

Table S1. Spatial correlation between PD-related MPM alterations and four dopamine markers across the HybraPD-derived ROIs.

ROI	Marker	rho	CI _{lower}	CI _{upper}	ESS	df	p _{spatial}	p _{FDR}
R1								
GP	FDOPA	-0.437	-0.643	-0.173	47.46	45.46	0.0020	0.0399
Putamen	FDOPA	-0.439	-0.652	-0.161	43.54	41.54	0.0030	0.0456
RN	FDOPA	0.249	0.009	0.462	66.86	64.86	0.0425	0.1866
SNr	FDOPA	0.440	0.008	0.734	20.77	18.77	0.0493	0.1866
GP	D1	-0.290	-0.480	-0.075	79.66	77.66	0.0092	0.0766
GPI	D1	-0.147	-0.284	-0.005	189.60	187.60	0.0430	0.1866
HN	D1	0.501	0.025	0.792	16.88	14.88	0.0413	0.1866
Putamen	D1	-0.352	-0.534	-0.140	77.11	75.11	0.0016	0.0399
RN	D1	0.426	0.149	0.642	43.82	41.82	0.0040	0.0475
SNc	D1	0.475	0.138	0.714	29.78	27.78	0.0081	0.0766
GPI	D2	-0.158	-0.303	-0.007	166.97	164.97	0.0409	0.1866
Putamen	D2	-0.373	-0.616	-0.065	39.08	37.08	0.0192	0.1283
SNr	D2	0.447	0.003	0.744	19.17	17.17	0.0493	0.1866
R2*								
DN	DAT	-0.250	-0.362	-0.129	249.92	247.92	<0.0001	<0.0001
NAC	DAT	0.640	0.012	0.906	9.08	7.08	0.0477	0.1907
DN	FDOPA	0.152	0.071	0.230	581.90	579.80	0.0002	0.0066
NAC	FDOPA	0.380	0.047	0.638	33.70	31.70	0.0272	0.1663
SN	FDOPA	0.523	0.030	0.811	16.00	14.00	0.0399	0.1853
SNc	FDOPA	0.472	0.018	0.765	18.69	16.69	0.0430	0.1853
SNr	FDOPA	0.514	0.077	0.786	18.91	17.91	0.0246	0.1663
Thalamus	FDOPA	0.230	0.095	0.357	200.72	198.72	0.0010	0.0188
SN	D1	0.528	0.044	0.812	16.00	14.00	0.0353	0.1797
SNc	D1	0.511	0.159	0.748	26.56	24.56	0.0069	0.0968
SNr	D1	0.491	0.065	0.773	19.58	17.58	0.0272	0.1663
Thalamus	D1	0.233	0.055	0.397	118.57	116.57	0.0109	0.1020
GPI	D2	-0.276	-0.491	-0.028	62.19	60.19	0.0297	0.1663
RN	D2	0.264	0.063	0.444	92.91	90.91	0.0106	0.1020
Proton density								
GP	FDOPA	-0.297	-0.463	-0.110	103.88	101.88	0.0022	0.0300
GPe	FDOPA	-0.336	-0.497	-0.152	102.64	100.64	0.0005	0.0099
HN	FDOPA	0.300	0.078	0.493	74.90	72.90	0.0090	0.0634
RN	FDOPA	0.450	0.290	0.586	113.40	111.40	<0.0001	<0.0001
SNr	FDOPA	0.490	0.041	0.774	18.66	16.66	0.0349	0.1398
Thalamus	FDOPA	0.079	0.008	0.148	769.16	767.15	0.0291	0.1295
GP	D1	-0.295	-0.478	-0.088	85.46	83.46	0.0059	0.0473
GPe	D1	-0.309	-0.483	-0.111	92.45	90.45	0.0027	0.0300
GPI	D1	-0.133	-0.245	-0.018	290.08	288.08	0.0230	0.1172
RN	D1	0.527	0.335	0.677	71.08	69.08	<0.0001	<0.0001
SNc	D1	-0.487	-0.736	-0.122	25.90	23.90	0.0117	0.0700
SNr	D1	0.455	0.009	0.750	19.48	17.48	0.0468	0.1747
Thalamus	D1	-0.138	-0.232	-0.040	402.60	400.60	0.0057	0.0473
GP	D2	-0.341	-0.589	-0.035	40.46	38.46	0.0300	0.1295
GPe	D2	-0.374	-0.604	-0.086	43.91	41.91	0.0125	0.0700
MTsat								
NAC	DAT	0.398	0.106	0.626	41.77	39.77	0.0093	0.0510
CN	FDOPA	0.249	0.074	0.409	121.15	119.15	0.0058	0.0425
NAC	FDOPA	0.476	0.187	0.689	38.60	36.60	0.0023	0.0297
RN	FDOPA	0.507	0.302	0.667	66.15	64.15	<0.0001	<0.0001
Thalamus	FDOPA	0.210	0.107	0.308	347.15	345.15	<0.0001	<0.0001
VeP	FDOPA	0.554	0.206	0.777	25.34	23.34	0.0038	0.0327

