

Title:

Reorganisation of diffusion microstructure in the precuneus is associated with preserved cognitive function in Parkinson's disease

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Supplementary Table 1. Neuropsychological test battery and cognitive domains

Cognitive domain	Test
Attention and working memory	Trail Making Test Part A ¹
	Digit span test ²
	Stroop color-word test, reading and color naming parts ³
Executive function	Tower of London ⁴
	Brixton ⁵
	MEC, orthographic verbal fluency subtest ⁶
	Trail Making Test Part B ¹
	Stroop color-word test, interference part ⁷
Language	Wechsler Abbreviated Scale of Intelligence, vocabulary subtest ⁸
	Boston Naming ^{9,10}
	MEC, semantic verbal fluency subtest ⁶
Memory	Rey Auditory Verbal Learning Test ¹¹
	Wechsler Memory Scale 3 rd ed., logical memory subtest (immediate and delayed recalls) ²
Visuo-spatial function	Hooper Visual Organization Test ¹²
	Clock-drawing subtest of the MoCA, evaluated by scores of Schulman et al. ¹³⁻¹⁵

Legend: MEC=Montreal Evaluation of Communication protocol; MoCA=Montreal Cognitive Assessment Scale.

References:

1. Tombaugh TN. Trail Making Test A and B: normative data stratified by age and education. Archives of clinical neuropsychology 2004; 19: 203-214.
2. Wechsler D. Wechsler adult intelligence scale-III (WAIS-III). New York: Psychological Corporation, 1997.
3. Delis DC, Kaplan E, Kramer JH. Delis-Kaplan executive function system: Technical manual. San-Antonio, TX: Psychological Corporation, 2001.
4. Culbertson CW, Zillmer EA. Tower of London Drexel University (TOL DX). North Tonawanda, NY: Multi-Health Systems Incorporated (MHS), 2005.
5. Burgess PW, Shallice T. The hayling and brixton tests. Test manual. Bury St Edmunds, UK: Thames Valley Test Company, 1997.
6. Joannette Y, Ska B, Côté H. Protocole Montréal d'évaluation de la communication (Protocole MEC). Isbergues, France: Ortho Édition, 2004.
7. Golden CJ, Freshwater SM. Stroop Color and Word Test: A manual for clinical and experimental uses. Wood Dale, IL: Stoelting Co, 1998.
8. Wechsler D. Wechsler abbreviated scale of intelligence (WASI). San Antonio, Tex: Psychological Corporation, 1999.
9. Kaplan EF, Goodglass H, Weintraub S. Boston naming test. Philadelphia: Lea & Febiger, 1983.
10. Spreen O, Strauss E. A compendium of neuropsychological tests. Administration, norms, and commentary. Oxford, USA: Oxford University Press, 1998.
11. Schmidt M. Rey auditory verbal learning test: A handbook. Los Angeles, CA: Western Psychological Services, 1996.

12. Hooper HE. The Hooper Visual Organization Test. Los Angeles, CA: Western Psychological Services, 1958.
13. Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc* 2005; 53: 695-699.
14. Shulman KI. Clock-drawing: is it the ideal cognitive screening test? *Int J Geriatr Psychiatry* 2000; 15: 548-561.
15. Shulman KI, Pushkar Gold D, Cohen CA, Zuccherro CA. Clock-drawing and dementia in the community: A longitudinal study. *Int J Geriatr Psychiatry* 1993; 8: 487-496.

Supplementary Table 2. Demography of participants.

