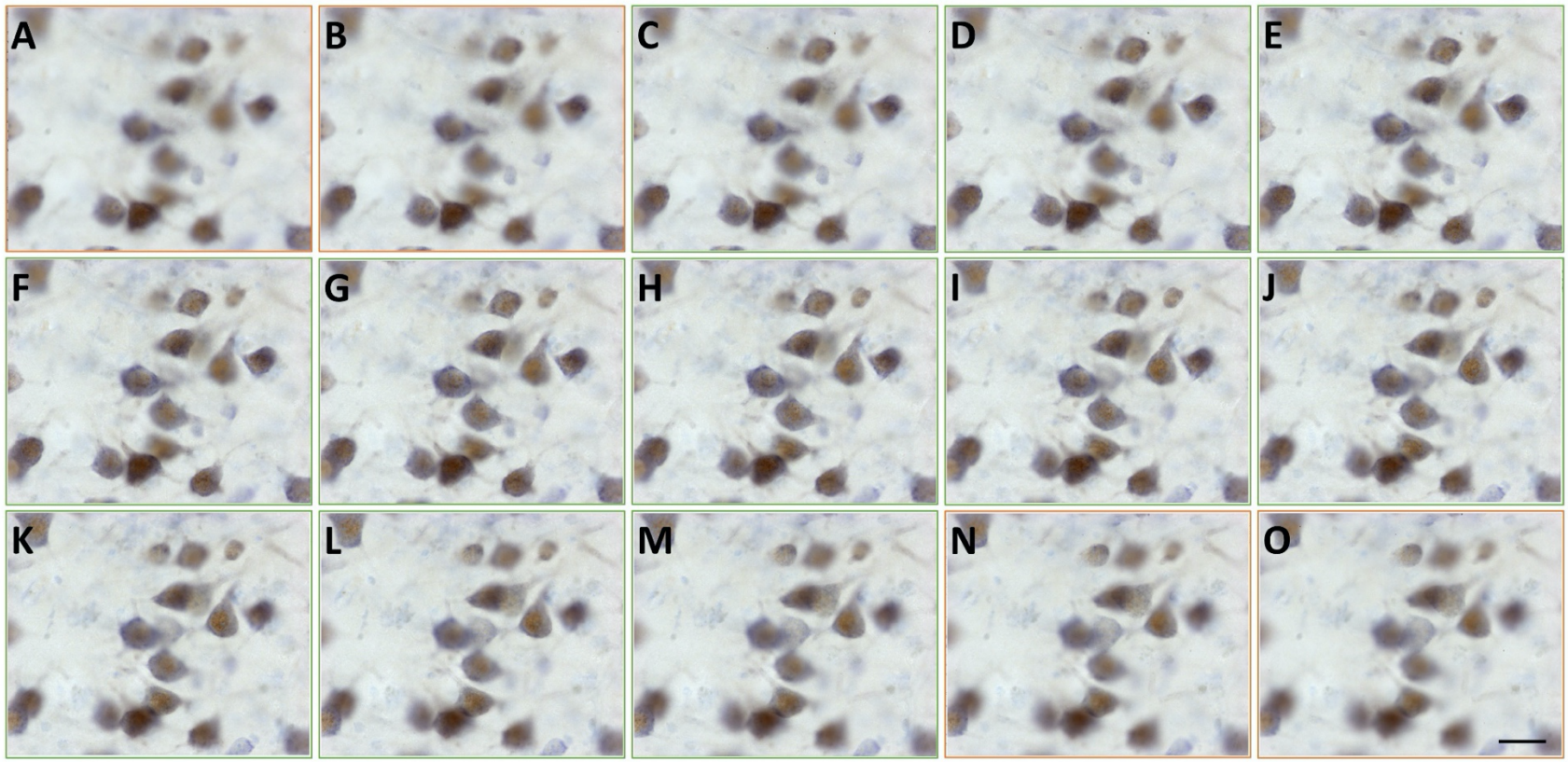
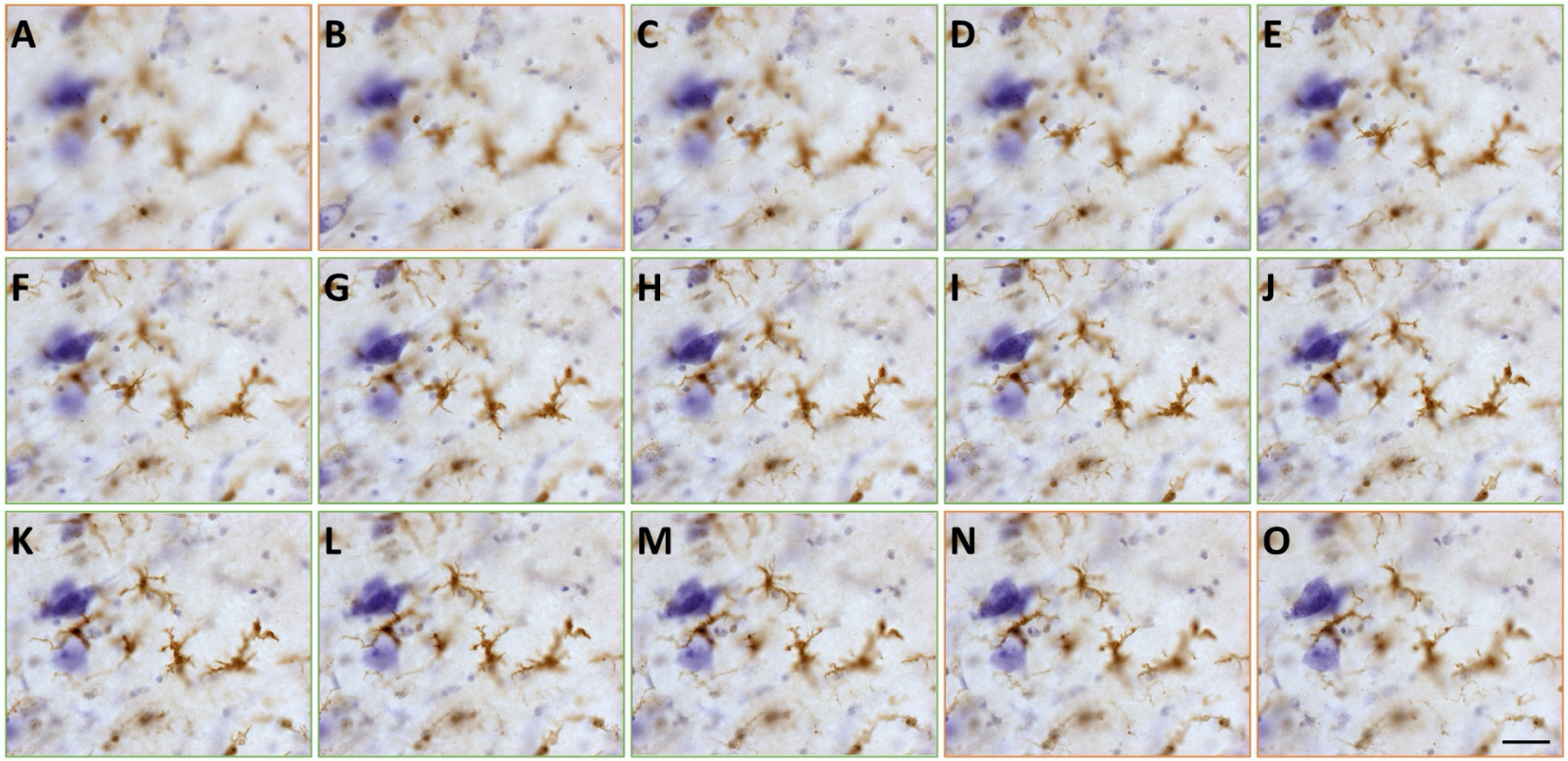
Supplementary Material

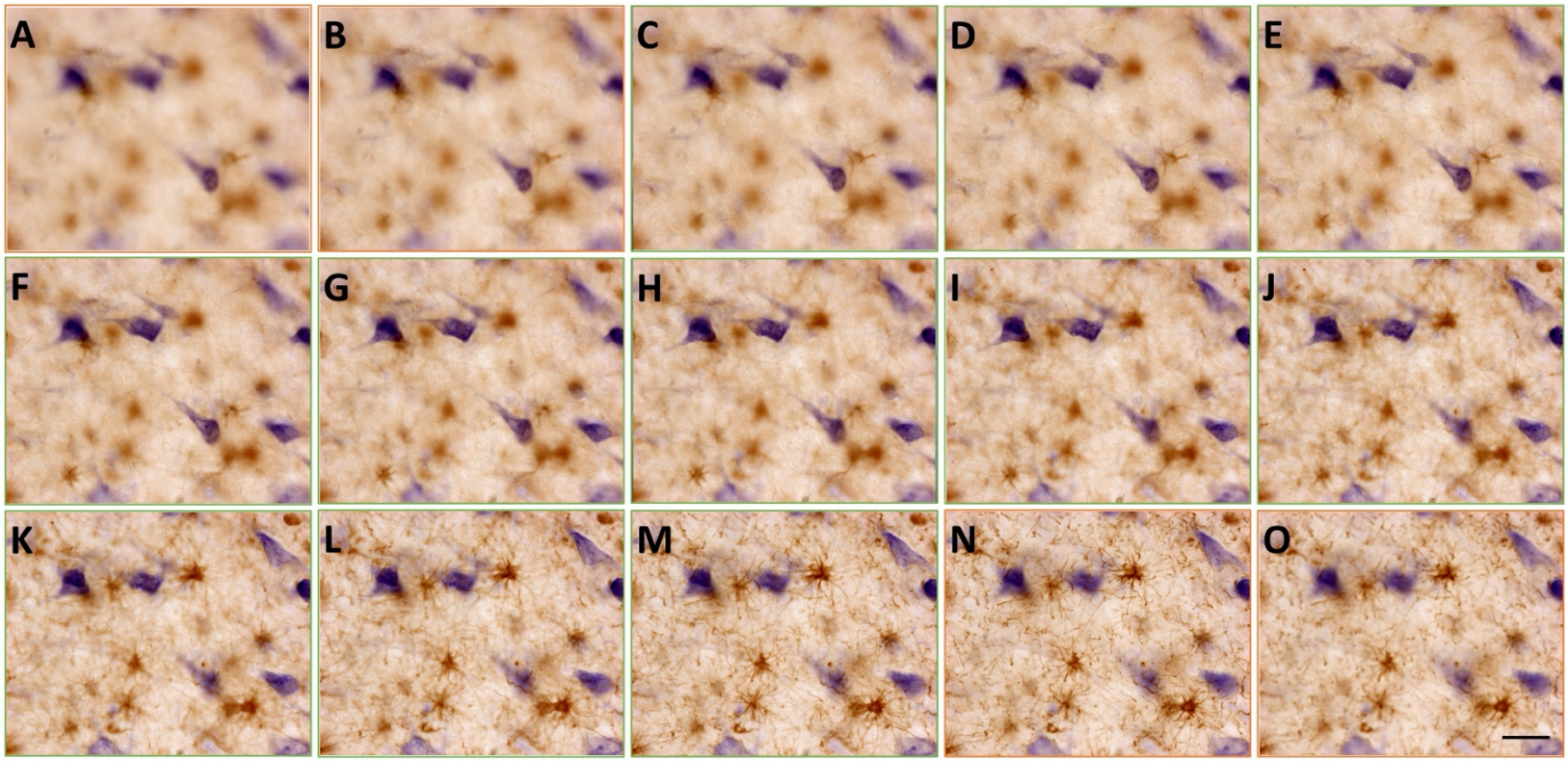
The Human Hippocampus in Parkinson's Disease: An Integrative Stereological and Proteomic Study



Supplementary Figure 2. Demonstration of NeuN-stained penetration in a section used for Z-axis. Images of NeuN-stained penetration in the human hippocampus section used for Z axis analysis (A-O). Orange (A, B, N, O) and green contours (C-M) represent the guard zones (± 2 µm) and the height dissector (11 µm), respectively. Presented are evenly spaced focal planes through a section for z axis with intervals of 1 µm from top (A) to bottom (O). Scale bar 25 µm.