NAC	D1	0.573	0.225	0.791	24.47	22.47	0.0031	0.0308
RN	D1	0.633	0.381	0.798	35.20	33.20	<0.0001	<0.0001
SNc	D1	0.468	0.128	0.710	29.76	27.76	0.0093	0.0510
VeP	D1	0.567	0.232	0.784	25.93	23.93	0.0025	0.0297
CN	D2	0.233	0.005	0.437	74.38	72.38	0.0455	0.1948
SN	D2	0.443	0.013	0.734	20.94	18.94	0.0448	0.1948
SNr	D2	0.473	0.022	0.764	18.88	16.88	0.0416	0.1948
VeP	D2	0.423	0.129	0.649	40.15	38.15	0.0064	0.0425

We assessed the group differences in R1, R2*, proton density, and MTsat using t-maps containing PwPD > HCs values and four dopaminergic markers: DAT, FDOPA, D1, and D2. For each type of analysis, we report Spearman's correlation coefficient (ρ), 95% confidence intervals (CI_{lower} & CI_{upper}), effective sample size (ESS), degrees of freedom (df) derived from ESS, p-value from Dutilleul's modified t-test, correcting for spatial autocorrelation ($p_{spatial}$), and false-discovery rate (FDR)-corrected p-values (p_{FDR}). CN: caudate nucleus. GP: globus pallidus. GPe/GPi: globus pallidus external/internal segment. D1: dopamine D1 receptor. D2: dopamine D2 receptor. DAT: dopamine transporter. FDOPA: [^{18}F]-fluoro-L-DOPA. HCs: healthy controls. HN: habenular nucleus. MPM: multiparametric mapping. MTsat: magnetization transfer saturation. NAC: nucleus accumbens. PD: Parkinson's disease. PwPD: patients with Parkinson's disease. R1: longitudinal relaxation rate. R2*: effective transverse relaxation rate. RN: red nucleus. SN: substantia nigra. SNc/SNr: substantia nigra pars compacta/reticulata. ROI: region of interest. VeP: ventral pallidum.

Table S2. Spatial correlation between PD-related MPM alterations and four dopamine markers across the HMAT-derived ROIs.

