Supplementary Information

Longer screen time utilization is associated with the polygenic risk for Attention-deficit/hyperactivity disorder with mediation by brain white matter microstructure

Anyi Yang[1,#], Edmund T. Rolls, PhD[1,2,3,4,#], Guiying Dong[1,2], Jingnan Du, PhD[1,2], Yuzhu Li[1,2], Jianfeng Feng, PhD[1,2,3,5,6,7], Wei Cheng, PhD[1,2,5,*] and Xing-Ming Zhao, PhD[1,2,6,8,*]

Author affiliations:
1 Institute of Science and Technology for Brain-Inspired Intelligence, Fudan University, Shanghai, China.
2 Key Laboratory of Computational Neuroscience and Brain-Inspired Intelligence, Ministry of Education, Shanghai, China.
3 Department of Computer Science, University of Warwick, Coventry, UK.
4 Oxford Centre for Computational Neuroscience, Oxford, UK.
5 Fudan ISTBI—ZJNU Algorithm Centre for Brain-inspired Intelligence, Zhejiang Normal University, Jinhua, China.
6 MOE Frontiers Center for Brain Science, Fudan University, Shanghai, China.
7 Zhangjiang Fudan International Innovation Center, Shanghai, China.
8 Research Institute of Intelligent Complex Systems, Fudan University, Shanghai, China.

# Anyi Yang and Edmund T. Rolls contributed equally to the study.

* Corresponding authors:
Associate Professor Wei Cheng, Institute of Science and Technology for Brain-Inspired Intelligence, Fudan University, Shanghai 200433, China. Tel: 86-2165-64837. E-mail address: wcheng.fdu@gmail.com;
Professor Xing-Ming Zhao, Institute of Science and Technology for Brain-Inspired Intelligence, Fudan University, Shanghai 200433, China. Tel: 86-2165-64837. E-mail address: xmzhao@fudan.edu.cn.

This PDF file includes:

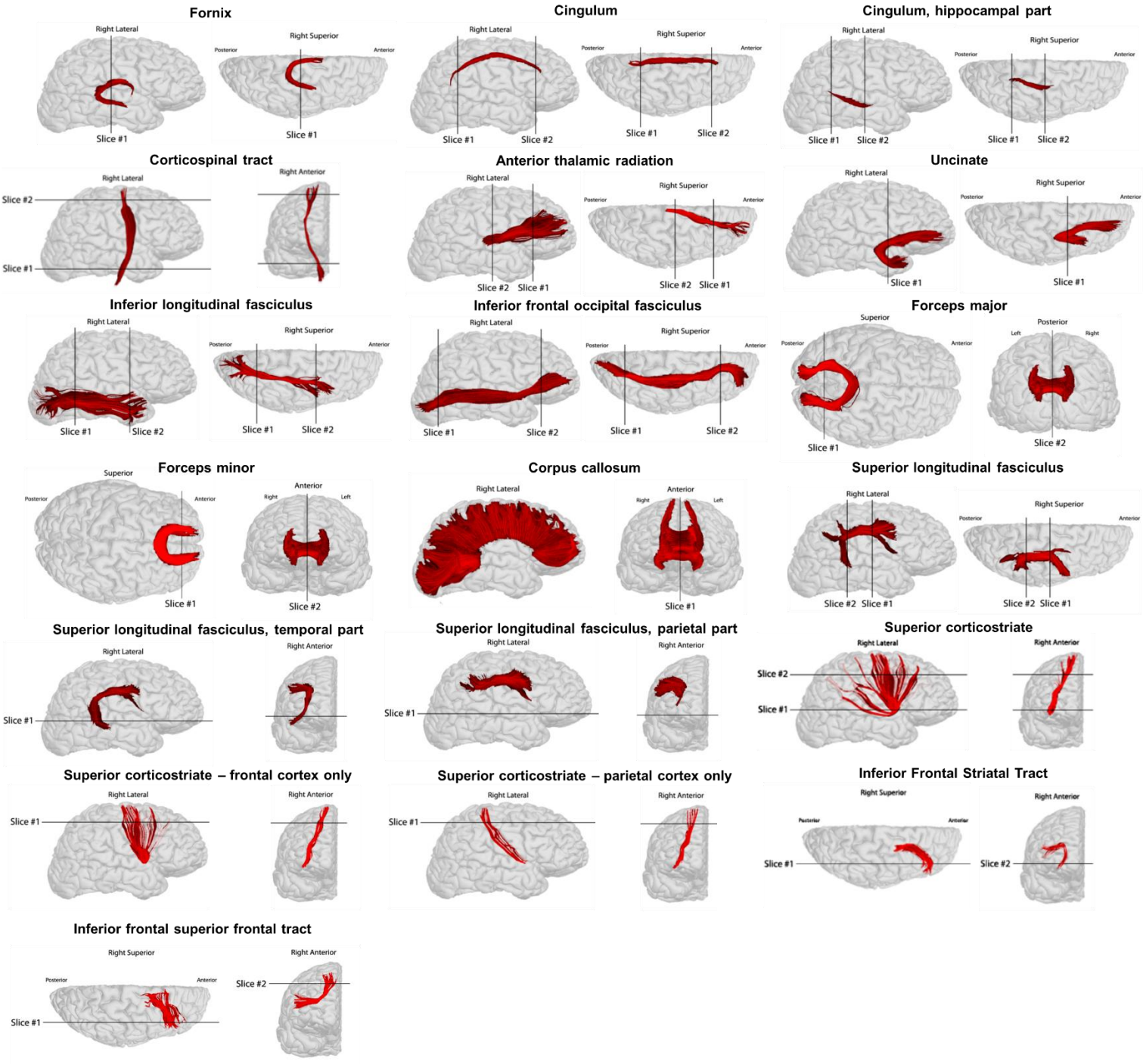

Figure S1: Visualization of each fiber tract in Atlas Track. The picture is directly derived from the manual of Atlas Track, and the slices on each fiber are not shown for brevity. More details can be found in the manual of Atlas Track (https://www.nitrc.org/projects/atlastrack/).[1]

