

## Supplementary Material

Title: Neuroplasticity of cognitive control networks following cognitive training for chronic traumatic brain injury<sup>†</sup>

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<sup>†</sup>The views and opinions expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of the Air Force, Department of Defense or United States Government.

## Supplementary Tables

**Table S1.** Changes in residual psychiatric symptom severity

Psychiatric measure	SMART (N=26)				BHW (N=30)			SMART vs BHW	
	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	<i>p</i> -values (M, NM) <sup>a</sup>	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	<i>p</i> -values (M, NM) <sup>a</sup>	<i>p</i> -values (M, NM) <sup>a</sup>
BDI-II	23.3±9.3	15.3±10.2	13.2±9.2	<0.01*, 0.05*	18.5±12.6	13.8±11.4	12.9±10.9	<0.01*, >0.1	>0.1, >0.1
PCL-S	46.4±16.5	43.5±17.8	37.8±16.6	<0.01*, >0.1	46.5±19.0	39.6±19.5	39.0±20.4	0.01*, >0.1	>0.1, >0.1

*Note:* SS, Scaled scores; M, Monotonic; MN, Non-monotonic. See Tables 1, 2 for other abbreviations.

<sup>a</sup> \* represents  $p < 0.05$ .

**Table S2.** Within-group changes in neuropsychological test scores

Neuropsychological measures	<i>p</i> -values (M, NM) <sup>a</sup>	
	SMART (N=26)	BHW (N=30)
Card-sorting (SS)	<0.01 <sup>*</sup> , 0.02 <sup>*</sup>	0.01 <sup>*</sup> , <0.01 <sup>*</sup>
Trail-making (SS)	0.03 <sup>*</sup> , 0.01 <sup>*</sup>	>0.1, >0.1

Note: See Table 3 for abbreviations.

<sup>a</sup> \* represents  $p < 0.05$ .

**Table S3.** The number of civilians and veterans per time point by group

Time point	Neuropsychological assessments		Resting-state fMRI scans	
	SMART <sup>a</sup>	BHW <sup>a</sup>	SMART <sup>a</sup>	BHW <sup>a</sup>
TP <sub>1</sub>	17, 9	18, 12	14, 6	14, 7
TP <sub>2</sub>	16, 9	16, 9	14, 6	14, 5
TP <sub>3</sub>	12, 7	15, 9	9, 5	10, 5

<sup>a</sup> Civilians, Veterans

**Table S4.** The distribution of primary cause of injury per time point by group

Time point	Neuropsychological assessments		Resting-state fMRI scans	
	SMART <sup>a</sup>	BHW <sup>a</sup>	SMART <sup>a</sup>	BHW <sup>a</sup>
TP <sub>1</sub>	5, 2, 2, 8, 7, 2	5, 6, 5, 5, 7, 2	2, 1, 2, 7, 6, 2	4, 5, 4, 4, 2, 2
TP <sub>2</sub>	5, 2, 2, 7, 7, 2	4, 6, 4, 4, 6, 1	3, 1, 2, 6, 6, 2	3, 5, 3, 5, 2, 1
TP <sub>3</sub>	4, 2, 1, 5, 6, 1	3, 5, 4, 5, 6, 1	2, 1, 1, 5, 5, 0	4, 3, 3, 2, 3, 0

<sup>a</sup> blast, blunt force trauma, fall, athletic impacts, vehicle accidents, combined

**Table S5.** Regions showing statistically significant group differences in changes in cognitive control networks connectivity (SMART > BHW;  $p_{\text{voxel}} < 0.001$ ;  $p_{\text{cluster}} < 0.05$ ).