	HV			PD-nonMCI			PD-MCI				
Age	61.84	±	5.51	60.25	±	4.19	63.97	±	5.29		***
Sex (M vs F)	7 vs 9			12 vs 8			12 vs 6				
MoCA	28.56	±	1.31	27.65	±	2.16	26.44	±	1.85		*
BDI	4.13	±	4.16	8.60	±	5.31	11.17	±	6.82		*, **
Brixton (Z score)	-0.02	±	2.21	-1.21	±	1.70	-2.47	±	2.60		*
RAVLT (Z score)	0.59	±	1.03	0.21	±	0.94	-0.53	±	1.16		*, ***
UPDRS	N/A			27.55	±	8.11	29.39	±	9.47		

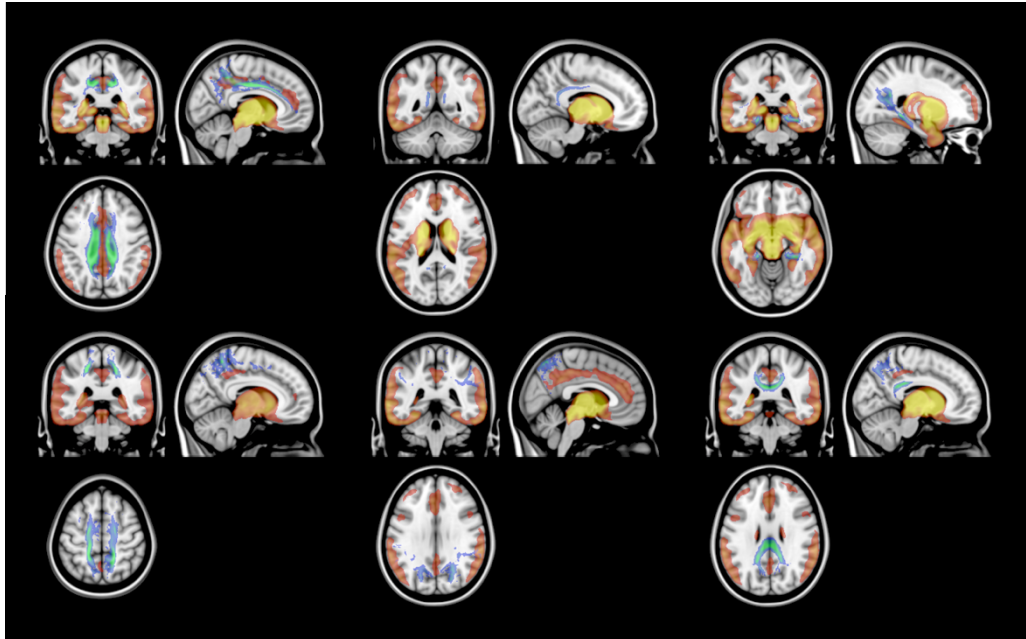
* indicates significant difference between HV and PD (all) ($p < 0.05$), ** indicates significant difference between HV vs PD-nonMCI, and *** indicates significant difference between PD-nonMCI and PD-MCI.

MoCA; Montreal Cognitive Assessment, BDI; Beck depression inventory, RAVLT; Rey Auditory Verbal Learning Test, UPDRS; Unified Parkinson's Disease Rating Scale, motor examination.

Supplementary Table 3. Correlation ratio between precuneus FA and AFD of each bundle

group		PCG-PCN	PCG-PHG	PCN-PHG	PCN-Cortex	PCN-Local	PCN-Cross
HV	r	0.645	0.168	-0.375	-0.232	0.050	0.036
	p	0.007	0.534	0.152	0.387	0.854	0.894
PD	r	0.390	0.083	-0.104	-0.257	-0.140	0.096
	p	0.015	0.621	0.536	0.119	0.402	0.567

Supplementary Figure 1. Tractography and dopamine D2/3 receptor distribution.



A binding potential (BP_{ND}) t-map of [18F]-fallypride PET (hot color) from young healthy volunteers (Nagano-Saito et al, 2017) and the bundles (green-blue, left) were overlapped on MNI T1 template. The PCG-Precuneus bundle (Top left) showed closely collocation with the D2/3 receptor distribution, in the midline of the brain.

Top left; PCG-Precuneus, middle; PCG-PHG, right; Precuneus-PHG, Bottom left; Precuneus-Cortex, middle; Precuneus-Local, right; Precuneus-Cross.