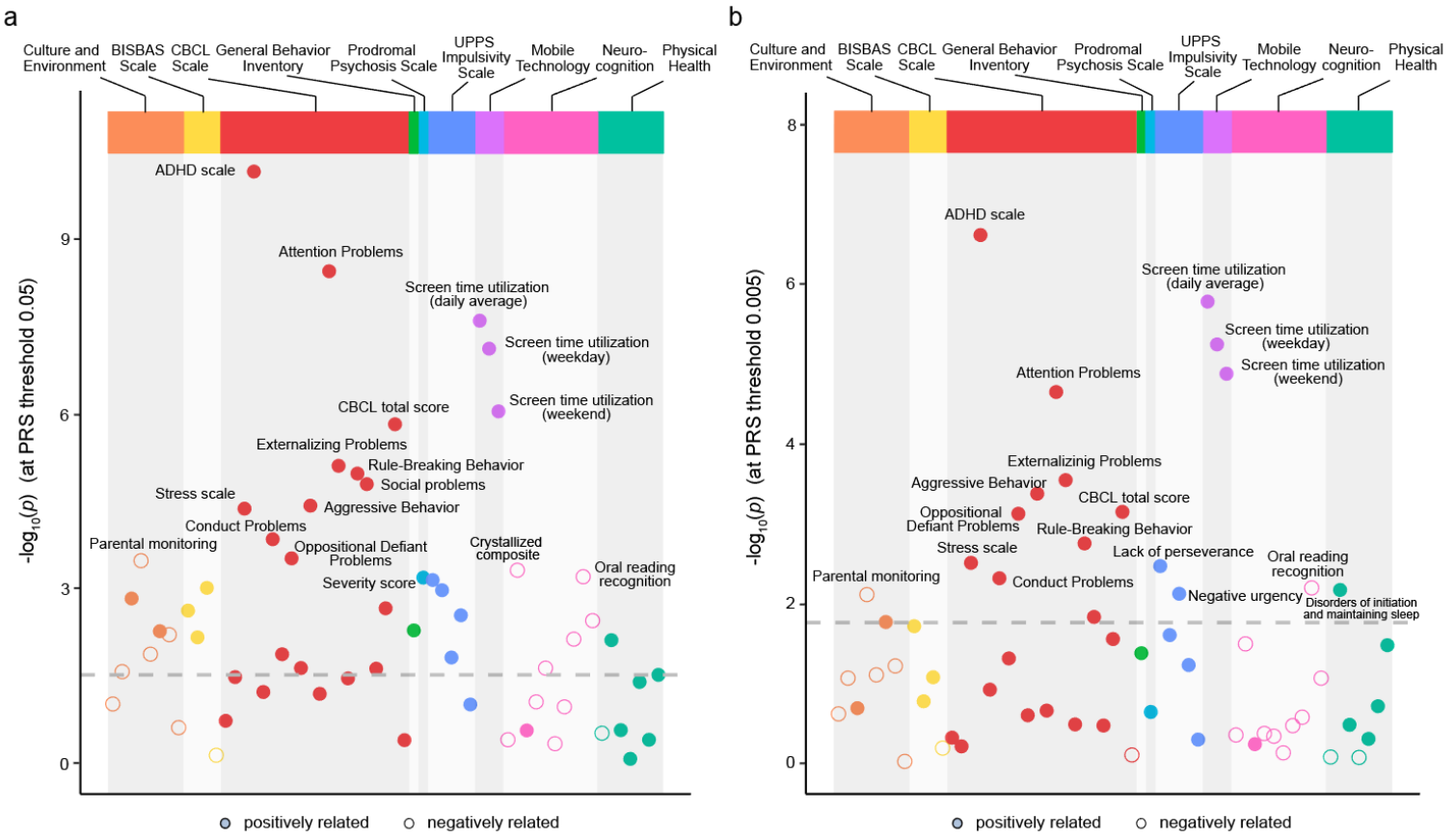

Figure S2: Associations between behavioral assessments and PRS^{ADHD} at PRS threshold neighboring 0.01: **(a)** 0.05; **(b)** 0.005. Each Manhattan plot illustrates the association between PRS^{ADHD} and all the behavioral assessments shown in Table S3. A point above the grey dotted line denotes that this assessment is significantly correlated with PRS^{ADHD} (FDR < 0.05). The ADHD scale, daily average screen time utilization (denoted as STU in default in our study), Attention Problems scale, and Externalizing Problems scale always reach the top several non-redundant assessments which were significantly correlated with PRS^{ADHD}.

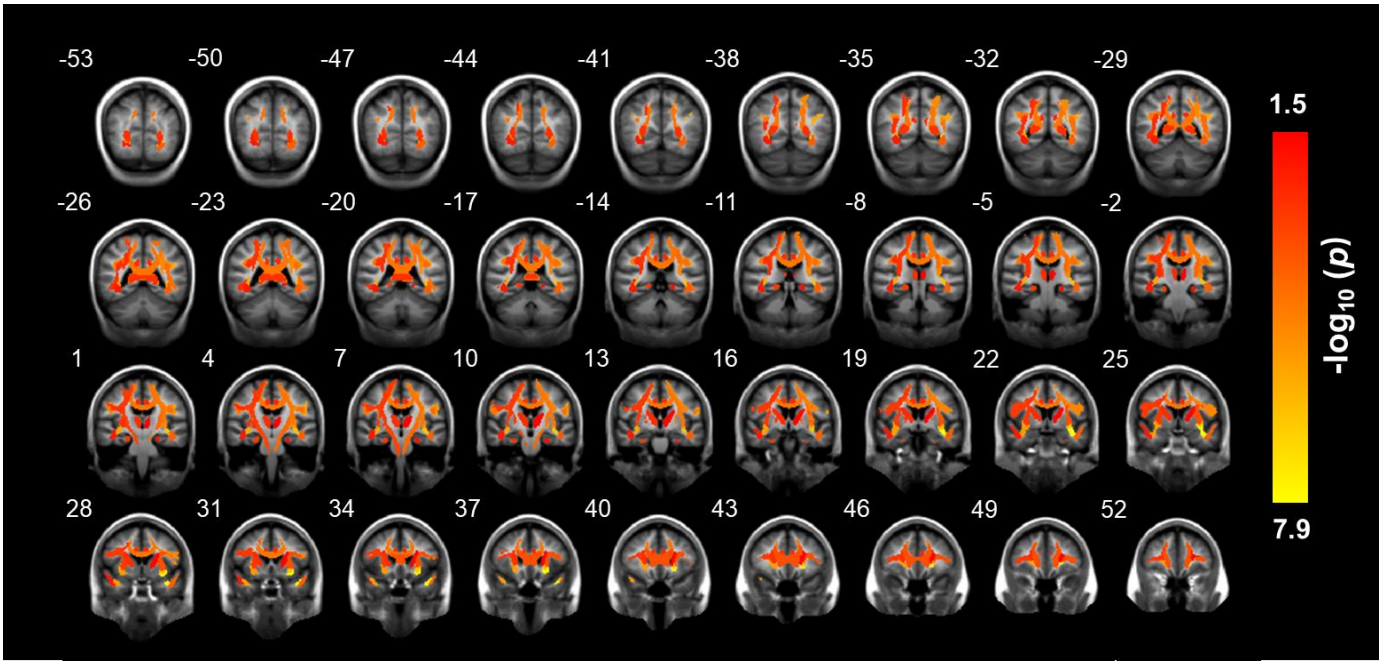

Figure S3: Significant brain tracts analyzed with DTI (FDR < 0.05) associated with the ADHD scale. The number above each brain anatomical section is the MNI coordinate for the selected plane.

