Supplementary materials for manuscript: Resting-State EEG Topographies: Reliable and Sensitive Signatures of Unilateral Spatial Neglect

Supplementary Material

In order to demonstrate that all subjects had similar spatial map per component, we first performed SVD decomposition of the EEG signal of each participant and every session. The spatial maps obtained for each participant and session were matched to the spatial maps obtained concatenating all subjects and sessions (i.e., group-level EEG-SVD maps) using Hungarian algorithm[1]. We computed correlation values between the individual spatial maps and the group-level EEG-SVD maps. The correlation was high for all top-five components (mean and standard deviation across components: 0.77± 0.10 – see Supplementary Figure 1A) highlighting that all the subjects had similar spatial maps. Second, to further support the similarity across the topographies of the individual subjects, we computed a spatial regression to acquire subject-specific spatial maps. Specifically, we ran the time-concatenated SVD (i.e., concatenating all subjects and sessions) and then we regressed per subject the spatial maps of the component; i.e., we used each subject/session part of the components' time-courses as regressors against this subject/session data to retrieve subject-level spatial maps. We then compute the correlation between these subject-level spatial maps with the group-level EEG-SVD maps obtained concatenating all subjects and sessions. The correlation was high for all top-five components (mean and standard deviation across components: 0.84 ± 0.12 – see Supplementary Figure 1B) highlighting that all the subjects had similar spatial maps and also similar to the group-level EEG-SVD topographies.

Supplementary figures

Supplementary figure 1: (A) Correlation between individual maps and group-level EEG-SVD maps for the first five components. Error bars represent average values +/− standard error of the mean (SEM) across participants. **(B)** Correlation between subject-level maps (i.e., obtained with spatial regression) and group-level EEG-SVD

maps for the first five components. Error bars represent average values +/− standard error of the mean (SEM) across participants. **(C)** We computed EEG-SVD decomposition concatenating separately RHD patients of group #1 and RHD patients of group #2. Bars represent correlation between EEG-SVD group-level topographical maps for RHD patients of group #1 and EEG-SVD maps for RHD patients of group #2.

Supplementary figure 2: Paper and pencil scores divided for no-neglect, mild, and severe spatial neglect patients identified using k-means clustering algorithm. Error bars represent average values +/− standard error of the mean (SEM) for no-neglect (black bars), mild-neglect (grey bars), and severe neglect (red bars) patients. When available we report the cut-off for spatial neglect. **(A)** The patients were clustered using the behavioral canonical correlation scores obtained from CCA between behavior and CVs of the EEG-SVD components. **(B)** The patients were clustered using the behavioral canonical correlation scores obtained from CCA between behavior and CVs for theta and alpha bands for the P3 and P4 electrodes.

Supplementary figure 3: Chance level confusion matrix for the three-class classifier built using the CVs of the EEG-SVD components **(A)** and for the three-class classifier built using the CVs for theta and alpha bands for the P3 and P4 electrodes **(B)**.

Supplementary tables

Table 1: summary of stroke patients enrolled in the study

	Patients	Gender	Age yrs	Days elapsed from the accident	Dominance	Location
Group #1	p101	M	66	78	R	Right MCA - TP
	p102	M	44	35	R	Left IC, BG, ACT
	p103	F	59	21	R	Left CP, IHWM
	p104	M	70	22	R	Right MCA- FP
	p105	M	79	57	R	Left MCA - TP
	p106	F	51	32	R	Right MCA - EC, INS
	p107	M	68	25	R	Right MCA - Th, IC
	p108	M	67	26	R	Right MCA - TP
	p109	M	77	91	R	Right MCA - F
	p110	M	47	21	L	Right MCA - FTP
	p111	M	63	34	R	Right MCA – IC, BG
	p112	F	62	32	R	Left MCA – IC, BG
	p113	M	54	71	R	Right MCA – TH, IC
	p114	M	56	60	R	Right MCA – TH, EC
	p115	M	53	48	R	Right PCA, MCA – TO
	p116	F	70	45	R	Right MCA – TP, IC, BG
	p117	F	65	39	R	Left MCA
	p118	M	77	43	R	Right MCA – FTP
	p119	M	54	52	R	Right MCA – Caudate
	p120	M	60	26	R	Right MCA – F
	p121	M	46	84	R	Right MCA
Group #2	p201	F	67	54	R	Right MCA – FP
	p202	M	66	45	R	Right MCA – FTP
	p203	M	71	60	R	Right MCA – FTP
	p204	M	63	34	R	Right MCA – FTP
	p205	F	54	13	R	Right MCA – CP
	p206	M	66	61	R	Right MCA – P
	p207	M	72	29	R	Right MCA – FP
	p208	M	67	26	R	Right MCA – TP
	p209	M	45	61	R	Right MCA – FTP
	p210	F	44	20	R	Right MCA – FTP
	p211	M	68	70	R	Right MCA – P
	p212	M	53	60	R	Right MCA – FTP
	p213	F	58	77	R	Right MCA – FTP

