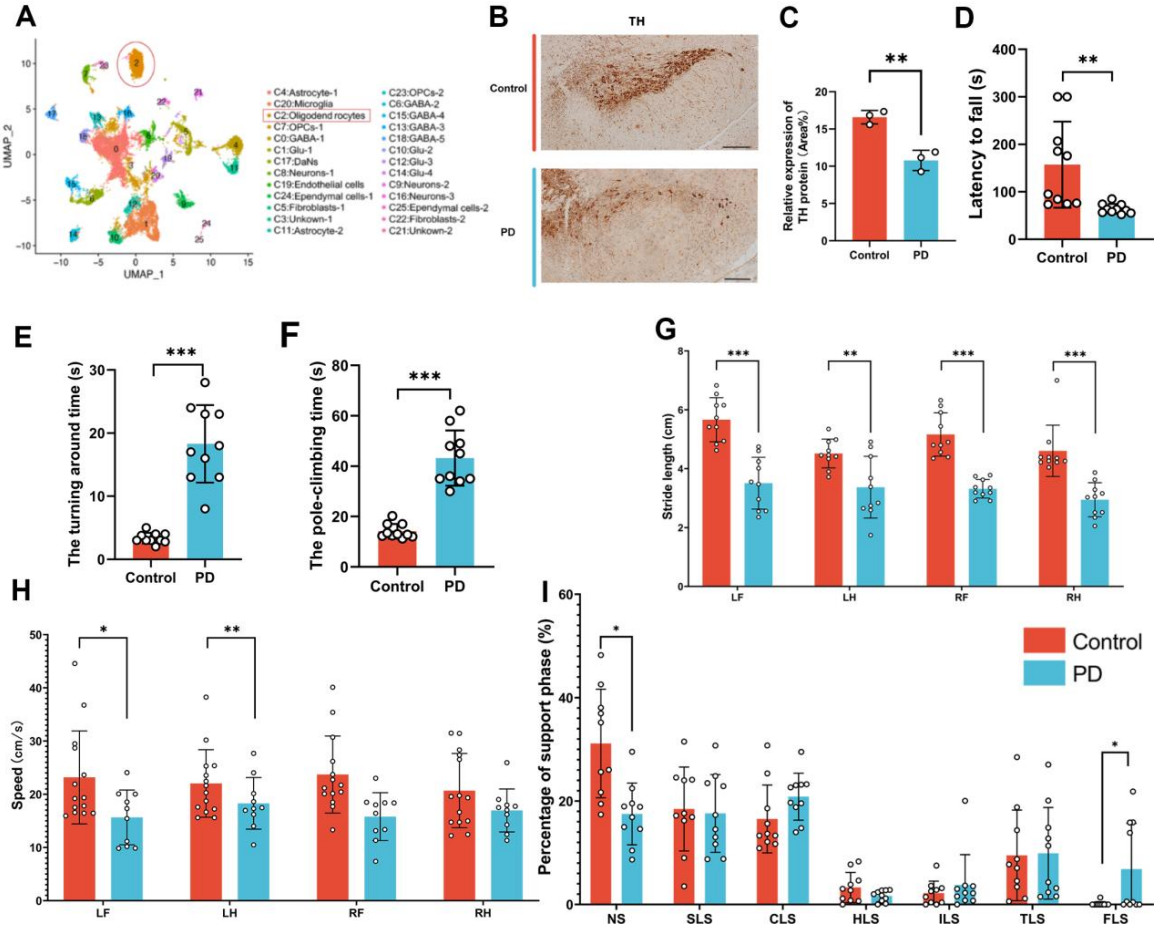
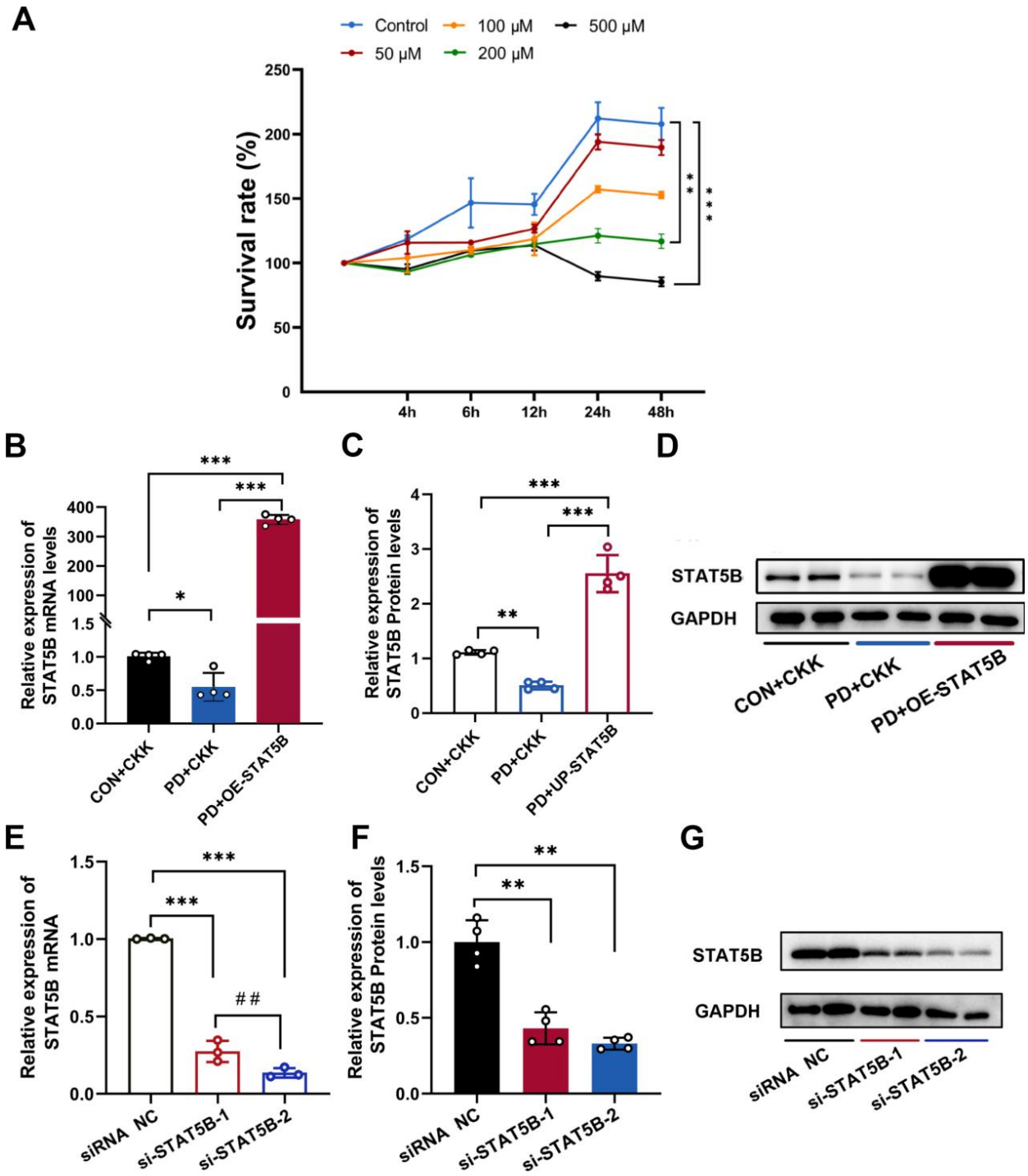
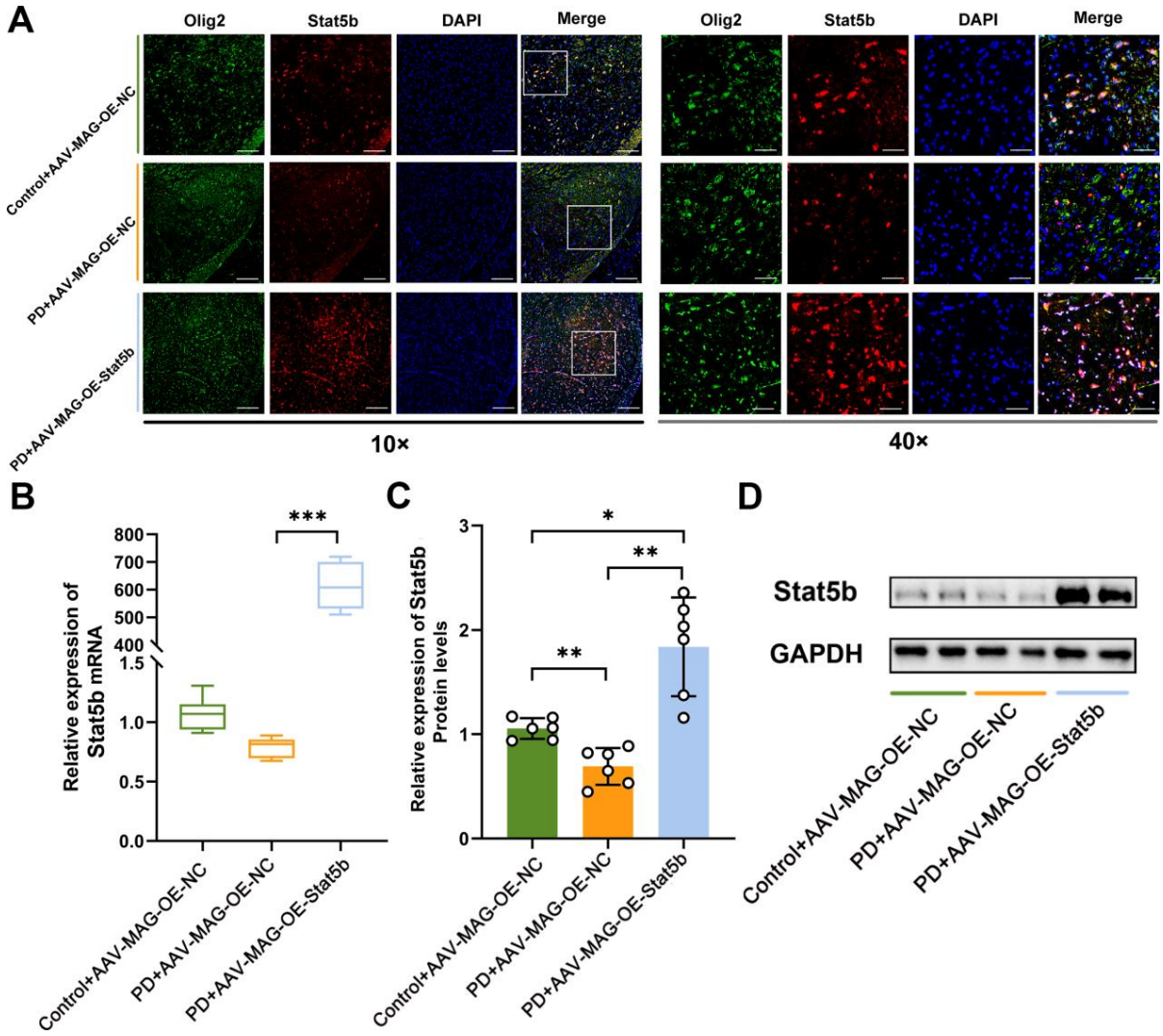


Supplementary Figure S1. The MPTP-induced subacute model mice were successfully constructed. (A) UMAP embedding of the 22,983 mouse SN nuclei; colored by cluster. Highlighted to represent the oligodendrocytes cluster. (B) Representative images and (C) quantification of TH^+ neurons in the SNpc for each group. Scale bar = 200 μm. (D) Rotarod test results showing fall latency. (E-F) Pole test results showing total time and turn time. (G-I) Gait analysis results showing movement speed, stride length and support time. NS: No Support, SLS: Single-Leg Support, CLS: Contralateral Limb Support, HLS: Homologous Limb Support, ILS: lpsilateral Limb Support, TLS:Three-Limb Support, FLS: Four-Limb Support. The results were expressed as the mean ± SD (n = 10; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$)



Supplementary Figure S2. Successful overexpression and Knockdown of STAT5B in MPP$^+$-induced MO3.13 cells. (A) Viability of MO3.13 cells treated with varying concentrations of MPP$^+$ for 4, 6, 12, 24, and 48 h. (B-D) qRT-PCR and western blot analysis of the STAT5B expression in STAT5B-overexpression MO3.13 cells. (E-G) qRT-PCR and western blot analysis of the STAT5B expression in STAT5B-Knockdown MO3.13 cells (*, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$).



