

Supplementary Materials

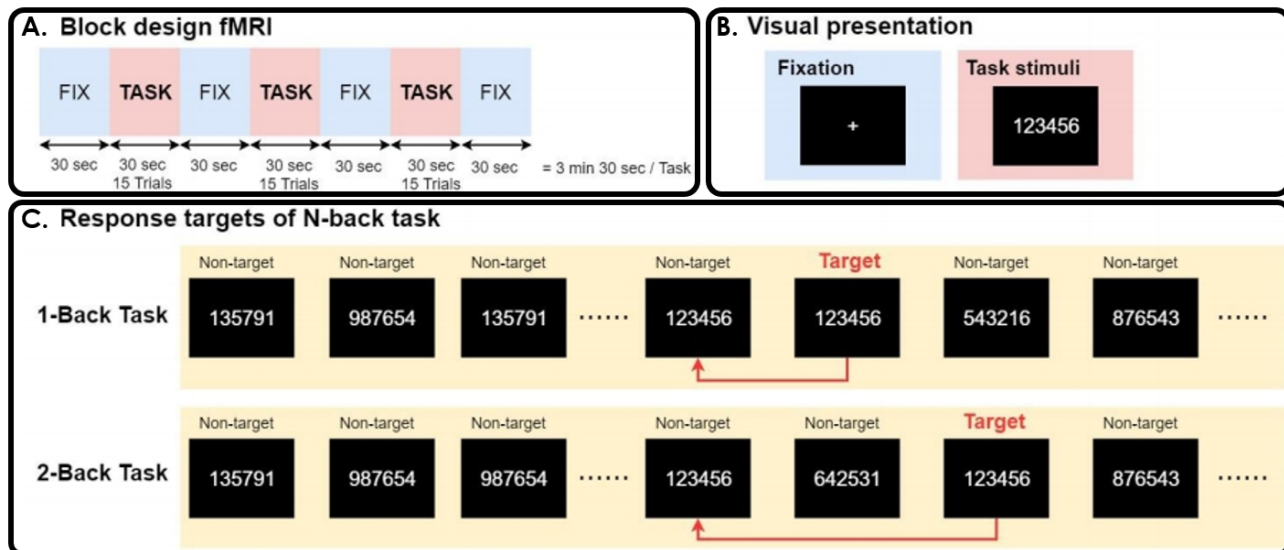


Figure S1. N-back WM task diagram.

(A) *N*-back task contains three epochs, (B) each composed of a 30-second task period and a 30-second fixing on a crosshair. The interstimulus interval between each trial during a task period was 2 s. In total, 45 trials were conducted, with each task consisting of 80% nontarget trials and 20% target trials. (C) In each run of the *N*-back tasks, participants were instructed to pay attention to a series of six-digit numerical stimuli and respond when the presented number matched the number presented *N* items before (*N* = 1 or 2).