Labels in the 2nd column refer to (F) Female and (M) Male. Labels in the 5th column refer to (L) Left and (R) Right. Labels in the 6th column refer to (RHD and LHD) right and left hemisphere damage, respectively; (MCA) middle cerebral artery; F/P/T/O - Frontal/ Parietal/ Temporal/ Occipital, respectively; (STG) superior temporal gyrus; (IPL) inferior parietal lobule; (BG) basal ganglia; (IC) internal capsule; (EC) External capsule; (INS) insula; (IHWM) intra-hemishperic white matter; (TH) Thalamus. Subjects highlighted in grey were excluded from the analysis because unable to complete any of the sessions of recordings (i.e., resting-state and SNT task). The subject highlighted in pink was excluded from the analysis because left-

handed. Subjects highlighted in orange were recorded in both studies.

Table 2: Paper and pencil test results and volume lesion for patients of group #2

	Patients	Lesion volume loss (cm^3)	BIT	SC	LB	MWCT L(/30)	MWCT R(/30)
Group #2	p201	30.92	135	52	14.5	25	30
	p202	90.57	133	51	13.8	26	30
	p203	169.93	63	35	38.0	0	14
	p204	96.64	95	30	23.2	0	13
	p205	20.77	125	46	10.5	3	16
	p206	92.41	135	52	10.1	22	24
	p207	19.33	135	52	17.0	29	30
	p208	129.95	106	32	8.7	15	19
	p209	59.21	71	19	11.8	7	14
	p210	19.12	139	53	12.1	16	23
	p211	29.39	128	52	3.8	26	28
	p212	199.79	72	30	31.4	0	8
	p213	54.8	121	29	11.8	8	20

Table 3: summary of the recordings sessions for healthy subjects and patients of group #1

	Subjects	Day 1			Day 2			Days between D1 and D2
		Morning	Afternoon	Evening	Morning	Afternoon	Evening	
Healthy subjects	c301							7
	c302							5
	c303							--
	c304							7
	c305							7
	c306							7
Patients group #1	p101							7
	p102							1
	p104							1
	p105							43
	p106							11
	p107							7
	p108							7
	p109							--
	p111							7
	p112							5
	p114							2
	p115							--
	p116							2
	p117							7
	p118							9
	p119							7
	p120							1
	p121							--

Green squares indicate that an entire session (i.e., resting-state and SNT task) was completed and included in the analysis.

Table 4: summary of the recordings sessions for patients of group #2. Days between sessions are reported as mean ± std over following sessions.

	Subjects	Days of recordings										Days between sessions
		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	
Patients group #2	p201											4 ± 2
	p202											3 ± 1
	p203											2 ± 1
	p204											2 ± 1
	p205											3 ± 3
	p206											2 ± 1
	p207											1 ± 1
	p208											2 ± 1
	p209											2 ± 1
	p210											2 ± 1
	p211											2 ± 2
	p212											2 ± 1
	p213											1 ± 1

Green squares indicate that an entire session (i.e., resting-state and SNT task) was completed and included in the analysis.

Table 5: Percentage of outliers for healthy control (first column), LHD patients (second column), RHD patients of group #1 (third column), and RHD patients of group #2 (fourth column). Values indicate mean ± SEM over subjects. We compared the number of outliers between healthy subjects and *i)* LHD, *ii)* RHD patients of group #1, and *iii)* RHD patients of group #2 (one-tailed, non-paired t-test with heteroschedasticity (α=0.05)). No significant differences were found.

