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Supplemental material

METHODS

Detailed recruitment procedures

An initial screening regarding CSBD and inclusion and exclusion criteria was made by telephone interview. Potential participants received information about the study and were invited to log into a secure web-based platform, leave a preliminary informed consent, and fill in questionnaires including details on personal information. Furthermore, detailed information on the study protocol was provided including that participation was voluntary and could be interrupted at any time. The participants were thereafter evaluated face to face by a psychiatrist and a psychologist at ANOVA Clinic, Karolinska University Hospital, Stockholm, Sweden. The psychiatrist obtained the medical history, assessed for CSBD according to the ICD-11 criteria and for psychiatric diagnoses using the Mini International Neuropsychiatric Interview (Sheehan et al., 1998). The study psychologist verified the participant's responses of sexual behaviors in the web-based questionnaires (e.g., the Hypersexual Disorder Screening Inventory, HDSI (Parsons et al., 2013), conducted a structured interview addressing the criteria for CSBD and HD, as well as assessed for paraphilia(s) in accordance with the criteria specified in DSM-5. To be eligible for the study, the participants had to meet the criteria of CSBD in ICD-11, and fulfill 3 of the 5 A-criteria and one of 2 B-criteria of the suggested DSM-5 conceptualization for HD as it was originally proposed (Kafka, 2010).

Participants were considered as eligible if both the psychiatrist and the psychologist agreed on the eligibility criteria and none of the psychiatric exclusion criteria (see below). Eligible participants were enrolled after signing a written informed consent. Study participants where the invited to Karolinska Institutet for cognitive and MRI data assessment performed by trained personal.

Inclusion criteria

Because of the high prevalence of males in CSBD and to facilitate recruitment and study completion, participants were male, at least 18 years of age, and fluent in the Swedish language. Patients had not started with any psychotherapy or psychological treatment. Controls were physically and psychologically healthy and show no indication of HD or CSBD, e.g., a score below 20 points on the Hypersexual Disorder Screening Inventory (HDSI,), and below 53 points on the Hypersexual Behavior Inventory (HBI) (Reid, Garos, & Carpenter, 2011).

Exclusion criteria

For both patients and controls any reported medical or clinical condition known to affect brain structure and function, test performance, or associated with risks for the MRI environment were exclusionary. We excluded for severe neurological/psychiatric diseases or conditions (e.g., major depression, bipolar disorder, ADHD, panic/ anxiety disorder, autism, obsessive compulsive disorder, personality disorder, Parkinson's disease, epilepsy, PTSD, chronic stress/burnout syndrome, Alzheimer's disease, dementia, history of psychotic symptoms). We further excluded for gender identity disorder/gender dysphoria and pedophilic disorder. We excluded persons reporting impaired vision, or other vision problems that cannot be corrected with MR-safe equipment, to assure the adequate performance in vision based fMRI

experiments, hearing impairments, or problems with other senses, history of severe brain damage/injuries, claustrophobia. Any MRI contraindications were exclusionary: e.g., having metal implants or a pacemaker. We further excluded for alcohol/drug dependence, eating disorder (e.g. binge-eating), pathological gambling, during the past 6 months, HIV and hepatitis C/B, if the condition was untreated or virus levels detectable, untreated endocrine diseases (e.g., thyroid disorder, pituitary dysfunction, gonadal dysfunction or diabetes). Use of the following medication types were excluded: benzodiazepines, antipsychotics, mood stabilizers (e.g., lithium), antidepressants/SSRI (if use started less than 3 months ago), any medication or pharmaceutical drug that interferes with sex hormone production or metabolism, e.g., ketoconazole, cyproterone acetate, spironolactone. Due to a potentially higher prevalence of comorbidities in HD patients (Kafka), we did not exclude patients who reported depression, GAD, panic disorder, ADHD, chronic pain, or an episode of elevated mood (hypomania). Full blown mania and bipolar disorder was however excluded. Paraphilias were also allowed in patients. The corresponding information was recorded in order to control for potential confounders. However, severe depression requiring immediate treatment, change of concurrent medication or dosage in the last 3 months, sexual behaviors with high risk for offending, or ongoing psychotherapeutic treatment were excluded.

No participants were excluded after enrolment. One patient did not provide MRI data due to discomfort in the MR scanner.

