Brazilian Journal of Psychiatry
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Revista Brasileira de Psiquiatria
Brazilian Psychiatric Association
Fully open access
No APCs

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(article published as accepted)

Original Article

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http://doi.org/10.47626/1516-4446-2026-4818

Submitted: 17-Jan-2026

Accepted: 07-Apr-2026

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This is a preliminary, unedited version of a manuscript that has been accepted for publication in the Brazilian Journal of Psychiatry. As a service to our readers, we are providing this early version of the manuscript. The manuscript will still undergo copyediting, typesetting, and review of the resulting proof before it is published in final form. The final version may present slight differences in relation to the present version.

A developmentally based approach to multidimensionality: disentangling unity from diversity in youth psychopathology

Running title: Unity and diversity in youth psychopathology

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Abstract

Objective: Prior research on the latent structure of psychopathology has indicated the presence of a multidimensional symptom organization and a higher-order factor. This study aimed to evaluate the reliability and validity of a developmentally informed model to disentangle unity and diversity.

Methods: We included 2512 children aged 6-14 years-old. Confirmatory factor analysis examined the validity and reliability of a bifactor model with one general dimension and ten dimensions of psychopathology: *fear, somatic, distressful thoughts, low mood, low motivation/energy, inattention-hyperactivity, temper loss, aggression, noncompliance*, and *low concern for others*, based on questions from Child Behavioral Checklist and Strengths and Difficulties Questionnaire. We analyzed the reliability of this model and competing models using omega statistics. External validity was examined using sex, executive functioning, and psychiatric diagnoses.

Results: The bifactor model demonstrated good overall fit. Reliability analyses indicated that most reliable variance in total scores was attributable to the general factor, whereas the reliability of specific dimensions was largely contingent on this overarching factor. Specific factors exhibited differential validity in terms of sex, executive function, and psychiatric diagnosis.

Conclusions: Reliability indices primarily supported unity, whereas external validation favored diversity. These results encourage the extension of developmentally based models to disentangle unity from diversity.

Keywords: developmental psychopathology; child and adolescent psychiatry; dimensional models; multidimensionality; psychometrics

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Introduction

Across development, children and adolescents may exhibit a wide range of emotional and behavioral symptoms considered deviant or abnormal, which frequently co-occur and result in high rates of comorbidity. This pattern reflects two complementary properties of psychopathology: *diversity*, referring to multidimensional symptom profiles that form distinguishable syndromes, and *unity*, referring to shared variance across symptom clusters resulting in a common underlying structure.

Developmental psychopathology has provided substantial evidence supporting the validity of diversity, defined here as the degree to which diagnostic distinctions correlate with expected external validators.[1] For instance, within the externalizing spectrum, dimensions of oppositional defiant disorder (ODD), including irritable, headstrong, and hurtful, have been associated with distinct genetic influences[2] and distinct developmental outcomes.[3,4] Similarly, the presence of callous unemotional traits in conduct disorder (CD) has been associated with divergent neural processing mechanisms,[3] distinct longitudinal outcomes,[5] and different treatment response.[6] In contrast, distinctions among inattention, hyperactivity, and impulsivity within attention deficit hyperactivity disorder (ADHD) have shown limited predictive utility.[7]

There is also evidence for valid distinctions among internalizing disorders. Fear and distress have distinct genetic influences,[8] temperamental origins,[9] attentional biases,[10] and contrasting neural activation patterns.[11] Specificity also exists in dimensions of depression such as low mood and low motivation/energy as presented by anhedonia, including differences in treatment response[12] and in functional MRI features.[13] Additionally, somatic complaints may be best conceptualized as a distinct cluster with unique clinical implications, including medical help-seeking.[14]

Despite strong evidence for the differential validity of psychopathology dimensions, scores indexing these dimensions are typically highly intercorrelated. This pervasive co-occurrence has motivated the proposal of a general psychopathology factor capturing shared liability across psychiatric syndromes.[15] Derived from hierarchical factor analytic models, this factor provides a framework for modeling common variance among symptoms.

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Nevertheless, although characterizing specific dimensions remains essential, most prior studies, with few exceptions,[16–19] have not employed models capable of disentangling the contribution of the general psychopathology factor from that of specific dimensions. Moreover, to our knowledge, no study has tested the general psychopathology factor within a developmentally informed framework that incorporates empirically validated dimensions grounded in the developmental psychopathology literature.[20] Rather than being oppositional, *unity* and *diversity* may be complementary, as accounting for the general factor may clarify whether multidimensionality remains reliable and valid.

Following the work from Robins and Guze,[21] we evaluated validity using three classes of external validators. “Clinical description” was assessed through sex differences, given the higher prevalence of externalizing dimensions among boys and internalizing dimensions among girls.[22,23] “Laboratory studies” focused on executive function deficits, due to their association with poor use of adaptive emotion regulation strategies,[24] and their hypothesized role as a transdiagnostic intermediate phenotype underlying emotional and behavioral disorder.[25] Lastly, we rely on “delimitation from other disorders”, by using differences on dimensional scores among clinical groups of non-comorbid psychiatric disorders.

Using cross-sectional data from a large community sample of children aged 6–14 years, [26] we applied a bifactor model to separate *unity* from *diversity* across ten psychiatric dimensions and examined external correlates. Reliability was evaluated using bifactor model-based psychometric indices.

Methods

Sample and study design

Participants were part of the ‘High Risk Cohort Study for Psychiatric Disorders[26] a large school based community study which includes a total of 57 state maintained schools (22 in Porto Alegre and 35 in São Paulo- Brazil). First, a screening phase was performed with families at public schools located close to research centers in Porto Alegre and São Paulo in the school registry day. After the families’ screening phase (8012 families), we recruited two subgroups: one randomly selected (n=958) and one constituting a high-risk sample (*n*=1554). The total cross-sectional sample that was analyzed in this study is composed by

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a combination of children from those two subgroups (n=2512). The high-risk sample selection involved a risk-prioritization procedure conducted targeting identification of individuals with current symptoms and/or a family history of specific disorders. Detailed information about the selection procedure can be found in.[26]

Procedures

Assessments comprised: (a) a household interview with parents, conducted by a lay interviewer with the primary caregiver, including standardized measures of child psychopathology—the Child Behavior Checklist (CBCL), the Strengths and Difficulties Questionnaire (SDQ), and the Development and Well-Being Assessment (DAWBA);[27] and (b) child neurocognitive testing conducted by trained psychologists and speech therapists at school or at home, assessing working memory, inhibitory control, and temporal processing, as detailed in the following section.

Instruments

Children Behavior Checklist (CBCL) includes 112 parent-rated items assessing emotional and behavioral problems in the past 6 months scored on a three-point scale: 0 (not true), 1 (somewhat or sometimes true), and 2 (very true or often.).

Strength and Difficulties Questionnaire (SDQ)[28] (parent and teacher versions) includes 25 items evaluating emotional symptoms, conduct problems, hyperactivity, and peer problems that are scored on a three point scale: 0 (not true); 1 (somewhat true) and 2 (certainly true).

We developed a model focusing on dimensions of psychopathology with established external and predictive validity. Ten dimensions were specified a priori: fear, somatic complaints, distressful thoughts, low mood, low energy–motivation, temper loss, inattention–hyperactivity, noncompliance, aggression, and low concern for others. To ensure stable parameter estimation, dimensions were equally distributed across internalizing and externalizing domains, with the first five classified as internalizing and the remaining five as externalizing, following prior recommendations.[29] From an initial pool of 112 CBCL items and 25 SDQ items, items were selected to represent each theoretically defined dimension. Bifactor confirmatory factor analyses were then iteratively conducted

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to retain items with higher loadings on both the general and specific factors. Finally, each dimension was balanced to include four items, resulting in a balanced (internalizing–externalizing) p-factor.[16] The resulting model comprised 40 items (29 from CBCL and 11 from SDQ). See Table 1 and Supplementary Figure 1.

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Table 1 Standardized factor loadings of the non-orthogonal bifactor model for ten dimensions of psychopathology

Factor	Item description	Factor loadings		Factor	Item description	Factor loadings	
		G	S			G	S
FEAR	Clings to adults or too dependent	0.563	0.307	IN/HYP	Inattentive or easily distracted	0.631	0.520
	Fears certain animals, situations or places other than school	0.264	0.477		Can't concentrate, can't pay attention for long	0.601	0.629
	Too shy or timid	0.340	0.363		Restless, cannot sit still for long	0.335	0.684
	Many fears easily scared	0.283	0.677		Can't sit still, restless or, hyperactive	0.476	0.721
SOMA	Physical problems without known physical cause - Aches or pains	0.460	0.521	TEMP	Temper tantrums or hot temper	0.651	0.496
	Physical problems without known physical cause – nausea, feels sick	0.343	0.631		Sudden changes in mood or feelings	0.753	0.411
	Often complains of headaches, stomach-aches or sickness	0.432	0.626		Sulks a lot	0.748	0.400
	Feels dizzy or lightheaded	0.299	0.674		Often loses temper	0.311	0.852
DIST	Worries	0.719	0.275	AGGR	Physically attacks people	0.421	0.691
	Many worries or often seems worried	0.358	0.272		Gets in many fights	0.481	0.723
	Can't get his/her mind from certain thoughts/obsessions	0.412	0.591		Threatens people	0.488	0.589
	Fears he/she might think or do something bad	0.165	0.710		Often fights with other youth or bullies them	0.343	0.673
LMOO	Unhappy, sad, or depressed	0.744	0.33	NONC	Disobedient at home	0.591	0.637
	Often unhappy, depressed or tearful	0.677	0.445		Disobedient at school	0.484	0.701
	Feels worthless or inferior	0.491	0.578		Breaks rules at home, at school, or elsewhere	0.644	0.605
	Feels or complains that nobody loves him/her	0.302	0.781		Generally well behaved, do what adults request*	0.315	0.560
LOWM	There is very little he/she enjoys	0.690	0.369	LOWC	Doesn't seem to feel guilty after misbehaving	0.631	0.380
	Underactive, slow moving or lacks energy	0.474	0.525		Often offers to help others (parents, teachers, children)*	0.118	0.489
	Overtired without good reason	0.647	0.452		Considerate of other people's feelings*	0.295	0.714
	Would rather be alone, than with others	0.413	0.557		Helpful if someone is hurt, upset or feeling ill*	0.064	0.619

Legend: G= general; S= specific; SOMA= somatic complaints; DIST= distress; LMOO= low mood; LOWM= anhedonia/low energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; AGGR= aggression; LOWC= Low concern for others. * Reverse scored.

