Supplementary Data

Additional Covariate and Quality Control Analysis

Head motion

Average relative and absolute head motion was estimated for each participant and compared across the two groups. Mean absolute motion ($t[(22.4] = 2.150$, $p < 0.05$) but not mean relative motion ($t[28.679] = 1.982$, $p > 0.05$) differed significantly between TBI and NC (Fig. S1).

Several steps were undertaken to ensure data quality, such as manual independent component analysis denoising, inclusion of six motion parameters as regressors and volume removal based on high motion and blood oxygen–level dependent (BOLD) signal spikes. In order to confirm that the significant difference in correlations between lateralized regions of interest (ROIs) was not driven by motion-related BOLD signal, the correlation between inter-hemispheric functional connectivity (FC) and average head motion within each group was computed. In particular, there were no correlations between relative (frame by frame) motion, which are more likely to drive spurious FC differences between groups, and ROI to ROI correlation between lateralized seeds of default mode network (DMN), executive control network (ECN), fronto-parietal network (FPN), and somato-motor network (SMN; supplementary Table S1).[43]

Finally, in order to ascertain that our brain-behavior correlation findings were not due to motion artifacts (e.g., participants who perform better also move less/more, and this is driving the association between inter-hemispheric FC and performance), the presence of correlations between absolute and relative motion and the Rey Osterrieth Complex Figure Test-Delayed Recall (ROCFT-DR) performance related FC in the right FPN was explored. There was no significant correlation between mean time series (obtained with the method explained in Figure 5) and mean absolute ($r = -0.293$, $p > 0.05$) and relative ($r = -0.194$, $p > 0.05$) head displacement.

Signal-to-noise ratio analysis

Given the multi-site acquisition of the neuroimaging data, a global signal-to-noise ratio (SNR) comparison was performed to assess differences between the two groups. Global SNR of echo planar imaging data was obtained by dividing mean signal intensity measured in ROIs placed in gray matter by the standard deviation of the signal intensity in ROIs placed in the background air for each repetition time. In particular, separate anterior and posterior gray matter ROIs were created following tissue segmentation (FAST) based on their relative position on the x and y axis and then averaged together.

A two tailed *t*-test showed a significantly lower SNR in the TBI group ($t[40] = -2.417$, $p < 0.05$). In order to ascertain that FC differences between groups were not generated by different SNRs, correlation between SNR values and inter-hemispheric FC values were computed. Pearson's correlation analysis revealed no significant relationship between SNR and FC for the TBI group or for the normal comparison (NC) group (supplementary Table S2).

In addition, visual inspection of individual mean global SNR values revealed the presence of two outliers in the traumatic brain injury (TBI) group (TBI1 and TBI2, with respective SNRs of 38.182 and 38.813). Not surprisingly, these individuals showed the most extensive lesions in the bilateral frontal lobe. In order to determine if the inclusion of this two low SNR participants could play a role in determining the reduced inter-hemispheric FC findings, data were re-processed excluding TBI1 and TBI2 and their NC from the sample ($n = 19$ for each group). The new analysis showed no significant difference in SNR between the two groups ($t[36] = -1.510$, $p > .05$), and replicated previous findings on the complete sample for lateralized ROI to ROI correlation in the DMN ($t[36] = 0.865$, $p > 0.05$), SMN ($t[36] = 1.332$, $p > 0.05$), ECN($t[36] = -1.879$, $p < 0.05$), and FPN ($t[36] = -4.369$, $p < 0.001$).

Analysis without TBI participants with focal lesions

In order to verify the influence of focal lesion TBI patients on the reported findings, ROI to ROI correlation analyses were repeated including only TBI participants without visible focal lesions due to head-contusion ($n = 13$) and their matching controls. Similarly to the original sample, inter-hemispheric FC between DMN ($t[24] = 0.365$, $p > 0.05$) and SMN ($t[24] = 0.432$, $p > 0.05$) did not differ between groups and FC between left and right FPN ($t[24] = -5.610$, $p < 0.001$) was significantly higher in NC than in TBI patients. However, the ECN seed pair FC was not significantly weaker in the TBI group ($t[24] = 0.235$, $p > 0.05$), although a significant

Supplementary Table S1. Correlations between Head Motion and Functional Connectivity

RSN (ROI to ROI)	*Mean relative displacement*	*Mean absolute displacement*
Correlation between mean motion and FC – TBI (n = 21)		
Left DMN-Right DMN	$r = -0.187$, $p = 0.417$	$r = 0.004$, $p = 0.985$
Left FPN-Right FPN	$r = -0.358$ $p = 0.111$	$r = -0.042$, $p = 0.855$
Left ECN-Right ECN	$r = -0.170$ $p = 0.462$	$r = 0.108$ $p = 0.641$
Left SMN-Right SMN	$r = -0.270$ $p = 0.236$	$r = 0.008$ $p = 0.973$
Correlation between mean motion and FC – NC (n = 21)		
Left DMN-Right DMN	$r = -0.286$, $p = 0.210$	$r = -0.278$, $p = 0.222$
Left FPN-Right FPN	$r = -0.008$, $p = 0.978$	$r = -0.137$, $p = 0.553$
Left ECN-Right ECN	$r = -0.051$, $p = 0.826$	$r = -0.006$, $p = 0.979$
Left SMN-Right SMN	$r = -0.007$, $p = 0.741$	$r = -0.024$, $p = 0.919$

FC, functional connectivity; TBI, traumatic brain injury; RSN, resting state network; ROI, region of interest; DMN, default mode network; FPN, fronto-parietal network; ECN, executive control network; SMN, somato-motor network.

Supplementary Table S2. Correlations between Signal to Noise Ratio and Functional Connectivity

RSN (ROI to ROI)	*Correlation between global SNR and FC – TBI (n = 21)*
Left DMN-Right DMN	r = –0.068, $p = 0.770$
Left FPN-Right FPN	r = –0.333 $p = 0.141$
Left ECN-Right ECN	r = –0.063 $p = 0.786$
Left SMN-Right SMN	r = 0.209 $p = 0.363$
	Correlation between global SNR and FC – NC (n = 21)
Left DMN-Right DMN	r = 0.312, $p = 0.168$
Left FPN-Right FPN	r = 0.057, $p = 0.807$
Left ECN-Right ECN	r = 0.145, $p = 0.531$
Left SMN-Right SMN	r = 0.169, $p = 0.464$

RSN, resting state network; ROI, region of interest; SNR, signal-to-noise; FC, functional connectivity; TBI, traumatic brain injury; DMN, default mode network; FPN, fronto-parietal network; ECN, executive control network; SMN, somato-motor network.

trend was preserved ($p = 0.085$). It is likely that the reason for this change in significance is at least partially due to the reduction of sample size; nevertheless, given the great number of TBI patients displaying focal frontal lesions and the substantial presence of frontal cortical and subcortical structures comprised in the ECN, it is possible that the difference in inter-hemispheric FC between the two lateralized seeds was partly enhanced by the presence of abnormally lesioned areas. Nonetheless, the FC matrices and the dendrograms generated for both groups showed that the RSNs clustering did not qualitatively differ from the original analysis. The significant correlation between performance on the ROCFT-DR and FC in the DMN (r = –0.696, $p < 0.01$) and the FPN (r = 0.775, $p < 0.01$) is still present in the sample of patients without focal lesions.