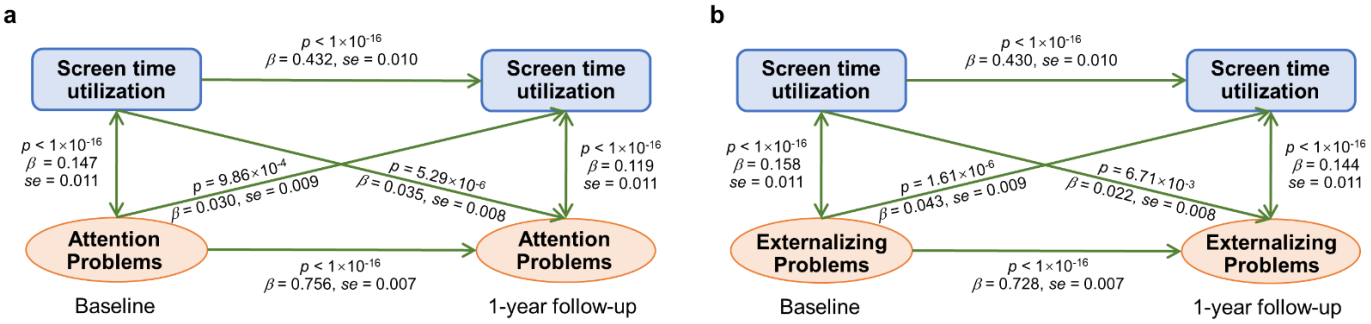

Figure S4: The longitudinal analyses between **(a)** STU and the Attention Problems scale at baseline and 1-year follow-up; **(b)** STU and the Externalizing Problems scale at baseline and 1-year follow-up.

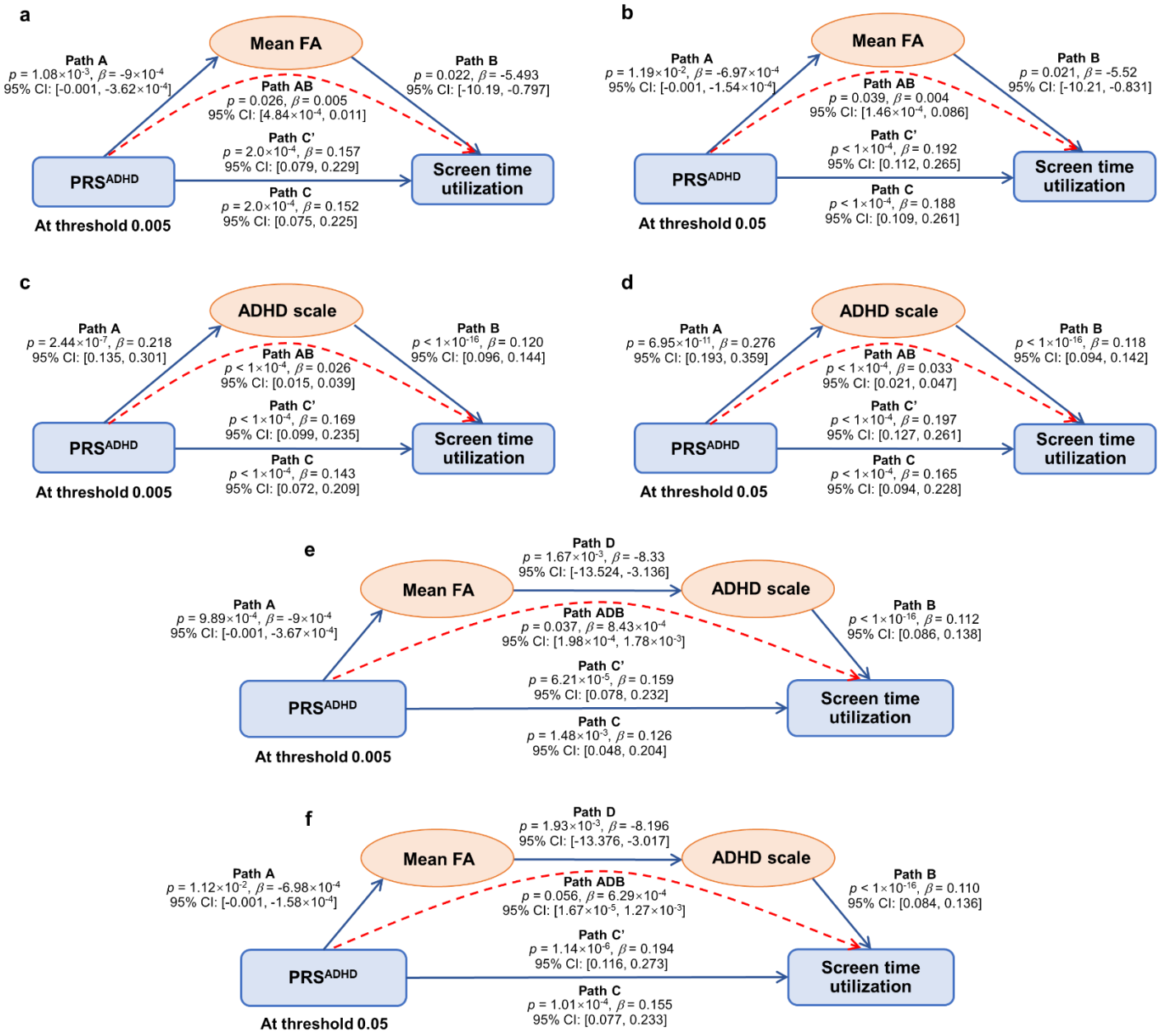

Figure S5: The mediation analyses at neighboring PRS threshold of 0.01. (a) Mediation analysis between PRS^{ADHD} at threshold 0.05 and STU through mean FA value of regional findings shown in Figure 3c; **(b)** Mediation analysis between PRS^{ADHD} at threshold 0.005 and STU through mean FA value of regional findings shown in Figure 3c; **(c)** Mediation analysis between PRS^{ADHD} at threshold 0.005 and STU through the ADHD scale; **(d)** Mediation analysis between PRS^{ADHD} at threshold 0.05 and STU through the ADHD scale; **(e)** Serial mediation analysis between PRS^{ADHD} at threshold 0.005 and STU through mean FA value of white matter tracts shown in Figure 3c and the ADHD scale (sequentially). **(f)** Serial mediation analysis between PRS^{ADHD} at threshold 0.05 and STU through mean FA value of white matter tracts shown in Figure 3c and the ADHD scale (sequentially). Path C shows the association between PRS^{ADHD} and STU when mediators are not taken into account. Path C' shows the association between PRS^{ADHD} and STU when mediators are taken into account. The mediation relationship is labelled with a red dotted line in **(a-f)**.