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Psychiatric diagnoses were established using DAWBA,[30] a structured interview based on DSM-IV criteria that assesses child mental health symptoms and associated impairment. DAWBA interviews were administered to biological parents and rated by a team of nine psychiatrists supervised by a senior child psychiatrist.[30] Based on DSM-IV diagnoses, we defined distinct non-overlapping diagnostic groups to be used as external validators. To create these groups, only participants meeting criteria for a single DSM-IV disorder were included, and cases with comorbid diagnoses were excluded from the diagnostic group comparisons. This approach was adopted to allow clearer comparisons between clinical phenotypes when evaluating the external validity of the dimensional scores of the following distinct groups: (1) *Typical developing controls* (TDC, n=1911) - absence of any psychiatric disorder; (2) *Phobic disorders* (n=112): separation anxiety (n=42), specific phobia (n=61), social phobia (n=18), agoraphobia (=3); (3) *Distress disorders* (n=94): generalized anxiety (n=30), depression (n=35), not-otherwise specified depression (n=5), obsessive compulsive (n=5), or post-traumatic stress disorder (n=9); and (4) *ADHD* (n=146) – combined (n=39), inattentive (n=61), hyperactive/impulsive (n=25), not-otherwise specified (n=21); and (5) *ODD/CD (n=60)* – ODD (n=44), CD (n=14) and not-otherwise specified (n=5).

Child Cognition

Child cognitive data was available for at least one measure for 2395 children. Descriptive statistics for each of the measures can be found in Supplementary Table 1).

Working memory

a) Digit span (sub-set of WISC-III):[31] evaluates verbal working memory by asking participants to repeat sequences of numbers to whom they were orally presented for either as heard or in reverse order with increasing level of difficulty. The dependent measure was the level at which the participant failed to correctly repeat the numbers on two consecutive trials.

b) Corsi blocks task:[32] evaluates the visuo-spatial working memory by asking participants to observe the researcher as he/she taps a sequence of up to nine identical spatially separated blocks and then mimic the pattern with increasing

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level of difficulty in sequential trials. The dependent measure was the level at which the participant failed to correctly repeat the sequence of blocks on two consecutive trials.

Inhibitory-control

c) Conflict control task:[33] evaluates the executive component of inhibitory control by initially asking participants to press the button indicating the direction of the green arrow appearing in the computer screen (i.e., congruent trials) in a total of 75 trials. The remaining 25 incongruent trials were presented with red arrows in which participants had to respond in the opposite direction (i.e., a conflict effect). Inter-trial interval was 1500 msec and the stimulus duration was 100 msec. Accuracy and speed was equally emphasized in task instructions. The dependent measure was the percentage of correct responses in the incongruent trials.

d) Go/No-Go:[34] evaluates the participants capacity to suppress a tendency to press the button indicating the direction of the green arrows (Go stimuli, n=75) when a double-headed green arrow (No-Go stimuli; n=25) appeared. The stimulus duration was 100 msec and inter-trial interval was 1500 msec. Accuracy and speed was equally emphasized in task instructions. The dependent measure was the percentage of failed inhibitions in the no-go trials (i.e., commission errors).

Time processing

e) Time Anticipation tasks (TA):[35] This game-like task examined the ability to modulate the time of a motor response to coincide with the onset of a visual stimulus. A brief narrative was created to help participants understand the task: they were told they were space explorers that had to refurnish an allied spaceship running out of oxygen in order to save the crew by anticipating when the target would reappear. In each task, the spaceship was visible for the first ten trials, and for the remaining 16 trials participants were asked to press a button to anticipate when it would arrive, because an invisible shield was activated. Participants had a 750 msec window of time to respond correctly and received feedback after every trial. In task one, the anticipation interval was 400 msec and in task two it was 2000 msec. The dependent measure for both the

400 msec and 2000 msec tasks was the mean percentage of total hits (i.e., button pressed in correct time).

Child Executive Function Model

We used a second-order model previously validated[36] developed to summarize child cognitive data that encompassed a higher-order executive function (EF) factor and three lower-order factors: working memory (WM), inhibitory control (IC), and temporal processing TP loading onto the superordinate EF factor. As previously found,[18] this model exhibited excellent fit (RMSEA=0.004, 90% CI <0.001-0.027, CFI>0.999, TLI=0.999) and it lower-order factors exhibited high loadings on the higher-order factor (λ ranging from 0.4 to 0.8).

Data Analysis

First, we examined the structure of psychopathology testing six models: a) One factor model; b) Correlated Model with internalizing and externalizing dimensions; c) Correlated Model with ten specific dimensions; d) Non-orthogonal Bifactor Model with one general factor and two dimensions; e) Orthogonal Bifactor Model with one general factor and ten dimensions; f) Non-orthogonal Bifactor Model with one general factor and ten factors allowed to correlate between each other. Models were compared using Chi-square fit statistics, comparative fit index (CFI), Tucker Lewis Index (TLI), and root mean square error of approximation (RMSEA). CFI and TLI above 0.95 and RMSEA below 0.06 indicate good model fit.

Second, we tested the reliability considering the following coefficients that may vary between 0 and 1, where higher scores indicate greater reliability: (a) Omega (ω); and (b) Omega subscale (ωs); both of them assess the systematic variance affecting unit-weighted composite scores attributable to multiple common factors; (c) Omega hierarchical (ω_H); assesses the degree to which composite scores are interpretable as measure of a single common factor that considers the error variance; (d) Omega hierarchical subscale (ωhs); measures the reliability of subscale scores after removing effects of the general factor. (e) Construct reliability (H); assesses how well the latent variable is being captured by its indicator; how well it is replicable across studies; and how feasible it is to specify a set of items as a measurement model in a SEM framework (standard

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criterion ≥0.70).[37] To assess the dimensionality of the model with the best fit to the data, we considered the following indices: (f) Expected common variance (ECV); assesses the degree of unidimensionality of the data, by calculating the general factor total contribution to the variance of the model, thus higher ECV values indicate a strong general factor but this index is moderated by the (g) Percent of uncontaminated correlations (PUC) which assesses the degree of parameter bias for forcing a multidimensional data (i.e. bifactor model data) into an unidimensional model. In addition, when PUC values are high, close to one, it indicates the presence of a strong general factor even when one obtains a low ECV value.

Lastly, we evaluated the validity of the dimensions by using executive function measures and sex as external validators in structural equation models. In addition, we performed a series of analyses of variance (ANOVA) using symptoms dimensions scores as the dependent measures and clinical non-overlapping groups as independent variables. Supplementary Figure 2 includes Pearson correlations between factor scores from the proposed model and executive function z-scores and SDQ scores rated by teachers. We also report associations between factor scores and number of psychiatric comorbidities (Supplementary Figure 3).

Analyses were performed in R software, version 3.2.3, with lavaan package; Mplus software package, version 7.4, using weighted least squares means and variance adjusted (WLSMV) estimation in both.

Results

Structure of psychopathology

The non-orthogonal bifactor model with a general psychopathology factor (g) and ten specific factors: *fear, somatic complaints, distressful thoughts, low mood, low energy-motivation, temper loss, inattention-hyperactivity, noncompliance, aggression and low concern for others* exhibited the best fit to the data when compared to other five models: CFI=0.992, TLI=0.990, RMSEA=0.030, 90% confidence interval (CI)= (0.028 - 0.031) (table 2). This model allowed specific factors to correlate with each other. On Figure 1 the latent correlations of the correlated 10-factor model (the models which did not account for the general factor) are displayed by the side of the non-orthogonal

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bifactor model correlations (the model accounting for the general factor). In the correlated model, latent correlations were all statistically significant with most correlations showing moderate positive values ranging from *0.350* to *0.898*. On the other hand, the non-orthogonal bifactor model was able to elucidate which correlations weren't statistically significant after partitioning the variance attributed to the general psychopathology factor; and also to show expected negative correlations between dimensions (*distressful thoughts* and *noncompliance*; *distressful thoughts* and *low concern for others*). Of note, despite *temper loss* traditional classification as an externalizing dimension, this factor showed moderate positive correlations with most dimensions considered internalizing.