Supplementary Figure 3. Demonstration of Iba1-stained penetration in a section used for Z-axis. Images of Iba-1-stained penetration in the human hippocampus section used for Z axis analysis (A-O). Orange (A, B, N, O) and green contours (C-M) represent the guard zones (± 2 µm) and the height dissector (11 µm), respectively. Presented are evenly spaced focal planes through a section for z axis with intervals of 1 µm from top (A) to bottom (O). Scale bar 25 µm.



Supplementary Figure 4. Demonstration of GFAP-stained penetration in a section used for Z-axis. Images of GFAP-stained penetration in the human hippocampus section used for Z axis analysis (A-O). Orange (A, B, N, O) and green contours (C-M) represent the guard zones (± 2 µm) and the height dissector (11 µm), respectively. Presented are evenly spaced focal planes through a section for z axis with intervals of 1 µm from top (A) to bottom (O). Scale bar 25 µm.

Supplementary Table 1. Area fraction occupied by α-syn.

Supplementary Table 1a. Area fraction occupied by α-syn in DG.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Grid Spacing (µm)	Number of Sampling Sites	Total Markers Counted	Area Sampling Fraction	Area Fraction	Estimated area (µm²)	Gundersen error m=1
1	4	50	13	90,000	640,000	20	98	93	0.14	0.0053	264,533.0	0.05
2	4	50	13	90,000	160,000	20	139	51	0.56	0.0022	36,266.7	0.05
5	3	50	13	90,000	160,000	20	99	44	0.56	0.0034	31,288.9	0.07
6	4	50	13	90,000	1,000,000	20	66	55	0.09	0.0056	244,444.0	0.06
7	4	50	13	90,000	2,250,000	20	35	32	0.04	0.0065	320,000.0	0.08
8	4	50	13	90,000	160,000	20	262	25	0.56	0.0006	17,777.8	0.09
11	4	50	13	90,000	640,000	20	60	45	0.14	0.0042	128,000.0	0.06
13	4	50	13	90,000	160,000	20	210	36	0.56	0.0011	25,600.0	0.08
15	4	50	13	90,000	1,000,000	20	42	50	0.09	0.0081	222,222.0	0.05

Supplementary Table 1b. Area fraction occupied by α-syn in CA3.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Grid Spacing (µm)	Number of Sampling Sites	Total Markers Counted	Area Sampling Fraction	Area Fraction	Estimated area (µm²)	Gundersen error m=1
6	4	50	13	90,000	1,000,000	30	42	90	0.09	0.0298	900,000.0	0.05
7	4	50	13	90,000	1,000,000	20	50	363	0.09	0.0425	1,613,330.0	0.04
8	4	50	13	90,000	160,000	20	253	80	0.56	0.0018	56,888.9	0.03
11	4	50	13	90,000	1,000,000	20	13	31	0.09	0.0143	137,778.0	0.06
13	4	50	13	90,000	160,000	20	67	14	0.56	0.0014	9,955.6	0.11
15	4	50	13	90,000	360,000	30	35	50	0.25	0.0277	180,000.0	0.05

Supplementary Table 1c. Area fraction occupied by α-syn in CA2.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Grid Spacing (µm)	Number of Sampling Sites	Total Markers Counted	Area Sampling Fraction	Area Fraction	Estimated area (µm²)	Gundersen error m=1
1	4	50	13	90,000	640,000	40	53	36	0.14	0.0158	409,600.0	0.08
2	4	50	13	90,000	160,000	40	82	37	0.56	0.0102	105,244.0	0.07
5	3	50	13	90,000	160,000	20	51	19	0.56	0.0028	13,511.1	0.09
6	4	50	13	90,000	1,000,000	40	32	108	0.09	0.0824	1,920,000.0	0.06
7	4	50	13	90,000	1,000,000	40	37	113	0.09	0.0716	2,008,890.0	0.05
8	4	50	13	90,000	360,000	40	82	20	0.25	0.0063	128,000.0	0.10
11	4	50	13	90,000	360,000	40	47	68	0.25	0.0405	435,200.0	0.05
13	4	50	13	90,000	160,000	20	98	64	0.56	0.0048	45,511.1	0.05
15	4	50	13	90,000	360,000	40	48	205	0.25	0.1310	1,312,000.0	0.02

Supplementary Table 1d. Area fraction occupied by α-syn in CA1.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Grid Spacing (µm)	Number of Sampling Sites	Total Markers Counted	Area Sampling Fraction	Area Fraction	Estimated area (µm²)	Gundersen error m=1
1	4	50	13	90,000	1,440,000	20	150	196	0.06	0.0072	1,254,400.0	0.04
2	4	50	13	90,000	16,000,000	20	15	37	0.01	0.0125	2,631,110.0	0.08
5	3	50	13	90,000	640,000	20	113	50	0.14	0.0028	142,222.0	0.07
6	4	50	13	90,000	1,000,000	20	60	78	0.09	0.0077	346,667.0	0.04
7	4	50	13	90,000	1,000,000	20	65	69	0.09	0.0064	306,667.0	0.05
8	4	50	13	90,000	160,000	20	349	62	0.56	0.0010	44,088.9	0.05
11	4	50	13	90,000	4,000,000	20	15	41	0.02	0.0174	728,889.0	0.07
13	4	50	13	90,000	160,000	20	438	72	0.56	0.0010	51,200.0	0.05
15	4	50	13	90,000	4,000,000	20	14	49	0.02	0.0179	871,111.0	0.08

Supplementary Table 2. Volume data.

Supplementary Table 2a. Estimated HP volume.

Case	Number of Sections	Section Cut Thickness (μm)	Section Evaluation Interval	Grid Size (μm)	Count	Estimated Area (mm^2)	Volume Corrected for Over Projection (mm^3)	Gundersen error m=1
1	4	50	13	250	5,408	338.00	214.86	0.03
2	4	50	13	250	5,621	351.31	223.41	0.02
3	4	50	13	250	3,283	205.19	130.61	0.02
4	4	50	13	250	5,924	370.25	235.90	0.02
5	4	50	13	250	5,214	325.87	207.54	0.02
6	4	50	13	250	3,218	201.12	127.89	0.02
7	4	50	13	250	3,611	225.69	143.26	0.02
8	4	50	13	250	2,769	173.06	110.10	0.02
9	4	50	13	250	3,822	238.87	152.03	0.02
10	4	50	13	250	3,845	240.31	153.10	0.02
11	5	50	13	250	3,505	219.06	140.04	0.02
12	5	50	13	250	4,427	276.69	176.78	0.02
13	5	50	13	250	3,434	214.62	137.15	0.02
14	5	50	13	250	3,600	225.00	143.73	0.02
15	5	50	13	250	3,077	192.31	123.03	0.02
22	4	50	13	250	3,848	240.50	153.25	0.02
23	4	50	13	250	3,612	225.75	143.80	0.02
24	4	50	13	250	4,473	279.56	177.92	0.03
25	4	50	13	250	4,050	253.12	161.12	0.02
26	4	50	13	250	5,457	341.06	216.92	0.02
27	4	50	13	250	4,195	262.19	164.13	0.04
28	4	50	13	250	3,350	209.37	133.18	0.02
29	4	50	13	250	6,288	393.00	250.39	0.02
30	4	50	13	250	3,408	213.00	135.72	0.02
31	4	50	13	250	3,769	235.56	149.50	0.02
32	5	50	13	250	2,787	174.19	111.25	0.02
33	5	50	13	250	3,619	226.19	144.70	0.02
34	5	50	13	250	3,087	192.94	123.37	0.02
35	5	50	13	250	3,930	245.62	157.08	0.02
36	5	50	13	250	2,978	186.12	119.03	0.02

*Gray shade shows PD cases.

Supplementary Table 2b. Estimated DG volume.

Case	Number of Sections	Section Cut Thickness (μm)	Section Evaluation Interval	Grid Size (μm)	Count	Estimated Area (mm^2)	Volume Corrected for Over Projection (mm^3)	Gundersen error m=1
1	4	50	13	250	917	57.31	36.14	0.05
2	2	50	13	250	180	11.25	6.90	0.07
3	4	50	13	250	1,060	66.25	41.82	0.03
4	4	50	13	250	1,272	79.50	50.29	0.03
5	5	50	13	250	497	31.06	19.44	0.04
6	4	50	13	250	772	48.25	30.37	0.04
7	4	50	13	250	920	57.50	36.55	0.02
8	4	50	13	250	750	46.87	29.53	0.04
9	4	50	13	250	860	53.75	34.07	0.03
10	4	50	13	250	904	56.50	35.80	0.03
11	5	50	13	250	1,027	64.19	40.95	0.02
12	5	50	13	250	1,292	80.75	51.58	0.01
13	5	50	13	250	824	51.50	32.93	0.02
14	5	50	13	250	949	59.31	37.81	0.02
15	5	50	13	250	838	52.37	33.47	0.02
21	4	50	13	250	731	45.69	28.82	0.03
22	2	50	13	250	164	10.25	6.35	0.05
23	3	50	13	250	877	54.81	34.07	0.05
24	4	50	13	250	745	46.56	29.21	0.05
25	3	50	13	250	936	58.50	36.42	0.04
26	4	50	13	250	1,402	87.62	55.37	0.03
27	4	50	13	250	805	50.31	31.72	0.03
28	4	50	13	250	2,077	129.81	82.39	0.02
29	4	50	13	250	1,146	71.62	45.32	0.03
30	4	50	13	250	1,715	107.19	68.17	0.02
31	5	50	13	250	833	52.06	33.27	0.02
32	5	50	13	250	1,031	64.44	41.10	0.02
33	5	50	13	250	1,032	64.50	41.22	0.02
34	5	50	13	250	1,134	70.87	45.33	0.02
35	5	50	13	250	827	51.69	33.02	0.02

*Gray shade shows PD cases.

Supplementary Table 2c. Estimated CA3 volume.

Case	Number of Sections	Section Cut Thickness (μm)	Section Evaluation Interval	Grid Size (μm)	Count	Estimated Area (mm^2)	Volume Corrected for Over Projection (mm^3)	Gundersen error m=1
6	4	50	13	250	693	43.31	27.52	0.02
7	4	50	13	250	713	44.56	28.13	0.03
8	4	50	13	250	610	38.12	24.22	0.02
9	4	50	13	250	911	56.94	35.90	0.03
10	3	50	13	250	365	22.81	14.33	0.04
11	5	50	13	250	339	21.19	13.51	0.02
12	5	50	13	250	359	22.44	14.29	0.02
13	5	50	13	250	217	13.56	8.64	0.02
14	5	50	13	250	182	11.37	7.25	0.02
15	5	50	13	250	168	10.50	6.71	0.02
26	4	50	13	250	716	44.75	27.38	0.08
27	4	50	13	250	719	44.94	28.27	0.02
28	4	50	13	250	763	47.69	29.62	0.05
29	2	50	13	250	303	18.94	11.83	0.05
30	4	50	13	250	450	28.12	17.68	0.04
31	5	50	13	250	222	13.87	8.85	0.02
32	5	50	13	250	316	19.75	12.58	0.02
33	5	50	13	250	185	11.56	7.38	0.02
34	5	50	13	250	253	15.81	10.10	0.02
35	5	50	13	250	160	10.00	6.38	0.02

*Gray shade shows PD cases.

