02 (-.05, .08)
Structural Equation Modeling	.02 (-.09, .06)	-.07 (-.14, .01)	-.12 (-.19, -.05)	.07 (-.01, .15)	.01 (-.08, .10)	-.01 (-.19, .17)	-.01 (-.15, .12)

Note. All models controlled for sex. [a]Adjusted for Internalizing and Thought Disorders; [b]Adjusted for Externalizing and Thought Disorders; [c]Adjusted for Externalizing and Internalizing. Cells highlighted in orange indicate that the point estimate of the factor score regression is not within the 95% Confidence Interval of the Structual Equation Modeling estimate. Three structural equation models did not converge; in the Bifactor-Oblique models the problem involved estimating the correlations between the p-free factors and in the Bifactor-Orthogonal model the problem involved the estimation of p-free internalizing on childhood maltreatment. The adjusted Correlated-Factors models could not be estimated within the structural equation modeling framework.

Supplemental Figure 1. Comparing different models of the structure of psychopathology. The figure shows structural models that have been used to examine the hierarchical structure of psychopathology. ADHD = attention deficit hyperactivity disorder; CD = conduct disorder; Alc = alcohol dependence; Can = cannabis dependence; Tob = tobacco dependence; MDE = major depressive disorder; GAD = generalized anxiety disorder; PTSD = posttraumatic stress disorder; Eat = eating disorder; PsyS = psychosis symptoms; PrdS A = prodromal psychosis symptoms, parcel A; PrdS B = prodromal psychosis symptoms, parcel B.
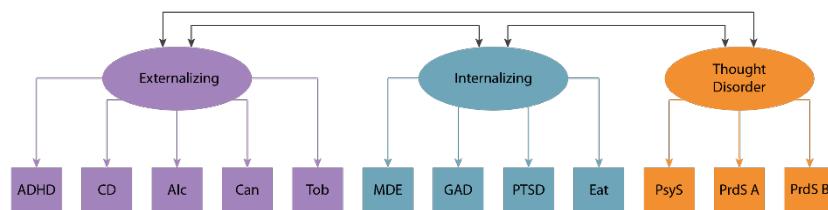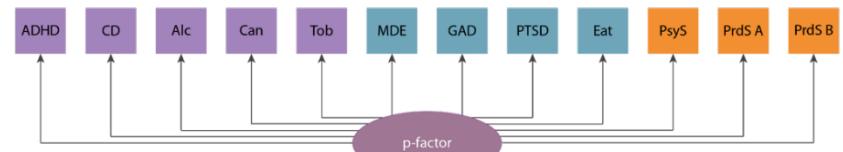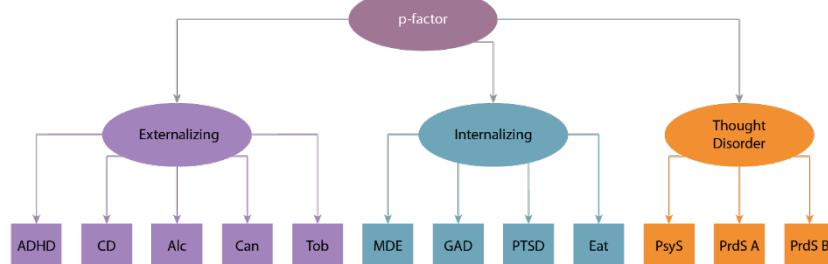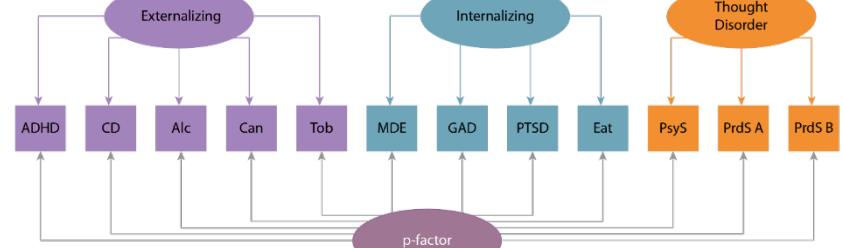
Supplemental Figure 1. Continued. Comparing different models of the structure of psychopathology.