Questionnaires

Using questionnaires we assessed depression symptom levels (Montgomery Asberg Depression Rating Scale (MADRS-S) (Montgomery & Asberg, 1979; Svanborg & Asberg, 2001), attention-deficit levels (Adult ADHD Self-Report Scale (ASRS) (Kessler et al., 2005), alcohol and drug consumption (Alcohol Use Disorders Identification Test (AUDIT) (Bergman & Kallmen, 2002); Drug Use Disorders Identification Test (DUDIT) (Berman, Bergman,

Palmstierna, & Schlyter, 2005), hypersexual symptoms (Hypersexual Disorder Screening Inventory (HDSI) (Parsons et al., 2013), Hypersexual Behavior Inventory (HBI) (Reid, Garos, & Carpenter, 2011), sexual compulsivity (Sexual Compulsivity Scale (SCS) (Kalichman & Rompa, 1995), State-Trait Anxiety Inventory - State (STAI-S) (Tluczek, Henriques, & Brown, 2009), autism spectrum disorder symptoms (Ritvo Autism Asperger Diagnostic Scale (RAADS) (Eriksson, Andersen, & Bejerot, 2013), sexual desire (Sexual Desire Inventory (SDI) (Spector, Carey, & Steinberg, 1996), general impulsivity (Barratt Impulsiveness Scale (BIS-11) (Stanford et al., 2009), and behavioral inhibition (Behavioral Inhibition/Activation System (BIS/BAS) (Carver & White, 1994).

In addition, we assessed sexual orientation through the Kinsey scale where a score of 0 corresponds to 'exclusively heterosexual' and a score of 6 to 'exclusively homosexual' (Kinsey, Pomeroy, & Martin, 1948). Finally, we assessed the frequency of sexual encounters within the last 6 months, as well as weekly pornography consumption.

Sensitivity analyses

We repeated group comparisons while using each variable listed in Table S1a as additional covariates (one at a time). For some variables, i.e., self-reported medication use and comorbidity, where the number of participants with a specific comorbidity or medication use was low (see Table S1b), sensitivity test were conducted by repeating the group comparisons while excluding corresponding participants.

Table S1a. Variables controlled for in sensitivity analyses

Control variable	p-value of case-control difference
AUDIT[a]	0.013
MADRS[a]	0.286

DUDIT[a]	0.003
ASRS[a]	0.010
RAADS-14[a]	0.011
BIS-11[a]	0.037
BAS drive[a]	0.009
BAS fun seeking[a]	0.008
BAS reward response[a]	0.003
BIS[a]	0.002
Kinsey scale[a]	0.004
STAI-S[a]	< 0.001
Depression[b]	0.003
Panic disorder[b]	0.005
General anxiety disorder (GAD) [b]	0.005
ADHD[b]	0.004
Chronic pain[b]	0.004
Hypomania[b]	0.005
Antidepressants[b]	0.011
Antihistamines[b]	0.008
Anxiety medicication[b]	0.003
Central stimulants[b]	0.010
Bloodpressure medication[b]	0.005
BMI[a]	0.011
Handedness[b]	0.003
Smoking[b]	0.002
Moist snuff[b]	0.009
Total brain volume[a]	0.001
Non-verbal intelligence[a,*]	0.003

a: used as covariate, b: participants who had that specific comorbidity or used that medication type were excluded from analyses; for smoking and moist snuff use, only non-users, and for handedness, only right handed individuals were included in sensitivity analyses.

*Measured with Ravens Standard Progressive Matrices, SPM (Raven, Raven, & Court, 2000) as part of the cognitive test battery previously reported in (Liberg et al., 2022).

Table S1b: Medication use and psychiatric comorbidity

	HC (n=20)	CSBD (n=23)	HC vs. CSBD, p
Medication			
antihistamine	3	2	0.431
stimulants	0	2	0.280
blood pressure	0	2	0.144
antidepressants	1	4	0.219
Comorbidity			
Panic disorder	0	1	0.535
GAD	0	2	0.280
ADHD	0	2	0.280
Chronic pain	0	1	0.535
Hypomania	0	1	0.535
Depression	0	2	0.280

These results have been reported and discussed previously (Liberg et al., 2022), but are listed here to provide reasoning for sensitivity tests conducted.

Table S2. Frequency of sexual encounters

Sexual encounter information	Group	Mean	SD	p

Nr of same-sex partners (last month)	HC	0.1	0.308	0.409
	CSBD	0.61	2.709	
Nr of same-sex partners (last 6 months)	HC	0.25	0.91047	0.383
	CSBD	1.6957	7.27658	
Nr of opposite-sex partners (last month)	HC	0.95	0.60481	
	CSBD	1.1304	0.96786	0.476
Nr of opposite-sex partners (last 6 months)	HC	1.25	1.06992	
	CSBD	3.5217	5.22989	0.064
Frequency of same-sex intercourse (last month)	HC	0.5	1.79179	
	CSBD	1.0435	4.21554	0.595
Frequency of same-sex intercourse (last 6 months)	HC	3.45	13.38292	
	CSBD	2.7826	9.71857	0.851
Frequency of opposite-sex intercourse (last month)	HC	4.2	4.112	
	CSBD	3.48	5.624	0.638
Frequency of opposite-sex intercourse (last 6 months)	HC	23.2	20.526	
	CSBD	20.48	32.404	0.748

Table S3. Group differences in subcortical volume ROIs. Volumetric measures are given in mm^3