Supplementary Table 2d. Estimated CA2 volume.

Case	Number of Sections	Section Cut Thickness (μm)	Section Evaluation Interval	Grid Size (μm)	Count	Estimated Area (mm^2)	Volume Corrected for Over Projection (mm^3)	Gundersen error m=1
1	4	50	13	250	528	33.00	20.97	0.03
2	1	50	13	250	91	5.69	3.41	0.11
3	2	50	13	250	190	11.87	7.41	0.05
4	4	50	13	250	320	20.00	12.57	0.04
5	3	50	13	250	239	14.94	9.35	0.03
6	4	50	13	250	579	36.19	22.94	0.03
7	4	50	13	250	588	36.75	23.12	0.03
8	4	50	13	250	461	28.81	18.25	0.02
9	4	50	13	250	482	30.12	19.10	0.02
10	4	50	13	250	622	38.87	24.72	0.03
11	5	50	13	250	316	19.75	12.61	0.02
12	5	50	13	250	294	18.37	11.73	0.02
13	5	50	13	250	231	14.44	9.18	0.03
14	5	50	13	250	273	17.06	10.90	0.02
15	5	50	13	250	186	11.62	7.40	0.03
21	2	50	13	250	217	13.56	8.35	0.06
22	1	50	13	250	43	2.69	1.61	0.12
23	3	50	13	250	452	28.25	17.54	0.05
24	4	50	13	250	485	30.31	19.05	0.04
25	2	50	13	250	431	26.94	16.66	0.05
26	4	50	13	250	864	54.00	33.98	0.04
27	4	50	13	250	562	35.12	22.22	0.02
28	4	50	13	250	1,262	78.87	49.88	0.03
29	4	50	13	250	564	35.25	22.42	0.03
30	4	50	13	250	828	51.75	32.88	0.03
31	5	50	13	250	180	11.25	7.17	0.03
32	5	50	13	250	310	19.37	12.37	0.02
33	5	50	13	250	231	14.44	9.21	0.02
34	5	50	13	250	346	21.62	13.79	0.03
35	5	50	13	250	246	15.37	9.82	0.02

*Gray shade shows PD cases.

Supplementary Table 2e. Estimated CA1 volume.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Grid Size (µm)	Count	Estimated Area (mm^2)	Volume Corrected for Over Projection (mm^3)	Gundersen error m=1
1	4	50	13	250	3,916	244.75	155.87	0.02
2	4	50	13	250	5,232	327.00	208.17	0.02
3	4	50	13	250	2,009	125.56	79.71	0.02
4	4	50	13	250	4,251	265.69	169.11	0.02
5	4	50	13	250	4,464	279.00	177.49	0.02
6	4	50	13	250	1,118	69.87	44.48	0.02
7	4	50	13	250	1,312	82.00	52.22	0.02
8	4	50	13	250	902	56.37	35.88	0.02
9	4	50	13	250	1,433	89.56	57.05	0.02
10	4	50	13	250	1,884	117.75	74.92	0.02
11	5	50	13	250	1,768	110.50	70.61	0.02
12	5	50	13	250	2,417	151.06	96.19	0.02
13	5	50	13	250	2,124	132.75	84.80	0.02
14	5	50	13	250	2,141	133.81	85.49	0.02
15	5	50	13	250	1,852	115.75	73.97	0.02
21	4	50	13	250	2,843	177.69	112.83	0.02
22	4	50	13	250	3,368	210.50	133.91	0.02
23	4	50	13	250	3,099	193.69	122.29	0.03
24	4	50	13	250	2,785	174.06	110.70	0.02
25	4	50	13	250	4,033	252.06	159.83	0.02
26	4	50	13	250	1,162	72.62	45.37	0.04
27	4	50	13	250	1,198	74.87	47.66	0.02
28	4	50	13	250	2,139	133.69	85.10	0.02
29	4	50	13	250	1,334	83.37	52.97	0.03
30	4	50	13	250	1,499	93.69	59.65	0.02
31	5	50	13	250	1,502	93.87	59.90	0.01
32	5	50	13	250	1,911	119.44	76.36	0.02
33	5	50	13	250	1,585	99.06	63.29	0.02
34	5	50	13	250	2,147	134.19	85.80	0.02
35	5	50	13	250	1,702	106.37	68.00	0.02

*Gray shade shows PD cases.

Supplementary Table 3. Estimated NeuN-positive cells number and density.

Supplementary Table 3a. Estimated DG neuron number and density.

Case	Number of Sections	Section Cut Thickness (μm)	Section Evaluation Interval	Disector Height (Z) (μm)	Guard Zone Distance (μm)	Mean Measured Section Thickness (μm)	Counting Frame Area (XY) (μm²)	Sampling Grid Area (XY) (μm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm^3)	Gundersen error m=1	Density ($cell/mm^3$)
1	4	50	13	11	2	13.76	2,500	810,000	78	222	1,169,421.75	40.66	0.08	28,762.12
2	2	50	13	11	2	13.70	2,500	160,000	131	297	615,693.06	25.45	0.10	24,192.55
3	4	50	13	11	2	13.47	2,500	562,500	118	318	2,278,633.00	81.87	0.07	27,832.09
4	4	50	13	11	2	13.67	2,500	562,500	126	325	1,181,049.50	44.72	0.06	26,411.53
5	3	50	13	11	2	14.36	2,500	250,000	71	209	354,628.78	10.57	0.08	33,556.85
6	4	50	13	11	2	15.51	2,500	422,500	89	235	727,869.94	23.13	0.07	31,467.43
7	4	50	13	11	2	14.45	2,500	422,500	135	417	1,203,746.00	35.30	0.06	34,099.58
8	4	50	13	11	2	13.58	2,500	562,500	68	161	849,660.38	34.08	0.09	24,931.93
9	4	50	13	11	2	13.49	2,500	360,000	117	313	718,396.63	26.36	0.07	27,252.67
10	4	50	13	11	2	13.54	2,500	562,500	82	191	687,662.63	28.84	0.07	23,844.14
11	5	50	13	11	2	16.58	2,500	360,000	127	298	841,088.00	28.00	0.06	30,038.86
12	5	50	13	11	2	15.11	2,500	360,000	169	535	1,376,161.75	37.87	0.05	36,341.50
13	5	50	13	11	2	15.00	2,500	360,000	104	232	592,071.88	23.70	0.07	24,981.94
14	5	50	13	11	2	14.93	2,500	360,000	142	279	708,841.19	31.00	0.08	22,861.86
15	5	50	13	11	2	14.64	2,500	360,000	136	341	849,525.06	30.70	0.07	27,671.83
21	4	50	13	11	2	14.33	2,500	250,000	175	356	602,725.00	26.97	0.07	22,349.97
23	4	50	13	11	2	13.98	2,500	562,500	106	319	1,185,760.25	36.93	0.08	32,110.93
24	4	50	13	11	2	14.13	2,500	250,000	162	364	608,060.50	25.26	0.06	24,069.78
25	2	50	13	11	2	13.61	2,500	90,000	396	825	1,432,743.63	66.14	0.10	21,663.10
26	4	50	13	11	2	14.33	2,500	422,500	200	461	1,319,730.50	52.25	0.06	25,257.42
27	4	50	13	11	2	15.38	2,500	422,500	90	184	565,305.56	23.91	0.08	23,642.66
28	4	50	13	11	2	14.54	2,500	422,500	260	635	1,844,309.63	68.25	0.05	27,022.93
29	4	50	13	11	2	14.11	2,500	562,500	127	334	1,253,300.63	42.86	0.08	29,240.57
30	4	50	13	11	2	13.95	2,500	422,500	203	306	852,622.56	51.02	0.06	16,709.77
31	5	50	13	11	2	16.23	2,500	360,000	113	281	735,647.75	26.00	0.06	28,294.14
32	5	50	13	11	2	15.19	2,500	360,000	119	401	1,036,934.75	25.70	0.06	40,347.66
33	5	50	13	11	2	14.60	2,500	360,000	175	274	680,730.56	37.90	0.06	17,961.23
34	5	50	13	11	2	13.95	2,500	562,500	103	256	949,341.38	35.75	0.07	26,555.30
35	5	50	13	11	2	13.78	2,500	562,500	82	173	634,039.38	28.20	0.08	22,482.07

*Gray shade shows PD cases.

Supplementary Table 3b. Estimated CA3 neuron number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm³)
6	4	50	13	11	2	15.82	2,500	202,500	162	159	240,719.25	20.22	0.08	11,903.12
7	4	50	13	11	2	14.45	2,500	202,500	190	169	233,780.53	24.20	0.08	9,659.67
8	4	50	13	11	2	13.67	2,500	250,000	154	150	242,319.19	23.78	0.09	10,189.14
9	4	50	13	11	2	13.47	2,500	250,000	184	203	323,265.16	28.47	0.07	11,355.07
10	3	50	13	11	2	13.64	2,500	160,000	157	128	192,954.34	22.80	0.09	8,464.47
11	5	50	13	11	2	16.49	2,500	22,500	866	638	111,886.55	11.70	0.05	9,562.95
12	5	50	13	11	2	15.64	2,500	22,500	732	634	105,472.50	9.54	0.04	11,054.31
13	5	50	13	11	2	16.18	2,500	22,500	582	342	58,859.34	7.70	0.06	7,644.07
14	5	50	13	11	2	15.30	2,500	22,500	487	246	40,036.55	6.58	0.07	6,079.93
15	5	50	13	11	2	14.93	2,500	22,500	533	374	59,385.89	7.10	0.06	8,364.21
26	4	50	13	11	2	14.25	2,500	202,500	189	184	250,980.34	23.48	0.08	10,687.02
27	4	50	13	11	2	15.46	2,500	202,500	174	159	235,318.45	21.66	0.09	10,862.09
28	4	50	13	11	2	14.68	2,500	202,500	208	202	283,927.66	25.80	0.09	11,004.73
29	2	50	13	11	2	14.67	2,500	90,000	163	175	109,220.39	8.89	0.09	12,285.08
30	4	50	13	11	2	14.05	2,500	202,500	121	95	127,727.96	15.61	0.10	8,183.91
31	5	50	13	11	2	17.25	2,500	22,500	445	361	66,218.80	5.90	0.06	11,223.52
32	5	50	13	11	2	16.23	2,500	22,500	573	417	71,982.09	7.70	0.06	9,348.32
33	5	50	13	11	2	14.78	2,500	22,500	600	287	45,112.04	8.10	0.06	5,569.39
34	5	50	13	11	2	13.86	2,500	90,000	215	176	103,783.93	11.80	0.08	8,793.98
35	5	50	13	11	2	13.70	2,500	90,000	175	164	95,575.64	9.43	0.08	10,131.88

*Gray shade shows PD cases.