E. Bi-Factor Model, Oblique p-free Factors
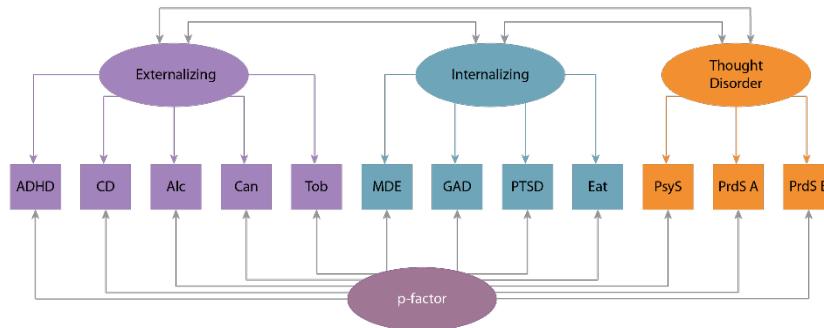
F. Bi-Factor Model, -p-free Externalizing
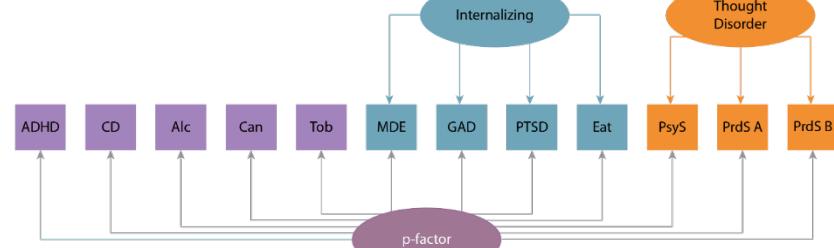
G. Bi-Factor Model, -p-free Internalizing
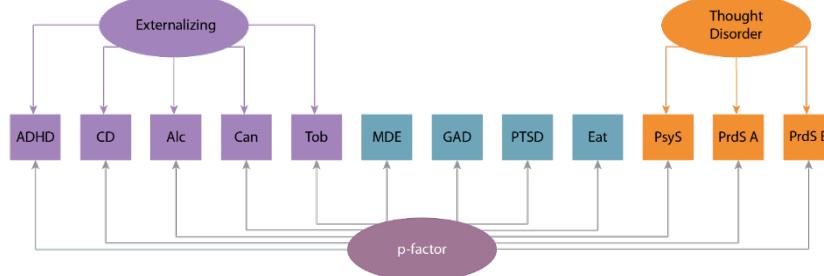
H. Bi-Factor Model, -p-free Thought Disorder
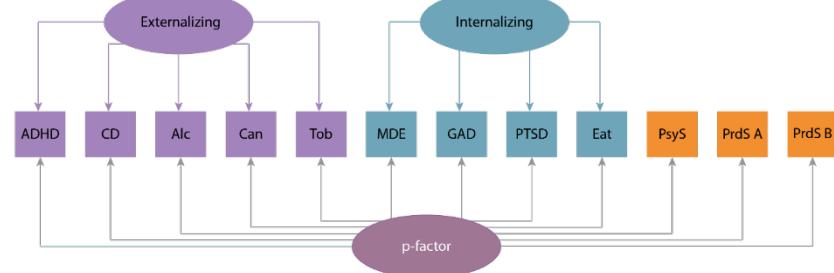
MPlus Syntax: Correlated-Factors Model

```
TITLE:   Correlated-Factors Model;
DATA:    FILE IS PCompare_Oct2020.dat;
VARIABLE:
     NAMES ARE
        familyid atwinid
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     MISSING
        ALL (999999);
     CLUSTER = familyid;
     USEVARIABLES ARE
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     IDVARIABLE IS
        atwinid;


ANALYSIS:
   TYPE         = COMPLEX;
   ESTIMATOR = MLR;
   MODEL        = NOCOVARIANCES;


MODEL:
   ext BY adhd18* alc18 mar18 smk18 cd18;
   int  BY gad18* mde18 eat18 PTSD18;
   thd BY psy18* prodA18 prodB18;

   [ext@0 int@0 thd@0];
    ext@1 int@1 thd@1;

   ext WITH int thd;
   int WITH thd;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
   FILE     = CorrelatedFactors.dat;
   SAVE    = FSCORES;
   MISSFLAG = 9999;
```

MPlus Syntax: One-Factor Model

```
TITLE:   One-Factor Model;
DATA:   FILE IS PCompare_Oct2020.dat;
VARIABLE:
     NAMES ARE
        familyid atwinid
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     MISSING
        ALL (999999);
     CLUSTER = familyid;
     USEVARIABLES ARE
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     IDVARIABLE IS
        atwinid;


ANALYSIS:
   TYPE        = COMPLEX;
   ESTIMATOR = MLR;
   MODEL       = NOCOVARIANCES;


MODEL:
   P BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
       prodA18 prodB18;

   [P@0];
    p@1;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
   FILE     = OneFactor.dat;
   SAVE    = FSCORES;
   MISSFLAG = 9999;
```

