**SUPPLEMENTARY MATERIAL**

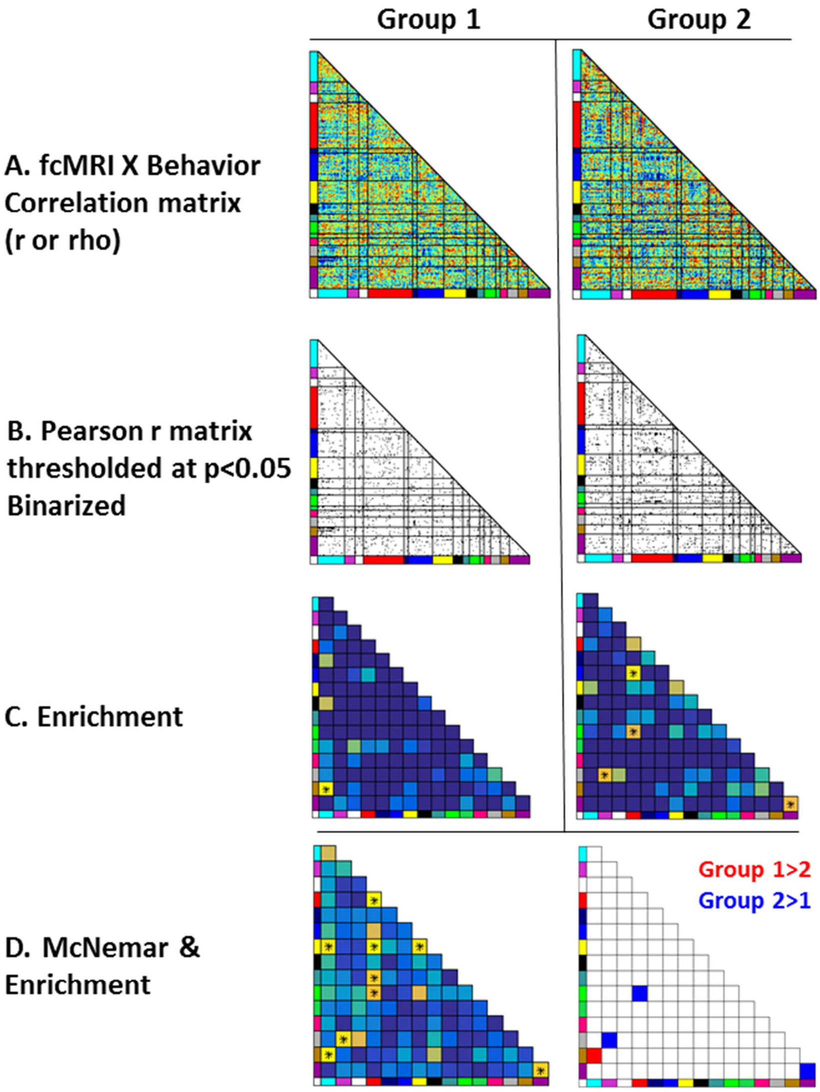


**Figure S1.** Brain-Behavior correlation methodology. A) MABC scale scores were correlated (Pearson or Spearman) across all rs-fMRI values of each ROI-ROI pair. B) Matrices in A were thesholded and binarized at $p<0.05$. C) Cells of the binarized matrices with significantly greater clustering of strong correlations than would be expected if they were uniformly distributed across the entire matrix were considered significantly enriched (based on permutation testing $p<0.025$). Significantly enriched networks are indicated with a star. D) The McNemar statistic was used to test which network pairs were significantly different in their pattern of strong correlations in one group than the other group (permutation testing $p<0.025$). Network-network pairs with significantly greater enrichment in one group than another are indicated by network square color (*i.e.*, red or blue). It is possible for both groups to demonstrate significant network-network pair enrichment (*e.g.*, Figure S2C green square), suggesting common neural mechanisms across groups.