Supplementary Table 3c. Estimated CA2 neuron number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm^3)
1	4	50	13	11	2	14.08	2,500	122,500	226	124	101,128.34	16.90	0.09	5,983.68
2	3	50	13	11	2	13.60	2,500	40,000	318	257	66,105.73	7.60	0.09	8,694.40
3	2	50	13	11	2	13.51	2,500	10,000	720	294	56,318.61	12.84	0.08	4,387.24
4	4	50	13	11	2	13.94	2,500	90,000	261	165	97,885.13	13.61	0.08	7,193.57
5	3	50	13	11	2	13.91	2,500	62,500	189	134	55,071.52	6.89	0.10	7,996.77
6	4	50	13	11	2	15.27	2,500	160,000	156	135	155,940.47	15.41	0.09	10,117.53
7	4	50	13	11	2	14.79	2,500	160,000	193	121	135,360.48	18.27	0.10	7,407.92
8	4	50	13	11	2	13.66	2,500	160,000	153	112	115,731.26	14.59	0.10	7,930.11
9	4	50	13	11	2	13.70	2,500	202,500	152	142	186,227.70	18.62	0.10	10,001.70
10	4	50	13	11	2	13.66	2,500	160,000	196	127	131,188.38	18.91	0.10	6,935.57
11	5	50	13	11	2	17.73	2,500	10,000	1,146	695	58,237.96	6.80	0.04	8,564.41
12	5	50	13	11	2	16.28	2,500	10,000	1,701	1,035	79,644.86	37.87	0.04	2,103.25
13	5	50	13	11	2	15.88	2,500	10,000	1,205	758	56,894.41	7.10	0.04	8,013.30
14	5	50	13	11	2	15.43	2,500	10,000	1,715	621	45,285.91	10.25	0.05	4,418.52
15	5	50	13	11	2	15.61	2,500	10,000	986	557	41,096.82	5.80	0.05	7,085.66
21	2	50	13	11	2	14.28	2,500	90,000	176	129	156,704.73	18.93	0.10	8,277.46
23	4	50	13	11	2	14.39	2,500	122,500	223	155	129,175.03	16.00	0.09	8,072.93
24	4	50	13	11	2	14.61	2,500	90,000	285	235	146,118.47	15.42	0.08	9,477.07
25	2	50	13	11	2	13.59	2,500	40,000	450	235	181,131.23	33.74	0.08	5,367.90
26	4	50	13	11	2	14.41	2,500	160,000	285	203	221,239.13	28.12	0.08	7,866.98
27	4	50	13	11	2	14.98	2,500	160,000	182	113	128,051.13	17.74	0.10	7,217.03
28	4	50	13	11	2	14.90	2,500	160,000	419	214	241,195.17	41.63	0.07	5,793.67
29	4	50	13	11	2	13.90	2,500	160,000	183	153	160,803.45	18.52	0.08	8,682.03
30	4	50	13	11	2	14.02	2,500	160,000	257	144	152,734.80	25.23	0.09	6,053.99
31	5	50	13	11	2	16.79	2,500	10,000	918	593	47,062.59	5.50	0.05	8,556.83
32	5	50	13	11	2	16.13	2,500	10,000	1,130	773	58,948.74	6.70	0.04	8,798.32
33	5	50	13	11	2	14.65	2,500	10,000	1,653	701	48,562.90	10.00	0.04	4,856.29
34	5	50	13	11	2	13.76	2,500	62,500	311	235	95,557.97	11.87	0.07	8,047.53
35	5	50	13	11	2	13.94	2,500	62,500	253	152	62,582.04	9.62	0.08	6,504.44

*Gray shade shows PD cases.

Supplementary Table 3d. Estimated CA1 neuron number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm³)
1	4	50	13	11	2	13.80	2,500	810,000	289	240	1,268,119.63	143.54	0.07	8,834.61
2	4	50	13	11	2	13.65	2,500	810,000	358	294	1,536,896.50	183.60	0.06	8,371.03
3	4	50	13	11	2	13.71	2,500	250,000	392	149	241,448.31	59.75	0.09	4,041.05
4	4	50	13	11	2	13.84	2,500	810,000	244	177	938,220.88	123.55	0.08	7,593.55
5	4	50	13	11	2	13.90	2,500	562,500	187	180	665,519.50	65.83	0.08	10,108.99
6	4	50	13	11	2	15.21	2,500	202,500	258	256	372,685.13	32.25	0.06	11,557.49
7	4	50	13	11	2	14.72	2,500	202,500	304	181	255,054.72	36.88	0.08	6,915.99
8	4	50	13	11	2	13.67	2,500	360,000	152	101	343,510.84	50.85	0.10	6,754.91
9	4	50	13	11	2	13.67	2,500	360,000	204	180	418,856.56	47.45	0.08	8,827.64
10	4	50	13	11	2	13.56	2,500	562,500	178	111	400,134.78	60.30	0.10	6,635.59
11	5	50	13	11	2	16.33	2,500	250,000	368	331	638,823.19	55.80	0.06	11,448.44
12	5	50	13	11	2	15.42	2,500	250,000	334	255	464,704.50	49.33	0.07	9,420.49
13	5	50	13	11	2	14.69	2,500	250,000	425	306	531,335.19	66.30	0.06	8,014.10
14	5	50	13	11	2	14.92	2,500	250,000	426	241	425,015.69	65.62	0.07	6,477.32
15	5	50	13	11	2	14.81	2,500	250,000	376	314	549,429.25	56.60	0.06	9,707.23
21	4	50	13	11	2	14.46	2,500	562,500	228	181	696,113.13	80.62	0.08	8,634.58
22	4	50	13	11	2	13.84	2,500	810,000	184	107	567,163.31	92.10	0.10	6,158.31
23	4	50	13	11	2	14.33	2,500	562,500	264	210	800,332.75	94.44	0.07	8,474.71
24	4	50	13	11	2	14.37	2,500	562,500	220	164	626,847.75	79.03	0.09	7,931.53
25	4	50	13	11	2	13.40	2,500	810,000	244	146	748,961.88	126.38	0.08	5,926.08
26	3	50	13	11	2	14.49	2,500	202,500	209	163	226,056.14	25.85	0.08	8,744.48
27	3	50	13	11	2	14.62	2,500	202,500	202	106	296,600.91	49.89	0.10	5,945.06
28	4	50	13	11	2	14.31	2,500	202,500	426	258	353,401.50	53.05	0.07	6,661.22
29	4	50	13	11	2	14.00	2,500	202,500	340	293	392,738.06	41.47	0.06	9,469.23
30	4	50	13	11	2	14.06	2,500	202,500	348	158	212,705.81	43.55	0.08	4,883.57
31	5	50	13	11	2	15.57	2,500	250,000	282	207	380,975.41	41.90	0.08	9,092.49
32	5	50	13	11	2	15.18	2,500	250,000	304	251	450,361.78	47.70	0.06	9,441.55
33	5	50	13	11	2	14.62	2,500	250,000	394	245	423,384.75	63.40	0.07	6,677.99
34	5	50	13	11	2	13.85	2,500	562,500	184	171	629,627.25	64.78	0.08	9,718.67
35	5	50	13	11	2	13.88	2,500	562,500	164	144	531,394.69	58.23	0.08	9,125.30

*Gray shade shows PD cases.

Supplementary Table 4. Estimated Iba-1-positive cells number and density.

Supplementary Table 4a. Estimated DG microglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm³)
1	4	50	13	11	2	14.10	2,500	160,000	344	133	141,799.05	34.90	0.09	4,063.15
2	2	50	13	11	2	13.55	2,500	22,500	967	466	67,147.76	13.29	0.09	5,051.93
3	4	50	13	11	2	13.55	2,500	302,500	191	130	251,958.94	36.26	0.10	6,947.98
4	4	50	13	11	2	13.45	2,500	562,500	116	147	525,703.06	41.10	0.09	12,790.14
5	4	50	13	11	2	13.82	2,500	90,000	274	145	85,281.13	14.89	0.09	5,728.49
6	4	50	13	11	2	14.76	2,500	250,000	144	336	586,136.31	21.79	0.07	26,901.67
7	4	50	13	11	2	14.29	2,500	422,500	114	205	584,965.75	30.58	0.08	19,129.03
8	4	50	13	11	2	13.52	2,500	422,500	95	119	321,243.72	22.96	0.10	13,990.54
9	4	50	13	11	2	13.54	2,500	422,500	127	160	432,826.06	30.80	0.08	14,050.60
10	4	50	13	11	2	14.06	2,500	250,000	198	333	553,268.81	30.54	0.06	18,118.63
11	5	50	13	11	2	14.94	2,500	302,500	165	316	675,137.00	30.66	0.06	22,022.71
12	5	50	13	11	2	14.73	2,500	202,500	312	98	138,204.34	39.31	0.10	3,516.12
13	5	50	13	11	2	14.47	2,500	302,500	125	103	213,100.31	22.54	0.10	9,453.23
14	5	50	13	11	2	14.55	2,500	302,500	155	193	401,546.59	29.14	0.07	13,778.82
15	5	50	13	11	2	14.70	2,500	302,500	144	257	540,132.00	27.43	0.06	19,693.94
21	4	50	13	11	2	13.94	2,500	302,500	129	185	368,809.03	24.32	0.08	15,162.66
23	3	50	13	11	2	13.85	2,500	160,000	365	243	372,069.09	52.05	0.08	7,148.40
24	4	50	13	11	2	14.01	2,500	302,500	152	246	492,969.56	28.06	0.07	17,567.03
25	2	50	13	11	2	13.54	2,500	40,000	673	304	77,804.34	16.64	0.07	4,676.47
26	4	50	13	11	2	14.22	2,500	422,500	198	426	1,210,305.50	50.48	0.05	23,974.09
27	4	50	13	11	2	14.85	2,500	250,000	165	120	210,649.63	25.14	0.10	8,377.46
28	4	50	13	11	2	14.89	2,500	422,500	255	224	666,029.50	66.85	0.07	9,962.72
29	4	50	13	11	2	13.53	2,500	360,000	165	258	593,933.06	36.31	0.06	16,356.20
30	4	50	13	11	2	13.65	2,500	422,500	203	280	763,604.00	53.49	0.07	14,275.67
31	5	50	13	11	2	15.56	2,500	202,500	231	111	153,430.44	29.14	0.10	5,264.96
32	5	50	13	11	2	15.08	2,500	302,500	146	312	672,602.19	26.94	0.06	24,963.43
33	5	50	13	11	2	14.71	2,500	302,500	174	227	477,570.78	32.14	0.07	14,860.83
34	5	50	13	11	2	14.97	2,500	302,500	195	278	594,944.88	37.24	0.07	15,977.72
35	5	50	13	11	2	14.44	2,500	202,500	231	111	153,430.44	29.14	0.10	5,264.96

*Gray shade shows PD cases.

Supplementary Table 4b. Estimated CA3 microglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm^3)	Gundersen error m=1	Density ($cell/mm^3$)
6	4	50	13	11	2	14.98	2,500	250,000	137	288	509,774.03	20.41	0.06	24,974.97
7	4	50	13	11	2	13.91	2,500	250,000	172	252	414,150.88	27.33	0.07	15,154.60
8	4	50	13	11	2	13.59	2,500	250,000	147	208	334,106.06	23.91	0.07	13,971.73
9	4	50	13	11	2	13.47	2,500	422,500	106	125	336,350.75	27.31	0.09	12,316.84
10	3	50	13	11	2	14.51	2,500	250,000	65	124	212,703.53	9.99	0.09	21,288.81
11	5	50	13	11	2	15.42	2,500	90,000	163	253	165,986.66	8.70	0.07	19,081.71
12	5	50	13	11	2	15.76	2,500	22,500	835	420	70,410.02	11.22	0.05	6,272.89
13	5	50	13	11	2	15.02	2,500	90,000	110	128	81,785.47	5.65	0.09	14,477.10
14	5	50	13	11	2	14.77	2,500	90,000	104	142	89,248.59	5.78	0.09	15,444.22
15	5	50	13	11	2	15.01	2,500	90,000	91	160	102,144.06	4.63	0.08	22,043.31
26	4	50	13	11	2	14.02	2,500	250,000	129	235	389,302.69	20.44	0.08	19,042.30
27	4	50	13	11	2	15.10	2,500	250,000	150	157	280,124.06	21.99	0.09	12,737.72
28	4	50	13	11	2	14.58	2,500	250,000	165	132	227,376.94	25.93	0.10	8,767.25
29	2	50	13	11	2	13.49	2,500	160,000	90	157	480,513.44	26.96	0.09	17,821.81
30	3	50	13	11	2	13.69	2,500	202,500	93	118	154,601.11	11.03	0.10	14,017.56
31	5	50	13	11	2	16.29	2,500	40,000	249	105	28,250.94	5.78	0.10	4,889.25
32	5	50	13	11	2	15.76	2,500	90,000	157	261	175,008.58	8.60	0.06	20,358.66
33	5	50	13	11	2	14.72	2,500	90,000	172	203	127,126.59	9.12	0.07	13,931.59
34	5	50	13	11	2	15.10	2,500	90,000	199	255	163,836.31	10.73	0.07	15,270.56
35	5	50	13	11	2	14.23	2,500	40,000	249	105	28,250.94	5.79	0.10	4,889.25

*Gray shade shows PD cases.