Table S1: The connected brain regions of each individual fiber tract in Atlas Track.

Fibers	Connection
fornix	hippocampus & mammilary nuclei of hypothalamus
cingulate (cingulum)	cingulate gyrus & entorhinal cortex (cingulate portion)
cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)
corticospinal tract or pyramidal tract	motor cortex & spinal cord
anterior thalamic radiations	thalamus & frontal lobe
uncinate fasciculus	inferior frontal lobe & anterior temporal lobe
inferior longitudinal fasciculus	occipital lobe & temporal lobe
inferior fronto-occipital fasciculus	occipital lobe & frontal lobe
forceps major	left occipital cortex & right occipital cortex
forceps minor	left prefrontal cortex & right prefrontal cortex
corpus callosum	left cortex & right cortex
superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe
temporal superior longitudinal fasciculus	temporal lobe & frontal lobe
parietal superior longitudinal fasciculus	parietal lobe & frontal lobe
superior corticostriate	superior cortex & striatum
superior corticostriate (frontal)	superior frontal cortex & striatum
superior corticostriate (parietal)	superior parietal cortex & striatum
inferior frontal-striatal tract	inferior frontal cortex & striatum
inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex

Table S2: The demographic characteristics of the ABCD European samples (genetic_af_european > 0.95).

Basic information				
Age (month)	Gender (Male/Female)	BMI	Parents income	Parents education
119.2 ± 7.36	2473/2200	18.62 ± 3.41	8.13 ± 1.64	17.54 ± 2
Puberty	Race (White/Black/Hispanic/Asian/Other)			
2 ± 0.73	4490/1/72/0/110			
Screen time utilization measurement				
Screen Time Youth Weekday Sum (stq_y_ss_weekday)	Screen Time Youth Weekend Sum (stq_y_ss_weekday)	Screen Time Youth daily average (stq_y_ss_ave_daily)		
2.87 ± 2.58	4.03 ± 3.09	3.2 ± 2.57		
Psychiatric problem measurement				
Anxious/Depressed CBCL Syndrome Scale (cbcl_scr_syn_anxdep)	Withdrawn/Depressed CBCL Syndrome Scale (cbcl_scr_syn_withdep)	Somatic Complaints CBCL Syndrome Scale (cbcl_scr_syn_somatic)	Social Problems CBCL Syndrome Scale (cbcl_scr_syn_social)	Thought Problems CBCL Syndrome Scale (cbcl_scr_syn_thought)
2.68 ± 3.11	0.97 ± 1.62	1.55 ± 1.9	1.49 ± 2.18	1.76 ± 2.21
Attention Problems CBCL Syndrome Scale (cbcl_scr_syn_attention)	Rule-Breaking Behavior CBCL Syndrome Scale (cbcl_scr_syn_rulebreak)	Aggressive Behavior CBCL Syndrome Scale (cbcl_scr_syn_aggressive)	Internalizing Problems CBCL Syndrome Scale (cbcl_scr_syn_internal)	Externalizing Problems CBCL Syndrome Scale (cbcl_scr_syn_external)
2.91 ± 3.41	1.05 ± 1.68	3.18 ± 4.1	5.2 ± 5.42	4.23 ± 5.45
Total Problems CBCL Syndrome Scale (cbcl_scr_syn_totprob)	Depressive Problems CBCL DSM5 Scale (cbcl_scr_dsm5_depress)	Anxiety Disorder CBCL DSM5 Scale (cbcl_scr_dsm5_anxdisord)	Somatic Problems CBCL DSM5 Scale (cbcl_scr_dsm5_somaticpr)	ADHD CBCL DSM5 Scale (cbcl_scr_dsm5_adhd)
18.04 ± 17.04	1.29 ± 1.97	2.14 ± 2.43	1.14 ± 1.5	2.55 ± 2.94
Oppositional Defiant Problems CBCL DSM5 Scale (cbcl_scr_dsm5_opposit)	Conduct Problems CBCL DSM5 Scale (cbcl_scr_dsm5_conduct)	Sluggish Cognitive Tempo CBCL Scale2007 Scale (cbcl_scr_07_sct)	Obsessive-Compulsive Problems CBCL Scale2007 Scale (cbcl_scr_07_ocd)	Stress Problems CBCL Scale2007 Scale (cbcl_scr_07_stress)
1.8 ± 2	1.12 ± 2.14	0.53 ± 0.96	1.47 ± 1.82	2.91 ± 3.26

Note: The detail information of how the measurement can be found on https://nda.nih.gov/data_dictionary.html.

Table S3: The average proportion of phenotypic variance explained by PRS^{ADHD} at different thresholds. R^2 denotes the proportion of the phenotype variance explained by PRS^{ADHD}. The R^2 was averaged among the measurements focused in this study, including 42 DTI FA metrics, the ADHD scale and STU. The PRS^{ADHD} at threshold 0.01 captured the largest average R^2, and was selected to illustrate our main results.

PRS threshold	Average R^2
0.5	0.157%
0.1	0.157%
0.05	0.148%
0.01	0.233%
0.005	0.129%
0.001	0.119%
0.0005	0.057%
0.0001	0.029%
5×10^{-5}	0.029%
5×10^{-8}	0.014%

Table S4: The behavior assessments used in this study from the ABCD.

Scale	ABCD ID	ABCD name	File name
Mental Health			
Behavioral inhibition and behavioral activation (BISBAS scale) – youth report	bis_y_ss_bas_drive	BIS/BAS: BAS drive	abcd_mhy02.txt
Behavioral inhibition and behavioral activation (BISBAS scale) – youth report	bis_y_ss_bas_fs	BIS/BAS: BAS Fun Seeking	abcd_mhy02.txt
Behavioral inhibition and behavioral activation (BISBAS scale) – youth report	bis_y_ss_bas_rr	BIS/BAS: BAS Reward Responsiveness	abcd_mhy02.txt
Behavioral inhibition and behavioral activation (BISBAS scale) – youth report	bis_y_ss_bis_sum	BIS/BAS: BIS Sum	abcd_mhy02.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_07_ocd_r	Obsessive-Compulsive Problems CBCL Scale2007 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_07_sct_r	Sluggish Cognitive Tempo CBCL Scale2007 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_07_stress_r	Stress CBCL Scale2007 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_adhd_r	ADHD CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_anxdisord_r	Anxiety Disorder CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_conduct_r	Conduct Problems CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_depress_r	Depressive Problems CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_opposit_r	Oppositional Defiant Problems CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_dsm5_somaticpr_r	Somatic Problems CBCL DSM5 Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_aggressive_r	Aggressive Behavior CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_anxdep_r	Anxious/Depressed CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_attention_r	Attention Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_external_r	Externalizing Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_internal_r	Internalizing Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_rulebreak_r	Rule-Breaking Behavior CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_social_r	Social Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_somatic_r	Somatic Complaints CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_thought_r	Thought Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_totprob_r	Total Problems CBCL Syndrome Scale	abcd_cbcls01.txt
Child behavior checklist (CBCL) - caregiver report	cbcl_scr_syn_withdep_r	Withdrawn/Depressed CBCL Syndrome Scale	abcd_cbcls01.txt
General behavior inventory – caregiver report	pgbi_p_ss_score	Parent General Behavior Inventory SUM	abcd_mhp02.txt
Prodromal psychosis scale (PQ-B) – youth report	pps_y_ss_severity_score	Prodromal Psychosis: Severity Score Sum	abcd_mhy02.txt
UPPS impulsivity scale – youth report	upps_y_ss_lack_of_perseverance	UPPS: Lack of Perseverance (GSSF)	abcd_mhy02.txt

