Functional Connectivity of Frontoparietal and Salience/Ventral Attention Networks Have Independent Associations With Co-Occurring Attention-Deficit/Hyperactivity Disorder Symptoms in Children With Autism

Supplemental Information

Table S1. Participant Characteristics for Those Children With ASD With and Without an ADHD Rating Scale, 4th Edition (ADHD-RS-IV)

	ADHD-RS-IV n=57	No ADHD-RS-IV n=20	*p*-value*	Hedges g
Age – M(SD)	145.8 (28.7)	157.5 (37.6)	0.22	0.37
GCA – M(SD)	107.8 (18.4)	108.3 (15.9)	0.92	0.03
Sex-Ratio (M:F)	47:10	13:7	0.19	--
ADOS Social Affect	8.8 (3.5)	8.1 (4.0)	0.47	0.19
ADOS Repetitive Behaviors	2.3 (1.7)	2.4 (1.6)	0.75	0.06
ADOS Total Score	11.1 (3.6)	10.5 (4.1)	0.57	0.16
ADOS Calibrated Severity Score	6.5 (2.0)	6.1 (2.2)	0.46	0.19
CASI-IV – Anxiety (20 items)	11.6 (7.5)	15.0 (9.7)	0.17	0.45
In-Scanner Motion (Relative Mean Displacement)	0.09 (0.04)	0.13 (0.05)	<0.001	0.93
FP-A	0.31 (0.09)	0.32 (0.07)	1.00	0.18
FP-B	0.32 (0.08)	0.29 (0.06)	0.56	0.47
FP-C	0.62 (0.12)	0.62 (0.10)	1.00	0.00
FP-A-FP-B	0.12 (0.10)	0.10 (0.05)	0.86	0.35
FP-A-FP-C	-0.05 (0.09)	-0.06 (0.07)	1.00	0.14
FP-B-FP-C	-0.11 (0.15)	-0.06 (0.13)	1.00	0.37
SAL-VA-A	0.05 (0.12)	0.02 (0.17)	0.86	0.25
SAL-VA-B	0.20 (0.11)	0.16 (0.15)	1.00	0.21
SAL-VA-A~SAL-VA-B	-0.05 (0.10)	-0.02 (0.09)	0.86	0.26
FP-A-SAL-VA-A	0.22 (0.12)	0.21 (0.12)	1.00	0.07
FP-A-SAL-VA-B	0.22 (0.09)	0.23 (0.07)	1.00	0.02
FP-B-SAL-VA-A	-0.09 (0.11)	-0.08 (0.11)	1.00	0.10
FP-B-SAL-VA-B	0.09 (0.09)	0.08 (0.06)	1.00	0.12
FP-C-SAL-VA-A	-0.12 (0.10)	-0.09 (0.10)	0.86	0.25
FP-C-SAL-VA-B	-0.02 (0.09)	0.02 (0.06)	0.44	0.58

FP-A=frontoparietal-A, FP-B=frontoparietal-B, FP-C=frontoparietal-C, SAL-VA-A=salience-ventral attention-A, SAL-VA-B=salience-ventral attention-B. For these rows, values in the ADHD-RS-IV and No ADHD-RS-IV columns represent z-transformed average correlations within each corresponding network.

*p-values reported for functional connectivity analyses are FDR-adjusted

Table S2. List of Parcels From Schaefer et al., (2017) That Were Included in the Three Frontoparietal Subsystems and Two Salience-Ventral Attention Subsystems

Subsystem	Hemisphere	Parcel Label	Parcel Number
FP-A	Right	Intraparietal Sulcus-1	165
		Intraparietal Sulcus-2	166
		Dorsal Prefrontal Cortex-1	167
		Lateral Prefrontal Cortex-1	168
		Lateral Prefrontal Cortex-2	169
		Anterior Cingulate-1	170
	Left	Temporal-1	57
		Intraparietal Sulcus-1	58
		Intraparietal Sulcus-2	59
		Intraparietal Sulcus-3	60
		Dorsal Prefrontal Cortex-1	61
		Lateral Prefrontal Cortex-1	62
		Lateral Prefrontal Cortex-2	63
		Lateral Prefrontal Cortex-3	64
		Lateral Prefrontal Cortex-4	65
		Anterior Cingulate-1	66
FP-B	Right	Temporal-1	171
		Temporal-2	172
		Intraparietal Lobule-1	173
		Intraparietal Lobule-2	174
		Lateral Dorsal Prefrontal Cortex-1	175
		Lateral Dorsal Prefrontal Cortex-2	176
		Lateral Ventral Prefrontal Cortex-1	177
		Lateral Ventral Prefrontal Cortex-2	178
		Medial Para-cingulate Prefrontal Cortex-1	179