Supplementary Table 4c. Estimated CA2 microglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm^3)	Gundersen error m=1	Density ($cell/mm^3$)
1	4	50	13	11	2	15.40	2,500	90,000	264	288	188,719.05	14.63	0.07	12,899.63
2	2	50	13	11	2	14.08	2,500	22,500	617	327	48,956.84	8.47	0.09	5,778.58
3	3	50	13	11	2	13.66	2,500	62,500	250	264	155,695.97	12.91	0.08	12,057.40
4	4	50	13	11	2	13.85	2,500	90,000	191	160	94,285.86	10.29	0.08	9,159.84
5	4	50	13	11	2	13.76	2,500	40,000	216	133	34,595.82	4.91	0.09	7,042.92
6	4	50	13	11	2	15.28	2,500	250,000	90	198	357,616.56	13.84	0.08	25,836.73
7	4	50	13	11	2	14.41	2,500	250,000	93	153	260,575.69	14.47	0.08	18,011.98
8	4	50	13	11	2	13.37	2,500	250,000	104	146	230,755.73	15.36	0.09	15,026.49
9	4	50	13	11	2	13.76	2,500	422,500	86	119	326,936.38	22.91	0.10	14,273.08
10	4	50	13	11	2	14.44	2,500	250,000	104	147	250,925.14	15.99	0.08	15,694.89
11	5	50	13	11	2	16.21	2,500	90,000	176	254	175,133.61	9.53	0.07	18,376.16
12	5	50	13	11	2	16.36	2,500	90,000	215	170	118,358.48	11.25	0.08	10,519.63
13	5	50	13	11	2	15.20	2,500	90,000	158	248	160,371.73	8.74	0.07	18,357.67
14	5	50	13	11	2	14.81	2,500	90,000	177	209	131,669.95	9.35	0.07	14,081.64
15	5	50	13	11	2	15.42	2,500	90,000	85	156	102,319.16	4.52	0.08	22,623.12
21	2	50	13	11	2	14.06	2,500	62,500	170	158	65,644.73	6.31	0.10	10,401.15
23	3	50	13	11	2	14.08	2,500	160,000	145	104	161,883.77	20.75	0.10	7,800.35
24	4	50	13	11	2	14.27	2,500	62,500	493	766	324,273.91	19.03	0.05	17,043.28
25	2	50	13	11	2	13.67	2,500	40,000	419	268	138,554.78	20.49	0.08	6,761.70
26	4	50	13	11	2	14.55	2,500	250,000	197	380	653,628.25	31.15	0.06	20,983.32
27	4	50	13	11	2	15.76	2,500	250,000	112	133	247,735.44	17.80	0.10	13,917.02
28	4	50	13	11	2	14.66	2,500	250,000	240	251	434,777.75	35.91	0.07	12,106.05
29	4	50	13	11	2	13.57	2,500	250,000	141	202	323,882.88	21.07	0.07	15,373.36
30	4	50	13	11	2	13.82	2,500	250,000	166	195	318,433.59	26.20	0.07	12,152.79
31	5	50	13	11	2	16.50	2,500	62,500	229	133	55,743.62	8.62	0.09	6,469.34
32	5	50	13	11	2	15.93	2,500	90,000	141	238	161,328.41	7.82	0.07	20,638.94
33	5	50	13	11	2	14.97	2,500	90,000	172	134	85,345.47	9.38	0.09	9,094.79
34	5	50	13	11	2	14.93	2,500	90,000	174	213	135,287.73	9.94	0.07	13,612.16
35	5	50	13	11	2	14.19	2,500	62,500	229	133	55,743.62	8.62	0.09	6,469.34

*Gray shade shows PD cases.

Supplementary Table 4d. Estimated dentate CA1 number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm^3)
1	4	50	13	11	2	14.75	2,500	810,000	282	215	1,214,611.63	142.18	0.07	8.542.47
2	4	50	13	11	2	13.98	2,500	810,000	369	176	941,803.19	185.47	0.08	5.077.90
3	4	50	13	11	2	13.77	2,500	562,500	141	98	358,863.47	46.63	0.10	7.696.04
4	4	50	13	11	2	13.55	2,500	810,000	254	205	1,063,512.63	127.57	0.08	8.336.44
5	4	50	13	11	2	13.67	2,500	160,000	715	466	481,825.25	69.95	0.06	6.887.83
6	4	50	13	11	2	15.04	2,500	250,000	237	415	737,717.75	36.11	0.06	20.429.23
7	4	50	13	11	2	14.78	2,500	422,500	160	221	652,219.56	41.98	0.07	15.537.29
8	4	50	13	11	2	13.52	2,500	422,500	128	186	502,223.22	33.99	0.08	14.773.53
9	4	50	13	11	2	13.50	2,500	422,500	194	214	576,998.38	50.08	0.07	11.522.08
10	4	50	13	11	2	13.95	2,500	250,000	287	333	549,147.81	45.17	0.06	12.158.46
11	5	50	13	11	2	15.23	2,500	302,500	239	347	755,652.00	44.90	0.06	16.830.27
12	5	50	13	11	2	15.40	2,500	302,500	404	307	676,058.88	77.07	0.06	8.772.49
13	5	50	13	11	2	14.73	2,500	302,500	329	345	726,666.88	61.42	0.06	11.830.36
14	5	50	13	11	2	14.54	2,500	302,500	357	328	681,887.25	65.75	0.06	10.370.25
15	5	50	13	11	2	14.80	2,500	302,500	239	386	817,133.56	42.71	0.06	19.131.29
21	4	50	13	11	2	13.96	2,500	562,500	235	210	779,737.13	81.50	0.07	9.567.09
23	4	50	13	11	2	13.96	2,500	810,000	193	140	748,223.56	100.56	0.09	7.440.35
24	4	50	13	11	2	14.27	2,500	562,500	189	226	857,346.56	66.92	0.07	12.810.65
25	4	50	13	11	2	13.82	2,500	422,500	507	124	342,153.59	135.57	0.10	2.523.74
26	4	50	13	11	2	14.56	2,500	422,500	174	216	628,249.19	45.33	0.07	13.858.54
27	4	50	13	11	2	15.32	2,500	250,000	179	123	222,635.94	26.69	0.09	8.342.02
28	4	50	13	11	2	14.73	2,500	422,500	199	155	456,152.88	51.30	0.09	8.890.95
29	4	50	13	11	2	13.51	2,500	422,500	139	207	558,593.81	36.78	0.07	15.187.80
30	4	50	13	11	2	13.95	2,500	422,500	158	130	362,107.16	40.61	0.09	8.916.41
31	5	50	13	11	2	15.46	2,500	302,500	303	135	297,765.06	57.52	0.09	5.177.03
32	5	50	13	11	2	15.05	2,500	302,500	242	343	738,384.25	45.24	0.06	16.320.73
33	5	50	13	11	2	14.76	2,500	302,500	270	216	456,047.81	49.99	0.07	9.122.71
34	5	50	13	11	2	15.18	2,500	302,500	373	348	755,626.31	71.04	0.06	10.637.01
35	5	50	13	11	2	15.42	2,500	302,500	303	135	297,765.06	57.52	0.09	5.177.03

*Gray shade shows PD cases.

Supplementary Table 5. Estimated GFAP-positive cells number and density.

Supplementary Table 5a. Estimated DG astroglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm3)
1	4	50	13	11	2	14.59	2,500	160,000	311	363	400,473.13	30.83	0.07	12,989.93
2	2	50	13	11	2	14.16	2,500	90,000	373	126	75,913.59	20.51	0.10	3,701.46
3	4	50	13	11	2	13.76	2,500	250,000	267	196	318,781.69	42.01	0.08	7,588.09
4	4	50	13	11	2	13.72	2,500	302,500	229	126	247,273.45	43.54	0.09	5,679.08
5	4	50	13	11	2	14.03	2,500	90,000	279	131	75,243.59	15.32	0.09	4,911.91
6	4	50	13	11	2	15.19	2,500	250,000	138	161	288,993.97	21.07	0.08	13,712.45
7	4	50	13	11	2	15.18	2,500	250,000	163	203	364,208.75	25.14	0.08	14,487.22
8	4	50	13	11	2	14.16	2,500	250,000	188	208	347,973.47	29.17	0.08	11,928.38
9	4	50	13	11	2	13.85	2,500	250,000	228	206	337,275.09	35.32	0.07	9,547.72
10	4	50	13	11	2	14.48	2,500	250,000	189	123	210,491.86	28.06	0.09	7,500.32
11	5	50	13	11	2	15.15	2,500	250,000	177	289	517,597.03	27.46	0.06	18,850.84
12	5	50	13	11	2	15.78	2,500	250,000	264	316	589,145.75	39.91	0.06	14,760.08
13	5	50	13	11	2	15.82	2,500	250,000	123	134	250,473.08	18.71	0.09	13,384.98
14	5	50	13	11	2	14.25	2,500	250,000	198	108	181,822.08	30.46	0.10	5,969.21
15	5	50	13	11	2	15.78	2,500	250,000	170	177	318,858.16	26.34	0.08	12,105.79
21	4	50	13	11	2	14.03	2,500	250,000	135	104	172,400.94	20.37	0.10	8,462.68
22	2	50	13	11	2	14.44	2,500	62,500	153	235	100,292.05	5.65	0.08	17,754.10
23	4	50	13	11	2	13.98	2,500	360,000	187	174	413,956.06	41.90	0.08	9,880.63
24	4	50	13	11	2	14.01	2,500	302,500	152	246	492,969.56	28.06	0.07	17,567.03
25	3	50	13	11	2	13.92	2,500	160,000	396	170	178,990.84	39.41	0.09	4,541.61
26	4	50	13	11	2	14.28	2,500	250,000	272	311	525,002.25	42.83	0.07	12,258.67
27	4	50	13	11	2	14.74	2,500	250,000	99	107	186,444.36	15.70	0.10	11,871.58
28	4	50	13	11	2	14.05	2,500	250,000	448	418	694,175.75	69.94	0.05	9,925.90
29	4	50	13	11	2	14.02	2,500	250,000	254	133	220,342.78	39.56	0.09	5,570.27
30	4	50	13	11	2	13.64	2,500	250,000	337	262	422,264.72	53.81	0.06	7,846.67
31	5	50	13	11	2	15.54	2,500	250,000	143	169	310,471.88	22.35	0.08	13,888.62
32	5	50	13	11	2	15.21	2,500	250,000	164	128	230,121.33	24.81	0.09	9,274.26
33	5	50	13	11	2	14.08	2,500	250,000	218	291	484,175.72	33.35	0.06	14,516.66
34	5	50	13	11	2	13.75	2,500	250,000	231	230	373,617.19	36.10	0.07	10,348.10
35	5	50	13	11	2	14.45	2,500	250,000	161	208	355,246.59	24.33	0.07	14,602.25

*Gray shade shows PD cases.