UPPS impulsivity scale – youth report	upps_y_ss_lack_of_planning	UPPS-P for Children Short Form (ABCD-version), Lack of Planning	abcd_mhy02.txt
UPPS impulsivity scale – youth report	upps_y_ss_negative_urgency	UPPS-P for Children Short Form (ABCD-version), Negative Urgency	abcd_mhy02.txt
UPPS impulsivity scale – youth report	upps_y_ss_positive_urgency	UPPS-P for Children Short Form (ABCD-version), Positive Urgency	abcd_mhy02.txt
UPPS impulsivity scale – youth report	upps_y_ss_sensation_seeking	UPPS-P for Children Short Form (ABCD-version), Sensation Seeking	abcd_mhy02.txt
Neurocognition			
NIH Toolbox	nihtbx_cardsort_uncorrected	NIH Toolbox Dimensional Change Card Sort Test Ages 8-11 v2.0	abcd_tbss04.txt
NIH Toolbox	nihtbx_cryst_uncorrected	Crystallized Composite	abcd_tbss09.txt
NIH Toolbox	nihtbx_flanker_uncorrected	NIH Toolbox Flanker Inhibitory Control and Attention Test Ages 8-11 v2.0	abcd_tbss02.txt
NIH Toolbox	nihtbx_fluidcomp_uncorrected	Cognition Fluid Composite	abcd_tbss08.txt
NIH Toolbox	nihtbx_list_uncorrected	NIH Toolbox List Sorting Working Memory Test Age 7+ v2.0	abcd_tbss03.txt
NIH Toolbox	nihtbx_pattern_uncorrected	NIH Toolbox Pattern Comparison Processing Speed Test Age 7+ v2.0	abcd_tbss05.txt
NIH Toolbox	nihtbx_picture_uncorrected	NIH Toolbox Picture Sequence Memory Test Age 8+ Form A v2.0	abcd_tbss06.txt
NIH Toolbox	nihtbx_picvocab_uncorrected	NIH Toolbox Picture Vocabulary Test Age 3+ v2.0	abcd_tbss01.txt
NIH Toolbox	nihtbx_reading_uncorrected	NIH Toolbox Oral Reading Recognition Test Age 3+ v2.0	abcd_tbss07.txt
NIH Toolbox	nihtbx_totalcomp_uncorrected	Cognition Total Composite Score	abcd_tbss10.txt
Culture and Environment			
ABCD Sum Scores Culture & Environment Youth	crpbi_y_ss_caregiver	CRPBI - Acceptance Subscale Mean of Report by Secondary Caregiver by youth	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	crpbi_y_ss_parent	CRPBI - Acceptance Subscale Mean of Report by Parent Completing Protocol by youth	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	fes_y_ss_fc	Conflict Subscale from the Family Environment Scale Sum of Youth Report	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	pmq_y_ss_mean	Parental Monitoring: Mean	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	psb_y_ss_mean	Prosocial Behavior Subscale Mean of Youth Self Report	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	srpf_y_ss_dfs	SRPF School Disengagement Subscale, Sum	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	srpf_y_ss_iiss	SRPF School Involvement Subscale, Sum	abcd_sscey01.txt
ABCD Sum Scores Culture & Environment Youth	srpf_y_ss_ses	SRPF School Environment Subscale, Sum	abcd_sscey01.txt
Physical health			
ABCD Sum Scores Physical Health Parent	sds_p_ss_da	Disorder of Arousal (DA) SUM	abcd_ssphp01.txt
ABCD Sum Scores Physical Health Parent	sds_p_ss_dims	Disorders of Initiating and Maintaining Sleep (DIMS) SUM	abcd_ssphp01.txt
ABCD Sum Scores Physical Health Parent	sds_p_ss_does	Disorders of Excessive Somnolence (DOES) SUM	abcd_ssphp01.txt
ABCD Sum Scores Physical Health Parent	sds_p_ss_sbd	Sleep Breathing disorders (SBD)	abcd_ssphp01.txt
ABCD Sum Scores Physical Health Parent	sds_p_ss_shy	Sleep Hyperhydrosis (SHY) SUM	abcd_ssphp01.txt
ABCD Sum Scores Physical Health Parent	sds_p_ss_swtd	Sleep-Wake transition Disorders (SWTD) SUM	abcd_ssphp01.txt

ABCD Sum Scores Physical Health Parent	sds_p_ss_total	Total Score (Sum of 6 Factors)	abcd_ssphp01.txt
Mobile Technology			
ABCD Sum Scores Mobile Tech Youth	stq_y_ss_weekday	Screen Time Youth: Weekday Sum	abcd_ssmty01.txt
ABCD Sum Scores Mobile Tech Youth	stq_y_ss_weekend	Screen Time Youth: Weekend Sum	abcd_ssmty01.txt
ABCD Sum Scores Mobile Tech Youth	stq_y_ss_ave_daily	Screen Time Youth: average daily use	

Table S5: Associations between PRS^{ADHD} and behavioral assessments. R^2 denotes the proportion of the phenotype variance explained by PRS^{ADHD}. The assessment of 'Screen Time Youth: average daily use' (i.e. stq_y_ss_ave_daily in Table S4) is denoted as STU in default in our study.