Brain region	HC		CSBD		F (1, 39)	p	Cohens d
	Mean	SD	Mean	SD			
Rh Accumbens	666.1	68.8	694.0	85.5	1.458	0.234	0.36
Rh Amygdala	1916.1	222.8	1843.9	187.7	1.302	0.261	-0.35
Rh Caudate	3632.4	421.3	3751.4	479.6	0.705	0.406	0.26
Lh Accumbens	619.8	96.5	592.0	88.2	0.976	0.329	-0.30
Lh Amygdala	1748.0	230.6	1742.6	214.6	0.006	0.938	-0.024
Lh Caudate	3609.0	393.4	3622.2	469.8	0.01	0.921	0.030

Table S4. Correlation between level of CSBD symptoms and right posterior cingulate surface area

	Total sample		HC		CSBD	
Measurement	beta	p	beta	p	beta	p
HDSI	-0.449	0.003	-0.213	0.396	-0.029	0.903
HBI	-0.407	0.008	0.060	0.816	-0.012	0.960
SCS	-0.396	0.011	0.094	0.701	0.003	0.989
SDI	-0.312	0.061	0.009	0.972	-0.063	0.812

Table S5. Whole brain analysis: surface area (exploratory)

	HC		CSBD				
Brain region	Mean	SD	Mean	SD	$F_{(1, 39)}$	p	Cohens d
Rh posterior cingulate	1301.75	181.2	1156.78	117.37	9.42	0.004	0.95
Rh caudalanteriorcingulate	763.74	148.23	664.1	110.95	6.17	0.017	0.76
lh_posteriorcingulate_area	1148.16	119.27	1260.17	187.26	5.09	0.030	-0.71
rh_inferiortemporal_area	3506.53	385.46	3305.79	309.58	3.42	0.072	0.57
lh_middletemporal_area	3347.86	340.48	3160.17	332.29	3.34	0.075	0.56
lh_paracentral_area	1343.58	111.01	1416.11	152.64	2.97	0.093	-0.54
rh_paracentral_area	1498.3	143.09	1578.23	172.92	2.6	0.115	-0.50
rh_rostralanteriorcingulate_area	654.8	111	609.14	91.61	2.08	0.157	0.45
lh_isthmuscingulate_area	1099.11	158.16	1037.77	122.16	1.95	0.170	0.43
rh_middletemporal_area	3619.1	467.68	3438.77	372.85	1.89	0.178	0.43

9

rh_isthmuscingulate_area	947.74	114.57	899.83	126.35	1.61	0.212	0.4
rh_fusiform_area	3271.11	374.41	3129.4	391.91	1.48	0.232	0.37
lh_inferiorparietal_area	4730.31	742.87	4499.99	454.71	1.46	0.234	0.37
lh_supramarginal_area	4180.2	538.34	4390.32	657.91	1.32	0.258	-0.35
rh_entorhinal_area	449.19	74.55	421.28	83.09	1.27	0.267	0.35
rh_bankssts_area	902	137.64	853.86	139.41	1.25	0.271	0.35
rh_parstriangularis_area	1609.66	274.2	1528.45	216.45	1.24	0.272	0.33
rh_lateraloccipital_area	5222.87	460.84	5409.39	697.23	1.18	0.284	-0.32
lh_lateralorbitofrontal_area	2861.49	275.65	2780.1	290.63	0.85	0.363	0.29
lh_medialorbitofrontal_area	2098.28	261.6	2034.11	195.09	0.83	0.367	0.28
lh_frontalpole_area	271.5	39.23	262.18	28.88	0.76	0.389	0.27
lh_bankssts_area	1033.64	265.82	974.05	171.26	0.74	0.394	0.27
lh_parsopercularis_area	1730.26	282.01	1652.63	296.71	0.74	0.394	0.27
rh_inferiorparietal_area	5544.03	831.41	5360.93	551.14	0.72	0.401	0.26
lh_precuneus_area	4116.52	431.6	4005.26	418.51	0.71	0.405	0.26
lh_rostralanteriorcingulate_area	916.58	143.95	876.15	166.15	0.69	0.412	0.26
rh_lingual_area	3310.2	301.97	3393.86	372.7	0.62	0.434	-0.25
rh_lateralorbitofrontal_area	2969.01	336.19	2890.54	324.93	0.58	0.450	0.24
lh_lingual_area	3098.14	342.8	3022.51	360.99	0.47	0.497	0.21
rh_pericalcarine_area	1554.65	227.66	1603.5	243.56	0.44	0.510	-0.21
rh_insula_area	2421.97	217.75	2474.07	283.69	0.43	0.516	-0.21
lh_cuneus_area	1607.44	242.88	1557.78	271.11	0.4	0.533	0.19
lh_lateraloccipital_area	5309.34	591.03	5216.42	421.4	0.35	0.561	0.18
lh_transversetemporal_area	487.94	90.76	473.55	67.29	0.34	0.562	0.18