MPlus Syntax: Higher-Order Factor Model

```
TITLE:   Higher-Order Factor Model;
DATA:    FILE IS PCompare_Oct2020.dat;
VARIABLE:
    NAMES ARE
       familyid atwinid
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    MISSING
       ALL (999999);
    CLUSTER = familyid;
    USEVARIABLES ARE
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    IDVARIABLE IS
       atwinid;


ANALYSIS:
  TYPE        = COMPLEX;
  ESTIMATOR = MLR;
  MODEL       = NOCOVARIANCES;


MODEL:
  ext BY adhd18* alc18 mar18 smk18 cd18;
  int BY gad18*  mde18 eat18 PTSD18;
  thd BY psy18*  prodA18 prodB18;


  p   BY ext* int thd;


  [ext@0 int@0 thd@0 p@0];
   ext@1 int@1 thd@1 p@1;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
  FILE     = HigherOrder.dat;
  SAVE     = FSCORES;
  MISSFLAG = 9999;
```

MPlus Syntax: Bi-Factor (Orthogonal p-free)

```
TITLE:   Bi-Factor (Orthogonal p-free);
DATA:   FILE IS PCompare_Oct2020.dat;
VARIABLE:
     NAMES ARE
        familyid atwinid
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     MISSING
        ALL (999999);
     CLUSTER = familyid;
     USEVARIABLES ARE
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     IDVARIABLE IS
        atwinid;


ANALYSIS:
   TYPE        = COMPLEX;
   ESTIMATOR = MLR;
   MODEL       = NOCOVARIANCES;


MODEL:
   ext BY adhd18* alc18 mar18 smk18 cd18;
   int BY gad18*  mde18 eat18 PTSD18;
   thd BY psy18*  prodA18 prodB18;

   p   BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
        prodA18 prodB18;

   [ext@0 int@0 thd@0 p@0];
    ext@1 int@1 thd@1 p@1;

   ext WITH int@0 thd@0;
   int WITH thd@0;
   P   WITH ext@0 int@0 thd@0;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
   FILE     = BiFactorOrtho.dat;
   SAVE     = FSCORES;
   MISSFLAG = 9999;
```

MPlus Syntax: Bi-Factor (Oblique p-free)

```
TITLE:    Bi-Factor (Oblique p-free);
DATA:     FILE IS PCompare_Oct2020.dat;
VARIABLE:
     NAMES ARE
        familyid atwinid
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     MISSING
        ALL (999999);
     CLUSTER = familyid;
     USEVARIABLES ARE
        smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
        prodA18 prodB18;
     IDVARIABLE IS
        atwinid;


ANALYSIS:
   TYPE        = COMPLEX;
   ESTIMATOR = MLR;
   MODEL       = NOCOVARIANCES;


MODEL:
   ext BY adhd18* alc18 mar18 smk18 cd18;
   int BY gad18*  mde18 eat18 PTSD18;
   thd BY psy18*  prodA18 prodB18;

   p   BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
         prodA18 prodB18;

   [ext@0 int@0 thd@0 p@0];
    ext@1 int@1 thd@1 p@1;

   ext WITH int thd;
   int WITH thd;
   P   WITH ext@0 int@0 thd@0;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
   FILE      = BiFactorOblique.dat;
   SAVE    = FSCORES;
   MISSFLAG = 9999;
```

MPlus Syntax: Bi-Factor (-p-free Externalizing)

```
TITLE:    Bi-Factor (-p-free Externalizing);
DATA:   FILE IS PCompare_Oct2020.dat;
VARIABLE:
    NAMES ARE
       familyid atwinid
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    MISSING
       ALL (999999);
    CLUSTER = familyid;
    USEVARIABLES ARE
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    IDVARIABLE IS
       atwinid;


ANALYSIS:
  TYPE        = COMPLEX;
  ESTIMATOR = MLR;
  MODEL      = NOCOVARIANCES;


MODEL:
  int BY gad18*  mde18 eat18 PTSD18;
  thd BY psy18*  prodA18 prodB18;

  p   BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
      prodA18 prodB18;

  [int@0 thd@0 p@0];
   int@1 thd@1 p@1;

  int WITH thd@0;
  P   WITH int@0 thd@0;


OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY


SAVEDATA:
  FILE     = BiFactorS-Ext.dat;
  SAVE    = FSCORES;
  MISSFLAG = 9999;
```