Behavior measures	***β* (*se*)**	***p***	R^2	**FDR**
ADHD CBCL DSM5 Scale	0.227 (0.042)	7.41E-08	0.723%	4.37E-06
Screen Time Youth: average daily use	0.184 (0.035)	2.00E-07	0.993%	5.91E-06
Screen Time Youth: Weekday Sum	0.178 (0.036)	5.27E-07	0.927%	1.04E-05
Screen Time Youth: Weekend Sum	0.196 (0.043)	5.30E-06	0.800%	7.82E-05
Attention Problems CBCL Syndrome Scale	0.218 (0.049)	8.17E-06	0.516%	9.64E-05
Externalizing Problems CBCL Syndrome Scale	0.298 (0.078)	1.27E-04	0.462%	1.25E-03
Aggressive Behavior CBCL Syndrome Scale	0.22 (0.059)	1.91E-04	0.420%	1.61E-03
Oppositional Defiant Problems CBCL DSM5 Scale	0.106 (0.029)	2.43E-04	0.374%	1.68E-03
UPPS: Lack of Perseverance (GSSF)	0.12 (0.033)	2.56E-04	0.359%	1.68E-03
Total Problems CBCL Syndrome Scale	0.847 (0.242)	4.76E-04	0.386%	2.81E-03
Rule-Breaking Behavior CBCL Syndrome Scale	0.078 (0.024)	1.03E-03	0.391%	5.53E-03
NIH Toolbox Oral Reading Recognition Test Age 3+ v2.0	-0.275 (0.087)	1.62E-03	0.347%	7.94E-03
Stress CBCL Scale2007 Scale	0.138 (0.047)	3.25E-03	0.252%	1.41E-02
Conduct Problems CBCL DSM5 Scale	0.09 (0.031)	3.39E-03	0.322%	1.41E-02
BIS/BAS: BAS drive	0.122 (0.042)	3.58E-03	0.217%	1.41E-02
UPPS-P for Children Short Form (ABCD-version), Negative Urgency	0.106 (0.038)	4.87E-03	0.191%	1.80E-02
Disorders of Initiating and Maintaining Sleep (DIMS) SUM	0.149 (0.054)	5.95E-03	0.204%	2.06E-02
UPPS-P for Children Short Form (ABCD-version), Positive Urgency	0.108 (0.04)	7.08E-03	0.259%	2.27E-02
Crystallized Composite	-0.227 (0.084)	7.32E-03	0.286%	2.27E-02
UPPS-P for Children Short Form (ABCD-version), Lack of Planning	0.089 (0.034)	9.27E-03	0.173%	2.74E-02
Parent General Behavior Inventory SUM	0.082 (0.033)	1.43E-02	0.244%	3.89E-02
Social Problems CBCL Syndrome Scale	0.077 (0.031)	1.45E-02	0.237%	3.89E-02
Parental Monitoring: Mean	-0.015 (0.007)	2.15E-02	0.171%	5.51E-02
Prodromal Psychosis: Severity Score Sum	0.301 (0.132)	2.27E-02	0.204%	5.58E-02
Cognition Total Composite Score	-0.227 (0.106)	3.24E-02	0.236%	7.64E-02
Thought Problems CBCL Syndrome Scale	0.067 (0.032)	3.66E-02	0.153%	8.31E-02
SRPF School Disengagement Subscale, Sum	0.042 (0.021)	4.33E-02	0.105%	9.46E-02
Conflict Subscale from the Family Environment Scale Sum of Youth Report	0.054 (0.028)	5.65E-02	0.124%	1.19E-01
Total Score (Sum of 6 Factors)	0.196 (0.11)	7.46E-02	0.134%	1.52E-01
Prosocial Behavior Subscale Mean of Youth Self Report	-0.009 (0.005)	7.91E-02	0.045%	1.56E-01
BIS/BAS: BAS Fun Seeking	0.066 (0.038)	8.51E-02	0.088%	1.56E-01
SRPF School Involvement Subscale, Sum	-0.058 (0.034)	8.67E-02	0.089%	1.56E-01
Depressive Problems CBCL DSM5 Scale	0.049 (0.029)	8.75E-02	0.091%	1.56E-01
Somatic Problems CBCL DSM5 Scale	0.036 (0.022)	1.05E-01	0.095%	1.82E-01
NIH Toolbox Picture Vocabulary Test Age 3+ v2.0	-0.155 (0.099)	1.18E-01	0.134%	1.95E-01
BIS/BAS: BAS Reward Responsiveness	0.066 (0.042)	1.20E-01	0.068%	1.95E-01
NIH Toolbox Picture Sequence Memory Test Age 8+ Form A v2.0	-0.265 (0.172)	1.22E-01	0.118%	1.95E-01
Disorder of Arousal (DA) SUM	-0.018 (0.012)	1.42E-01	0.018%	2.21E-01

NIH Toolbox List Sorting Working Memory Test Age 7+ v2.0	-0.217 (0.154)	1.60E-01	0.140%	2.43E-01
Somatic Complaints CBCL Syndrome Scale	0.038 (0.028)	1.69E-01	0.074%	2.49E-01
CRPBI - Acceptance Subscale Mean of Report by Secondary Caregiver by youth	-0.007 (0.006)	1.82E-01	0.062%	2.56E-01
Anxiety Disorder CBCL DSM5 Scale	0.047 (0.036)	1.82E-01	0.053%	2.56E-01
Anxious/Depressed CBCL Syndrome Scale	0.06 (0.046)	1.90E-01	0.037%	2.61E-01
Sleep-Wake transition Disorders (SWTD) SUM	0.048 (0.038)	2.05E-01	0.061%	2.74E-01
CRPBI - Acceptance Subscale Mean of Report by Parent Completing Protocol by youth	-0.005 (0.004)	2.32E-01	0.058%	3.04E-01
Cognition Fluid Composite	-0.146 (0.134)	2.74E-01	0.101%	3.51E-01
Internalizing Problems CBCL Syndrome Scale	0.081 (0.079)	3.02E-01	0.041%	3.79E-01
UPPS-P for Children Short Form (ABCD-version), Sensation Seeking	0.037 (0.038)	3.25E-01	0.005%	4.00E-01
Sleep Hyperhydrosis (SHY) SUM	0.015 (0.017)	3.82E-01	0.030%	4.59E-01
Obsessive-Compulsive Problems CBCL Scale2007 Scale	0.023 (0.027)	3.89E-01	0.024%	4.59E-01
Withdrawn/Depressed CBCL Syndrome Scale	-0.017 (0.024)	4.79E-01	0.000%	5.54E-01
NIH Toolbox Dimensional Change Card Sort Test Ages 8-11 v2.0	-0.084 (0.121)	4.88E-01	0.040%	5.54E-01
Sluggish Cognitive Tempo CBCL Scale2007 Scale	0.008 (0.014)	5.82E-01	0.031%	6.48E-01
NIH Toolbox Flanker Inhibitory Control and Attention Test Ages 8-11 v2.0	0.059 (0.117)	6.14E-01	0.001%	6.71E-01
SRPF School Environment Subscale, Sum	-0.017 (0.04)	6.64E-01	0.016%	7.12E-01
BIS/BAS: BIS Sum	-0.008 (0.053)	8.78E-01	0.000%	9.25E-01
Disorders of Excessive Somnolence (DOES) SUM	0.002 (0.033)	9.42E-01	0.017%	9.75E-01
Sleep Breathing disorders (SBD)	-0.001 (0.015)	9.65E-01	0.004%	9.82E-01
NIH Toolbox Pattern Comparison Processing Speed Test Age 7+ v2.0	0.002 (0.201)	9.91E-01	0.003%	9.91E-01

Table S6: The white matter tracts (quantified as FA values) significantly associated with PRS^{ADHD} (FDR < 0.05). R^2 denotes the proportion of phenotype variance explained by PRS^{ADHD}. 'std_β' denotes the standardized coefficient of this DTI measure in the regression analysis.