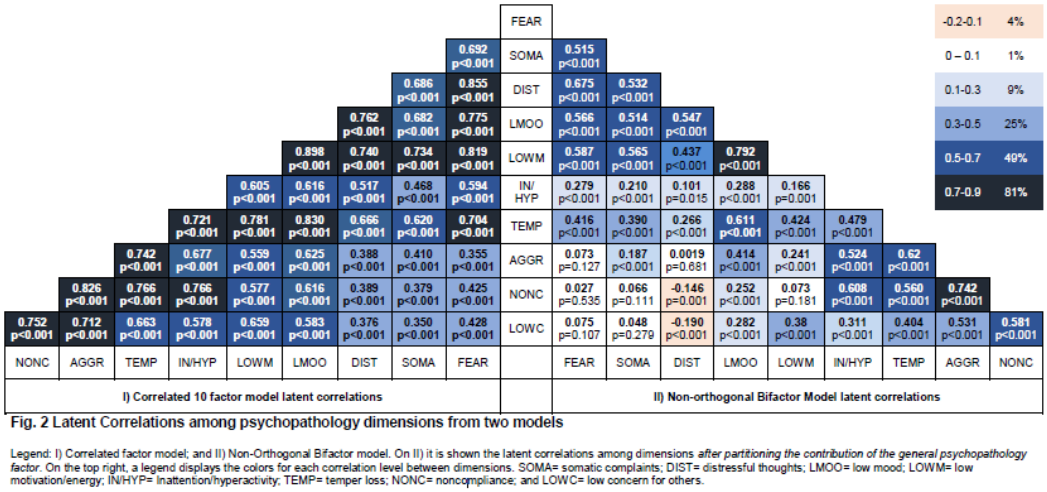


Fig. 2 Latent Correlations among psychopathology dimensions from two models

Legend: I) Correlated factor model; and II) Non-Orthogonal Bifactor model. On II) it is shown the latent correlations among dimensions *after partitioning the contribution of the general psychopathology factor*. On the top right, a legend displays the colors for each correlation level between dimensions. SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others.

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Table 2 Model fit indices for the six tested models of psychopathology

Fit indices	One factor model	Correlated Model (2 factors: int x ext)	Correlated Model (10 factors)	Non-Orthogonal Bifactor Model (1 general factor and 2 specific factors; int x ext)	Orthogonal Bifactor Model* (1 general factor and 10 specific factors)	Non-Orthogonal Bifactor Model (1 general factor and 10 specific factors)
χ^2	170810.972 (df =780; p<0.001)	170810.972 (df =780; p<0.001)	170810.972 (df =780; p<0.001)	170810.972 (df =780; p<0.001)	* Matrix psi non positive definite.	170810.792 (df =780; p<0.001)
CFI	0.943	0.962	0.983	0.981		0.992
TLI	0.940	0.960	0.981	0.979		0.990
RMSEA	0.072	0.059	0.041	0.043		0.030
90% CI RMSEA	0.071-0.073	0.058 - 0.060	0.040-0.042	0.042 - 0.044		0.028-0.031
WRMR	3.475	2.889	2.050	2.147		1.562

Legend: Int= internalizing; Ext= externalizing; χ 2 = Chi Square and; df= degrees of freedom; CFI= Comparative Fit Index; TLI= Tucker-Lewis Index; RMSEA= Root-Mean-Square Error of Approximation; CI= Confidence Interval; and WRMSR= Weighted Root Mean Square Residual.

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Reliability

As shown in table 3, the omega for the general factor was high *(ω=0.94)* as was the omega subscale values *(ω_s=0.94)* indicating a highly reliable multidimensional composite. The hierarchical omega for the general factor was *0.82*, meaning that *82%* of the variance of unit-weighted total scores can be attributed to the individual differences on the general factor. When comparing the ω_h *(0.82)* with ω *(0.94)*, one finds that most of the reliable variance in total scores *87% (0.82/0.94=0.87)* are due to individual differences in the general factor; that only *12% (0.94-0.82=0.12)* of the reliable variance of the total scores can be attributed to the multidimensionality caused by the group factors and that *6% (1-0.94)* of the variance is due to random error. In addition, with the small values of ω_{hs}, it is evidenced that after partitioning the reliable variance attributed to the general factor, ωs=0.94 withers drastically *(ω_{hs} ranging from 0.01 to 0.02)* suggesting that the suppositious reliability of ωs was due to individual differences on the general factor. Despite the ECV low value *0.43*, the moderation exerted by the PUC and its high value *0.92* indicates the presence of a strong general factor. In general, factors presented an adequate construct replicability with most *H* values being higher than *0.7*. As expected, the general

factor displayed the higher value *(H=0.94)* suggesting that this particular set of items better define the general factor in expenses of the specific ones.

Table 3 Reliability indices from the non-orthogonal bifactor model of psychopathology with ten dimensions

	Reliability indices				
Dimensions	Omega (ᴐ)	Omega Hierarchical (ᴐH)	Omega Subscale (ᴐs)	Omega hierarchical subscale (ᴐhs)	Construct Replicability (H)
General Psychopathology	0.94	0.82	-	-	0.94
Fear	-	-	0.94	0.01	0.58
Somatic Complaints	-	-	0.94	0.02	0.72
Distressful thoughts	-	-	0.94	0.01	0.63
Low Mood	-	-	0.94	0.01	0.71
Low motivation/energy	-	-	0.94	0.01	0.56
Inattention/hyperactivity	-	-	0.94	0.02	0.75
Temper Loss	-	-	0.94	0.01	0.77
Aggression	-	-	0.94	0.02	0.77
Noncompliance	-	-	0.94	0.02	0.73
Low Concern for others	-	-	0.94	0.01	0.68
Dimensionality indices					
Explained Common Variance (ECV)			Percentage of Uncontaminated Correlations (PUC)		
0.43			0.92		

External correlates

Clinical description: sex differences

We found a significant sex effect (Supplementary Figure 4) after separating general psychopathology from specific dimensions: boys presented higher scores on externalizing dimensions (*inattention-hyperactivity, noncompliance and aggression*); whereas girls presented higher scores on most internalizing dimensions (*fear*, *somatic complaints*, *distressful thoughts* and *low mood*). The general psychopathology factor*, low motivation/energy, temper loss* and *low concern for others* were not associated with sex.

Laboratory tests: executive function dimensions and psychopathology

Regressions of child psychopathology dimensions on executive function dimensions (Supplementary Figure 5) revealed negative associations between

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global executive function and general psychopathology *(β=-0.105, p=0.003)*; and between EF and *inattention- hyperactivity (β=-0.222, p<0.001)*; *aggression (β=-0.166, p<0.001)*, *noncompliance (β=-0.101, p=0.011) and fear (β=-0.148, p<0.001)*. On the other hand, better general executive function predicted more *somatic complaints (β=0.090, p=0.025)* and *distressful thoughts (β=0.144, p=0.001)*. Post-hoc univariate regressions revealed most of the findings in the EF domain were related to working memory and inhibitory control domains (Supplementary Table 3). Regression of dimensions from the 10-factor correlated model on global executive function was also performed (Supplementary Table 4).

Delimitation from clinical disorders: clinical associations

ANOVAs demonstrated an effect of group (Supplementary Figure 6) on all psychiatric symptoms' dimensions. As depicted in Supplementary Figure 6; TDC group presented the lowest standardized scores on psychiatric symptoms dimensions. The phobias group tended to show significantly less noncompliance and low concern for others than the TDC group. Phobias group also presented significantly lower scores on general psychopathology dimension when compared to distress group and to ODD/CD. Phobias and distress groups presented similar levels of *fear, somatic complaints* and *distressful thoughts* scores, however, the distress group had higher scores *on low motivation/energy* and *low mood*, and also displayed significantly higher scores on dimensions considered externalizing (*temper loss, aggression, low concern for others*) than the phobias group. As expected, ADHD group presented significantly less general psychopathology, temper loss, aggression and low concern for others than the ODD/CD group. When compared to the other groups, ODD/CD group showed significantly lower scores on *distressful thoughts* and *fear* dimensions.

Discussion

Our study examined the reliability and validity of a developmentally informed dimensional model designed to assess ten empirically derived symptom dimensions (*diversity*) while accounting for a general psychopathology (*unity*) factor using a bifactor framework. Overall, the model showed good fit, and the

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bifactor structure allowed a more informative examination of latent associations among psychopathology dimensions than a correlated factors model. Reliability analyses indicated that most reliable variance in total scores was attributable to the general factor, whereas the reliability of specific dimensions largely depended on this overarching factor. Despite this, specific dimensions demonstrated differential validity beyond the general factor through distinct associations with sex, executive functioning, and clinical indicators.