	Healthy subjects	**LHD**	**RHD group #1**	**RHD group #2**
%Outliers	2.08 ±0.20	0.82 ±0.31	1.72 ±0.26	2.08 ±0.16

Table 6: p-values, degree of freedom of the test, and t-value of the statistical test comparing RHD patients and healthy controls for the behavioral measures for the two groups.

		Hit	LMRT	LVRT	RMRT	RVRT	F	LI
Group #1	p-value	0.02	0.0003	0.006	0.004	0.07	0.006	0.003
	df	13.00	15.74	13.50	16.62	17.67	13.69	15.35
	t	2.23	4.21	2.94	3.00	1.53	2.90	-3.15
Group #2	p-value	0.04	0.003	0.013	0.04	0.19	0.002	0.0002
	df	12.00	14.83	12.49	14.00	13.95	13.12	15.54
	t	1.97	3.29	2.55	1.83	0.91	3.49	-4.50

Table 7: test-retest correlation values for behavioral measures for patients of group #1 and group #2. (*) indicate significant correlation. For patients of group #2 the test-retest correlation was calculated between days that had all the 13 patients included in the analysis (i.e., day 1, day 3, and day 7). Values indicate mean±std over pair of days.

	Hit	**LMRT**	**LVRT**	**RMRT**	**RVRT**	**F**	**LI**
Group #1	0.55	0.82 (*)	0.61 (*)	0.91 (*)	0.27	0.62 (*)	0.85 (*)
Group #2	0.94± 0.04(*)	0.95± 0.03(*)	0.90± 0.04(*)	0.80± 0.09(*)	0.67± 0.19(*)	0.30± 0.12	0.86± 0.09(*)

Table 8: test-retest correlation values for resting-state brain measures for patients of group #1 and group #2. (*) indicate significant correlation. For patients of group #2 the test-retest correlation was calculated between days that had all the 13 patients included in the analysis (i.e., day 1, day 3, and day 7). Values indicate mean±std over pair of days.

	Frequency band	1st	2nd	3rd	4th	5th
Group #1	δ	0.96 (*)	0.92 (*)	0.92 (*)	0.92 (*)	0.97 (*)
	θ	0.82 (*)	0.91 (*)	0.79 (*)	0.93 (*)	0.87 (*)
	α	0.70 (*)	0.92 (*)	0.79 (*)	0.68 (*)	0.82 (*)
	β	0.95 (*)	0.93 (*)	0.77 (*)	0.96 (*)	0.91 (*)
Group #2	δ	0.95 ± 0.03 (*)	0.95 ± 0.03 (*)	0.89 ± 0.07 (*)	0.90 ± 0.06 (*)	0.91 ± 0.06 (*)
	θ	0.84 ± 0.10(*)	0.88 ± 0.05 (*)	0.85 ± 0.07 (*)	0.79 ± 0.09 (*)	0.85 ± 0.04 (*)
	α	0.55 ± 0.23 (*)	0.83 ± 0.05 (*)	0.78 ± 0.10 (*)	0.57 ± 0.18 (*)	0.80 ± 0.09 (*)
	β	0.79 ±	0.72 ±	0.78 ±	0.54 ±	0.67 ±

		0.01 (*)	0.13 (*)	0.06 (*)	0.11 (*)	0.19 (*)

Table 9: p-values, degree of freedom of the test, and t-value of the statistical test comparing RHD patients and healthy controls for the CVs of delta band for the five EEG-SVD components and the two groups.

	Freq. band		1st	2nd	3rd	4th	5th
Group #1	δ	p-value	0.004	0.003	0.048	0.008	0.028
		df	17.04	17.29	15.29	17.99	17.88
		t	-3.06	-3.08	-1.78	-2.69	-2.04
Group #2	δ	p-value	0.009	0.005	0.009	0.018	0.013
		df	13.10	14.04	16.98	13.98	15.39
		t	-2.70	-3.00	-2.65	-2.31	-2.47

Table 10: Number of patients (and sessions) per cluster. For the sessions we reported the mean and standard deviation over the patients of the cluster.

	No-neglect	**Mild-neglect**	**Severe-neglect**
Group #1	11 (4±2)	9 (2±1)	8 (1.2±0.5)
Group #2	10 (3±2)	12 (5±2)	5 (6±3)

Reference

1 Munkres, J. Algorithms for the assignment and transportation problems. *Journal of the society for industrial and applied mathematics* **5**, 32-38 (1957).