MPlus Syntax: Bi-Factor (-p-free Internalizing)

TITLE: Bi-Factor (-p-free Internalizing);
DATA: FILE IS PCompare_Oct2020.dat;
VARIABLE:
    NAMES ARE
       familyid atwinid
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    MISSING
       ALL (999999);
    CLUSTER = familyid;
    USEVARIABLES ARE
       smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
       prodA18 prodB18;
    IDVARIABLE IS
       atwinid;

ANALYSIS:
  TYPE   = COMPLEX;
  ESTIMATOR = MLR;
  MODEL   = NOCOVARIANCES;

MODEL:
  ext BY adhd18* alc18 mar18 smk18 cd18;
  thd BY psy18* prodA18 prodB18;

  p   BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
       prodA18 prodB18;

  [ext@0 thd@0 p@0];
   ext@1 thd@1 p@1;

  ext WITH thd@0;
  P   WITH ext@0 thd@0;

OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY

SAVEDATA:
  FILE   = BiFactorS-Int.dat;
  SAVE   = FSCORES;
  MISSFLAG = 9999;

MPlus Syntax: Bi-Factor (-p-free Thought Disorders)

TITLE: Bi-Factor (-p-free Thought Disorders);
DATA: FILE IS PCompare_Oct2020.dat;
VARIABLE:
      NAMES ARE
         familyid atwinid
         smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
         prodA18 prodB18;
      MISSING
         ALL (999999);
      CLUSTER = familyid;
      USEVARIABLES ARE
         smk18 cd18 adhd18 psy18 alc18 mar18 gad18 mde18 eat18 PTSD18
         prodA18 prodB18;
      IDVARIABLE IS
         atwinid;

ANALYSIS:
   TYPE   = COMPLEX;
   ESTIMATOR = MLR;
   MODEL   = NOCOVARIANCES;

MODEL:
   ext BY adhd18* alc18 mar18 smk18 cd18;
   int BY gad18* mde18 eat18 PTSD18;

   p   BY adhd18* alc18 mar18 smk18 cd18 gad18 mde18 eat18 PTSD18 psy18
         prodA18 prodB18;

   [ext@0 int@0 p@0];
    ext@1 int@1 p@1;

   ext WITH int@0;
   P   WITH ext@0 int@0;

OUTPUT: SAMPSTAT STANDARDIZED FSDETERMINACY

SAVEDATA:
   FILE   = BiFactorS-ThD.dat;
   SAVE   = FSCORES;
   MISSFLAG = 9999;