Supplementary Figure S3. The AAV-MAG-OE-STAT5B can effectively overexpress STAT5B specifically in oligodendrocytes of the SN of mice. (A) Representative images of brain-stereotaxic AAV virus in the SN for each group (10× Scale bars=200 μm). (B-D) qRT-PCR analysis and western blot analysis of the STAT5B expression in SN of mice. (n = 6; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$).

Table S1. The primers and siRNA sequences.

Name	Primer	
Hum-STAT5B	Forward:	5' AGTTTGATTCTCAGGAAAGAATGT 3'
	Reverse:	5' TCCATCAACAGCTTTAGCAGT 3'
Hum-MBP	Forward:	5' CCCTGAGCAGATTTAGCTGG 3'
	Reverse:	5' GAATCCCTTGTGAGCCGATT 3'
Hum-GAPDH	Forward:	5' GCAAATTCCATGGCACCGT 3'
	Reverse:	5' TCGCCCCACTTGATTTTGG 3'
Mus-STAT5B	Forward:	5' TCAACATCAGCAGCAACCACCTC 3'
	Reverse:	5' TCCATCACGCCATCAAACCACTG 3'
Mus-MBP	Forward:	5' GGACCCAAGATGAAAACCCC 3'
	Reverse:	5' CCTTGAATCCCTTGTGAGCC 3'
Hum-DNMT3A	Forward:	5' TATTGATGAGCGCACAAGAGAGC 3'
	Reverse:	5' TATTGATGAGCGCACAAGAGAGC 3'
Hum-DNMT1	Forward:	5' AGCGAGCGAGCCAGAGATAG 3'
	Reverse:	5' GAGATGCCTGCTTGGTGGAATCC 3'
Hum-DNMT3B	Forward:	5' AGCAGCCCTGGAGACTCATTGG 3'
	Reverse:	5' CTGGTTGCGTGTTGTTGGGTTTG 3'
Hum-TET1	Forward:	5' GATGACAGAGGTTCTTGCACAT 3'
	Reverse:	5' GATGACAGAGGTTCTTGCACAT 3'
Hum-TET2	Forward:	5' GCCTTTGCTCCTGTTGAGTT 3'
	Reverse:	5' ACAAGGCTGCCCTCTAGTTG 3'
Hum-TET3	Forward:	5' CACTCCGGAGAAGATCAAGC 3'
	Reverse:	5' GGACAATCCACCCTTCAGAG 3'
STAT5B-2202 Methylation	Forward:	5' GTGGGTGTGTGGGGATTTC 3'
	Reverse:	5' CCCTATTTCTTAAAACTTTACTAATACCC 3'
STAT5B-2202 Unmethylation	Forward:	5' GTGGGTGTGTGGGGATTTT 3'
	Reverse:	5' CCCTATTTCTTAAAACTTTACTAATACCC 3'

	siRNA	
Si-STAT5B-1	Forward:	5' UCAGAUGCAAGCGUUAUAUTT 3'
	Reverse:	5' AUAUAACGCUUGCAUCUGAUG 3'
Si-STAT5B-2	Forward:	5' UGUCCCUGAAACGAAUUAATT 3'
	Reverse:	5' UUAAUUCGUUUCAGGGACAUA 3'
Si-DNMT3A	Forward:	5' AGAUGUUCUUUGCCAAUAATT 3'
	Reverse:	5' UUAUUGGCAAAGAACAUCUGG 3'