DTI measures	Connection	std_β	*p*	R^2
Global measures				
all tract fibers		-3.459	5.48E-04	0.33%
L tract fibers		-3.440	5.88E-04	0.30%
R tract fibers		-3.389	7.08E-04	0.35%
R tract fibers without corpus callosum		-3.290	1.01E-03	0.32%
L tract fibers without corpus callosum		-3.177	1.50E-03	0.24%
Regional measures				
L uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-3.517	4.41E-04	0.19%
R uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-3.264	1.11E-03	0.29%
R corticospinal tract or pyramidal tract	motor cortex & spinal cord	-3.141	1.70E-03	0.32%
L inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-3.124	1.80E-03	0.24%
R temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-3.052	2.29E-03	0.32%
corpus callosum	left cortex & right cortex	-2.965	3.05E-03	0.28%
R inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-2.862	4.24E-03	0.28%
R superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-2.693	7.12E-03	0.28%
L inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-2.637	8.39E-03	0.22%
L corticospinal tract or pyramidal tract	motor cortex & spinal cord	-2.634	8.46E-03	0.21%
R inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-2.624	8.74E-03	0.27%
L anterior thalamic radiations	thalamus & frontal lobe	-2.534	1.13E-02	0.09%
R anterior thalamic radiations	thalamus & frontal lobe	-2.485	1.30E-02	0.07%
L inferior frontal-striatal tract	inferior frontal cortex & striatum	-2.473	1.34E-02	0.22%
R parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-2.435	1.49E-02	0.24%
forceps major	left occipital cortex & right occipital cortex	-2.369	1.79E-02	0.22%
R cingulum (cingulate)	cingulate gyrus & entorhinal cortex (cingulate portion)	-2.311	2.09E-02	0.13%
R inferior frontal-striatal tract	inferior frontal cortex & striatum	-2.285	2.24E-02	0.21%

Table S7: The white matter tracts (quantified as FA values) significantly correlated with STU (FDR < 0.05). R^2 denotes the proportion of phenotype variance explained by this DTI measure. 'std_β' denotes the standardized coefficient of this DTI measure in the regression analysis.

DTI measures	Connection	std_β	p	R^2
Global measures				
R tract fibers		-3.311	9.34E-04	0.67%
all tract fibers		-3.228	1.25E-03	0.78%
R tract fibers without corpus callosum		-3.226	1.26E-03	0.71%
L tract fibers		-3.083	2.06E-03	0.84%
L tract fibers without corpus callosum		-2.745	6.07E-03	0.87%
Regional measures				
R superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-3.661	2.53E-04	0.47%
R parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-3.598	3.23E-04	0.45%
R temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-3.541	4.01E-04	0.49%
L fornix	hippocampus & mammilary nuclei of hypothalamus	-3.538	4.05E-04	1.26%
R fornix	hippocampus & mammilary nuclei of hypothalamus	-3.278	1.05E-03	0.95%
corpus callosum	left cortex & right cortex	-3.139	1.70E-03	0.46%
L parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-3.070	2.15E-03	0.85%
forceps minor	left prefrontal cortex & right prefrontal cortex	-3.009	2.63E-03	0.03%
L corticospinal tract or pyramidal tract	motor cortex & spinal cord	-2.999	2.72E-03	0.38%
R uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-2.835	4.60E-03	0.09%
L superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-2.778	5.49E-03	0.96%
R inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-2.762	5.75E-03	0.92%
R corticospinal tract or pyramidal tract	motor cortex & spinal cord	-2.591	9.59E-03	0.43%
L temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-2.463	1.38E-02	0.92%
R inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-2.431	1.51E-02	0.12%
L inferior frontal-striatal tract	inferior frontal cortex & striatum	-2.177	2.95E-02	0.06%
L anterior thalamic radiations	thalamus & frontal lobe	-2.153	3.14E-02	0.18%
R superior corticostriate (parietal)	superior parietal cortex & striatum	-2.113	3.47E-02	0.44%
R cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)	-2.102	3.56E-02	0.48%

Table S8: The white matter tracts (quantified as FA values) significantly correlated with the ADHD scale (FDR < 0.05). R^2 denotes the proportion of phenotype variance explained by this DTI measure. 'std_β' denotes the standardized coefficient of this DTI measure in the regression analysis.

DTI measures	Connection	std_β	p	R^2
Global measures				
L tract fibers without corpus callosum		-5.520	3.51E-08	0.61%
L tract fibers		-5.269	1.41E-07	0.61%
all tract fibers		-5.145	2.75E-07	0.60%
R tract fibers		-4.877	1.10E-06	0.56%
R tract fibers without corpus callosum		-4.806	1.57E-06	0.49%
Regional measures				
L uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-5.672	1.47E-08	0.31%
L inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-5.082	3.82E-07	0.61%
L parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-4.795	1.66E-06	0.49%
R inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-4.751	2.06E-06	0.55%
R uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-4.621	3.88E-06	0.39%
R parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-4.476	7.72E-06	0.34%
L superior corticostriate	superior cortex & striatum	-4.463	8.22E-06	0.49%
L superior corticostriate (parietal)	superior parietal cortex & striatum	-4.406	1.07E-05	0.48%
L superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-4.398	1.11E-05	0.44%
L inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-4.341	1.44E-05	0.57%
R superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-4.152	3.34E-05	0.31%
L superior corticostriate (frontal)	superior frontal cortex & striatum	-4.152	3.34E-05	0.40%
corpus callosum	left cortex & right cortex	-4.136	3.58E-05	0.45%
L temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-4.055	5.07E-05	0.40%
L corticospinal tract or pyramidal tract	motor cortex & spinal cord	-3.961	7.54E-05	0.29%
L inferior longitudinal fasciculus	occipital lobe & temporal lobe	-3.831	1.29E-04	0.39%
L inferior frontal-striatal tract	inferior frontal cortex & striatum	-3.606	3.13E-04	0.30%
forceps minor	left prefrontal cortex & right prefrontal cortex	-3.599	3.22E-04	0.24%
R corticospinal tract or pyramidal tract	motor cortex & spinal cord	-3.451	5.62E-04	0.29%
R superior corticostriate	superior cortex & striatum	-3.372	7.51E-04	0.24%
R cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)	-3.265	1.10E-03	0.20%
R inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-3.257	1.13E-03	0.40%
R superior corticostriate (frontal)	superior frontal cortex & striatum	-3.254	1.14E-03	0.22%
R inferior frontal-striatal tract	inferior frontal cortex & striatum	-3.248	1.17E-03	0.24%
R cingulum (cingulate)	cingulate gyrus & entorhinal cortex (cingulate portion)	-3.145	1.67E-03	0.06%
forceps major	left occipital cortex & right occipital cortex	-3.132	1.75E-03	0.21%
R superior corticostriate (parietal)	superior parietal cortex & striatum	-3.118	1.83E-03	0.24%
R temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-3.105	1.91E-03	0.22%
R anterior thalamic radiations	thalamus & frontal lobe	-3.069	2.16E-03	0.05%
L cingulum (cingulate)	cingulate gyrus & entorhinal cortex (cingulate portion)	-3.010	2.62E-03	0.06%
R inferior longitudinal fasciculus	occipital lobe & temporal lobe	-2.732	6.30E-03	0.23%
L cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)	-2.551	1.08E-02	0.12%
L anterior thalamic radiations	thalamus & frontal lobe	-2.275	2.29E-02	0.03%