Supplementary Table 5b. Estimated CA3 astroglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm3)
6	4	50	13	11	2	15.45	2,500	160,000	148	126	147,287.14	15.0409	0.09	9,792.44
7	4	50	13	11	2	14.71	2,500	250,000	230	166	288,642.81	33.5784	0.08	8,596.09
8	4	50	13	11	2	14.32	2,500	160,000	229	185	200,412.78	22.4567	0.08	8,924.41
9	4	50	13	11	2	13.96	2,500	62,500	582	303	124,950.84	22.3668	0.07	5,586.44
10	3	50	13	11	2	14.21	2,500	90,000	192	142	125,509.51	15.4430	0.09	8,127.27
11	5	50	13	11	2	16.08	2,500	90,000	148	187	127,896.45	7.6146	0.08	16,796.24
12	5	50	13	11	2	15.99	2,500	90,000	173	175	119,073.99	9.0702	0.08	13,128.12
13	5	50	13	11	2	16.33	2,500	90,000	91	115	79,894.63	4.7552	0.10	16,801.56
14	5	50	13	11	2	14.18	2,500	62,500	173	141	59,056.71	6.4632	0.09	9,137.36
15	5	50	13	11	2	15.14	2,500	90,000	111	121	77,924.09	5.5731	0.09	13,982.13
26	4	50	13	11	2	14.11	2,500	160,000	225	240	256,131.05	21.9669	0.07	11,659.86
27	4	50	13	11	2	14.74	2,500	160,000	223	186	207,421.09	22.1506	0.08	9,364.13
28	4	50	13	11	2	14.09	2,500	160,000	212	143	152,383.28	21.1045	0.09	7,220.42
29	2	50	13	11	2	14.52	2,500	62,500	228	167	71,664.86	8.5469	0.09	8,384.88
30	4	50	13	11	2	13.64	2,500	90,000	323	178	103,330.38	18.2728	0.08	5,654.87
31	5	50	13	11	2	15.84	2,500	90,000	109	104	70,075.12	5.9357	0.10	11,805.70
32	5	50	13	11	2	15.70	2,500	90,000	151	114	76,156.88	8.2625	0.10	9,217.14
33	5	50	13	11	2	14.34	2,500	90,000	106	121	73,842.65	5.7402	0.09	12,864.06
34	5	50	13	11	2	13.95	2,500	62,500	298	399	164,476.81	11.4297	0.05	14,390.30
35	5	50	13	11	2	15.11	2,500	90,000	92	96	61,725.02	4.9313	0.10	12,517.04

*Gray shade shows PD cases.

Supplementary Table 5c. Estimated CA2 astroglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm³)
1	4	50	13	11	2	15.06	2,500	40,000	819	223	63,504.05	20.30	0.08	3,127.75
2	2	50	13	11	2	14.28	2,500	10,000	1,395	111	7,494.47	8.45	0.12	886.38
3	4	50	13	11	2	13.84	2,500	62,500	382	380	155,432.11	13.52	0.07	11,495.86
4	4	50	13	11	2	13.76	2,500	22,500	730	123	18,005.23	9.99	0.10	1,801.87
5	2	50	13	11	2	14.02	2,500	22,500	302	145	20,998.68	4.01	0.09	5,236.47
6	4	50	13	11	2	15.39	2,500	160,000	119	99	115,274.47	11.57	0.10	9,961.15
7	4	50	13	11	2	15.23	2,500	122,500	132	113	99,685.25	9.86	0.10	10,107.32
8	4	50	13	11	2	14.45	2,500	160,000	162	112	122,369.61	15.58	0.10	7,853.42
9	4	50	13	11	2	13.97	2,500	122,500	323	141	114,081.21	24.80	0.09	4,599.23
10	4	50	13	11	2	14.36	2,500	90,000	358	129	78,804.09	20.17	0.09	3,907.00
11	5	50	13	11	2	16.61	2,500	90,000	118	144	101,765.20	6.01	0.08	16,920.96
12	5	50	13	11	2	16.36	2,500	90,000	227	137	95,378.96	12.15	0.09	7,847.99
13	5	50	13	11	2	16.15	2,500	90,000	124	133	91,391.57	6.25	0.09	14,612.71
14	5	50	13	11	2	14.20	2,500	62,500	252	128	53,714.37	9.24	0.09	5,814.40
15	5	50	13	11	2	15.25	2,500	90,000	105	112	72,648.27	5.70	0.10	12,745.65
21	2	50	13	11	2	14.02	2,500	40,000	361	135	71,562.75	17.03	0.10	4,201.24
22	2	50	13	11	2	14.15	2,500	62,500	231	147	122,883.29	17.13	0.10	7,171.27
23	4	50	13	11	2	13.77	2,500	122,500	235	134	106,860.89	17.39	0.09	6,143.12
24	4	50	13	11	2	14.33	2,500	62,500	493	766	324,273.91	19.03	0.05	17,043.28
25	3	50	13	11	2	15.37	2,500	40,000	813	113	32,841.87	20.07	0.10	1,636.71
26	4	50	13	11	2	14.27	2,500	160,000	254	272	293,640.13	24.96	0.06	11,763.63
27	4	50	13	11	2	15.15	2,500	160,000	163	152	174,226.19	15.69	0.09	11,106.41
28	4	50	13	11	2	14.23	2,500	160,000	347	138	148,491.92	34.55	0.09	4,297.95
29	4	50	13	11	2	14.62	2,500	122,500	259	171	144,819.83	19.10	0.08	7,580.56
30	4	50	13	11	2	13.88	2,500	62,500	645	213	87,362.98	24.74	0.07	3,531.41
31	5	50	13	11	2	16.41	2,500	40,000	184	118	47,877.98	5.54	0.09	8,637.81
32	5	50	13	11	2	16.05	2,500	40,000	260	161	48,850.98	6.26	0.08	7,800.84
33	5	50	13	11	2	14.16	2,500	62,500	138	157	65,700.20	5.15	0.08	12,763.84
34	5	50	13	11	2	13.87	2,500	40,000	482	340	89,142.11	11.55	0.06	7,717.33
35	5	50	13	11	2	14.72	2,500	40,000	284	176	48,992.55	6.85	0.08	7,150.71

*Gray shade shows PD cases.

Supplementary Table 5d. Estimated CA1 astroglia number and density.

Case	Number of Sections	Section Cut Thickness (µm)	Section Evaluation Interval	Disector Height (Z) (µm)	Guard Zone Distance (µm)	Mean Measured Section Thickness (µm)	Counting Frame Area (XY) (µm²)	Sampling Grid Area (XY) (µm²)	Number of Sampling Sites	Total Markers Counted	Estimated Population using Mean Section Thickness	Measured Volume (mm³)	Gundersen error m=1	Density (cell/mm3)
1	4	50	13	11	2	15.23	2,500	160,000	1,345	299	344,370.22	135.75	0.06	2,536.83
2	4	50	13	11	2	14.96	2,500	160,000	1,470	127	143,682.31	149.85	0.10	958.84
3	4	50	13	11	2	13.92	2,500	250,000	280	276	453,992.81	43.87	0.07	10,347.96
4	4	50	13	11	2	14.00	2,500	202,500	1,016	161	215,713.95	128.06	0.08	1,684.49
5	4	50	13	11	2	14.02	2,500	160,000	620	246	254,651.55	61.28	0.07	4,155.82
6	4	50	13	11	2	15.30	2,500	250,000	178	128	231,479.47	28.60	0.09	8,094.25
7	4	50	13	11	2	14.71	2,500	250,000	230	166	288,642.81	33.58	0.08	8,596.09
8	4	50	13	11	2	13.91	2,500	250,000	196	108	177,542.05	30.33	0.10	5,853.02
9	4	50	13	11	2	13.92	2,500	122,500	675	136	109,620.34	51.97	0.09	2,109.16
10	4	50	13	11	2	14.40	2,500	62,500	1,507	230	97,828.33	57.91	0.07	1,689.18
11	5	50	13	11	2	15.58	2,500	250,000	262	219	403,277.00	40.23	0.07	10,024.73
12	5	50	13	11	2	16.53	2,500	250,000	392	125	244,254.97	61.54	0.09	3,968.70
13	5	50	13	11	2	15.66	2,500	250,000	314	206	381,214.50	46.87	0.07	8,133.89
14	5	50	13	11	2	13.84	2,500	202,500	556	155	205,309.52	69.48	0.08	2,955.11
15	5	50	13	11	2	16.21	2,500	250,000	266	118	226,086.02	41.08	0.09	5,503.24
21	4	50	13	11	2	14.02	2,500	250,000	471	151	249,850.50	73.03	0.08	3,421.29
22	4	50	13	11	2	14.60	2,500	250,000	625	425	733,515.94	97.00	0.06	7,562.31
23	4	50	13	11	2	14.16	2,500	360,000	414	173	416,919.97	94.73	0.09	4,400.90
24	4	50	13	11	2	14.27	2,500	562,500	189	226	857,346.56	66.92	0.07	12,810.65
25	4	50	13	11	2	15.72	2,500	160,000	1,376	156	185,505.59	140.64	0.09	1,318.99
26	4	50	13	11	2	14.35	2,500	250,000	208	97	240,408.11	44.51	0.10	5,400.55
27	4	50	13	11	2	14.65	2,500	90,000	553	197	122,770.25	29.74	0.08	4,127.37
28	3	50	13	11	2	14.37	2,500	62,500	868	150	63,699.17	32.49	0.09	1,960.61
29	4	50	13	11	2	14.30	2,500	90,000	674	245	149,033.86	37.04	0.07	4,024.03
30	4	50	13	11	2	13.79	2,500	122,500	631	109	87,018.01	48.25	0.10	1,803.53
31	5	50	13	11	2	16.19	2,500	250,000	279	130	248,809.72	42.66	0.09	5,832.16
32	5	50	13	11	2	15.15	2,500	160,000	484	126	144,378.31	46.82	0.09	3,083.52
33	5	50	13	11	2	14.43	2,500	250,000	378	171	291,565.63	57.08	0.08	5,108.20
34	5	50	13	11	2	14.03	2,500	160,000	661	175	185,722.92	65.61	0.08	2,830.52
35	5	50	13	11	2	15.24	2,500	250,000	350	136	245,024.17	54.26	0.09	4,515.72

*Gray shade shows PD cases.

Supplementary Table 6. Statistical data.