These findings are consistent with prior evidence supporting a general psychopathology factor in both adult[16,17] and youth samples.[18,19] Our earlier work using the same cohort,[18] based on diagnostic rather than symptom-level data, similarly highlighted the prominence of a general factor of psychopathology. The present study extends this literature by applying a developmentally based dimensional model that offers a useful framework for examining relations among latent dimensions of psychopathology. Within this framework, several theoretically meaningful associations emerged. Comorbidity between anxiety and psychopathy in children has been previously documented,[38] which parallels the positive correlation observed here between *distressful thoughts* and *low concern for others*. However, when accounting for the bifactor structure, a negative association between these dimensions emerged, supporting prior findings of inverse relations between trait anxiety and callous-unemotional traits. This suggests that previously reported positive associations may primarily reflect the influence of general psychopathology. The negative association is also theoretically coherent, given that *low concern for others*, paralleling the concept of CU traits,[5] has been linked to insensitivity to punishment,[5] whereas *distressful thoughts* are associated with heightened sensitivity to future punishment or omission of reward.[39] A second negative latent association emerged between *distressful thoughts* and *noncompliance*, mirroring prior evidence of coherence between conduct, understood as rule compliance, and normative moral emotions such as distress following transgressions.[40] Together, these findings reinforce the notion that understanding psychiatric comorbidity requires examining relations among specific dimensions while accounting for the contribution of the general psychopathology factor.[15] Notably, the *temper loss* dimension showed moderate associations with externalizing dimensions and significant correlations with

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internalizing dimensions, particularly *low mood*, *low motivation/energy*, and *fear*. This pattern is consistent with previous evidence of heterotypic comorbidity of irritability and its heterotypic continuity predicting internalizing disorders later in life.[41]

Regarding reliability, the present study extends prior work by applying recently proposed model-based psychometric indices.[42] Consistent with our previous findings using the same sample,[18] the general factor showed high omega values, indicating that the total score represents a highly reliable composite dominated by general psychopathology. Subscale scores also showed acceptable omega values. However, ω_H and ω_{hs} indicated that the reliability of specific factors was largely dependent on the general factor. ECV and PUC values further supported the general factor as the dominant source of systematic variance. The H-index was also higher for the general factor, suggesting that it may be more clearly defined and delimited across studies than specific dimensions. If the *p-factor* is conceptualized as a liability for deviation from normative development toward psychopathology, this liability appears to be the most reliable construct, whereas the phenomenological expression of this liability through specific dimensions may represent more elusive constructs.

Despite their lower reliability, specific dimensions showed meaningful associations with external validators, supporting their differential validity. In terms of sex differences, boys were more likely to exhibit *inattention-hyperactivity*, *aggression*, and *noncompliance*, whereas girls were more likely to present *fear*, *somatic complaints*, *distressful thoughts*, and *low mood*. This pattern of female liability toward internalizing dimensions and male liability toward externalizing dimensions is consistent with findings in both adult[16] and youth[19] samples and suggests that sex may influence how the general psychopathology factor manifests phenomenologically, with a tendency toward internalizing presentations in girls and externalizing presentations in boys[43] *Temper loss* did not show sex differences, consistent with its strong associations across both spectra. No sex effect was observed for the general factor, replicating previous findings.[16,19] Despite these results, we did not formally test measurement invariance across age, sex, site, or sampling subgroups. Although the primary aim of this study was to evaluate the reliability

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and external validity of a developmentally informed dimensional structure in the overall sample, the absence of formal invariance testing limits conclusions regarding the equivalence of factor loadings and latent scores across subgroups.

In line with prior evidence, worse working memory predicted higher *inattention-hyperactivity* scores in univariate analyses.[44] However, in multivariable models, only inhibitory control and global executive function remained statistically significant, indicating that the effect of working memory impairment was largely explained by broader executive dysfunction. The association with inhibitory control aligns with previous findings.[41] Additionally, negative associations between executive function and both *noncompliance* and *aggression* suggest that executive dysfunction is not specific to ADHD.[45] *Low concern for others* was not associated with executive function deficits, in line with studies reporting no association between executive functioning and callous-unemotional traits.[46]

Consistent with the reliability analyses, our findings highlight the dominant contribution of the general psychopathology factor in explaining shared variance across symptom domains. Although the model allowed the identification of specific dimensions with differential external associations, the reliability of these dimensions was substantially lower than that of the general factor. Thus, future research should examine whether alternative dimensional structures with fewer specific factors, such as internalizing–externalizing frameworks or intermediate-spectrum models, may provide a more parsimonious representation of psychopathology and contribute to the development of a more usable diversity construct.

The model also demonstrated good concurrent clinical validity, as general and specific dimension z-scores differentiated non-overlapping clinical groups. The distress group showed higher levels of *low mood* than the phobias group, paralleling findings of homotypic comorbidity between anxiety and depression[47] and evidence that continuity from childhood anxiety to adult depression is largely driven by generalized anxiety disorder.[48] Specific dimensions further distinguished ADHD from ODD or CD, with higher *low mood* observed in the latter group, consistent with evidence that ODD mediates the association between ADHD and depression.[42] To facilitate construct validation through clinical delimitation, diagnostic groups were defined as non-overlapping

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categories based on DAWBA assessments. Even though this approach allowed clearer differentiation between clinical phenotypes, this may result in the analysis of groups that are less severe or less representative of typical clinical populations, where comorbidity is common.

Some limitations should be acknowledged. The proposed model was not composed of all items from the CBCL or SDQ; instead, it was constructed by selecting items from established instruments to represent theoretically defined dimensions. These dimensions were theorized to parallel prior work on *fear*, *somatic complaints*, *distressful thoughts*, *low mood*, *low motivation/energy*, and *inattention-hyperactivity*[13] as well as developmental models of psychopathology.[49] Although item selection was guided by developmental theory and prior empirical literature, the absence of cross-validation in an independent sample raises the possibility of sample-specific parameter estimates. Replication in independent cohorts and convergent validation using other consolidated measures of psychopathology, as well as the development of instruments specifically designed to disentangle general and specific psychopathology dimensions, will be important to further establish the robustness and generalizability of the proposed model. Nevertheless, both general and specific factors showed acceptable reliability, and the model enabled the evaluation of dimensions across opposing spectra, which has not been feasible in previous studies that relied exclusively on validated instruments. Additionally, psychopathology dimensions and diagnostic validators were primarily derived from parent reports, which may introduce shared method variance and potentially inflate associations among symptom indicators and the general psychopathology factor. Furthermore, the sample included both a randomly selected subsample and a high-risk oversampled group, which may limit generalizability to the general school population. However, this sampling strategy increased variability in psychopathology, which is advantageous for examining latent dimensional structure. Finally, executive function was assessed using a limited set of neurocognitive tasks, which capture only selected aspects of executive functioning and may contribute to the modest magnitude of associations.

Notwithstanding, this study has notable strengths. It draws on a large community-based sample and adopts a dimensional approach grounded in a

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developmental framework, modelling ten specific factors alongside a general factor. In addition, the reliability of symptom dimensions was examined using bifactor psychometric indices, and dimension-specific neuropsychological deficits were investigated after accounting for variance attributable to general psychopathology.

The present findings should be interpreted within the context of a cross-sectional design. Although developmental psychopathology frameworks emphasize that the expression of mental disorders evolves over time, the present study was not designed to examine developmental trajectories. Rather, our analyses focused on the static latent dimensional structure of psychopathology within a heterogeneous developmental sample. Longitudinal data would be necessary to directly examine how the balance between general and specific psychopathology dimensions changes across development.

This study underscores the importance of multidimensional approaches in developmental psychopathology and provides a theoretical framework for testing differential validators of specific dimensions over and above the contribution of the general psychopathology factor. Future research should evaluate whether the *p-factor* reflects a liability driving transitions from normative development toward mental illness and should test, using mixture models, whether this liability underlies the transition from normative misbehavior to clinically significant psychopathology.

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Acknowledgments

GAS was supported and this study was financed in part by Financiamento e Incentivo à Pesquisa (Fipe/HCPA - 001) – Brazil, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Finance Code 001, and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq - 001), Brazilian federal government agencies. The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The views expressed are those of the authors and not necessarily those of FIPE/HCPA, CAPES, and CNPq. We thank FIPE/HCPA, CAPES, and CNPq for the financial support for this work.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Requests should be directed to gsalum@hcpa.edu.br

Conflict of interest

The authors declare none.

Funding: Financiamento e Incentivo à Pesquisa (Fipe/HCPA), (Grant / Award Number: '001'); Conselho Nacional de Desenvolvimento Científico e Tecnológico, (Grant / Award Number: '001'); Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, (Grant / Award Number: '001').

Author contributions

LSTM and GAS conceived, designed, had full access to all data in the study and takes responsibility for
the integrity of data and accuracy of data analysis. LSTM and GAS analyzed the data. LSTM, NPG, GVP, LAR, and GAS interpreted the data and contributed to the writing of the manuscript. All authors have reviewed and approved the final submitted version of this article. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Edited by: Laiana Quagliato

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References

1 Kendler KS, Parnas J. Philosophical Issues in Psychiatry Ii: Nosology. 2012:387–403.

2 Stringaris A, Zavos H, Leibenluft E, Maughan B, Eley TC. Adolescent irritability: phenotypic associations and genetic links with depressed mood. Am J Psychiatry. 2012;169:47–54.

3 Wakschlag LS, Henry DB, Tolan PH, Carter AS, Burns JL, Briggs-Gowan MJ. Putting theory to the test: modeling a multidimensional, developmentally-based approach to preschool disruptive behavior. J Am Acad Child Adolesc Psychiatry. 2012;51:593-604.e4.

4 Stringaris A, Goodman R. Longitudinal outcome of youth oppositionality: irritable, headstrong, and hurtful behaviors have distinctive predictions. J Am Acad Child Adolesc Psychiatry. 2009;48:404–12.

5 Frick PJ, White SF. Research review: the importance of callous-unemotional traits for developmental models of aggressive and antisocial behavior. J Child Psychol Psychiatry. 2008;49:359–75.

6 Hawes DJ, Dadds MR, Brennan J, Rhodes T, Cauchi A. Revisiting the treatment of conduct problems in children with callous-unemotional traits. Aust N Z J Psychiatry. 2013;47:646–53.

7 Wagner F, Martel MM, Cogo-Moreira H, Maia CRM, Pan PM, Rohde LA, et al. Attention-deficit/hyperactivity disorder dimensionality: the reliable “g” and the elusive “s” dimensions. Eur Child Adolesc Psychiatry. 2016;25:83–90.