rh_superiortemporal_area	3699.1	319.92	3758.45	362.87	0.31	0.582	-0.17
lh_superiorparietal_area	5781.87	592.73	5685.98	614.71	0.28	0.599	0.16
lh_temporalpole_area	504.73	96.41	489.38	89.23	0.28	0.60	0.17
lh_entorhinal_area	525.51	47.15	533.22	45.99	0.28	0.60	-0.17
lh_caudalmiddlefrontal_area	2343.27	383.25	2400.4	345.4	0.25	0.618	-0.16
lh_parsorbitalis_area	729.78	81.03	742.79	86.84	0.25	0.618	-0.15
lh_WhiteSurfArea_area	90139.52	6052.66	89274.26	5430.91	0.24	0.630	0.15
rh_precuneus_area	4283.24	501.49	4209.96	504.9	0.22	0.644	0.15
rh_superiorfrontal_area	7582.65	674.04	7479.64	739.38	0.22	0.645	0.15
rh_WhiteSurfArea_area	89720.42	6198.81	88874.18	5612.53	0.21	0.646	0.14
rh_parahippocampal_area	640.55	79.95	651.55	78.22	0.21	0.652	-0.14
rh_postcentral_area	4030.81	395.76	4084.81	415.56	0.18	0.673	-0.13
rh_superiorparietal_area	5602.7	580.74	5537.13	509.95	0.15	0.697	0.12
rh_frontalpole_area	339.07	35.05	335.57	24.32	0.15	0.704	0.12
lh_inferiortemporal_area	3534.92	371.08	3496.03	318.83	0.13	0.720	0.11
lh_superiortemporal_area	4197.69	420.54	4147.56	490.14	0.13	0.723	0.11
rh_rostralmiddlefrontal_area	5998.43	798.36	6077.16	695.77	0.12	0.731	-0.11
rh_temporalpole_area	508.1	63.47	501.64	73.07	0.09	0.764	0.09
rh_medialorbitofrontal_area	2106.33	171.44	2091.7	169.59	0.08	0.780	0.09
rh_cuneus_area	1677.87	182.98	1694.39	197.75	0.08	0.783	-0.09
lh_superiorfrontal_area	7804.51	718.84	7747.68	665.48	0.07	0.793	0.08
lh_caudalanteriorcingulate_area	666.49	141	676.78	111.39	0.07	0.795	-0.08
lh_insula_area	2501.02	181.36	2485.53	246.87	0.05	0.822	0.07

lh_postcentral_area	4224.25	431.31	4251.23	427.71	0.04	0.842	-0.06
rh_supramarginal_area	3805.59	500.05	3831.46	442.26	0.04	0.852	-0.05
lh_pericalcarine_area	1420.63	229.72	1435.29	273.39	0.04	0.853	-0.06
lh_precentral_area	5068.01	345.86	5089.22	486.67	0.03	0.874	-0.05
lh_parahippocampal_area	683.6	73.35	680.09	70.44	0.03	0.876	0.05
rh_parsopecularis_area	1462.47	235.06	1474.26	262.73	0.02	0.878	-0.05
rh_transversetemporal_area	340.25	43.9	342.09	48.7	0.02	0.896	-0.04
lh_parstriangularis_area	1344.09	180.26	1351.56	222.9	0.02	0.903	-0.04
lh rostral middlefrontal_area	6147.34	735.92	6168.56	696.92	0.01	0.925	-0.03
rh_precentral_area	4949.5	515.35	4956.27	437.6	0	0.964	-0.01
rh_parsorbitalis_area	890.08	106.64	889.43	96.07	0	0.983	0.01
rh_caudalmiddlefrontal_area	2264.97	329.88	2266.76	331.88	0	0.986	-0.01
lh fusiform	3297.57	348.83	3297.11	270.2	0	0.996	0.00

Table S6. Whole brain analysis: Cortical thickness (exploratory)

Brain region	HC		CSBD		F (1. 39)	p	Cohens d
	Mean	SD	Mean	SD			
lh frontalpole	2.799	0.237	2.961	0.194	6.888	0.012	0.75
rh precuneus	2.495	0.097	2.572	0.13	6.348	0.016	0.67
lh superiorfrontal	2.803	0.154	2.89	0.148	5.726	0.022	0.58
rh caudalmiddlefrontal	2.494	0.111	2.566	0.125	4.605	0.038	0.61
lh parstriangularis	2.526	0.131	2.623	0.177	4.5	0.040	0.62
rh superiorfrontal	2.774	0.135	2.839	0.141	3.986	0.053	0.47
lh parsopercularis	2.644	0.107	2.714	0.154	3.432	0.072	0.53
rh posteriorcingulate	2.58	0.127	2.647	0.154	3.363	0.074	0.48
rh lateralorbitofrontal	2.717	0.113	2.781	0.125	3.344	0.075	0.54
rh superiorparietal	2.265	0.077	2.307	0.1	2.695	0.109	0.47
lh fusiform	2.838	0.095	2.884	0.099	2.627	0.113	0.47
rh parsopercularis	2.549	0.139	2.616	0.156	2.346	0.134	0.45
rh isthmuscingulate	2.594	0.2	2.679	0.204	2.178	0.148	0.42
lh paracentral	2.469	0.126	2.52	0.129	2.032	0.162	0.40
lh superiorparietal	2.221	0.078	2.256	0.109	1.825	0.185	0.37
rh paracentral	2.518	0.111	2.557	0.109	1.809	0.186	0.35
lh precuneus	2.424	0.096	2.461	0.114	1.795	0.188	0.35
rh fusiform	2.852	0.132	2.898	0.12	1.661	0.205	0.37
lh medialorbitofrontal	2.644	0.138	2.686	0.116	1.639	0.208	0.33
rh transversetemporal	2.5	0.161	2.575	0.213	1.581	0.216	0.40