		Volume		NeuN Density		Iba-1 Density		GFAP Density	
		U/tdf	p	U/tdf	p	U/tdf	p	U/tdf	p
HP	R	U=7000	0.3095	U=7.000	0.5238	U=6.000	0.4127	t_{8}=1.043	0.3273
	I	t_{8}=1.266	0.2412	t_{8}=0.1251	0.9035	t_{8}=1.121	0.2948	t_{8}=0.4135	0.6901
	C	t_{8}=1.060	0.3201	t_{8}=0.1251	0.9035	t_{8}=0.4139	0.6898	t_{8}=0.9657	0.3625
	T	U=110.0	0.9237	t_{27}=0.4161	0.6806	t_{27}=0,1899	0.6898	t_{28}=0.09980	0.9212
DG	R	U=9000	0.5317	U=4.000	0.1905	U=5.000	0.2857	t_{8}=1.517	0.1677
	I	$t_{4.208}$=2.619	0.0559	t_{8}=1.366	0.2090	t_{8}=1.671	0.1332	t_{8}=1.073	0.3144
	C	t_{8}=0.1344	0.8964	t_{8}=0.2112	0.8380	t_{8}=0.4210	0.6848	t_{8}=0.2052	0.8425
	T	t_{28}=1.200	0.2403	t_{27}=1.379	0.1792	t_{27}=0,08727	0.9311	t_{28}=0.4883	0.6291
CA3	I	t_{8}=0.6203	0.5523	t_{8}=0.6203	0.5523	t_{8}=1.013	0.3406	t_{8}=0.2091	0.8396
	C	t_{8}=0.5296	0.6108	t_{8}=0.3710	0.7202	t_{8}=0.4321	0.6771	t_{8}=1.097	0.3045
	T	t_{18}=0.8987	0.3807	t_{18}=0.4558	0.6540	t_{18}=1.025	0.3191	t_{18}=0.5176	0.6110
CA2	R	t_{8}=0.4264	0.6810	U=6.000	0.4127	U=9.00	0.8730	U=8.000	0.4127
	I	$t_{4.488}$=2.045	0.1027	t_{8}=1.579	0.1529	t_{8}=1.071	0.3153	t_{8}=0.1732	0.8666
	C	t_{8}=0.07337	0.9433	t_{8}=0.1418	0.8907	t_{8}=0.8902	0.3994	t_{8}=1.200	0.2644
	T	$t_{20.18}$=1.260	0.2219	t_{27}=0.1958	0.8462	t_{27}=0.7308	0.4712	t_{28}=0.06758	0.9466
CA1	R	t_{8}=1.300	0.2298	t_{8}=0.3107	0.7640	U=8.000	0.7143	t_{8}=0.7513	0.4740
	I	t_{8}=0.5387	0.6047	t_{8}=0.7816	0.4569	t_{8}=1.798	0.1099	t_{8}=1.123	0.2942
	C	t_{8}=1.767	0.1153	U=12.00	0.9444	t_{8}=1.129	0.2917	t_{8}=1.287	0.2340
	T	U=105.0	0.7654	t_{28}=0.7877	0.4375	t_{27}=0.2354	0.2354	U=104.0	0.7346

C, caudal; CA, *Cornu ammonis*; DG, dentate gyrus; HP, hippocampus; I, intermediate; R, rostral; T, total

Supplementary Table 7. Systematic searches.

Three **systematic searches** were carried out with the following objectives:

Reviewing the existing literature that analyzed Lewy pathology in at least CA2 of the human hippocampus in PD.
The keywords "human AND hippocampus AND Lewy bodies AND Lewy neurites" were searched in PubMed on May 27, 2020. The search was filtered to the human species, other filters such as article type, text availability or the date of publication. 370 articles were listed as a result of the search. For a first filtering, it was taken into account that the title of the article had a clear relationship with the objective of the search, reducing the articles to 9. After reading the content of the 9 articles, 4 final articles were selected because they had all the information collected in the following table. This reading allowed access to specific citations from 5 other articles included in the final selection (Supplementary Table 7a).

Reviewing all the published articles on MRI and morphometry based on voxel that studied the volumetric changes of the human hippocampus of patients with PD, PDMIC or PDD.
The search was carried out on March 18, 2020. PubMed was used to search for the keywords " Human hippocampal AND Parkinson's disease AND magnetic resonance". Filters such as article type, text availability, publication date or species were not taken into account. 162 items were indicated as result of the search. For a first filtering it was taken into account that the title of the article had a clear relationship with the objective of the search. For those articles, whose title did not allow making a decision, the information in the summary was used. Finally, 40 articles were selected and classified depending on the groups of comparation and results (Supplementary Table 7b).

Reviewing all the published articles on MRI that studied the volumetric changes of the subfields of the human hippocampus of patients with PD, PDMIC or PDD.
The search was carried out on May 14, 2020. PubMed was used to search for the keywords " Human AND hippocampal subfields AND Parkinson's disease AND MRI" filtering by Human species. Other filters such as article type, text availability, or publication date were not taken into account. 9 items were indicated as a result of the search and 3 of them were discarded for studying other parameters, such as connectivity, instead of volume change; analyzing the changes in the volume of the hippocampal subfields produced by other variables than PD and not including CA2 measures, a field of special interest for our study (Supplementary Table 7c).

Supplementary Table 7a. Studies that analyzed Lewy pathology in human hippocampal subfields in PD

REFERENCE*	N	ANTIBODY	HP ZONE	AREA		QUANTIFICATION
(Dickson et al 1994)	13PD	Ubiquitin (UltraClone, Ltd., Isle of Wight, UK)	Full length	CA2-3	Clinical signs compatible with PD	Semiquantitative
(Kim et al 1995)	2PD	Ubiquitin (East Acres Biologicals, Southbridge, MA)	Full length	CA2-3	Not specified	Semiquantitative
(Churchyard & Lees 1997)	10PD 7PDMID 10PD	Ubiquitin (Dako, Glostrup, Denmark)	HP at the level of *Cornu Ammonis*, and through the anterior cingulate gyrus at the level of the anterior frontal lobe.	CA1, CA2, CA3 and CA4	H&Y 3.6±0.3 H&Y 3.8±0.3 H&Y 4.0±0.3	Qualitatively
(Mattila et al 1999)	45PD	Ubiquitin (Dako, Glostrup, Denmark)	Full length	CA2-3	Not specified	Semiquantitative
(Harding & Halliday 2001)	25PD 16PDD	Ubiquitin (Dako, Glostrup, Denmark) α-syn (Zymed Laboratories, San Francisco, Calif)	HP at the level of the lateral geniculate nucleus	CA2	H&Y 2–3 and H&Y 4–5	Semiquantitative
(Braak et al 2003)	41PD	α-syn generated by W.P. Gai (Flinders Medical Centre, Australia)	Full length	CA2	PD stage 1-6	Semiquantitative
(Armstrong et al 2014)	15PDD	Ubiquitin (Dako, Glostrup, Denmark) α-syn-P (Wako Chemicals USA Inc., Richmond, VA)	Full length	CA1, CA2, CA3, CA4, DGm and DGg	Braak 5 and 6	Quantitative
(Flores-Cuadrado et al 2016)	3 PD	α-syn (Novocastra, Newcastle, UK)	Bregma 29-31 and 34-37	CA1, CA2, CA3 and DG	Braak 3, 4 and 5	Unbiased semiautomatic quantification

*See supplementary references. CA, Cornu ammonis; DG, dentate gyrus; DGm, molecular layer of dentate gyrus; DGg, granule layer of dentate gyrus; NPD, non Parkinson's disease; PD, Parkinson's disease; PDD, Parkinson's disease with dementia; PDMCI, Parkinson's disease with mild cognitive impairment.

Supplementary Table 7b. MRI studies about volume changes produced on human hippocampus in PD with and without dementia

	DECREASE VOLUME*	INCREASE VOLUME*	NO CHANGE VOLUME*
PD vs NPD	(Laakso et al 1996) (Camicioli et al 2003) (Brück et al 2004) (Summerfield et al 2005) (Aarsland 2006) (Bouchard et al 2008) (Jokinen et al 2009) (Goldman et al 2012) (Lee et al 2013) (Zhang et al 2014) (Lee et al 2014) (Noh et al 2014) (Cohn et al 2016) (Radziunas et al 2018) (Vasconcellos et al 2018)	(Nyberg et al 2015) (Zeng et al 2017)	(Burton et al 2004) (Nagano-Saito et al 2005) (Junqué et al 2005) (Apostolova et al 2010) (Messina et al 2011) (Melzer et al 2012) (Carlesimo et al 2012) (Rektorova et al 2014) (Chen et al 2015) (Yao et al 2016) (Lenka et al 2018) (Kamps et al 2018)
PDMCI vs NPD	(Melzer et al 2012) (Noh et al 2014) (Chen et al 2015)		(Apostolova et al 2010) (Rektorova et al 2014) (Kunst et al 2019)
PDD vs NPD	(Laakso et al 1996) (Camicioli et al 2003) (Burton et al 2004) (Nagano-Saito et al 2005) (Summerfield et al 2005) (Bouchard et al 2008) (Junqué et al 2005) (Jokinen et al 2010) (Melzer et al 2012) (Goldman et al 2012) (Lee et al 2013) (Rektorova et al 2014) (Novellino et al 2018) (Kunst et al 2019)		(Apostolova et al 2010)
PDMCI vs PD	(Kandiah et al 2014) (Noh et al 2014) (Schneider et al 2017)		
PDD vs PD	(Bouchard et al 2008) (Aybek et al 2009) (Lee et al 2013) (Kandiah et al 2014) (Gee et al 2017) (Low et al 2019) (Mihaescu et al 2019)		(Cwc et al 2005)
PDD vs PDMCI	(Chung et al 2017)		

*See supplementary references. NPD, non Parkinson's disease; PD, Parkinson's disease; PDD, Parkinson's disease with dementia; PDMCI, Parkinson's disease with mild cognitive impairment.

Supplementary Table 7c. MRI studies about volume changes produced on human hippocampus fields in PD with and without dementia.

REFERENCE*	N	AREA	RESULT
(Pereira et al 2013)	18 PD 18 PD with hallucinations 18 NPD	F, PrS, S, CA1, CA2-3, CA4-DG and HPf	Atrophy of CA2-3 and CA4-DG in PD compare to NPD Atrophy of CA2-3, CA4-DG and S in PD with hallutinations compare to NPD
(Foo et al 2016)	11 PDMCI 54 PD that convert to: 42 PD-stables 12 PDMCI - converters	F, alv, ml, PrS, PaS, S, CA1, CA2-3, CA4, DGg, HPf, HPt and HATA	Atrophy of F(l), CA1(r) and HATA(r) in PDMCI compare to PD Basal atrophy of PaS(l), DGg, CA4(r) and HATA(l) in PDMCI-converters compare to PD-stables Atrophy of CA2-3(r) in PDMCI-converters compare to PD-stables
(Lenka et al 2018)	51PD 42PD with psychosis 48NPD	F, ml, PrS, PaS, S, CA1, CA2-3, CA4, DGg, HPf, HPt and HATA	No differences between PD and NPD Atrophy of ml, DGg, S(l), HPt(l), CA2-3(r), CA4(r) and HATA(r) and higher volume of HPf in PD with psychosis compare to NPD
(Novellino et al 2018)	22AD 18PDD 17NPD	F, PrS, S, CA1, CA2-3, CA4-DG and HPf	Atrophy of PrS(l) and CA2-3 in PDD compare to NPD Atrophy of CA2-3, CA4-DG, PrS, S, F, in AD compare to NPD
(Low et al 2019)	73PD that convert to: 62PD-stables 11PDD-converters	F, ml, PrS, PaS, S, CA1, CA2-3, CA4, DGg, HPf, HPt and HATA	Basal atrophy of CA1, S and PrS in PDD-converters compare to PD-stables Atrophy of PaS, PrS and F in PDD-converters compare to PD-stables
(Wang et al 2019)	26PDMCI 30NPD 30MSAMCI	alv, ml, PrS, PaS, S, CA1, CA2-3, CA4, DGg, HPf, HPt, and HATA	Hight volume of HPf in PDMCI compare to NPD Atrophy of ml, PrS(r), PaS(r), S(r), CA2-3(l), CA1(r), HATA in MSAMCI compare to NPD Atrophy of ml, PrS, PaS(r), CA2-3(l), CA1, HPt, HATA(r) in MSAMCI compare to PDMCI

*See supplementary references. AD, Alzheimer's disease; alv, alveus; CA, *Cornu ammonis*; DG, dentate gyrus; DGg, granule layer of dentate gyrus; F, fimbria; HATA, hippocampus-amygdala-transition; HPf, hippocampus fissure; HPt, hippocampus tail; (l), left; ml, molecular layer; MSAMCI, multiple system atrophy with mild cognitive impairment; NPD, non Parkinson's disease; PaS, parasubicul;, PD, Parkinson's disease; PDD, Parkinson's disease with dementia; PDMCI, Parkinson's disease with mild cognitive impairment; PrS, presubiculo; (r), right; S, subiculo.