8 Kendler KS, Prescott CA, Myers J, Neale MC. The structure of genetic and environmental risk factors for common psychiatric and substance use disorders in men and women. Arch Gen Psychiatry. 2003;60:929–37.

9 Rothbart MK, Ahadi SA, Evans DE. Temperament and personality: origins and outcomes. J Pers Soc Psychol. 2000;78:122–35.

10 Salum GA, Mogg K, Bradley BP, Gadelha A, Pan P, Tamanaha AC, et al. Threat bias in attention orienting: evidence of specificity in a large community-based study. Psychol Med. 2013;43:733–45.

11 Shanmugan S, Wolf DH, Calkins ME, Moore TM, Ruparel K, Hopson RD, et al. Common and Dissociable Mechanisms of Executive System Dysfunction Across Psychiatric Disorders in Youth. Am J Psychiatry. 2016;173:517–26.

BJP PRE-PROOF

12 McMakin DL, Olino TM, Porta G, Dietz LJ, Emslie G, Clarke G, et al. Anhedonia predicts poorer recovery among youth with selective serotonin reuptake inhibitor treatment–resistant depression. J Am Acad Child Adolesc Psychiatry. 2012;51:404–11.

13 Stringaris A, Vidal-Ribas Belil P, Artiges E, Lemaitre H, Gollier-Briant F, Wolke S, et al. The Brain's Response to Reward Anticipation and Depression in Adolescence: Dimensionality, Specificity, and Longitudinal Predictions in a Community-Based Sample. Am J Psychiatry. 2015;172:1215–23.

14 Kotov R, Ruggero CJ, Krueger RF, Watson D, Yuan Q, Zimmerman M. New Dimensions in the Quantitative Classification of Mental Illness. Arch Gen Psychiatry. 2011;68:1003.

15 Lahey BB, Applegate B, Hakes JK, Zald DH, Hariri AR, Rathouz PJ. Is there a general factor of prevalent psychopathology during adulthood? J Abnorm Psychol. 2012;121:971–7.

16 Caspi A, Houts RM, Belsky DW, Goldman-Mellor SJ, Harrington H, Israel S, et al. The p factor one general psychopathology factor in the structure of psychiatric disorders? Clin Psychol Sci. 2014;2:119–37.

17 Lahey BB, Applegate B, Hakes JK, Zald DH, Hariri AR, Rathouz PJ. Is there a general factor of prevalent psychopathology during adulthood? J Abnorm Psychol. 2012;121:971.

18 Martel, M, Pan, M.P, Hoffmann M.S., Gadelha, A., Rosario, M.C., Mari, J.J, et al. (in press) A general psychopathology factor (p-factor) in children: Structural model analysis and external validation through familial risk and child cognition. J Abnorm Psychol. 2016.

19 Patalay P, Fonagy P, Deighton J, Belsky J, Vostanis P, Wolpert M. A general psychopathology factor in early adolescence. Br J Psychiatry. 2015;207:15–22.

20 Wakschlag LS, Tolan PH, Leventhal BL. Research Review:'Ain't misbehavin': Towards a developmentally-specified nosology for preschool disruptive behavior. J Child Psychol Psychiatry. 2010;51:3–22.

21 Robins E, Guze SB. Establishment of diagnostic validity in psychiatric illness: its application to schizophrenia. Am J Psychiatry. 1970;126:983–7.

22 Patalay P, Fonagy P, Deighton J, Belsky J, Vostanis P, Wolpert M. A general psychopathology factor in early adolescence. Br J Psychiatry J Ment Sci. 2015;207:15–22.

BJP PRE-PROOF

23 Caspi A, Houts RM, Belsky DW, Goldman-Mellor SJ, Harrington H, Israel S, et al. The p Factor: One General Psychopathology Factor in the Structure of Psychiatric Disorders? Clin Psychol Sci J Assoc Psychol Sci. 2014;2:119–37.

24 McRae K, Jacobs SE, Ray RD, John OP, Gross JJ. Individual differences in reappraisal ability: Links to reappraisal frequency, well-being, and cognitive control. J Res Personal. 2012;46:2–7.

25 Nolen-Hoeksema S, Watkins ER. A heuristic for developing transdiagnostic models of psychopathology explaining multifinality and divergent trajectories. Perspect Psychol Sci. 2011;6:589–609.

26 Salum GA, Gadelha A, Pan PM, Moriyama TS, Graeff-Martins AS, Tamanaha AC, et al. High risk cohort study for psychiatric disorders in childhood: rationale, design, methods and preliminary results. Int J Methods Psychiatr Res. 2015;24:58–73.

27 Goodman A, Heiervang E, Collishaw S, Goodman R. The “DAWBA bands” as an ordered-categorical measure of child mental health: description and validation in British and Norwegian samples. Soc Psychiatry Psychiatr Epidemiol. 2011;46:521–32.

28 Goodman R. Psychometric properties of the strengths and difficulties questionnaire. J Am Acad Child Adolesc Psychiatry. 2001;40:1337–45.

29 Reise SP, Moore TM, Haviland MG. Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scale scores. J Pers Assess. 2010;92:544–59.

30 Goodman R, Ford T, Richards H, Gatward R, Meltzer H. The Development and Well-Being Assessment: description and initial validation of an integrated assessment of child and adolescent psychopathology. J Child Psychol Psychiatry. 2000;41:645–55.

31 Wechsler D. WISC-III: escala de inteligência de Wechsler para crianças III. 2002.

32 Vandierendonck A, Kemps E, Fastame MC, Szmalec A. Working memory components of the Corsi blocks task. Br J Psychol. 2004;95:57–79.

33 Hogan AM, Vargha-Khadem F, Kirkham FJ, Baldeweg T. Maturation of action monitoring from adolescence to adulthood: an ERP study. Dev Sci. 2005;8:525–34.

BJP PRE-PROOF

34 Bitsakou P, Psychogiou L, Thompson M, Sonuga-Barke EJS. Inhibitory deficits in attention-deficit/hyperactivity disorder are independent of basic processing efficiency and IQ. J Neural Transm. 2008;115:261–8.

35 Toplak ME, Tannock R. Tapping and anticipation performance in attention deficit hyperactivity disorder. Percept Mot Skills. 2005;100:659–75.

36 Martel MM, Pan PM, Hoffmann MS, Gadelha A, do Rosário MC, Mari JJ, et al. A general psychopathology factor (P factor) in children: Structural model analysis and external validation through familial risk and child global executive function. J Abnorm Psychol. 2017;126:137–48.

37 Hancock GR, Mueller RO. Rethinking construct reliability within latent variable systems. Struct Equ Model Present Future. 2001:195–216.

38 Russo MF, Beidel DC. Comorbidity of childhood anxiety and externalizing disorders: Prevalence, associated characteristics, and validation issues. Clin Psychol Rev. 1994;14:199–221.

39 Blair RJR. The neurobiology of psychopathic traits in youths. Nat Rev Neurosci. 2013;14:786–99.

40 Kochanska G, Aksan N. Children's conscience and self-regulation. J Pers. 2006;74:1587–618.

41 Brotman MA, Schmajuk M, Rich BA, Dickstein DP, Guyer AE, Costello EJ, et al. Prevalence, clinical correlates, and longitudinal course of severe mood dysregulation in children. Biol Psychiatry. 2006;60:991–7.

42 Maughan B, Collishaw S, Stringaris A. Depression in childhood and adolescence. J Can Acad Child Adolesc Psychiatry J Acad Can Psychiatr Enfant Adolesc. 2013;22:35–40.

43 Martel MM. Sexual selection and sex differences in the prevalence of childhood externalizing and adolescent internalizing disorders. Psychol Bull. 2013;139:1221.

44 Martinussen R, Hayden J, Hogg-Johnson S, Tannock R. A meta-analysis of working memory impairments in children with attention-deficit/hyperactivity disorder. J Am Acad Child Adolesc Psychiatry. 2005;44:377–84.

45 Morgan AB, Lilienfeld SO. A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. Clin Psychol Rev. 2000;20:113–36.

BJP PRE-PROOF

46 Feilhauer J, Cima M, Korebrits A, Kunert H-J. Differential associations between psychopathy dimensions, types of aggression, and response inhibition. Aggress Behav. 2012;38:77–88.

47 Copeland WE, Angold A, Shanahan L, Costello EJ. Longitudinal patterns of anxiety from childhood to adulthood: The Great Smoky Mountains Study. J Am Acad Child Adolesc Psychiatry. 2014;53:21–33.

48 Copeland WE, Shanahan L, Costello J, Angold A. Childhood and adolescent psychiatric disorders as predictors of young adult disorders. Arch Gen Psychiatry. 2009.

49 Wakschlag LS, Leventhal BL, Briggs-Gowan MJ, Danis B, Keenan K, Hill C, et al. Defining the “disruptive” in preschool behavior: What diagnostic observation can teach us. Clin Child Fam Psychol Rev. 2005;8:183–201.