ROI	MitoF	rho	CI _{lower}	CI _{upper}	ESS	df	p _{spatial}	p _{FDR}
R1								
M1	DAT	-0.199	-0.248	-0.149	1454.88	1452.88	<0.0001	<0.0001
PMd	DAT	-0.411	-0.483	-0.334	474.78	472.78	<0.0001	<0.0001
preSMA	DAT	-0.557	-0.597	-0.515	1083.31	1081.31	<0.0001	<0.0001
S1	DAT	-0.155	-0.273	-0.032	252.67	250.67	0.0138	0.0184
SMA	DAT	-0.431	-0.482	-0.378	961.48	959.48	<0.0001	<0.0001
M1	FDOPA	-0.263	-0.328	-0.195	755.04	753.04	<0.0001	<0.0001
PMd	FDOPA	-0.460	-0.534	-0.373	349.27	347.27	<0.0001	<0.0001
preSMA	FDOPA	-0.627	-0.659	-0.593	1334.27	1332.27	<0.0001	<0.0001
S1	FDOPA	-0.187	-0.312	-0.056	218.92	216.92	0.0054	0.0081
SMA	FDOPA	-0.513	-0.546	-0.478	1807.18	1805.18	<0.0001	<0.0001
M1	D1	-0.199	-0.248	-0.149	1454.88	1452.88	<0.0001	<0.0001
PMd	D1	-0.356	-0.429	-0.278	518.57	516.57	<0.0001	<0.0001
preSMA	D1	-0.501	-0.547	-0.452	963.10	965.03	<0.0001	<0.0001
S1	D1	-0.115	-0.217	-0.001	349.68	347.68	0.0320	0.0404
SMA	D1	-0.285	-0.351	-0.035	379.34	377.34	<0.0001	<0.0001
M1	D2	-0.119	-0.196	-0.039	606.34	604.34	0.0034	0.0054
PMd	D2	-0.350	-0.412	-0.286	746.85	744.85	<0.0001	<0.0001
preSMA	D2	-0.418	-0.487	-0.343	508.51	506.51	<0.0001	<0.0001
SMA	D2	-0.135	-0.546	-0.478	1807.18	1805.18	0.0085	0.0121
R2*								
M1	DAT	-0.171	-0.205	-0.136	2964.45	2962.54	<0.0001	<0.0001
PMd	DAT	-0.247	-0.308	-0.183	867.48	865.48	<0.0001	<0.0001
preSMA	DAT	-0.252	-0.324	-0.177	628.72	626.72	<0.0001	<0.0001
SMA	DAT	-0.341	-0.430	-0.245	353.32	351.32	<0.0001	<0.0001
M1	FDOPA	-0.086	-0.158	-0.012	704.02	702.02	0.0230	0.0325
PMd	FDOPA	-0.276	-0.344	-0.204	666.28	664.28	<0.0001	<0.0001
preSMA	FDOPA	-0.334	-0.401	-0.264	639.68	637.68	<0.0001	<0.0001
SMA	FDOPA	-0.349	-0.409	-0.285	779.10	777.10	<0.0001	<0.0001
M1	D1	-0.082	-0.129	-0.034	1695.81	1693.81	0.0007	0.0015
PMd	D1	-0.203	-0.268	-0.136	807.62	805.62	<0.0001	<0.0001
preSMA	D1	-0.236	-0.336	-0.131	325.60	323.60	<0.0001	<0.0001
SMA	D1	-0.156	-0.256	-0.052	352.70	350.70	0.0033	0.0057
M1	D2	-0.083	-0.128	-0.037	1851.43	1849.43	0.0004	0.0081
PMd	D2	-0.114	-0.165	-0.062	1411.50	1409.50	<0.0001	<0.0001
PMv	D2	-0.066	-0.111	-0.021	1858.31	1856.31	0.0043	0.0069
preSMA	D2	-0.210	-0.337	-0.075	205.42	203.42	0.0025	0.0046
S1	D2	0.115	0.020	0.209	420.17	418.17	0.0180	0.0269
Proton density								
preSMA	DAT	-0.760	-0.776	-0.743	2630.93	2628.93	<0.0001	<0.0001
SMA	DAT	-0.789	-0.806	-0.770	1775.73	1773.73	<0.0001	<0.0001
preSMA	FDOPA	-0.717	-0.733	-0.700	3332.72	3330.72	<0.0001	<0.0001
SMA	FDOPA	-0.618	-0.640	-0.594	2845.42	1843.42	<0.0001	<0.0001
preSMA	D1	-0.667	-0.688	-0.644	2416.13	2414.13	<0.0001	<0.0001
SMA	D1	-0.457	-0.498	-0.413	1343.23	1341.23	<0.0001	<0.0001
M1	D2	0.116	0.036	0.194	594.62	592.62	0.0047	0.0103
preSMA	D2	-0.428	-0.471	-0.383	1333.60	1331.60	<0.0001	<0.0001
S1	D2	0.080	0.026	0.133	1343.68	1341.68	0.0034	0.0082
SMA	D2	-0.284	-0.365	-0.200	477.25	475.25	<0.0001	<0.0001
MTsat								
M1	DAT	-0.065	-0.097	-0.033	3770.09	3775.09	<0.0001	0.0001
PMd	DAT	-0.158	-0.213	-0.102	1180.76	1178.76	<0.0001	<0.0001