#	Seed	Region	Major cluster	Z <sup>a</sup>	x <sup>b</sup>	y <sup>b</sup>	z <sup>b</sup>	Temporal change pattern <sup>c</sup>	
								SMART	BHW
1	R al/fO	L Parahippocampal gyrus	1 (21 voxels)	4.5	-22	-26	-10	–	↓ <sup>d</sup>
2		L Ventrolateral prefrontal cortex	2 (19 voxels)	4.0	-52	27	-8	↑ <sup>d</sup>	–
3		Ventral anterior cingulate cortex	3 (16 voxels)	4.6	-2	22	-2	↑ <sup>d</sup>	–
4	R dFC	Anterior prefrontal cortex	4 (15 voxels)	3.9	-6	66	-10	↑	–
5	L dlPFC	R Intraparietal sulcus	5 (57 voxels)	4.8	38	-46	50	–	↓
6		Paracentral lobule	6 (48 voxels)	4.1	6	-22	58	↑ <sup>d</sup>	–
7		R Precentral gyrus	7 (19 voxels)	4.9	34	-14	58	–	↓ <sup>d</sup>
8		R Subcentral gyrus	8 (15 voxels)	4.1	54	-14	18	–	↓
9	L IPS	L Superior temporal gyrus	9 (12 voxels)	4.4	-58	-26	2	–	–
10	R IPS	L Superior temporal gyrus	10 (22 voxels)	4.3	-70	-22	-6	↑ <sup>d</sup>	–
11		L Ventrolateral prefrontal cortex	11 (14 voxels)	3.9	-46	34	-14	↑ <sup>d</sup>	–
12		L Superior temporal gyrus	12 (12 voxels)	4.2	-54	-10	-14	–	–
13	mCC	L Posterior insula	13 (18 voxels)	4.2	-46	-42	14	↑ <sup>d</sup>	↓ <sup>d</sup>
14	L PCUN	R Subcentral gyrus	14 (44 voxels)	4.5	62	-6	10	↑ <sup>d</sup>	–
15		L Subcentral gyrus	15 (30 voxels)	4.7	-62	-6	14	↑ <sup>d</sup>	↓ <sup>d</sup>
16		L Middle temporal complex	16 (27 voxels)	3.8	-42	-74	6	↑ <sup>d</sup>	–
17		R Middle temporal complex	17 (23 voxels)	3.9	42	-70	-6	↑ <sup>d</sup>	–
18		R Superior temporal gyrus	18 (14 voxels)	4.0	38	-30	18	↑ <sup>d</sup>	–
19		L Lingual gyrus	19 (13 voxels)	3.7	-14	-78	-2	↑	–
20	R PCUN	R Cuneus	20 (37 voxels)	4.0	22	-86	2	↑ <sup>d</sup>	–
21		L Middle temporal complex	21 (36 voxels)	4.2	-42	-62	6	↑	–
22		L Superior temporal gyrus	22 (28 voxels)	4.5	-50	-30	2	↑ <sup>d</sup>	↓ <sup>d</sup>
23		L Subcentral gyrus	23 (26 voxels)	4.4	-62	-6	14	↑	–
24		R Precentral gyrus	24 (20 voxels)	4.4	50	-2	50	↑ <sup>d</sup>	–
25		R Middle temporal complex	25 (19 voxels)	4.2	38	-74	-6	↑	–
26		R Subcentral gyrus	26 (13 voxels)	4.2	62	-6	10	↑ <sup>d</sup>	–
27		L Precentral gyrus	27 (13 voxels)	4.2	-54	-6	46	↑ <sup>d</sup>	–

*Note:* L, Left; R, Right; al/fO; anterior insula/frontal operculum; dFC, dorsal frontal cortex; dlPFC, dorsolateral prefrontal cortex; IPS, inferior parietal sulcus; mCC, middle cingulate cortex; PCUN, precuneus..

<sup>a</sup> Local peak whose distance from other peaks within the cluster was longer than 30 mm.

<sup>b</sup> The Montreal Neurological Institute (MNI) space.

<sup>c</sup> ‘↑’, ‘↓’ and ‘–’ symbols indicate monotonic increases, monotonic decreases and no significant changes, respectively.

<sup>d</sup> Within-group changes at  $p_{\text{voxel}} < 0.001$ .

**Table S6.** The amount of subject motion during fMRI scans per time point by group

Measure	SMART (N=21)			BHW (N=24)			<i>p</i> <0.05
	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	
FD (mm)	0.20 ± 0.08	0.21 ± 0.07	0.19 ± 0.10	0.21 ± 0.08	0.23 ± 0.10	0.23 ± 0.09	none

*Note:* FD, Framewise displacement.

**Table S7.** Neuropsychological assessment results for the participants who underwent MRI scans

Neuropsychological measure	SMART (N=21)			BHW (N=24)			<i>p</i> -values (M, NM) <sup>a</sup>
	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	TP <sub>1</sub>	TP <sub>2</sub>	TP <sub>3</sub>	
Card sorting (SS)	9.7±2.6	11.7±2.1	11.9±2.2	9.7±2.9	11.4±3.0	11.2±3.4	>0.1, >0.1
Trail making (SS)	7.9±2.8	9.8±3.0	9.8±1.9	8.8±2.6	9.2±2.9	8.5±2.6	0.07 <sup>†</sup> , >0.1

See Tables 3 for abbreviations.

<sup>a</sup> † represents  $p < 0.1$ .