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Supplementary Material

Supplementary Figure 1- Schematic Structure of the non-orthogonal bifactor model with one general factor and 10 specific factors (pg. 2)

Supplementary Table 1- Descriptive statistics on executive function tasks (crude scores) (pg. 3)

Supplementary Figure 2- Pearson's correlation between z-scores of executive function tasks and psychiatric symptoms dimensions for A) the correlated 10 factor model; and B) the non-orthogonal bifactor model (pg. 4)

Supplementary Figure 3- Association between number of psychiatric disorders (comorbidity) and z-score of the general psychopathology factor and specific factors (pg. 5)

Supplementary Figure 4- Sex differences on psychiatric symptoms dimensions (pg. 6)

Supplementary Figure 5- Regression Coefficients (β) of psychopathological dimensions on global executive function (pg. 7)

Supplementary Table 2– Pearson's correlation matrix between developmental psychopathology dimensions and raw scores of the SDQ rated by the teacher (n= 1189) (pg. 8)

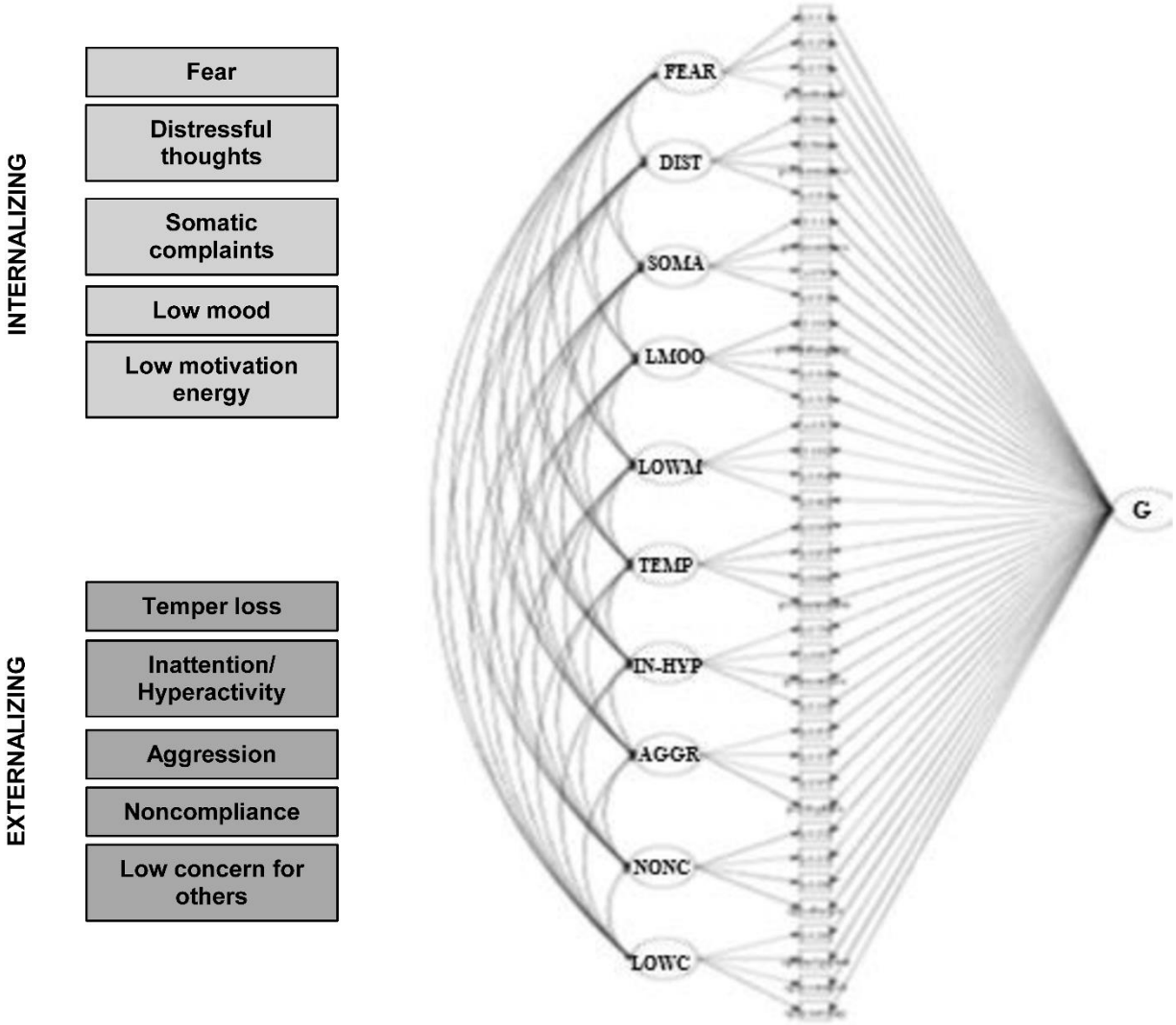
Supplementary Table 3- Univariate Regression Coefficients (β) of psychopathological dimensions from the non- orthogonal bifactor model on executive function dimensions (pg. 9)

Supplementary Table 4 - Regression Coefficients (β) of psychopathological dimensions on global executive function for the correlated 10 factor model (pg. 10)

Supplementary Figure 6- Comparison of between group differences on the standardized scores of psychopathological dimensions (pg. 11)

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Supplementary Figure 1- Schematic Structure of the non-orthogonal bifactor model with one general factor and 10 specific factors



Legend: SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others.

Supplementary Table 1. Descriptive statistics on executive function tasks (crude scores)

	Mean	SD	p25	p75	Minimum	Maximum	Valid N
Digit span (backward)	3.54	1.57	3.00	4.00	0	12.00	2243
Corsi block (backward)	4.80	2.10	3.00	6.00	0	14.00	2213
CCT % Correct Inhibitions (inc)	.59	.22	.42	.76	0	1	2166
Go/No-Go: Comission	.25	.22	0.08	.38	0	1	2158
Time Anticipation (0.4s): hits	.66	.22	.50	.86	0	1	2185
Time Anticipation (2s): hits	.33	.25	.143	.500	0	1	2180

Abbreviations: SD = standard deviations; p25 = percentile 25; p75 = percentile 75.

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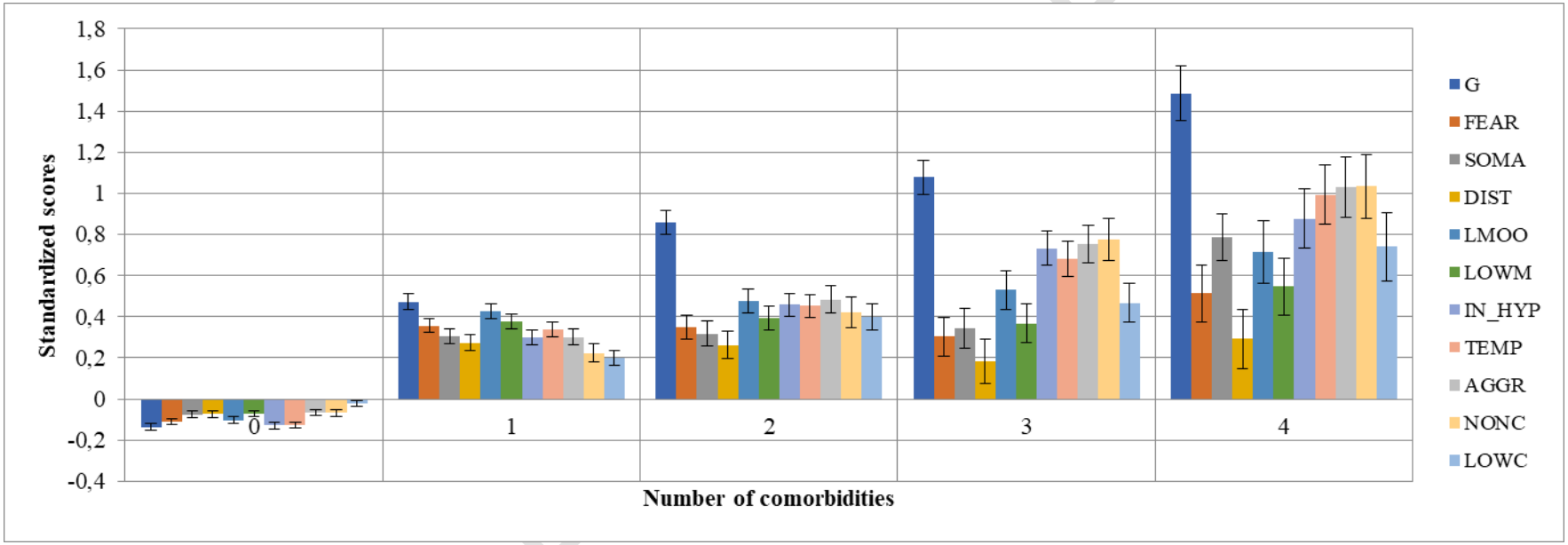
Supplementary Figure 2: Pearson's correlation between z scores of executive function tasks and psychiatric symptoms dimensions for A) the correlated 10-factor model; and B) the non-orthogonal bifactor model