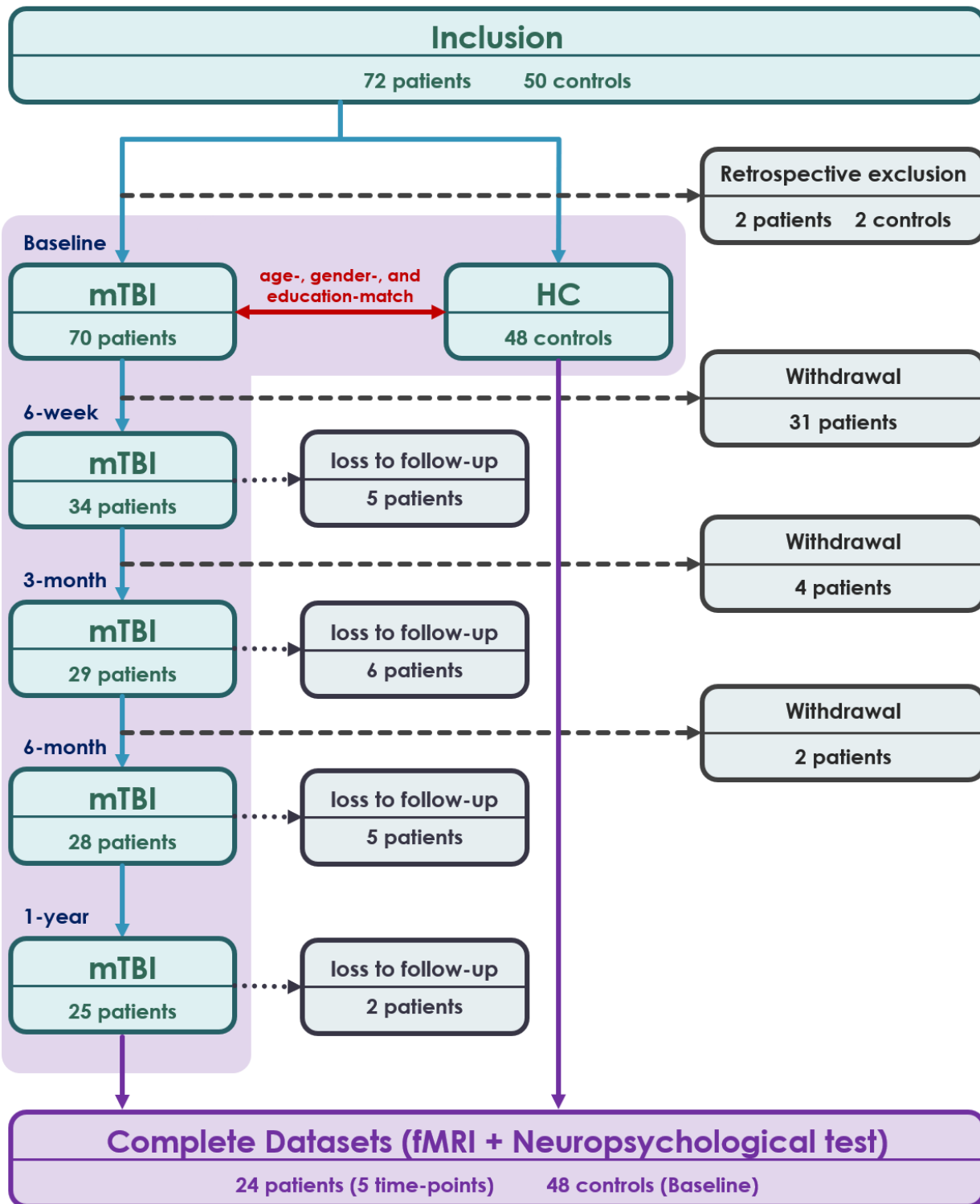


Figure S2. Flow chart.

Flow chart of participant inclusion and exclusion in this study.

Table S1. WM 2-back task-induced activation and deactivation peak regions among all participants