## Supplementary figures

## Monotonic changes over time (SMART vs BHW)

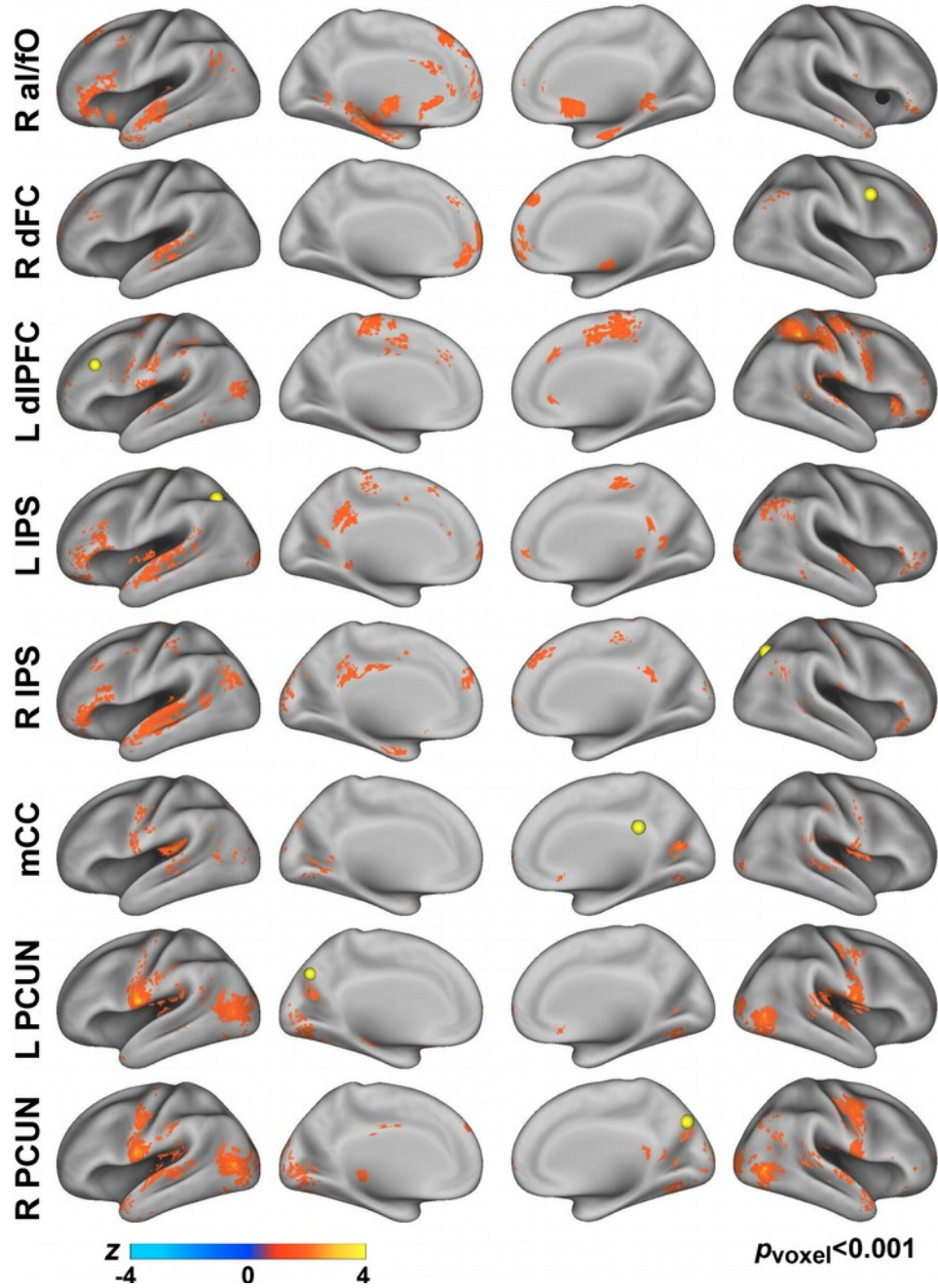