Supplementary R code used to calculate ancillary factor-level fit statistics:

```
# Table 2, Bi-Factor (Orthogonal p-free)
# Symptom correlation matrix (Supplementary Table 2)
sig <- matrix(c(1.000, 0.302, 0.215, 0.224, 0.429, 0.257, 0.341, 0.275, 0.193, 0.127, 0.268, 0.272,
                0.302, 1.000, 0.192, 0.192, 0.370, 0.131, 0.257, 0.202, 0.118, 0.044, 0.104, 0.169,
                0.215, 0.192, 1.000, 0.376, 0.402, 0.081, 0.169, 0.088, 0.080, 0.114, 0.191, 0.222,
                0.224, 0.192, 0.376, 1.000, 0.320, 0.084, 0.194, 0.148, 0.174, 0.089, 0.145, 0.121,
                0.429, 0.370, 0.402, 0.320, 1.000, 0.137, 0.235, 0.169, 0.150, 0.109, 0.212, 0.251,
                0.257, 0.131, 0.081, 0.084, 0.137, 1.000, 0.460, 0.266, 0.240, 0.166, 0.296, 0.298,
                0.341, 0.257, 0.169, 0.194, 0.235, 0.460, 1.000, 0.350, 0.342, 0.168, 0.339, 0.335,
                0.275, 0.202, 0.088, 0.148, 0.169, 0.266, 0.350, 1.000, 0.218, 0.135, 0.262, 0.210,
                0.193, 0.118, 0.080, 0.174, 0.150, 0.240, 0.342, 0.218, 1.000, 0.156, 0.346, 0.272,
                0.127, 0.044, 0.114, 0.089, 0.109, 0.166, 0.168, 0.135, 0.156, 1.000, 0.346, 0.294,
                0.268, 0.104, 0.191, 0.145, 0.212, 0.296, 0.339, 0.262, 0.346, 0.346, 1.000, 0.500,
                0.272, 0.169, 0.222, 0.121, 0.251, 0.298, 0.335, 0.210, 0.272, 0.294, 0.500, 1.000),
              nrow = 12,
              ncol = 12,
              byrow = TRUE)


# Modelled factor correlations
phi <- matrix(c( 1, 0, 0, 0,
                 0, 1, 0, 0,
                 0, 0, 1, 0,
                 0, 0, 0, 1),
              nrow = 4,
              ncol = 4,
              byrow = TRUE)
# Standardized factor loadings
lam <- matrix(c(0.324, 0.000, 0.000, 0.502,
                0.348, 0.000, 0.000, 0.318,
                0.468, 0.000, 0.000, 0.249,
                0.381, 0.000, 0.000, 0.265,
                0.676, 0.000, 0.000, 0.367,
                0.000, 0.230, 0.000, 0.504,
                0.000, 0.584, 0.000, 0.647,
                0.000, 0.077, 0.000, 0.472,
                0.000, 0.039, 0.000, 0.489,
                0.000, 0.000, 0.369, 0.280,
                0.000, 0.000, 0.508, 0.564,
                0.000, 0.000, 0.390, 0.535),
              nrow = 12,
              ncol = 4,
              byrow = TRUE)
```

```
# Residual variances
bfresid <- matrix(c(0.643, 0.778, 0.719, 0.784, 0.408, 0.693, 0.241, 0.771, 0.760, 0.785, 0.424, 0.562),
                  nrow = 12,
                  ncol = 1,
                  byrow = TRUE)

# Extract sub-matrix with factor loadings for each specific factor
extlam_r  <- lam[1:5,]
intlam_r  <-  lam[6:9,]
thdlam_r  <- lam[10:12,]

# Extract sub-matrix with residual variances for specific factors
extres_r  <- bfresid[1:5,]
intres_r  <-  bfresid[6:9,]
thdres_r  <- bfresid[10:12]

# Extract column with factor loadings for p and specific factors
plam_c   <- lam[,4]
elam_c   <- lam[,1]
ilam_c   <-  lam[,2]
tlam_c   <- lam[,3]

# Omega
omega     <- sum(colSums(lam)*colSums(lam))/(sum(colSums(lam)*colSums(lam))+sum(bfresid))
omega_e <- sum(colSums(extlam_r)*colSums(extlam_r))/(sum(colSums(extlam_r)*colSums(extlam_r))+
           sum(extres_r))
omega_i <-  sum(colSums(intlam_r)*colSums(intlam_r))/(sum(colSums(intlam_r)*colSums(intlam_r))+
           sum(intres_r))
omega_t <- sum(colSums(thdlam_r)*colSums(thdlam_r))/(sum(colSums(thdlam_r)*colSums(thdlam_r))+
           sum(thdres_r))

# OmegaH
omegaH_p   <- sum(plam_c)*sum(plam_c)/(sum(colSums(lam)*colSums(lam))+sum(bfresid))
omegaHS_e <- sum(elam_c)*sum(elam_c)/(sum(colSums(extlam_r)*colSums(extlam_r))+sum(extres_r))
omegaHS_i  <- sum(ilam_c)*sum(ilam_c)/(sum(colSums(intlam_r)*colSums(intlam_r))+sum(intres_r))
omegaHS_t  <- sum(tlam_c)*sum(tlam_c)/(sum(colSums(thdlam_r)*colSums(thdlam_r))+sum(thdres_r))

# Percent reliable variance (relative omega)
PRV_p <- omegaH_p   / omega
PRV_e <- omegaHS_e / omega_e
PRV_i  <- omegaHS_i / omega_i
PRV_t  <- omegaHS_t / omega_t
```

```
# H Index
H  <- 1/(1+(1/colSums((lam*lam)/(1-lam*lam))))

# Explained Common Variance
ECV_p <- sum(plam_c*plam_c)/sum(lam*lam)
ECV_e <- sum(elam_c*elam_c)/sum(lam*lam)
ECV_i  <- sum(ilam_c*ilam_c)  /sum(lam*lam)
ECV_t  <- sum(tlam_c*tlam_c) /sum(lam*lam)
```