lh caudalmiddlefrontal	2.603	0.133	2.653	0.161	1.562	0.219	0.34
lh parsorbitalis	2.853	0.139	2.908	0.168	1.399	0.244	0.36
rh inferiorparietal	2.513	0.095	2.544	0.103	1.313	0.259	0.31
rh rostralmiddlefrontal	2.367	0.088	2.396	0.083	1.285	0.264	0.34
lh rostralmiddlefrontal	2.524	0.13	2.569	0.161	1.259	0.269	0.31
lh rostralanteriorcingulate	2.944	0.208	2.999	0.177	1.22	0.276	0.28
rh parstriangularis	2.453	0.135	2.496	0.15	1.222	0.276	0.30
lh temporalpole	3.739	0.281	3.652	0.328	0.82	0.371	-0.29
lh superiortemporal	2.862	0.134	2.9	0.17	0.797	0.378	0.25
lh bankssts	2.457	0.159	2.418	0.138	0.785	0.381	-0.26
lh middletemporal	2.892	0.12	2.925	0.127	0.772	0.385	0.27
lh lateralorbitofrontal	2.847	0.137	2.876	0.106	0.605	0.441	0.24
rh pericalcarine	1.676	0.149	1.641	0.14	0.583	0.450	-0.24
lh pericalcarine	1.741	0.115	1.771	0.144	0.503	0.482	0.23
rh middletemporal	2.803	0.153	2.774	0.119	0.476	0.494	-0.21
lh insula	3.082	0.149	3.111	0.143	0.471	0.497	0.20
lh precentral	2.663	0.116	2.686	0.13	0.46	0.502	0.19
rh rostralanteriorcingulate	2.944	0.184	2.989	0.264	0.457	0.503	0.20
lh posteriorcingulate	2.58	0.154	2.606	0.169	0.453	0.505	0.16
lh lateraloccipital	2.211	0.074	2.227	0.109	0.343	0.561	0.17
lh isthmuscingulate	2.514	0.161	2.548	0.234	0.308	0.582	0.17
rh medialorbitofrontal	2.637	0.122	2.658	0.161	0.306	0.583	0.15
rh insula	3.065	0.134	3.09	0.196	0.278	0.601	0.15
rh caudalanteriorcingulate	2.524	0.231	2.558	0.255	0.272	0.605	0.14
rh precentral	2.583	0.091	2.6	0.117	0.271	0.605	0.16

lh entorhinal	3.56	0.265	3.521	0.242	0.233	0.632	-0.15
rh lingual	2.175	0.092	2.161	0.099	0.226	0.637	-0.15
rh postcentral	2.134	0.068	2.149	0.123	0.205	0.654	0.15
rh parsorbitalis	2.767	0.122	2.75	0.165	0.169	0.683	-0.12
lh transversetemporal	2.447	0.233	2.471	0.215	0.13	0.720	0.11
rh lateraloccipital	2.351	0.101	2.361	0.097	0.129	0.722	0.10
rh bankssts	2.52	0.142	2.534	0.113	0.124	0.727	0.11
rh supramarginal	2.537	0.099	2.549	0.134	0.105	0.747	0.10
lh parahippocampal	2.966	0.322	2.938	0.252	0.105	0.748	-0.10
lh lingual	2.188	0.119	2.197	0.108	0.075	0.785	0.08
rh frontalpole	2.844	0.227	2.863	0.283	0.061	0.807	0.07
lh cuneus	1.976	0.114	1.97	0.1	0.039	0.844	-0.06
rh temporalpole	3.704	0.29	3.688	0.308	0.028	0.868	-0.05
rh cuneus	2.003	0.14	2.01	0.134	0.026	0.873	0.05
rh parahippocampal	2.891	0.234	2.901	0.272	0.02	0.887	0.04
lh postcentral	2.193	0.088	2.189	0.122	0.02	0.888	-0.04
rh entorhinal	3.704	0.26	3.693	0.341	0.016	0.901	-0.04
lh inferiortemporal	2.91	0.122	2.913	0.1	0.008	0.929	0.03
lh supramarginal	2.548	0.105	2.545	0.139	0.007	0.932	-0.02
rh superiortemporal	2.825	0.128	2.822	0.136	0.006	0.941	-0.02
rh inferiortemporal	2.851	0.129	2.848	0.122	0.004	0.952	-0.02
lh caudalanteriorcingulate	2.691	0.273	2.69	0.226	0.001	0.981	0.00
lh inferiorparietal	2.443	0.132	2.443	0.117	0.001	0.981	0.00