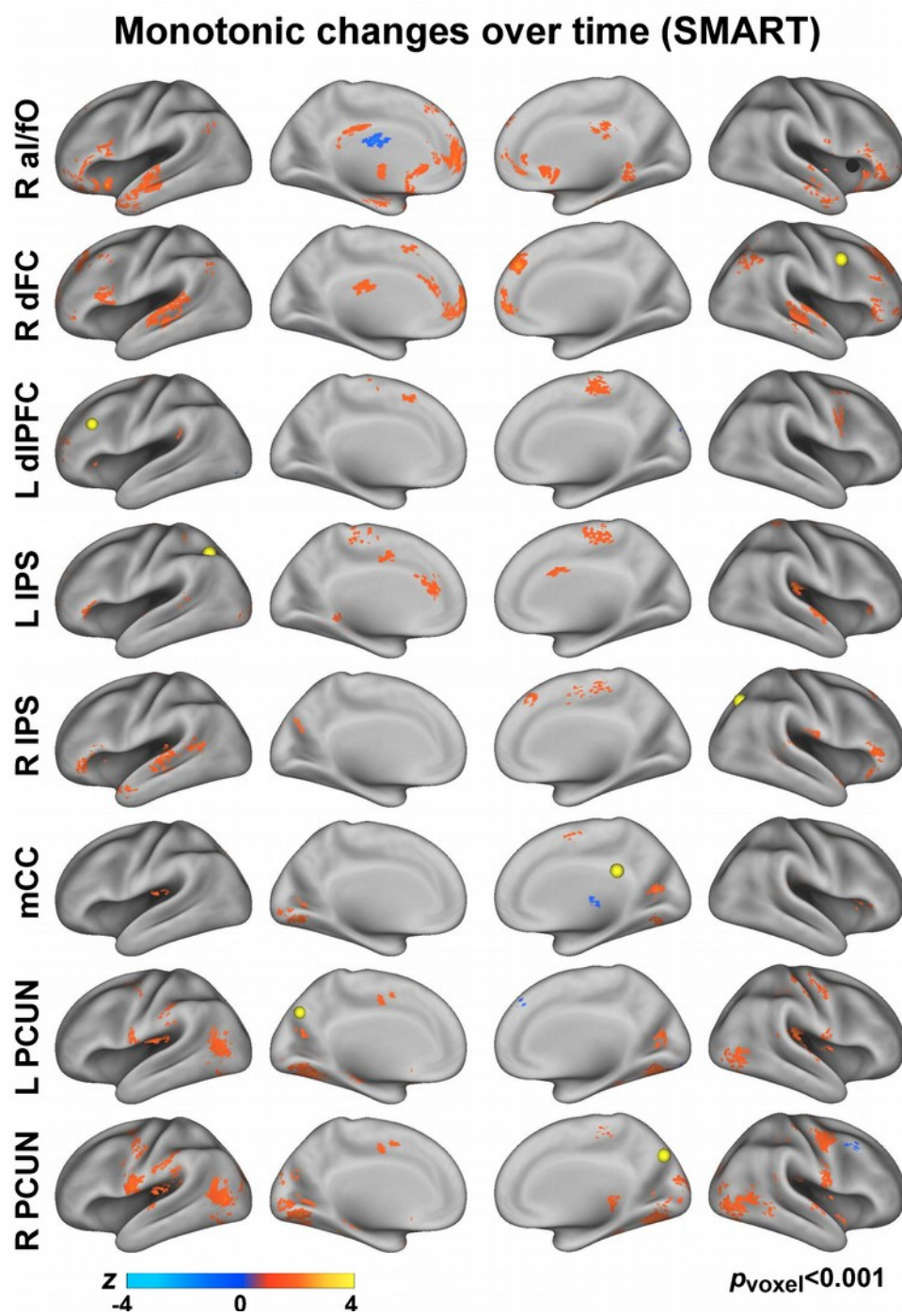
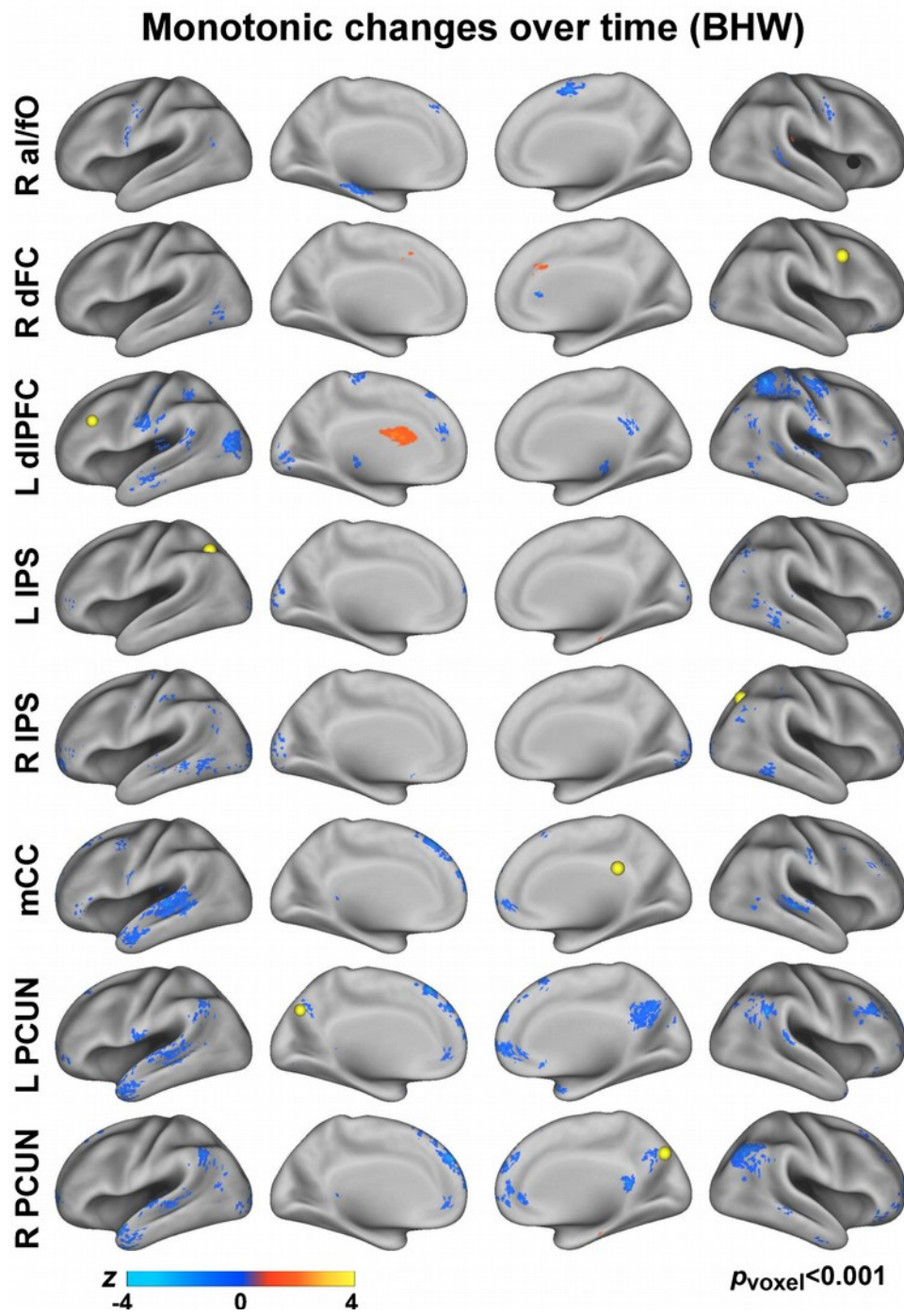