preSMA	DAT	-0.501	-0.544	-0.456	1104.76	1102.76	<0.0001	<0.0001
SMA	DAT	-0.468	-0.515	-0.419	1023.87	1021.87	<0.0001	<0.0001
M1	FDOPA	-0.095	-0.127	-0.064	3827.95	3825.95	<0.0001	<0.0001
PMd	FDOPA	-0.200	-0.261	-0.137	913.35	911.35	<0.0001	<0.0001
preSMA	FDOPA	-0.510	-0.549	-0.468	1287.05	1285.05	<0.0001	<0.0001
SMA	FDOPA	-0.421	-0.462	-0.378	1441.50	1439.50	<0.0001	<0.0001
M1	D1	-0.044	-0.073	-0.015	4611.16	4609.16	0.0027	0.0041
PMd	D1	-0.098	-0.154	-0.041	1187.71	1185.71	0.0007	0.0013
preSMA	D1	-0.468	-0.525	-0.407	676.21	674.21	<0.0001	<0.0001
SMA	D1	-0.355	-0.427	-0.278	529.40	527.50	<0.0001	<0.0001
M1	D2	-0.082	-0.113	-0.051	3956.29	3954.29	<0.0001	<0.0001
PMd	D2	-0.141	-0.197	-0.083	1127.28	1125.28	<0.0001	<0.0001
PMv	D2	-0.192	-0.299	-0.080	296.75	294.75	0.0009	0.0014
preSMA	D2	-0.323	-0.417	-0.232	363.18	361.18	<0.0001	<0.0001
S1	D2	0.073	0.012	0.133	1053.42	1051.42	<0.0001	<0.0001
SMA	D2	-0.159	-0.275	-0.039	261.70	259.70	0.0010	0.0137

We assessed the group differences in R1, R2*, proton density, and MTsat using t-maps containing PwPD > HCs values and four dopaminergic markers: DAT, FDOPA, D1, and D2. For each type of analysis, we report Spearman's correlation coefficient (ρ), 95% confidence intervals (CI_{lower} & CI_{upper}), effective sample size (ESS), degrees of freedom (df) derived from ESS, p-value from Dutilleul's modified t-test, correcting for spatial autocorrelation ($p_{spatial}$), and false-discovery rate (FDR)-corrected p-values (p_{FDR}). D1: dopamine D1 receptor. D2: dopamine D2 receptor. DAT: dopamine transporter. FDOPA: [^{18}F]-fluoro-L-DOPA. HCs: healthy controls. M1: primary motor area. MPM: multiparametric mapping. MTsat: magnetization transfer saturation. PD: Parkinson's disease. PMd/PMv: dorsal/ventral premotor cortex. preSMA: presupplementary motor area. PwPD: patients with Parkinson's disease. R1: longitudinal relaxation rate. R2*: effective transverse relaxation rate. ROI: region of interest. S1: primary somatosensory cortex. SMA: supplementary motor area.