Observed Z scores on executive function tasks							Observed Z scores on executive function tasks					
GNG	CCT	TA 2s (hits)	TA 0,4s (hits)	Corsi Blocks	Digit Span	Dimensions	Digit Span	Corsi Blocks	TA 0,4s (hits)	TA 2s (hits)	CCT	GCG
-0,03 p= 0,15	-0,03 p= 0,16	-0,067 p= 0,002	-0,04 p= 0,1	-,085 p<0.01	-,053 p= 0,012	FEAR	-0,042 p=0,051	-0,013 p=0,5	-,069 p=0,0012	-0,03 p=0,14	-0,04 p=0,07	-0,01 p=0,6
-0,02 p= 0,43	-0,02 p= 0,2	-0,03 p= 0,126	0,004 p= 0,8	-0,043 p= 0,04	-0,02 p=0,29	SOMA	0,02 p=0,31	-0,005 p=0,8	0,03 p=0,12	0,01 p=0,6	-0,01 p=0,6	0,01 p=0,6
-0,02 p= 0,37	-0,01 p= 0,58	-0,03 p= 0,13	-0,01 p= 0,7	-,055 p=0.01	-0,03 p= 0,15	DIST	0,04 p=0,053	0,01 p=0,6	0,03 p=0,15	0,03 p=0,1	0,03 p=0,2	0,028 p=0,19
-0,04 p= 0,06	-0,03 p= 0,15	-0,055 p= 0,01	-0,02 p= 0,28	-0,058 p= 0,006	-,044 p=0,039	LMOO	0,002 p=0,9	-0,02 p=0,4	0,001 p=0,9	-0,009 p=0,6	-0,016 p=0,5	-0,01 p=0,6
-0,03 p= 0,17	-0,02 p= 0,25	-0,054 p= 0,012	-0,02 p= 0,32	-0,065 p= 0,002	-0,043 p= 0,040	LOWM	0,023 p=0,27	-0,01 p=0,6	0,02 p=0,5	0,006 p=0,8	0,013 p=0,5	0,015 p=0,5
-,095 p<0.01	-,101 p<0.01	-,123 p<0.01	-,084 p<0.01	-,125 p<0.01	-,122 p<0.01	IN_HYP	-,121 p<0.001	-,123 p<0.001	-,099 p<0.001	-,122 p<0.001	-,125 p<0.001	-,105 p<0.001
-,055 p= 0,01	-0,06 p= 0,005	-,071 p<0.01	-0,04 p= 0,08	-,085 p<0.01	-,080 p<0.01	TEMP	-,066 p=0,002	-,073 p<0.001	-0,03 p=0,15	-,045 p=0,035	-,076 p<0.001	-,043 p=0,04
-,072 p<0.01	-,081 p<0.01	-,091 p<0.01	-,063 p= 0,003	-,092 p<0.01	-,103 p<0.01	AGGR	-,099 p<0.001	-,081 p<0.001	-,069 p=0,001	-,078 p=0,001	-,092 p<0.001	-,062 p=0,004
-,073 p<0.01	-,076 p<0.01	-,085 p<0.01	-,054 p= 0,01	-,100 p<0.01	-,105 p<0.01	NONC	-,101 p<0.001	-,087 p<0.001	-,058 p=0,007	-,070 p=0,001	-,090 p<0.001	-,070 p=0,001
-,052 p= 0,016	-0,046 p= 0,03	-,067 p<0.01	-0,04 p= 0,05	-,075 p<0.01	-,067 p<0.01	LOWC	-0,04 p=0,07	-0,04 p=0,07	-0,02 p=0,3	-0,026 p=0,2	-0,033 p=0,17	-0,03 p=0,15
						G	-,063 p=0,003	-,068 p=0,001	-0,03 p=0,17	-,066 p=0,002	-0,03 p=0,17	-0,04 p=0,05
A) Correlated 10 factor model							**B) Non orthogonal bifactor model**					

Abbreviations: GNG= Go/ No Go (comission errors); CCT= Conflict Control (inhibitions); TA 2s = Time Anticipation 2s (hits); TA 0,4s= Time Anticipation 0,4s (hits); Corsi Blocks= corsi blocks backwards; Digit Span= Digit Span Backwards; SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others.

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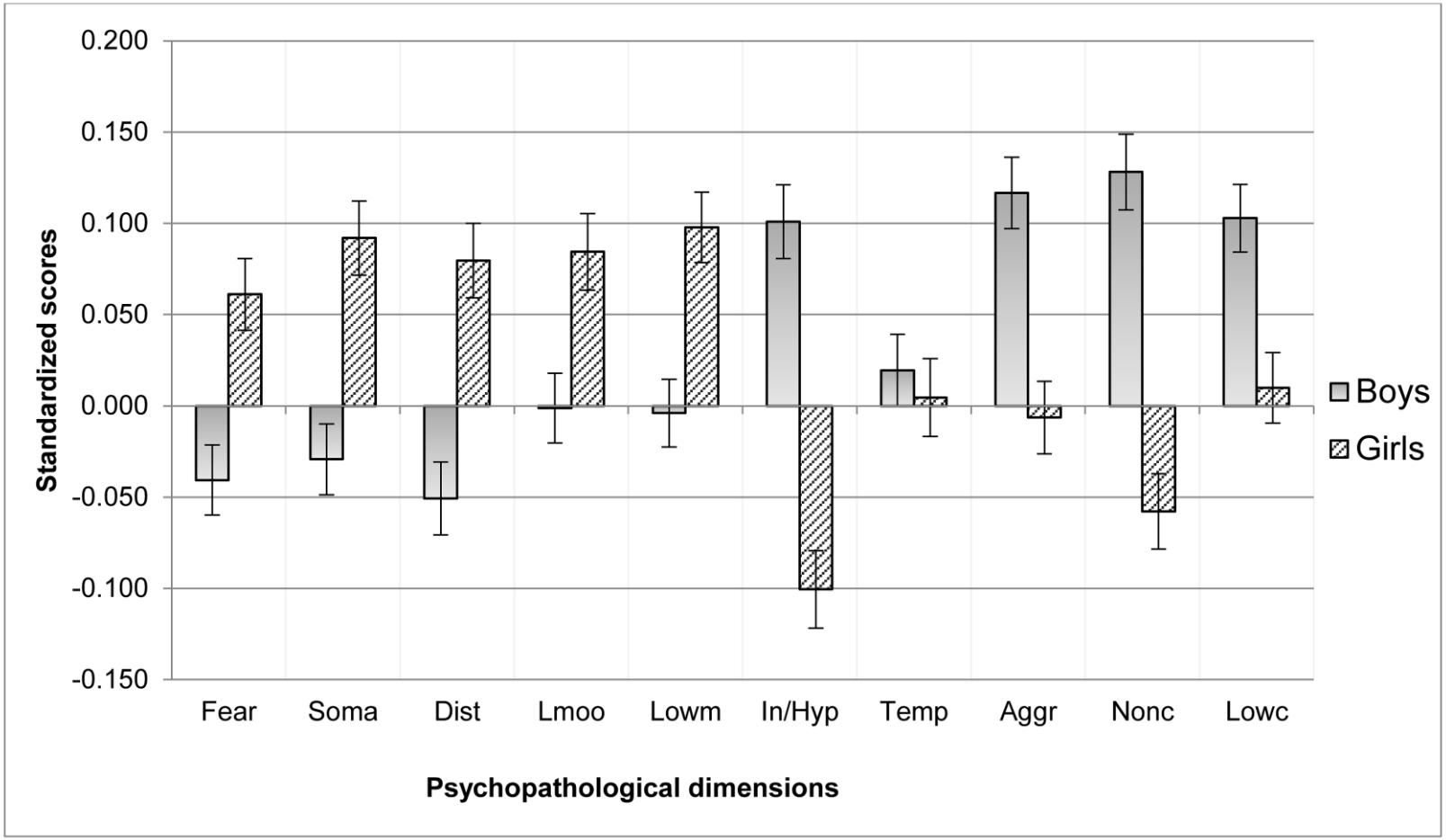
Supplementary Figure 3: Association between number of psychiatric disorders (Comorbidity) and z score of the general psychopathology factor and specific factors



Abbreviations: SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others; TDC, Typically Developing Children; ADHD, Attention Deficit/Hyperactivity Disorder; ODD/CD, Oppositional Defiant Disorder/Conduct Disorder.