Figure S1. Between-group contrast maps for changes in connectivity over time (uncorrected).

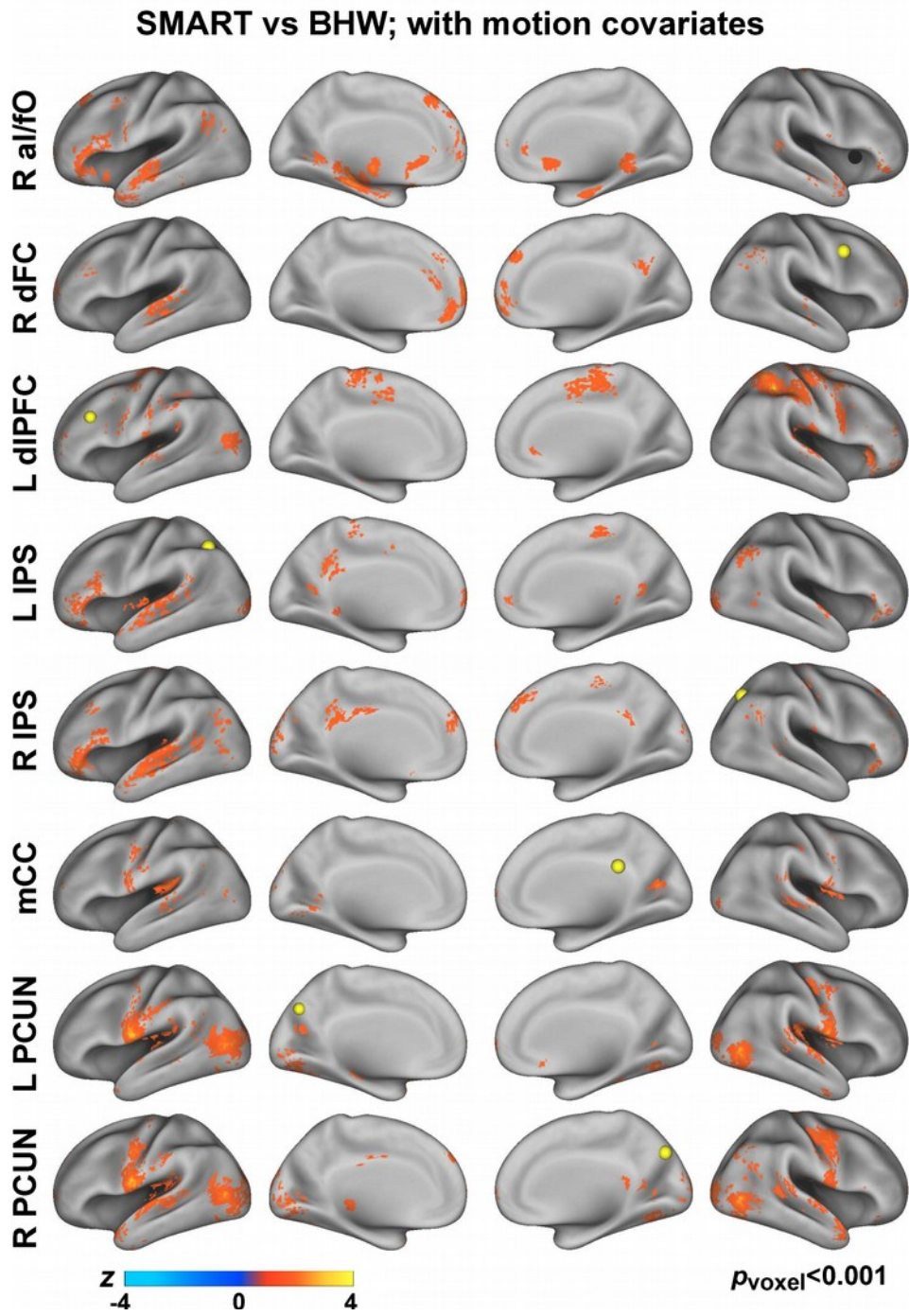


**Figure S2.** Within-group contrast maps for changes in