

Distinct affective and impulsivity-related profiles are associated with facets of state boredom in adults with attention-deficit hyperactivity disorder

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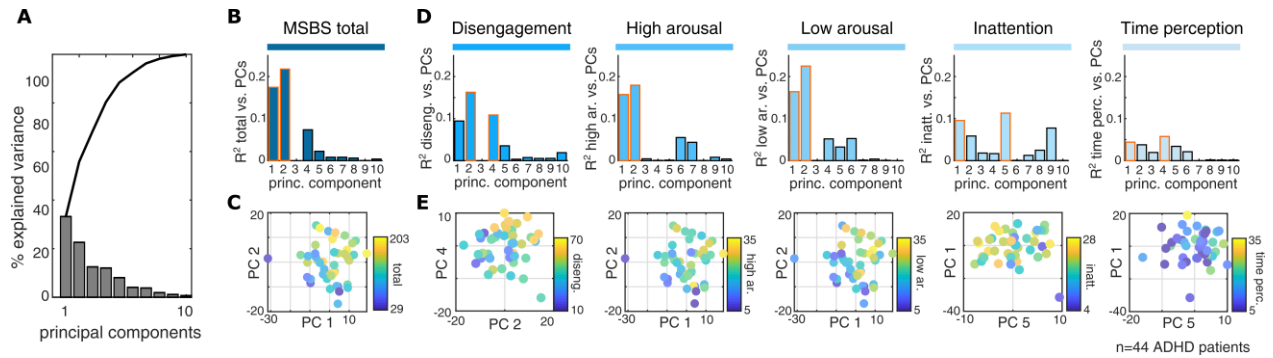
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- Supplementary Information (version 2) -

Supplementary Figures

Supplementary Figure 1



Supplementary Figure 1 – Different psychopathological patterns reflect individual variations in state boredom: We sought to test, how strongly our ADHD sample varied in respect to its psychometric features, and if these differences qualitatively relate to differences in boredom experience. To this end, we conducted a principal component analysis (PCA) with the psychometric ratings of all ADHD patients (n=44; characterized by the ten dimensions: DASS depression, DASS anxiety, DASS stress, ASRS inattention, ASRS hyperactivity/impulsivity, UPPS lack of premeditation, UPPS positive urgency, UPPS negative urgency, UPPS sensation-seeking, and UPPS lack of perseverance; see Methods). This approach characterized each patient by the ten different questionnaire scores, and identified global axes in this feature space that best captured psychometric variance between patients. Each of these axes (principal components) were tested for their correlation with boredom scores. The loadings of the ten different questionnaire scores on each principal component can be found in Supplementary Table 2. **(A)** Scree plot depicting the amount of variance explained by each principal component. **(B)** R squared values obtained from a linear correlation between patients' MSBS sum scores and the principal component scores. A high value reflects that a given principal component is capturing a large fraction of variance in boredom ratings. The two dimensions explaining most variance are framed by orange lines. **(C)** Dimension-reduced PCA projection of the psychometric ratings of all ADHD patients (n=44), in the two principal components explaining most variance in total MSBS scores (see bars framed in orange in B). The individual dots, each reflecting a single ADHD patient, are color-coded by the overall state boredom (total MSBS score) of the patients. The color-gradient indicates a systematic relation between individual psychometric patterns and boredom experience. **(D,E)** Equivalent analyses to B and C for each respective MSBS sub-scale. The observed color-gradients reflect associations of the pooled psychometric features of an individual and different facets of state boredom.

Supplementary Tables

Supplementary Table 1

Adult ADHD sample (n=47)	Mean $\pm$ SD or n (%)	Range
Demographics		
Age [years]	32.6 $\pm$ 10.3	18-54
Male	27 (57.4%)	
Female	20 (42.6%)	
Concomitant symptoms		
Depressive symptoms	10 (21.3%)	
Anxiety symptoms	6 (12.8%)	
Substance use	3 (6.4%)	
Pragmatic deficits	2 (4.3%)	
Dyslexia	5 (10.6%)	
Cognitive function		
IQ (mean $\pm$ SD)	112.1 $\pm$ 12.3	82-136
Verbal IQ (mean $\pm$ SD)	112.4 $\pm$ 11.5	87-143
Executed/performance IQ (mean $\pm$ SD)	107.9 $\pm$ 14.1	71-133
BPA total (mean $\pm$ SD)	269.6 $\pm$ 58.4	64-356
BPA errors (mean $\pm$ SD)	1.5 $\pm$ 2.3	0-9
BPA omissions (mean $\pm$ SD)	20.7 $\pm$ 18.7	1-97
BPA concentrated attention (mean $\pm$ SD)	98.0 $\pm$ 17.2	54-120
BPA alternating attention (mean $\pm$ SD)	99.8 $\pm$ 18.3	44-120
BPA divided attention (mean $\pm$ SD)	74.5 $\pm$ 30.1	37-120
State boredom (MSBS)		
Total (mean $\pm$ SD)	117.5 $\pm$ 30.2	49-180
Disengagement (mean $\pm$ SD)	44.1 $\pm$ 13.3	13-64
High Arousal (mean $\pm$ SD)	20.4 $\pm$ 6.5	5-33
Inattention (mean $\pm$ SD)	19.6 $\pm$ 5.2	6-28
Low Arousal (mean $\pm$ SD)	20.1 $\pm$ 7.1	6-34
Time Perception (mean $\pm$ SD)	13.2 $\pm$ 7.3	5-34
Affective symptoms (DASS-21)		
Depression (mean $\pm$ SD)	8.6 $\pm$ 6.3	0-21
Anxiety (mean $\pm$ SD)	8.0 $\pm$ 4.2	0-17
Stress (mean $\pm$ SD)	6.4 $\pm$ 3.3	1-12
ADHD symptoms (ASRS-18)		
Inattention (mean $\pm$ SD)	4.7 $\pm$ 2.7	0-9
Hyperactivity/Impulsivity (mean $\pm$ SD)	3.3 $\pm$ 2.6	0-9
Impulsive behavior (UPPS)		
Total (mean $\pm$ SD)	143.1 $\pm$ 18.7	80-172
Lack of premeditation (mean $\pm$ SD)	21.0 $\pm$ 5.3	11-32
Positive urgency (mean $\pm$ SD)	32.9 $\pm$ 5.8	17-44
Negative Urgency (mean $\pm$ SD)	32.4 $\pm$ 5.8	17-43
Sensation-seeking (mean $\pm$ SD)	32.0 $\pm$ 6.8	8-46
Lack of perseverance (mean $\pm$ SD)	24.1 $\pm$ 5.3	10-33
Mind-wandering (MEWS)		
Total (mean $\pm$ SD)	24.1 $\pm$ 8.9	3-36