Subsystem	Hemisphere	Parcel Label	Parcel Number
		Medial Para-cingulate Prefrontal Cortex-2	180
	Left	Temporal-1	67
		Intraparietal Lobule-1	68
		Lateral Prefrontal Cortex-1	69
		Lateral Ventral Prefrontal Cortex-1	70
		Lateral Ventral Prefrontal Cortex-2	71
FP-C	Right	Pre-Cuneous-1	181
		Pre-Cuneous-2	182
		Posterior Cingulate-1	183
	Left	Pre-Cuneous-1	72
		Pre-Cuneous-2	73
		Posterior Cingulate-1	74
SAL-VA-A	Right	Pars Opercularis-1	142
		Pre-Central Gyrus-1	143
		Insula-1	144
		Insula-2	145
		Insula-3	146
		Medial Frontal-1	147
		Medial Frontal-2	148
		Medial Frontal -3	149
		Medial Frontal-4	150
	Left	Pars Opercularis-1	40
		Insula-1	41
		Insula-2	42

Subsystem	Hemisphere	Parcel Label	Parcel Number
		Insula-3	43
		Medial Parietal-1	44
		Medial Frontal-1	45
		Medial Frontal-2	46
SAL-VA-B	Right	Intraparietal Lobule-1	151
		Lateral Prefrontal Cortex-1	152
		Lateral Prefrontal Cortex-2	153
		Ventral Prefrontal Cortex-1	154
		Ventral Prefrontal Cortex-2	155
		Medial Para-cingulate Prefrontal Cortex-1	156
	Left	Intraparietal Lobule-1	47
		Lateral Prefrontal Cortex-1	48
		Ventral Prefrontal Cortex-1	49
		Medial Para-cingulate Prefrontal Cortex-1	50

Table S3. Group Differences Using Bayesian Approach

Systems		ASD n=77	TDC n=82	BEST Mean Difference [95% CI]	*p*-value
FP-A	Mean: SD:	0.31 [0.29, 0.33] 0.09 [0.07, 0.10]	0.34 [0.32, 0.36] 0.09 [0.07, 0.10]	0.03 [-0.00, 0.06]	$p = 0.027$
FP-B	Mean: SD:	0.31 [0.29, 0.33] 0.08 [0.07, 0.09]	0.33 [0.32, 0.35] 0.08 [0.07, 0.10]	0.02 [-0.01, 0.046]	$p = 0.065$
FP-C	Mean: SD:	0.62 [0.59, 0.64] 0.11 [0.09, 0.13]	0.68 [0.65, 0.71] 0.13 [0.10, 0.15]	0.06 [0.02, 0.10]	$p < 0.001$
FP-A~FP-B	Mean: SD:	0.11 [0.09, 0.13] 0.08 [0.07, 0.10]	0.12 [0.10, 0.14] 0.08 [0.07, 0.11]	0.01 [-0.02, 0.04]	$p = 0.349$
FP-A~FP-C	Mean: SD:	-0.06 [-0.08, -0.04] 0.08 [0.06, 0.09]	-0.01 [-0.04, -0.16] 0.12 [0.10, 0.15]	0.04 [0.01, 0.08]	$p = 0.006$
FP-B~FP-C	Mean: SD:	-0.10 [-0.13, -0.06] 0.14 [0.11, 0.17]	-0.08 [-0.11, -0.05] 0.14 [0.11, 0.17]	0.02 [-0.03, 0.07]	$p = 0.201$
SAL-VA-A	Mean: SD:	0.42 [0.40, 0.44] 0.09 [0.08, 0.11]	0.47 [0.45, 0.50] 0.11 [0.09, 0.13]	0.06 [0.03, 0.09]	$p < 0.001$
SAL-VA-B	Mean: SD:	0.41 [0.39, 0.44] 0.10 [0.09, 0.12]	0.48 [0.46, 0.51] 0.11 [0.10, 0.13]	0.07 [0.04, 0.10]	$p < 0.001$
SAL-VA-A~SAL-VA-B	Mean: SD:	-0.04 [-0.06, -0.02] 0.09 [0.08, 0.11]	-0.02 [-0.04, 0.01] 0.11 [0.09, 0.14]	0.02 [-0.11, 0.06]	$p = 0.086$
FP-A~SAL-VA-A	Mean: SD:	0.22 [0.19, 0.24] 0.12 [0.10, 0.14]	0.25 [0.23, 0.28] 0.12 [0.10, 0.14]	0.04 [0.00, 0.08]	$p = 0.024$