connectivity over time for the SMART group (uncorrected).

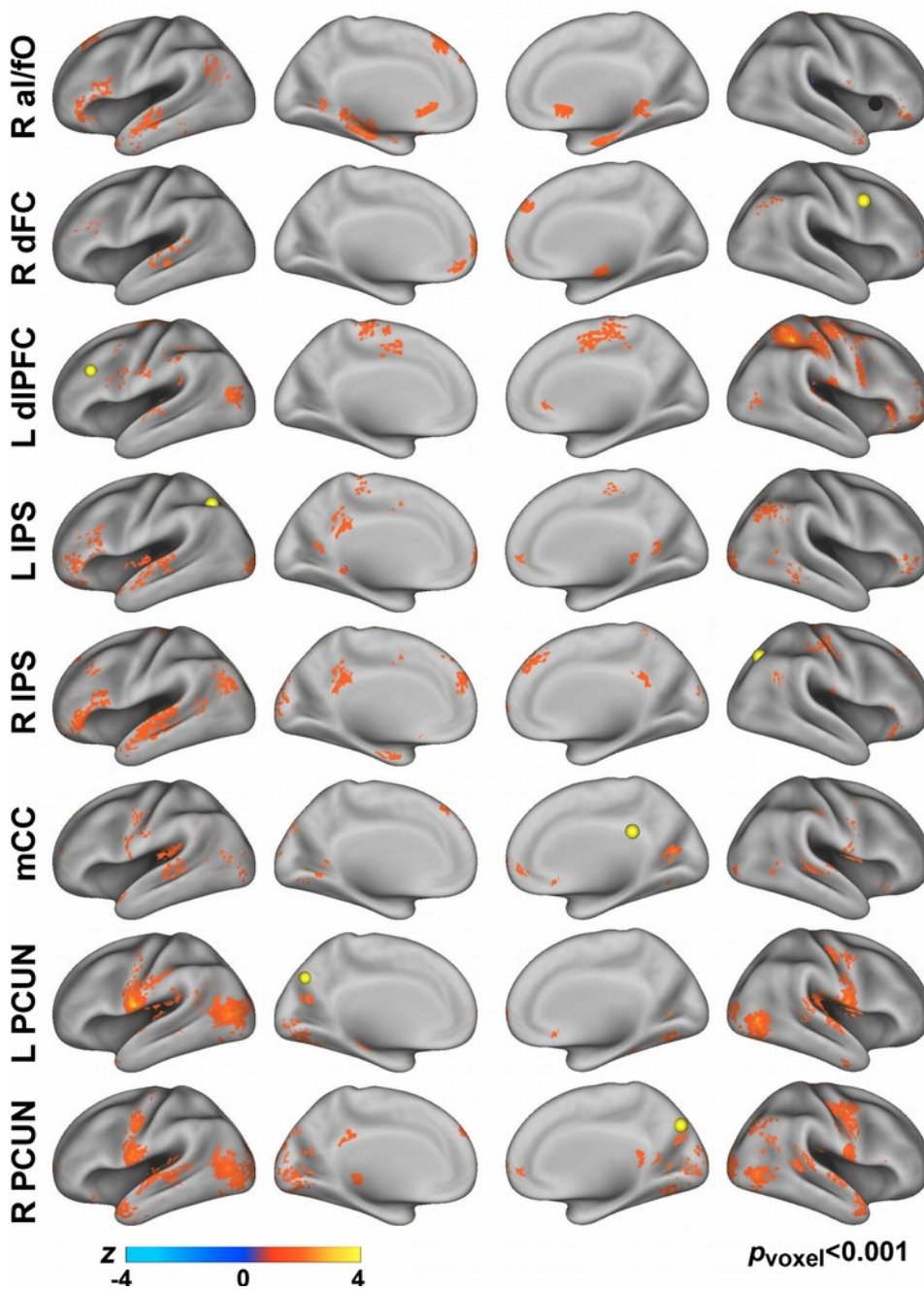


**Figure S3.** Within-group contrast maps for changes in connectivity over time for the BHW group (uncorrected).