	Brain Regions	Side	MNI			Area (mm ³)	t value	
			X	Y	Z		HC	mTBI
Basal Ganglia	Caudate	L	-15	-1.5	16.5	2207	11.15	9.92
	Caudate	R	15	-1.5	16.5	2707	10.44	11.19
	Putamen	L	-19.5	6	12	857	5.56	5.89
	Putamen	R	19.5	6	12	780	6.61	7.76
Cerebellum	CRB crus1	L	-7.5	-78	-25.5	5798	12.94	9.65
	CRB crus1	R	6	-75	-28.5	2953	12.20	9.34
	CRB6	L	-28.5	-63	-25.5	10419	13.27	9.85
	CRB6	R	7.5	-75	-21	11684	15.09	8.65
	CRB4.5	L	-4.5	-61.5	-16.5	881	6.52	4.49
	CRB4.5	R	12	-57	-16.5	1310	6.71	4.42
	CRB10	L	-25.5	-31.5	-42	874	6.20	0.87
	CRB10	R	22.5	-36	-45	888	6.34	3.53
Task Positive Network	dIPFC	R	37.5	55.5	12	10625	7.35	5.24
	dIPFC	L	-37.5	55.5	12	7277	7.52	2.94
	FEF	R	31.5	6	60	8289	11.54	8.79
	FEF	L	-31.5	6	60	6311	9.50	6.01
	IFG(orb.)	R	48	12	33	6483	14.43	8.96
	IFG(orb.)	L	-39	7.5	30	3260	13.80	10.53
	IFG(tri.)	R	46.5	43.5	21	17135	6.18	3.66
	IFG(tri.)	L	-46.5	30	31.5	30463	7.77	4.86
	SPL	L	-25.5	-61.5	43.5	8127	15.13	12.81
	SPL	R	34.5	-58.5	51	6318	13.67	10.25
	IPS	L	-36	-51	45	12572	15.31	10.62
	IPS	R	36	-51	45	8451	17.08	12.14
	TPJ	L	-51	-40.5	21	2028	5.14	5.18
	TPJ	R	60	-34.5	21	2565	5.06	2.26
	rolandicoper.	L	-48	9	1.5	479	6.44	2.22
	rolandicoper.	R	51	7.5	16.5	284	6.68	6.16
	ITG	L	-45	-64.5	-9	5599	7.79	6.10
	ITG	R	51	-57	-19.5	9619	3.20	1.21
	Calcarine	L	-13.5	-90	-6	4023	14.73	8.62
	Calcarine	R	13.5	-90	-3	2440	7.51	8.21
	SMA	L	-3	15	52.5	10689	16.89	11.41
	SMA	R	1.5	9	61.5	8846	10.33	9.41
	dACC	L	-1	36	30	854	5.76	4.71
	dACC	R	7.5	25.5	30	2393	11.88	6.62
	AINS	L	-30	22.5	4.5	5073	16.62	13.93
	AINS	R	31.5	24	3	4330	19.50	14.85
Task Negative Network	PINS	L	-36	-19.5	19.5	1397	-9.33	-8.42
	PINS	R	37.5	-12	19.5	2612	-12.10	-9.92
	amyg.	L	-21	-6	-16.5	668	-6.14	-4.46
	amyg.	R	27	-1.5	-19.5	419	-4.24	-4.40
	MCC	L	-7.5	-28.5	43.5	6173	-8.20	-7.37
	MCC	R	12	-22.5	48	4577	-6.39	-5.06
	PCC	L	-4.5	-49.5	30	2514	-13.33	-13.06
	PCC	R	6	-48	30	1407	-13.27	-10.56
	aPFC	L	1.5	51	-7.5	3871	-7.66	-7.00
	aPFC	R	-6	46.5	-10.5	9430	-6.88	-5.48
	rmPFC	L	1.5	40.5	-15	5123	-11.39	-6.71
	rmPFC	R	-3	48	-10.5	7239	-10.51	-6.60
	vmPFC	L	1.5	19.5	-18	1299	-5.05	-0.18
	vmPFC	R	-3	24	-6	1775	-5.48	-3.43
	angular	L	46.5	-76.5	28.5	4475	-2.49	-1.45
	angular	R	-46.5	-72	28.5	7911	-8.01	-7.22
	IFC	L	-28.5	3.5	-10.5	2477	-6.40	-0.31
	IFC	R	19.5	22.5	-19.5	827	-3.18	-0.68
	MTG	L	-45	-67.5	24	6406	-7.63	-7.47
	MTG	R	48	-75	24	3898	-3.69	-2.45
	Hippo.	L	-24	-18	-18	4860	-8.06	-6.30
	Hippo.	R	27	-18	-18	3054	-8.35	-5.64

cerebellum; dACC = dorsal anterior cingulate cortex; dlPFC = dorsolateral prefrontal cortex; FEF = frontal eye fields; Hippo. = hippocampus; IFC = inferior frontal cortex; IFG = inferior frontal gyrus; IPS = inferior parietal sulcus; ITG = inferior temporal gyrus; L = left; MCC = middle cingulate cortex; MTG = middle temporal gyrus; Orb. = orbitalis; PCC = posterior cingulate cortex; R = right; rmPFC = rostro-medial prefrontal cortex; Rolandicoper. = Rolandic operculum; SMA = supplementary motor area; SPL = superior parietal lobe; TPJ = temporal parietal junction; Tri. = triangularis; vmPFC = ventromedial prefrontal cortex; fMRI = functional magnetic resonance imaging; mTBI = mild traumatic brain injury; WM = working memory; MRI = magnetic resonance imaging; PCS = postconcussive symptoms; HC = healthy control; MMSE = Mini-Mental State Examination; WAIS-IV = Wechsler Adult Intelligence Scale, fourth edition; WMI = WM index; AMT = arithmetic ability; DS = digit span score; SPM = Statistical Parametric Mapping; ROI = region-of-interest; SVM = support vector machine; ROC-AUC = area under receiver operating characteristic curve; DMN = default mode network.