Systems		ASD n=77	TDC n=82	BEST Mean Difference [95% CI]	*p*-value
FP-A~SAL-VA-B	Mean: SD:	0.21 [0.00, 0.04] 0.09 [0.07, 0.10]	0.06 [0.04, 0.08] 0.10 [0.08, 0.12]	0.04 [0.01, 0.07]	$p = 0.009$
FP-B~SAL-VA-A	Mean: SD:	-0.08 [-0.11, -0.06] 0.11 [0.09, 0.13]	-0.08 [-0.10, -0.06] 0.10 [0.08, 0.12]	0.00 [-0.03, 0.04]	$p = 0.428$
FP-B~SAL-VA-B	Mean: SD:	0.09 [0.07, 0.11] 0.08 [0.07, 0.10]	0.12 [0.10, 0.14] 0.09 [0.07, 0.10]	0.03 [0.00, 0.06]	$p = 0.014$
FP-C~SAL-VA-A	Mean: SD:	-0.11 [-0.14, -0.09] 0.10 [0.09, 0.12]	-0.10 [-0.12, -0.07] 0.12 [0.10, 0.14]	0.01 [-0.23, 0.05]	$p = 0.233$
FP-C~SAL-VA-B	Mean: SD:	-0.1 [-0.03, 0.01] 0.08 [0.06, 0.10]	0.01 [-0.01, 0.03] 0.09 [0.07, 0.11]	0.02 [-0.01, 0.05]	$p = 0.068$

FP-A=frontoparietal sub-system A
FP-B=frontoparietal sub-system B
FP-C=frontoparietal sub-system C
SAL-VA-A=salience-ventral attention A
SAL-VA-B=salience-ventral attention B
For these rows, values in the ASD and TDC columns represent z-transformed average correlations within each corresponding network.

Table S4. Group Differences Using Analysis of Covariance

Systems	Confounds included in final model	FDR-corrected *p*-value for Group	Group h_p^2
FP-A	Age (linear, quadratic), Relative Mean Displacement	0.111	0.02
FP-B	Relative Mean Displacement	0.232	0.01
FP-C	None	**<0.005**	**0.07**
FP-A~FP-B	None	0.807	0.00
FP-A~FP-C	IQ, Relative Mean Displacement	0.063	0.04
FP-B~FP-C	IQ, Relative Mean Displacement	0.684	0.00
SAL-VA-A	Age (cubic), Scan Sequence	**<0.005**	**0.07**
SAL-VA-B	Gender, Scan Sequence	**<0.005**	**0.09**
SAL-VA-A~SAL-VA-B	Age (linear), Relative Mean Displacement	0.257	0.01
FP-A~SAL-VA-A	None	0.101	0.03
FP-A~SAL-VA-B	Relative Mean Displacement, Scan Sequence	0.101	0.03
FP-B~SAL-VA-A	Relative Mean Displacement	0.896	0.00
FP-B~SAL-VA-B	Relative Mean Displacement	0.101	0.03
FP-C~SAL-VA-A	Relative Mean Displacement	0.645	0.00
FP-C~SAL-VA-B	Relative Mean Displacement	0.188	0.02

FP-A=frontoparietal sub-system A
FP-B=frontoparietal sub-system B
FP-C=frontoparietal sub-system C
SAL-VA-A=salience-ventral attention A
SAL-VA-B=salience-ventral attention B

Table S5. Non-significant Group Differences Using t-Tests

	ASD M(SD)	TDC M(SD)	FDR corrected-*p-value*	Hedges g
FP-A	0.31	0.33	0.082	0.32
FP-B	0.31	0.33	0.171	0.24
FP-A~FP-B	0.12	0.12	0.753	0.05
FP-B~FP-C	-0.10	-0.08	0.428	0.15
SAL-VA-A~SAL-VA-B	-0.04	-0.02	0.171	0.24
FP-A~SAL-VA-A	0.22	0.26	0.082	0.32
FP-B~SAL-VA-A	-0.08	-0.08	0.753	0.05
FP-B~SAL-VA-B	0.09	0.12	0.062	0.36
FP-C~SAL-VA-A	-0.11	-0.10	0.451	0.14
FP-C~SAL-VA-B	-0.01	0.01	0.113	0.29

FP-A=frontoparietal sub-system A
FP-B=frontoparietal sub-system B
FP-C=frontoparietal sub-system C
SAL-VA-A=salience-ventral attention A
SAL-VA-B=salience-ventral attention B
For these rows, values in the ASD and TDC columns represent z-transformed average correlations within each corresponding network.

Table S6. Correlation Matrix of Partial Correlations of ADHD Rating Scale Caregiver Version with Frontoparietal and Salience-Ventral Attention Subsystems and Bayesian Correlations

	ASD Symptoms Covaried	Residual Motion Covaried	Bayesian Correlation
ADHD Symptoms~Sal-VA-B	-0.30*	-0.27*	-0.28* [-0.51 -0.027]
ADHD Symptoms~FP-A-FP-C	-0.27*	-0.25^	-0.26* [-0.50 -0.004]

ADHD Symptoms=ADHD Rating Scale, 4th Edition (total raw score is used)
FP-A-FP-C= Functional connectivity between frontoparietal subsystem A and frontoparietal subsystem C (Fisher's z)
Sal-VA-B=Functional connectivity within salience-ventral attention subsystem B (Fisher's z)
*p< .05; ^p<0.10
Note. Values in the brackets are the 95% credibility intervals for the correlation.