Table S7. Whole brain analysis: subcortical volume (exploratory)

Brain region	HC Mean	SD	CSBD Mean	SD	F (1, 39)	p	Cohens d
Right Accumbens	666	69	694	86	1.458	0.234	0.36
Right Amygdala	1916	223	1844	188	1.302	0.261	-0.35
Left Hippocampus	4493	372	4354	424	1.243	0.272	-0.35
Left Accumbens	620	96	592	88	0.976	0.329	-0.30
Right Caudate	3632	421	3751	480	0.705	0.406	0.26
Right Thalamus	7440	672	7503	463	0.14	0.710	0.11
Left Thalamus	8072	849	8157	811	0.114	0.737	0.10
Right Putamen	4986	557	5031	520	0.104	0.749	0.08
Right Pallidum	2082	280	2108	230	0.101	0.752	0.10
Right Hippocampus	4452	367	4434	445	0.021	0.884	-0.05
Left Pallidum	2069	228	2077	238	0.015	0.902	0.04
Left Putamen	4938	543	4954	537	0.011	0.918	0.03
Left Caudate	3609	393	3622	470	0.01	0.921	0.03
Left Amygdala	1748	231	1743	215	0.006	0.938	-0.02

Table S8. Whole brain analysis: white matter volume (exploratory)

Brain region	HC		CSBD		F (1, 39)	p	Cohens *d*
	Mean	SD	Mean	SD			
lh-bankssts	2818.95	730.08	2783.85	760.29	0.023	0.881	-0.05
lh-caudalanteriorcingulate	2923.92	493.60	2954.27	376.52	0.05	0.825	0.07
lh-cuneus	2961.02	609.84	2775.8	450.38	1.254	0.270	-0.35
lh-entorhinal	1137.37	245.66	1092.25	236.71	0.359	0.552	-0.19
lh-fusiform	7225.17	797.68	6992.18	675.58	1.022	0.318	-0.32
lh-inferiorparietal	10427.41	1805.03	9915.12	1218.52	1.161	0.288	-0.33
lh-inferiortemporal	7123.86	957.19	6949.37	923.42	0.354	0.556	-0.19
lh-isthmuscingulate	4182.38	510.85	4087.58	412.64	0.446	0.508	-0.20
lh-lateraloccipital	10735.62	1724.31	10343.03	1228.56	0.714	0.403	-0.26
lh-lateralorbitofrontal	7473.91	929.21	7260.47	921.59	0.556	0.460	-0.23
lh-lingual	5806.30	859.37	5619.78	859.74	0.49	0.488	-0.22
lh-medialorbitofrontal	4352.63	697.94	4237.39	729.23	0.284	0.597	-0.16
lh-middletemporal	6108.49	906.18	5849.07	801.02	1.118	0.297	-0.30
lh-parahippocampal	1727.06	242.92	1691.96	187.48	0.275	0.603	-0.16

lh-paracentral	3953.88	542.23	4124.07	433.90	1.239	0.272	0.35
lh-parsopercularis	4011.26	762.67	3771.73	722.25	1.064	0.309	-0.32
lh-parsorbitalis	1109.26	190.95	1140.70	206.30	0.254	0.617	0.12
lh-parstriangularis	3325.36	472.82	3334.96	580.95	0.003	0.954	0.02
lh-pericalcarine	3613.89	805.76	3405.97	566.52	0.926	0.342	-0.30
lh-postcentral	7723.10	954.07	7719.54	1088.35	0	0.991	0.00
lh-posteriorcingulate	4604.09	470.09	4792.90	503.81	1.531	0.223	0.39
lh-precentral	14201.99	1192.64	14205.09	1396.76	0	0.994	0.00
lh-precuneus	10184.44	1654.50	9980.11	1377.58	0.186	0.669	-0.13
lh-rostralanteriorcingulate	2837.03	404.71	2814.39	495.88	0.025	0.874	-0.05
lh-rostralmiddlefrontal	14141.72	2024.59	14226.38	2225.58	0.016	0.899	0.04
lh-superiorfrontal	20069.72	2458.41	20007.50	1968.31	0.008	0.929	-0.03
lh-superiorparietal	13255.20	1605.14	13180.70	1551.34	0.023	0.880	-0.05
lh-superiortemporal	9153.49	1379.96	8956.19	1231.17	0.236	0.630	-0.15
lh-supramarginal	9600.74	1290.49	9906.46	1508.42	0.484	0.491	0.22
lh-frontalpole	331.81	82.33	300.73	57.78	2.013	0.164	-0.44
lh-temporalpole	817.17	100.19	804.74	102.90	0.163	0.689	-0.12
lh-transversetemporal	888.74	134.81	819.91	128.0	2.811	0.102	-0.52