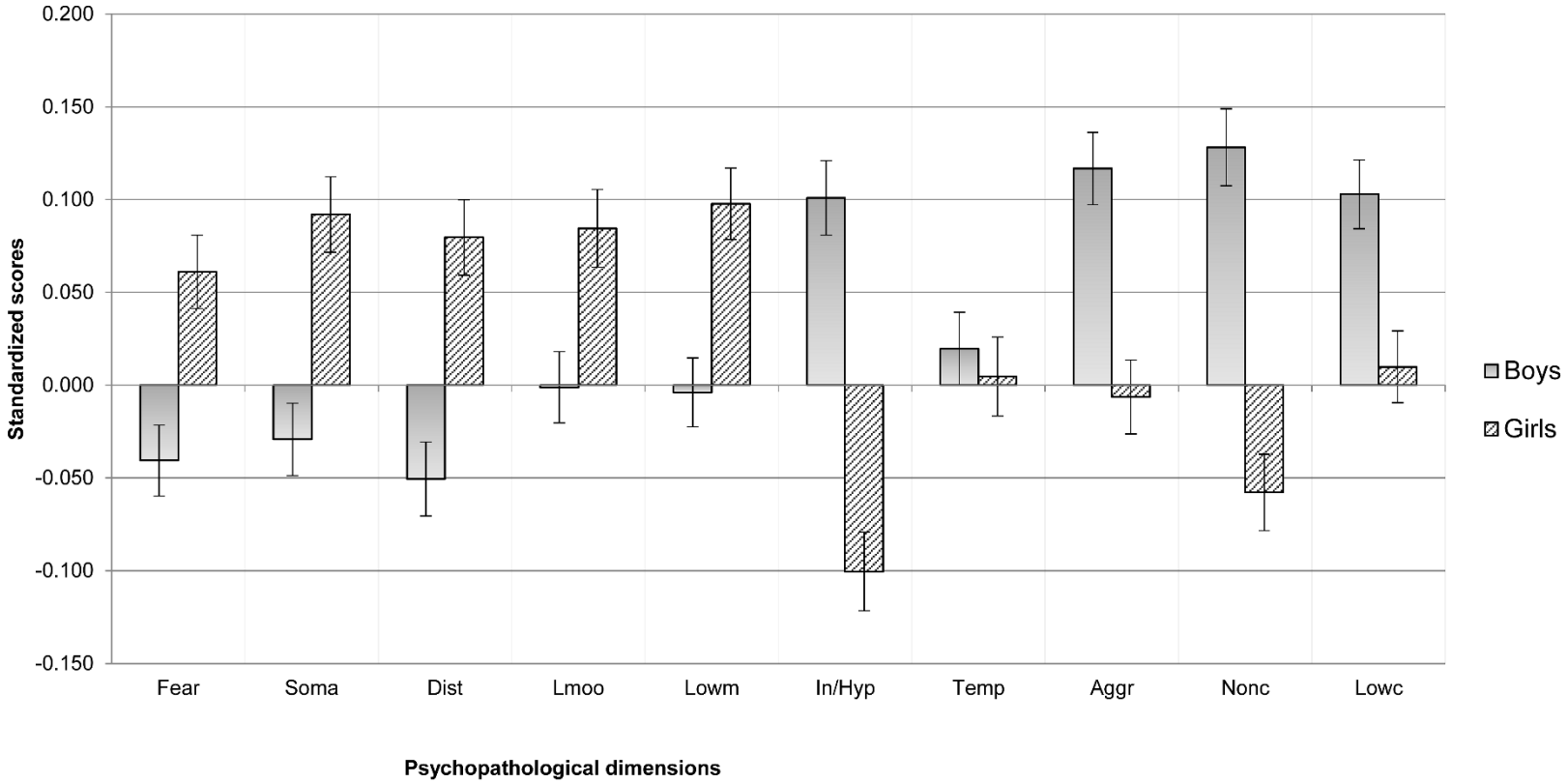
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Supplementary Figure 4: Sex differences on psychiatric symptoms dimensions



Legend: SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others.

Supplementary Figure 5: Regression Coefficients (β) of psychopathological dimensions on global executive function



Legend: SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; LOWC= low concern for others. Note: (*) represents 0.05 level of significance and (**) represents 0.01 level of significance.

Supplementary Table 2: Pearson's correlation matrix between developmental psychopathology dimensions and raw scores of the SDQ rated by the teacher (n= 1189)

	SDQ raw scores					
Model Dimensions	Emotional Problems r; p value	Conduct Problems r; p value	Hyperactivity Inattention r; p value	Peer problems r; p value	Prosocial behavior r; p value	Impact r; p value
General Psycho-pathology	0.174; < .001	0.176; < .001	0.183; < .001	0.142; < .001	-0.114; < .001	0.229; < .001
Fear	0.137; < .001	-0.003; 0.930	-0.008; 0.791	0.031; 0.288	0.037; 0.198	0.035; 0.224
Somatic Complaints	0.123; < .001	-0.010; 0.738	-0.027; 0.345	0.031; 0.290	0.002; 0.951	0.011; 0.716
Distressful thoughts	0.100; < .001	-0.028; 0.341	-0.057; 0.048	0.003; 0.909	0.064; 0.027	-0.007; 0.819
Low Mood	0.140; < .001	0.106; < .001	0.071; 0.014	0.103; < .001	-0.067; 0.022	0.103; < .001
Low motivation/ Energy	0.152; < .001	0.015; 0.597	-0.008; 0.796	0.087; 0.003	-0.029; 0.322	0.070; 0.015
Inattention-Hyperactivity	0.123; < .001	0.287; < .001	0.331; < .001	0.175; < .001	-0.169; < .001	0.234; < .001
Temper Loss	0.115; < .001	0.192; < .001	0.162; < .001	0.116; < .001	-0.092; 0.001	0.132; < .001
Aggression	0.078; 0.007	0.334; < .001	0.281; < .001	0.185; < .001	-0.216; < .001	0.214; < .001
Non-compliance	0.051; 0.081	0.322; < .001	0.323; < .001	0.163; < .001	-0.213; < .001	0.205; < .001
Low concern for others	0.074; 0.011	0.209; < .001	0.185; < .001	0.144; < .001	-0.157; < .001	0.144; < .001

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Supplementary Table 3: Univariate Regression Coefficients (β) of psychopathological dimensions from the non- orthogonal bifactor model on executive function dimensions

Dimensions	Univariate regression		
	Working Memory	Time Processing	Inhibitory Control
General Psychopathology	-0.051 (p=0.007)	-0.015 (p=0.726)	-0.065 (p=0.010)
Fear	-0.071 (p=0.003)	-0.021 (p=0.727)	-0.087 (p=0.005)
Somatic Complaints	0.043 (p=0.039)	0.013 (p=0.728)	0.054 (p=0.053)
Distressful thoughts	0.067 (p=0.006)	0.021 (p=0.726)	0.091 (p=0.006)
Low Mood	0.023 (p=0.245)	0.006 (p=0.737)	0.027 (p=0.304)
Low motivation/energy	0.057 (p=0.045)	0.017 (p=0.727)	0.082 (p=0.031)
Inattention/hyperactivity	-0.104 (p<0.001)	-0.031 (p=0.725)	-0.148 (p<0.001)
Temper Loss	-0.033 (p=0.083)	-0.009 (p=0.729)	-0.048 (p=0.064)
Aggression	-0.078 (p=0.002)	-0.023 (p=0.726)	-0.107 (p=0.002)
Noncompliance	-0.049 (p=0.019)	-0.014 (p=0.727)	-0.070 (p=0.013)
Low Concern for others	0.031 (p=0.158)	0.009 (p=0.731)	0.039 (p=0.197)

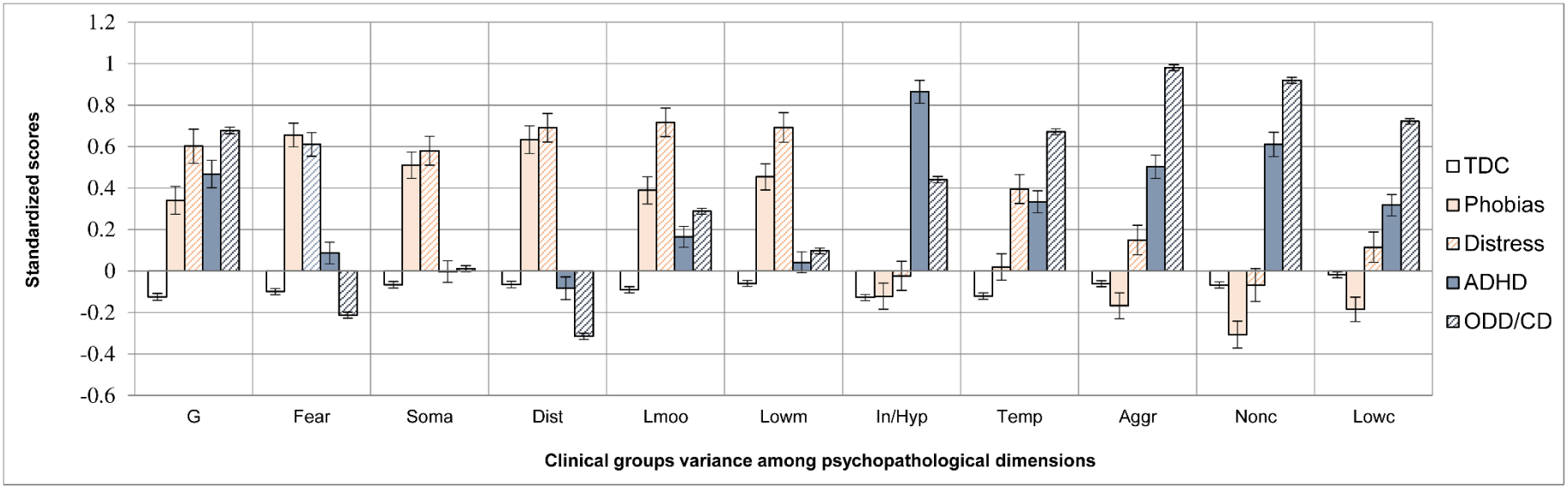
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Supplementary Table 4: Regression Coefficients (β) of psychopathological dimensions on global executive function for the correlated 10 factor model

Dimensions	General Executive Function
Fear	-0.222 (p< 0.001)
Somatic Complaints	0.024 (p=0.529)
Distressful thoughts	0.035 (p=0.368)
Low Mood	-0.033 (p=0.335)
Low motivation/energy	-0.012 (p=0.756)
Inattention/hyperactivity	-0.120 (p< 0.001)
Temper Loss	-0.241 (p< 0.001)
Aggression	-0.143 (p< 0.001)
Noncompliance	-0.191 (p< 0.001)
Low concern for others	-0.034 (p=0.405)

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Supplementary Figure 6: Comparison of between group differences on the standardized scores of psychopathological dimensions



Legend: A) Comparison between dimensions. B) Comparison between clinical groups. Abbreviations: SOMA= somatic complaints; DIST= distressful thoughts; LMOO= low mood; LOWM= low motivation/energy; IN/HYP= Inattention/hyperactivity; TEMP= temper loss; NONC= noncompliance; and LOWC= low concern for others; TDC, Typically Developing Children; ADHD, Attention Deficit/Hyperactivity Disorder; ODD/CD, Oppositional Defiant Disorder/Conduct Disorder.

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