Table S9: Associations between the white matter tracts (quantified as FA values) and the ADHD scale with head motion included as a covariate (ABCD ID: iqc_dmri_1_mean_motion). R^2 denotes the proportion of phenotype variance explained by this DTI measure. 'std_β' denotes the standardized coefficient of this DTI measure in the regression analysis.

DTI measures	Connection	std_β	*p*	R^2	FDR
Global measures					
L tract fibers without corpus callosum		-3.234	1.23E-03	0.61%	1.14E-02
L tract fibers		-2.837	4.57E-03	0.61%	2.56E-02
all tract fibers		-2.630	8.56E-03	0.60%	3.89E-02
R tract fibers without corpus callosum		-2.340	1.93E-02	0.49%	6.90E-02
R tract fibers		-2.309	2.10E-02	0.56%	7.20E-02
Regional measures					
L uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-3.722	1.99E-04	0.31%	7.59E-03
L superior corticostriate (parietal)	superior parietal cortex & striatum	-3.476	5.12E-04	0.48%	7.81E-03
L superior corticostriate	superior cortex & striatum	-3.417	6.36E-04	0.49%	8.39E-03
L inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-3.056	2.25E-03	0.61%	1.69E-02
L superior corticostriate (frontal)	superior frontal cortex & striatum	-3.035	2.41E-03	0.40%	1.69E-02
R inferior fronto-occipital fasciculus	occipital lobe & frontal lobe	-2.659	7.86E-03	0.55%	3.89E-02
R superior corticostriate	superior cortex & striatum	-2.641	8.29E-03	0.24%	3.89E-02
L parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-2.539	1.11E-02	0.49%	4.68E-02
R superior corticostriate (frontal)	superior frontal cortex & striatum	-2.502	1.24E-02	0.22%	5.07E-02
L corticospinal tract or pyramidal tract	motor cortex & spinal cord	-2.450	1.43E-02	0.29%	5.58E-02
R uncinate fasciculus	inferior frontal lobe & anterior temporal lobe	-2.347	1.89E-02	0.39%	6.90E-02
R superior corticostriate (parietal)	superior parietal cortex & striatum	-2.283	2.25E-02	0.24%	7.55E-02
L superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-2.209	2.72E-02	0.44%	8.79E-02
R parietal superior longitudinal fasciculus	parietal lobe & frontal lobe	-2.187	2.88E-02	0.34%	8.96E-02
L inferior longitudinal fasciculus	occipital lobe & temporal lobe	-2.065	3.89E-02	0.39%	1.15E-01
L inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-2.014	4.41E-02	0.57%	1.25E-01
L temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-1.920	5.49E-02	0.40%	1.49E-01
R superior longitudinal fasciculus	temporal and parietal lobes & frontal lobe	-1.900	5.74E-02	0.31%	1.53E-01
R cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)	-1.778	7.55E-02	0.20%	1.92E-01
R corticospinal tract or pyramidal tract	motor cortex & spinal cord	-1.753	7.97E-02	0.29%	2.00E-01
R anterior thalamic radiations	thalamus & frontal lobe	-1.614	1.06E-01	0.05%	2.48E-01
corpus callosum	left cortex & right cortex	-1.592	1.11E-01	0.45%	2.56E-01
forceps major	left occipital cortex & right occipital cortex	-1.469	1.42E-01	0.21%	3.04E-01
L inferior frontal-striatal tract	inferior frontal cortex & striatum	-1.454	1.46E-01	0.30%	3.04E-01
R inferior frontal-striatal tract	inferior frontal cortex & striatum	-1.439	1.50E-01	0.24%	3.04E-01
R cingulum (cingulate)	cingulate gyrus & entorhinal cortex (cingulate portion)	-1.308	1.91E-01	0.06%	3.26E-01
forceps minor	left prefrontal cortex & right prefrontal cortex	-1.296	1.95E-01	0.24%	3.28E-01
L cingulum (cingulate)	cingulate gyrus & entorhinal cortex (cingulate portion)	-1.041	2.98E-01	0.06%	4.39E-01
R temporal superior longitudinal fasciculus	temporal lobe & frontal lobe	-1.024	3.06E-01	0.22%	4.43E-01
L cingulum (parahippocampal)	cingulate gyrus & entorhinal cortex (parahippocampal portion)	-0.956	3.39E-01	0.12%	4.75E-01
R inferior frontal superior frontal tract	inferior frontal cortex & superior frontal cortex	-0.902	3.67E-01	0.40%	5.02E-01
R inferior longitudinal fasciculus	occipital lobe & temporal lobe	-0.844	3.99E-01	0.23%	5.31E-01
L anterior thalamic radiations	thalamus & frontal lobe	-0.755	4.50E-01	0.03%	5.74E-01
L fornix	hippocampus & mammilary nuclei of hypothalamus	-0.590	5.55E-01	0.10%	6.62E-01
R fornix	hippocampus & mammilary nuclei of hypothalamus	-0.124	9.01E-01	0.03%	9.29E-01

References

1 Hagler DJ, Ahmadi ME, Kuperman J, Holland D, Dale AM. Automated white-matter tractography using a probabilistic diffusion tensor atlas: Application to temporal lobe epilepsy. *Human Brain Mapping* 2010; **30**(5): 1535-47.