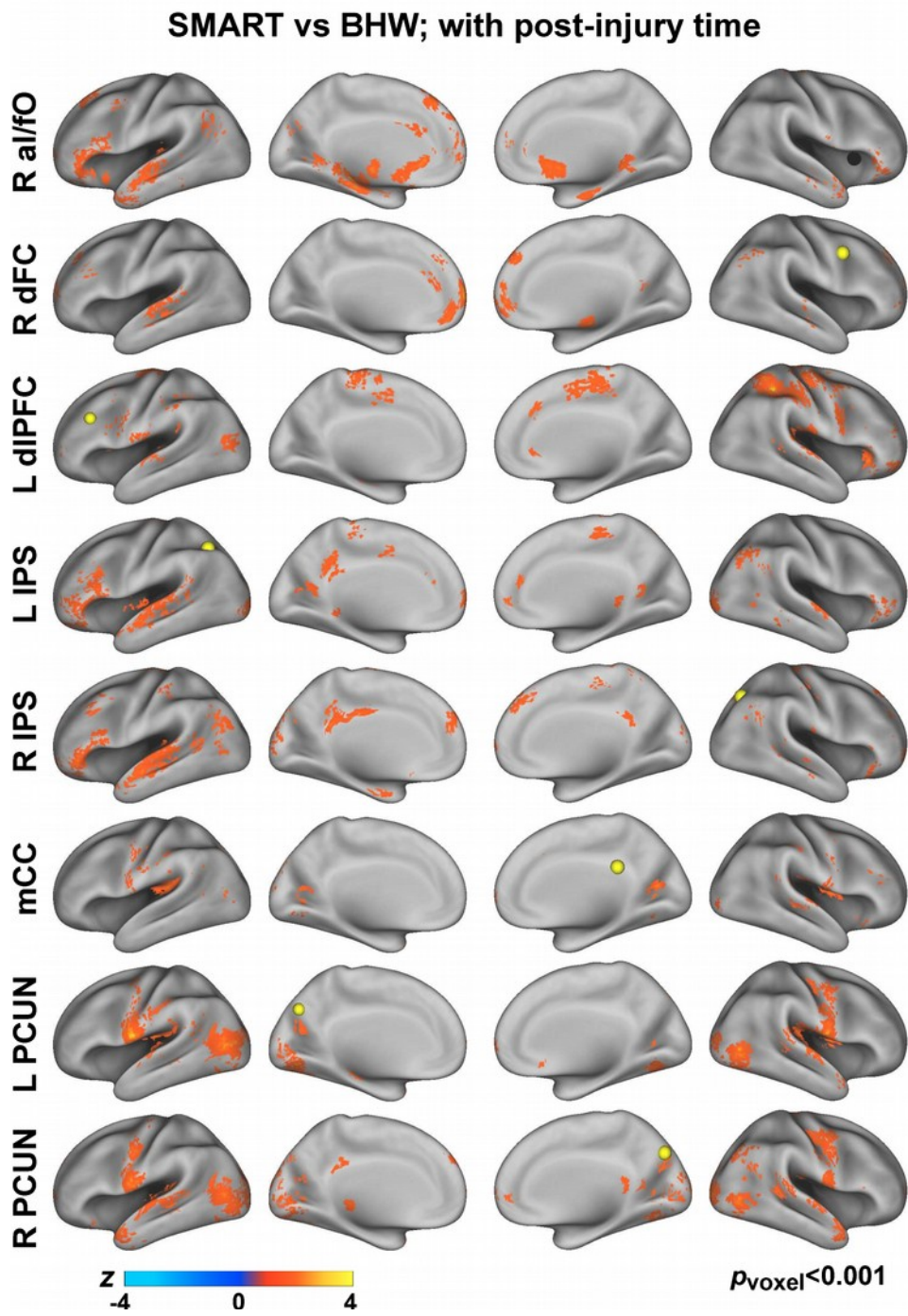




**Figure S4.** Between-group contrast maps for changes in connectivity over time with covariates for framewise displacement (uncorrected).