Table S2. Demographics, clinical and cognitive characteristics, and WM task performance of the participants

		HC			mTBI			mTBI (6w)			mTBI (3m)			mTBI (6m)			mTBI (1Y)		
Sample size		N = 48			N = 70						N = 24								
Sex (female/male)		32 / 16			47 / 23						16 / 8								
Age		37.44	±	12.01	37.94	±	12.24				33.29	±	9.56						
Education (year)		14.36	±	4.41	14.45	±	2.96				15.14	±	2.20						
GOSE		N.A.			6.20	±	1.98				5.85	±	2.18						
Clinical symptoms	MMSE	29.40	±	0.76	28.44	±	1.61 ***	29.05	±	1.36	28.86	±	1.46	28.90	±	1.45	28.80	±	1.45 *
	PSQI	4.90	±	2.35	8.07	±	4.36 ***	7.38	±	4.40 **	7.29	±	5.43 **	6.10	±	4.09	6.67	±	9.45 *
	ESS	5.63	±	3.27	7.44	±	4.23 *	6.89	±	4.11	7.11	±	4.23	5.85	±	4.07	5.63	±	3.32 †
	DHI	5.75	±	7.17	18.64	±	22.46 ***	12.10	±	16.90 *	6.32	±	11.97 †	10.48	±	15.78	11.53	±	17.35 †
	PCSQ	4.92	±	5.73	13.30	±	13.43 ***	8.24	±	10.72	8.30	±	10.77	4.33	±	6.60 ††	9.03	±	9.45 *
	BAI	4.33	±	4.80	9.80	±	9.57 ***	6.25	±	8.32	4.95	±	5.46 †	3.90	±	5.49 ††	7.27	±	7.84 *
	BDI	4.69	±	4.95	9.70	±	9.86 **	5.40	±	7.05	6.63	±	5.60	4.10	±	5.35 †	6.97	±	6.18 *
WAIS - IV	DS	34.28	±	5.67	34.29	±	6.50	34.40	±	4.81	35.42	±	5.02	34.08	±	5.13	35.71	±	5.27
	Arithmetic	16.63	±	3.41	14.63	±	4.40 **	15.31	±	3.52 *	16.33	±	3.43 ††	15.21	±	4.00 *	15.52	±	4.80 *
	WMI	109.72	±	12.75	104.54	±	17.33 **	105.60	±	12.53 *	108.81	±	12.49 †	105.02	±	14.07 *	108.63	±	14.28 *
	PSI	108.86	±	12.24	95.92	±	16.77 **	104.42	±	16.61 ††	110.69	±	18.22 †††	111.67	±	16.85 †††	112.94	±	16.72 †††
WM task	1b ACC (%)	95.37	±	8.52	90.95	±	8.09	97.88	±	10.57 †	91.11	±	10.57	98.94	±	3.34 ††	95.79	±	8.09
	1b RT (ms)	566.21	±	114.73	577.31	±	161.00	630.58	±	107.52 *	617.13	±	107.52	601.49	±	111.80	609.08	±	77.04 *†
	2b ACC (%)	71.53	±	21.49	70.63	±	26.08	73.54	±	22.05	73.33	±	22.05	76.72	±	16.06	67.78	±	20.14
	2b RT (ms)	717.14	±	184.38	783.45	±	187.51	715.80	±	211.13	786.17	±	211.13 †	757.35	±	123.77	738.39	±	101.81 †

Significance:

* indicated the significant difference compared with HC group. (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, FDR corrected)

† indicated the significant difference compared with the initial mTBI group. (†: $p < 0.05$, ††: $p < 0.01$, †††: $p < 0.001$, FDR corrected)

Abbreviations:

GOSE: Glasgow Outcome Scale-Extended

MMSE: Mini-Mental State Examination

PSQI: Pittsburgh Sleep Quality Index

ESS: Epworth Sleepiness Scale

DHI: Dizziness Handicap Inventory

PCSQ: Post-Concussive Symptoms Questionnaire

BAI: Beck Anxiety Inventory

BDI: Beck Depression Inventory

WAIS: Wechsler Adult Intelligence Scale

DS: Digit Span

WMI: Working Memory Index

PSI: Processing Speed Index

WM: Working Memory

ACC: Accuracy

RT: Reaction Time

FDR: False Discovery Rate