Supplementary Table 1 – Descriptive statistics of ADHD sample: Abbreviations: BPA: Psychological Battery for Attention Assessment; MSBS: Multidimensional State Boredom Scale; DASS: Depression, Anxiety and Stress Scale; ASRS: Adult ADHD Self-Report Scale; UPPS: Urgency, Premeditation, Perseverance and Sensation-seeking Scale; MEWS: Mind Excessively Wandering Scale.

Supplementary Table 2

Component (var. explained)	PC1 (33.2%)	PC2 (22.6%)	PC3 (12.5%)	PC4 (12.0%)	PC5 (8.1%)	PC6 (4.1%)	PC7 (3.8%)	PC8 (1.9%)	PC9 (1.1%)	PC10 (0.7%)
DASS Depression	.363	.628	.304	.192	.127	-.037	.530	.161	.113	.083
DASS Anxiety	.211	.397	.102	-.012	.121	-.023	-.519	-.142	-.146	-.680
DASS Stress	.101	.301	.062	-.058	.142	-.195	-.483	-.316	-.086	.702
ASRS Inattention	.112	.030	-.164	.147	-.164	-.222	-.127	.657	-.636	.100
ASRS Hyperactivity/ Impulsivity	.114	.006	-.041	-.116	-.002	-.115	-.358	.569	.710	.040
UPPS Premeditation	.255	-.305	-.288	.225	.800	-.247	.074	-.016	-.003	-.049
UPPS Pos. Urgency	.450	-.111	-.123	-.624	-.236	-.498	.209	-.160	-.023	-.079
UPPS Neg. Urgency	.526	-.007	-.357	-.167	-.012	.739	-.045	.021	-.059	.124
UPPS Sensation- seeking	.419	-.501	.712	.181	-.085	.061	-.138	.002	-.056	.041
UPPS Perseverance	.262	-.020	-.363	.651	-.468	-.197	-.043	-.269	.206	-.028

Supplementary Table 2 – Loadings for principal component analysis of psychopathological features:

Impulsivity and depressive symptoms show the highest loadings on explaining variance among the psychometric scores of all ADHD patients. Bold letters highlight loadings with an absolute value ≥ 0.3 .

Supplementary Table 3

Variable		AGE	IQ scores
DIS	Pearson's R	-0.162	-0.100
	p-value	0.278	0.505
HA	Pearson's R	-0.132	0.047
	p-value	0.378	0.753
INA	Pearson's R	-0.242	0.020
	p-value	0.101	0.895
LA	Pearson's R	0.088	-0.028
	p-value	0.557	0.852
TP	Pearson's R	-0.422**	-0.261
	p-value	0.003	0.077
MSBS TOT	Pearson's R	-0.213	-0.097
	p-value	0.164	0.531

Supplementary Table 3 – Pearson correlations between total state boredom, age and IQ scores:

Correlations are computed with the data of n=47 ADHD patients. Abbreviations: MSBS: Multidimensional State Boredom Scale, DIS: Disengagement, HA: High Arousal, INA: Inattention, LA: Low Arousal, TP: Time Perception, TOT: Total score (sum).

Supplementary Table 4

Variable		DIS	HA	INA	LA	TP	MSBS TOT
BPA-TOT	Pearson's R	-0.019	9.805×10 ⁻⁴	-0.041	-0.103	-0.093	-0.083
	p-value	0.904	0.995	0.790	0.504	0.549	0.605
BPA-ER	Pearson's R	-0.109	0.057	-0.016	-0.169	-0.053	-0.106
	p-value	0.487	0.719	0.919	0.278	0.736	0.516
BPA-OM	Pearson's R	0.243	0.143	-0.132	0.227	0.392**	0.280
	p-value	0.116	0.360	0.399	0.143	0.009	0.081

Supplementary Table 4 – Pearson correlations between state boredom and performance in an attention

task: Correlations are computed with the data of n=47 ADHD patients. Abbreviations: MSBS: Multidimensional State Boredom Scale, DIS: Disengagement, HA: High Arousal, INA: Inattention, LA: Low Arousal, TP: Time Perception, BPA: Psychological Battery for Attention Assessment (attention task), ER: Error count, OM: omission count, TOT: Total score (sum).