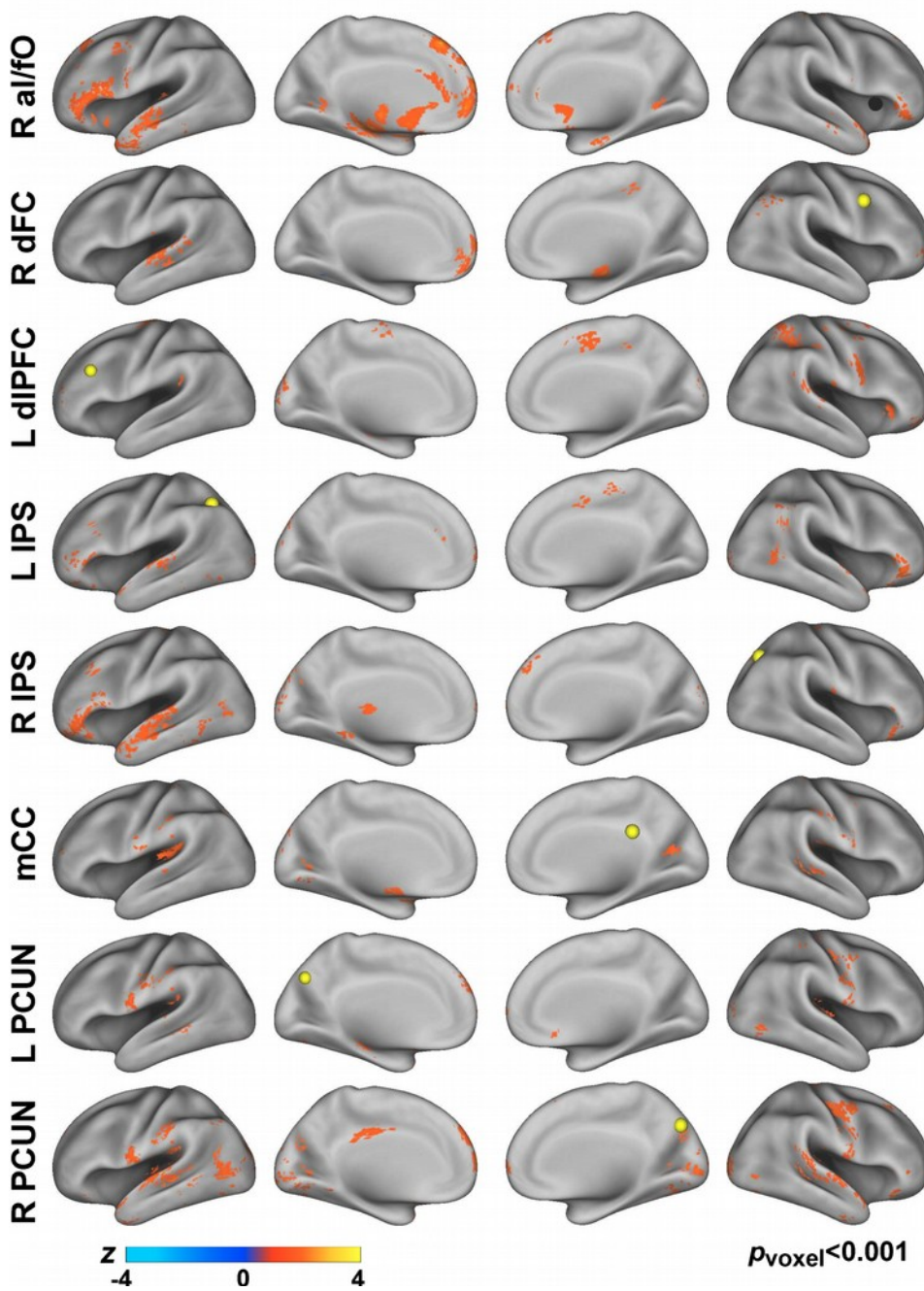
**SMART vs BHW; w/o controlling for psychiatric symptoms**

**Figure S5.** Between-group contrast maps for changes in connectivity over time without covariates for residual psychiatric symptom severity (uncorrected).



**Figure S6.** Between-group contrast maps for changes in connectivity over time with post-injury time covariates (uncorrected).



**SMART vs BHW; participants with scans at all time points**

**Figure S7.** Between-group contrast maps for changes in connectivity of the subset of the participants who underwent MRI scans at all time points (uncorrected).