Supplementary References

Aarsland ARD. 2006. Management of Parkinson ' s Practical Considerations. Drugs & Aging 23: 807-22

Apostolova LG, Beyer M, Green AE, Hwang KS, Morra JH, et al. 2010. Hippocampal, caudate, and ventricular changes in Parkinson's disease with and without dementia. Movement Disorders 25: 687-95

Armstrong RA, Kotzbauer PT, Perlmutter JS, Campbell MC, Hurth KM, et al. 2014. A quantitative study of α-synuclein pathology in fifteen cases of dementia associated with Parkinson disease. Journal of Neural Transmission 121: 171-81

Aybek S, Lazeyras F, Gronchi-Perrin A, Burkhard PR, Villemure JG, Vingerhoets FJG. 2009. Hippocampal atrophy predicts conversion to dementia after STN-DBS in Parkinson's disease. Parkinsonism and Related Disorders 15: 521-24

Bouchard TP, Malykhin N, Martin WRW, Hanstock CC, Emery DJ, et al. 2008. Age and dementia-associated atrophy predominates in the hippocampal head and amygdala in Parkinson's disease. Neurobiology of Aging 29: 1027-39

Braak H, Del Tredici K, Rüb U, De Vos RAI, Jansen Steur ENH, Braak E. 2003. Staging of brain pathology related to sporadic Parkinson's disease. Neurobiology of Aging 24: 197-211

Brück A, Kurki T, Kaasinen V, Vahlberg T, Rinne JO. 2004. Hippocampal and prefrontal atrophy in patients with early non-demented Parkinson's disease is related to cognitive impairment. Journal of Neurology, Neurosurgery and Psychiatry 75: 1467-69

Burton EJ, McKeith IG, Burn DJ, Williams ED, O'Brien JT. 2004. Cerebral atrophy in Parkinson's disease with and without dementia: A comparison with Alzheimer's disease, dementia with Lewy bodies and controls. Brain 127: 791-800

Camicioli R, Moore MM, Kinney A, Corbridge E, Glassberg K, Kaye JA. 2003. Parkinson's disease is associated with hippocampal atrophy. pp. 784-90: Mov Disord

Carlesimo GA, Piras F, Assogna F, Pontieri FE, Caltagirone C, Spalletta G. 2012. Hippocampal abnormalities and memory deficits in Parkinson disease: A multimodal imaging study. Neurology 78: 1939-45

Chen B, Fan GG, Liu H, Wang S. 2015. Changes in anatomical and functional connectivity of Parkinson's disease patients according to cognitive status. European Journal of Radiology 84: 1318-24

Chung SJ, Shin JH, Cho KH, Lee Y, Sohn YH, et al. 2017. Subcortical shape analysis of progressive mild cognitive impairment in Parkinson's disease. Movement Disorders 32: 1447-56

Churchyard A, Lees AJ. 1997. The relationship between dementia and direct involvement of the hippocampus and amygdala in Parkinson's disease. Neurology 49: 1570-76

Cohn M, Giannoylis I, De Belder M, Saint-Cyr JA, McAndrews MP. 2016. Associative reinstatement memory measures hippocampal function in Parkinson's Disease. Neuropsychologia 90: 25-32

Cwc T, Ej B, Ig M, Dj B, Jt OB. 2005. Temporal lobe atrophy on MRI in Parkinson disease with dementia: a comparison with Alzheimer disease and dementia with Lewy bodies. Neurology 64: 861-65 5p

Dickson DW, Schmidt ML, Lee VMY, Zhao ML, Yen SH, Trojanowski JQ. 1994. Immunoreactivity profile of hippocampal CA2/3 neurites in diffuse Lewy body disease. Acta Neuropathologica 87: 269-76

Flores-Cuadrado A, Ubeda-Bañon I, Saiz-Sanchez D, de la Rosa-Prieto C, Martinez-Marcos A. 2016. Hippocampal α-synuclein and interneurons in Parkinson's disease: Data from human and mouse models. Movement Disorders 31: 979-88

Foo H, Mak E, Chander RJ, Ng A, Au WL, et al. 2016. Associations of hippocampal subfields in the progression of cognitive decline related to Parkinson's disease. NeuroImage: Clinical 14: 37-42

Gee M, Dukart J, Draganski B, Wayne Martin WR, Emery D, Camicioli R. 2017. Regional volumetric change in Parkinson's disease with cognitive decline. Journal of the Neurological Sciences 373: 88-94

Goldman JG, Stebbins GT, Bernard B, Stoub TR, Goetz CG, deToledo-Morrell L. 2012. Entorhinal cortex atrophy differentiates Parkinson's disease patients with and without dementia. Movement Disorders 27: 727-34

Harding AJ, Halliday GM. 2001. Cortical Lewy body pathology in the diagnosis of dementia. Acta Neuropathologica 102: 355-63

Jokinen P, Brück A, Aalto S, Forsback S, Parkkola R, Rinne JO. 2009. Impaired cognitive performance in Parkinson's disease is related to caudate dopaminergic hypofunction and hippocampal atrophy. Parkinsonism and Related Disorders 15: 88-93

Jokinen P, Scheinin N, Aalto S, Någren K, Savisto N, et al. 2010. [11C]PIB-, [18F]FDG-PET and MRI imaging in patients with Parkinson's disease with and without dementia. Parkinsonism and Related Disorders 16: 666-70

Junqué C, Ramírez-Ruiz B, Tolosa E, Summerfield C, Martí MJ, et al. 2005. Amygdalar and hippocampal MRI volumetric reductions in Parkinson's disease with dementia. Movement Disorders 20: 540-44

Kamps S, Heuvel OAVD, Werf YDVD, Berendse HW, Weintraub D. 2018. Smaller subcortical volume in Parkinson patients with rapid eye movement sleep behavior disorder. Brain Imaging and Behavior i

Kandiah N, Zainal NH, Narasimhalu K, Chander RJ, Ng A, et al. 2014. Hippocampal volume and white matter disease in the prediction of dementia in Parkinson's disease. Parkinsonism and Related Disorders 20: 1203-08

Kim HBA, Gearing M, Mirra SS. 1995. Ubiquitin-positive ca2/3 neurites in hippocampus coexist with cortical lewy bodies. Neurology 45: 1768-70

Kunst J, Marecek R, Klobusiakova P, Balazova Z, Anderkova L, et al. 2019. Patterns of Grey Matter Atrophy at Different Stages of Parkinson’s and Alzheimer’s Diseases and Relation to Cognition. Brain Topography 32: 142-60

Laakso MP, Partanen K, Riekkinen P, Lehtovirta M, Helkala EL, et al. 1996. Hippocampal volumes in Alzheimer's disease, Parkinson's disease with and without dementia, and in vascular dementia: An MRI study. Neurology 46: 678-81

Lee HM, Kwon KY, Kim MJ, Jang JW, Suh Si, et al. 2014. Subcortical grey matter changes in untreated, early stage Parkinson's disease without dementia. Parkinsonism and Related Disorders 20: 622-26

Lee SH, Kim SS, Tae WS, Lee SY, Lee KU, Jhoo J. 2013. Brain volumetry in Parkinson's disease with and without dementia: Where are the differences? Acta Radiologica 54: 581-86

Lenka A, Ingalhalikar M, Shah A, Saini J, Arumugham SS, et al. 2018. Hippocampal subfield atrophy in patients with Parkinson's disease and psychosis. Journal of Neural Transmission 125: 1361-72

Low A, Foo H, Yong TT, Tan LCS, Kandiah N. 2019. Hippocampal subfield atrophy of CA1 and subicular structures predict progression to dementia in idiopathic Parkinson's disease. Journal of Neurology, Neurosurgery and Psychiatry 90: 681-87

Mattila PM, Rinne JO, Helenius H, Röyttä M. 1999. Neuritic degeneration in the hippocampus and amygdala in Parkinson's disease in relation to Alzheimer pathology. Acta Neuropathologica 98: 157-64

Melzer TR, Watts R, MacAskill MR, Pitcher TL, Livingston L, et al. 2012. Grey matter atrophy in cognitively impaired Parkinson's disease. Journal of Neurology, Neurosurgery and Psychiatry 83: 188-94

Messina D, Cerasa A, Condino F, Arabia G, Novellino F, et al. 2011. Patterns of brain atrophy in Parkinson's disease, progressive supranuclear palsy and multiple system atrophy. Parkinsonism and Related Disorders 17: 172-76

Mihaescu AS, Masellis M, Graff-Guerrero A, Kim J, Criaud M, et al. 2019. Brain degeneration in Parkinson's disease patients with cognitive decline: a coordinate-based meta-analysis. Brain Imaging and Behavior 13: 1021-34

Nagano-Saito A, Washimi Y, Arahata Y, Kachi T, Lerch JP, et al. 2005. Cerebral atrophy and its relation to cognitive impairment in Parkinson disease. Neurology 64: 224-29

Noh SW, Han YH, Mun CW, Chung EJ, Kim EG, et al. 2014. Analysis among cognitive profiles and gray matter volume in newly diagnosed Parkinson's disease with mild cognitive impairment. Journal of the Neurological Sciences 347: 210-13

Novellino F, Vasta R, Sarica A, Chiriaco C, Salsone M, et al. 2018. Relationship between Hippocampal Subfields and Category Cued Recall in AD and PDD: A Multimodal MRI Study. Neuroscience 371: 506-17

Nyberg EM, Tanabe J, Honce JM, Krmpotich T, Shelton E, et al. 2015. Morphologic changes in the mesolimbic pathway in Parkinson's disease motor subtypes. Parkinsonism and Related Disorders 21: 536-40

Pereira JB, Junqué C, Bartrés-Faz D, Ramírez-Ruiz B, Marti M-J, Tolosa E. 2013. Regional vulnerability of hippocampal subfields and memory deficits in Parkinson's disease. Hippocampus 23: 720-28

Radziunas A, Deltuva VP, Tamasauskas A, Gleizniene R, Pranckeviciene A, et al. 2018. Brain MRI morphometric analysis in Parkinson's disease patients with sleep disturbances. BMC Neurology 18

Rektorova I, Biundo R, Marecek R, Weis L, Aarsland D, Antonini A. 2014. Grey matter changes in cognitively impaired Parkinson's disease patients. PLoS ONE 9

Schneider CB, Donix M, Linse K, Werner A, Fauser M, et al. 2017. Accelerated age-dependent hippocampal volume loss in Parkinson disease with mild cognitive impairment. American Journal of Alzheimer's Disease and other Dementias 32: 313-19

Summerfield C, Junqué C, Tolosa E, Salgado-Pineda P, Gómez-Ansón B, et al. 2005. Structural Brain Changes in Parkinson Disease With Dementia. Archives of Neurology 62: 281-81

Vasconcellos LF, Pereira JS, Adachi M, Greca D, Cruz M, et al. 2018. Volumetric brain analysis as a predictor of a worse cognitive outcome in Parkinson's disease. Journal of Psychiatric Research 102: 254-60

Wang N, Zhang L, Yang HG, Luo XG, Fan GG. 2019. Do multiple system atrophy and Parkinson's disease show distinct patterns of volumetric alterations across hippocampal subfields? An exploratory study. European Radiology 29: 4948-56

Yao N, Cheung C, Pang S, Shek-kwan Chang R, Lau KK, et al. 2016. Multimodal MRI of the hippocampus in Parkinson's disease with visual hallucinations. Brain Structure and Function 221: 287-300

Zeng Q, Guan X, Law Yan Lun JCF, Shen Z, Guo T, et al. 2017. Longitudinal Alterations of Local Spontaneous Brain Activity in Parkinson's Disease. Neuroscience Bulletin 33: 501-09

Zhang Y, Zhang J, Xu J, Wu X, Zhang Y, et al. 2014. Cortical gyrification reductions and subcortical atrophy in Parkinson's disease. Movement Disorders 29: 122-26