lh-insula	10684.15	960.66	10637.58	945.07	0.024	0.877	-0.05
rh-bankssts	2825.81	537.12	2569.5	562.46	2.389	0.130	-0.47
rh-caudalanteriorcingulate	2947.11	449.03	2708.07	360.37	3.602	0.065	-0.59
rh-caudalmiddlefrontal	6230.73	1001.70	6248.91	1263.23	0.003	0.959	0.02
rh-cuneus	3043.73	505.95	3093.41	428.94	0.115	0.736	0.11
rh-entorhinal	999.63	199.04	882.77	177.46	3.959	0.054	-0.62
rh-fusiform	7036.90	1030.81	6582.22	728.79	2.783	0.103	-0.51
rh-inferiorparietal	12062.45	1837.57	11629.54	1394.52	0.743	0.394	-0.27
rh-inferiortemporal	6970.26	1107.54	6569.75	805.61	1.772	0.191	-0.41
rh-isthmuscingulate	3614.38	465.93	3503.83	462.48	0.581	0.451	-0.24
rh-lateraloccipital	11118.12	1477.95	11297.24	1720.79	0.13	0.721	0.11
rh-lateralorbitofrontal	7922.78	1136.11	7582.66	917.34	1.127	0.295	-0.33
rh-lingual	6513.62	902.96	6523.44	850.06	0.001	0.972	0.01
rh-medialorbitofrontal	4087.23	394.88	4057.58	440.59	0.055	0.816	-0.07
rh-middletemporal	6823.17	1111.43	6263.05	859.20	3.746	0.060	-0.56
rh-parahippocampal	1698.04	231.85	1675.42	257.14	0.092	0.763	-0.09
rh-paracentral	4874.44	774.53	5040.27	758.01	0.486	0.490	0.22
rh-parsopercularis	3569.21	619.88	3465.11	726.70	0.242	0.625	-0.15

rh-parsorbitalis	1409.23	277.36	1400.37	176.48	0.015	0.903	-0.04
rh-parstriangularis	3651.41	670.39	3417.65	451.62	1.792	0.188	-0.41
rh-pericalcarine	3758.80	752.78	3743.54	545.76	0.006	0.941	-0.02
rh-postcentral	7548.38	1073.55	7512.17	922.56	0.014	0.907	-0.04
rh-posteriorcingulate	**4731.51**	**477.42**	**4315.89**	**347.88**	**10.258**	**0.003**	**1.00**
rh-precentral	14108.79	1767.91	14024.38	1383.24	0.031	0.862	-0.05
rh-precuneus	10944.32	1973.81	10755.72	1522.47	0.122	0.729	-0.11
rh-rostralanteriorcingulate	2109.97	338.51	2161.74	373.93	0.215	0.646	0.15
rh-rostralmiddlefrontal	13620.40	1912.23	14040.18	1767.21	0.539	0.467	0.23
rh-superiorfrontal	19816.92	2596.70	19236.20	2237.32	0.606	0.441	-0.24
rh-superiorparietal	12848.31	1848.16	12514.92	1320.32	0.448	0.507	-0.21
rh-superiortemporal	7045.96	975.69	7048.57	931.39	0	0.993	0.00
rh-supramarginal	9327.63	1598.46	9199.87	1150.60	0.088	0.769	-0.09
rh-frontalpole	412.29	85.70	398.85	51.91	0.379	0.542	-0.19
rh-temporalpole	795.78	160.25	758.06	150.81	0.668	0.419	-0.24
rh-transversetemporal	598.08	114.06	645.22	154.35	1.221	0.276	0.35
rh-insula	10270.98	1004.82	10495.46	921.99	0.56	0.459	0.23

Note: across all white matter regions covering the whole brain, the only significant ($p<0.05$) case-control difference was found in white matter volume underlying the right posterior cingulate cortex (bold).
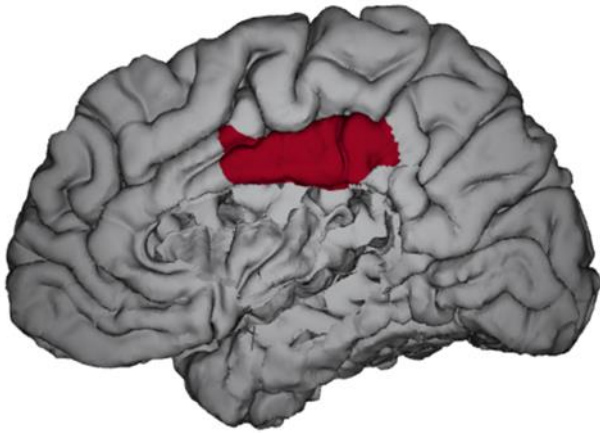
Figure S1. Anatomical location of posterior cingulate cortex, where case- control differences in

surface area where observed after multiple comparison correction.

REFERENCES

Kafka, M. P. (2010). Hypersexual disorder: a proposed diagnosis for DSM-V. *Archives of Sexual Behavior, 39*(2), 377-400. doi:10.1007/s10508-009-9574-7

Liberg, B., Görts-Öberg, K., Jokinen, J., Savard, J., Dhejne, C., Arver, S., . . . Abé, C. (2022). Neural and behavioral correlates of sexual stimuli anticipation point to addiction-like mechanisms in compulsive sexual behavior disorder. *J Behav Addict, 11*(2), 520-532. doi:10.1556/2006.2022.00035

Parsons, J. T., Rendina, H. J., Ventuneac, A., Cook, K. F., Grov, C., & Mustanski, B. (2013). A psychometric investigation of the hypersexual disorder screening inventory among highly sexually active gay and bisexual men: an item response theory analysis. *J Sex Med, 10*(12), 3088-3101. doi:10.1111/jsm.12117

Raven, J., Raven, J. C., & Court, J. H. (2000). *Manual for Raven's progressive matrices and vocabulary scales. Section 3, The Standard Progressive Matrices.* San Antonio, TX: Harcourt Assessment.

Reid, R. C., Garos, S., & Carpenter, B. N. (2011). Reliability, Validity, and Psychometric Development of the Hypersexual Behavior Inventory in an Outpatient Sample of Men. *Sexual Addiction & Compulsivity, 18*(1), 30-51. doi:10.1080/10720162.2011.555709

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., . . . Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry, 59 Suppl 20*, 22-33;quiz 34-57.

Bergman, H., & Kallmen, H. (2002). Alcohol use among Swedes and a psychometric evaluation of the alcohol use disorders identification test. *Alcohol and Alcoholism, 37*(3), 245-251. doi:10.1093/alcalc/37.3.245

Berman, A. H., Bergman, H., Palmstierna, T., & Schlyter, F. (2005). Evaluation of the Drug Use Disorders Identification Test (DUDIT) in criminal justice and detoxification settings and in a Swedish population sample. *European Addiction Research, 11*(1), 22-31. doi:10.1159/000081413

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and Social Psychology, 67*(2), 319-333. doi:10.1037/0022-3514.67.2.319

Eriksson, J. M., Andersen, L. M., & Bejerot, S. (2013). RAADS-14 Screen: validity of a screening tool for autism spectrum disorder in an adult psychiatric population. *Molecular Autism, 4*(1), 49. doi:10.1186/2040-2392-4-49

Kafka, M. P. (2010). Hypersexual disorder: a proposed diagnosis for DSM-V. *Archives of Sexual Behavior, 39*(2), 377-400. doi:10.1007/s10508-009-9574-7

Kalichman, S. C., & Rompa, D. (1995). Sexual sensation seeking and Sexual Compulsivity Scales: reliability, validity, and predicting HIV risk behavior. *Journal of Personality Assessment, 65*(3), 586-601. doi:10.1207/s15327752jpa6503_16

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E., . . . Walters, E. E. (2005). The World Health Organization Adult ADHD Self-Report Scale (ASRS): a short screening scale for use in the general population. *Psychological Medicine, 35*(2), 245-256. doi:10.1017/s0033291704002892

Montgomery, S. A., & Asberg, M. (1979). A new depression scale designed to be sensitive to change. *British Journal of Psychiatry, 134*, 382-389.

Parsons, J. T., Rendina, H. J., Ventuneac, A., Cook, K. F., Grov, C., & Mustanski, B. (2013). A psychometric investigation of the hypersexual disorder screening inventory among highly sexually active gay and bisexual men: an item response theory analysis. *The Journal of Sexual Medicine, 10*(12), 3088-3101. doi:10.1111/jsm.12117

Reid, R. C., Garos, S., & Carpenter, B. N. (2011). Reliability, Validity, and Psychometric Development of the Hypersexual Behavior Inventory in an Outpatient Sample of Men. *Sexual Addiction & Compulsivity, 18*(1), 30-51. doi:10.1080/10720162.2011.555709

Spector, I. P., Carey, M. P., & Steinberg, L. (1996). The sexual desire inventory: development, factor structure, and evidence of reliability. *Journal of Sex and Marital Therapy, 22*(3), 175-190. doi:10.1080/00926239608414655

Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences, 47*(5), 385-395. doi:10.1016/j.paid.2009.04.008

Svanborg, P., & Asberg, M. (2001). A comparison between the Beck Depression Inventory (BDI) and the self-rating version of the Montgomery Asberg Depression Rating Scale (MADRS). *Journal of Affective Disorders, 64*(2-3), 203-216. doi:10.1016/s0165-0327(00)00242-1

Tluczek, A., Henriques, J. B., & Brown, R. L. (2009). Support for the reliability and validity of a six-item state anxiety scale derived from the State-Trait Anxiety Inventory. *Journal of Nursing Measurement, 17*(1), 19-28. doi:10.1891/1061-3749.17.1.19