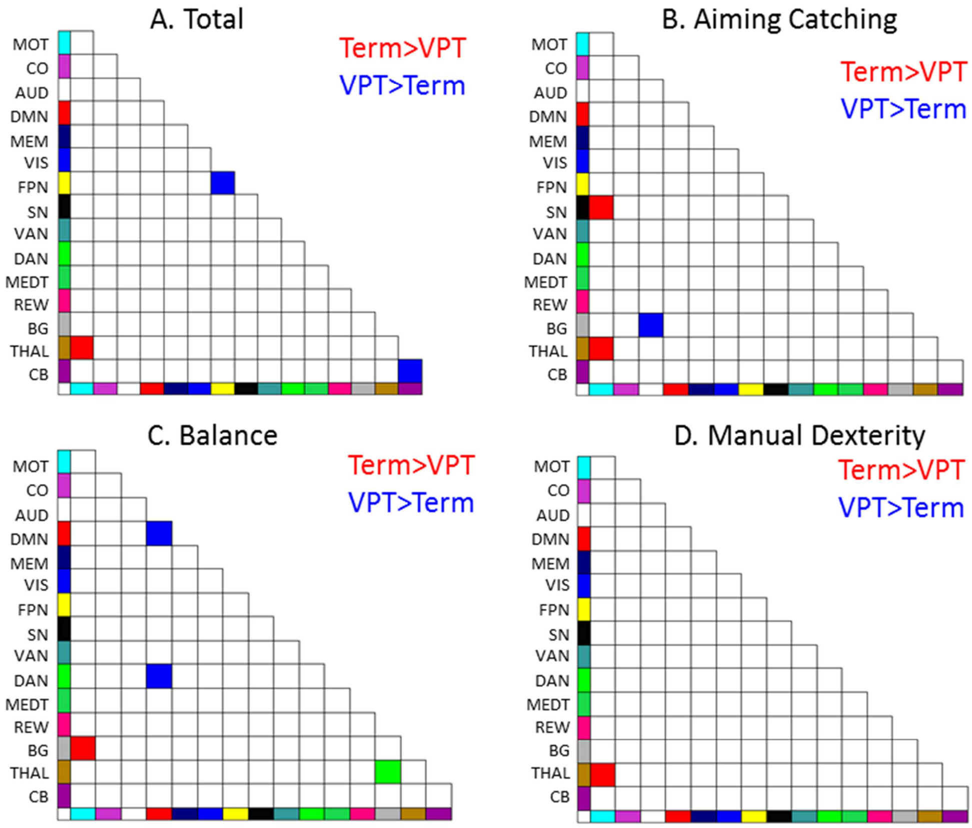


**Figure S2.** MABC Total and subscale brain-behavior correlation differences between groups. Pearson r correlations were used for Aiming and Catching and Manual Dexterity scores, while Spearman rho was used for Total and Balance scores. MOT, Motor; CO, cingulo-opercular; AUD, Auditory; DMN, Default Mode Network; MEM, Memory; VIS, Visual; FPN, Frontoparietal Network; SN, salience network; VAN, ventral attention network; DAN, dorsal attention network; MEDT, medial temporal; REW, reward; BG, Basal Ganglia; THAL, Thalamus; CB, Cerebellum.

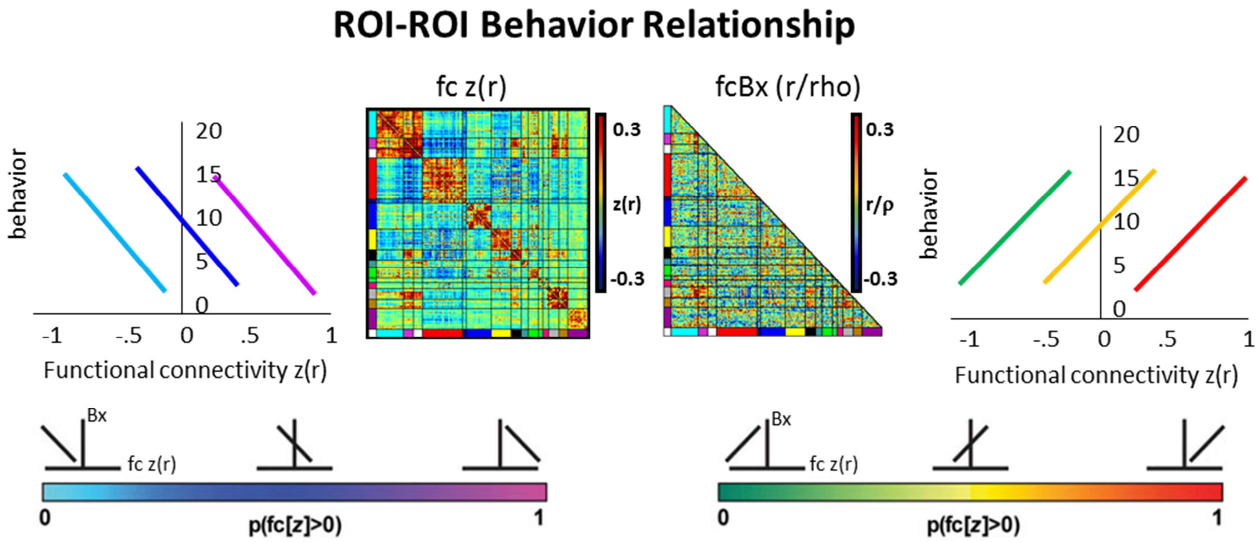


**Figure S3.** Methods for plotting the brain-behavior correlation (negative or positive) while respecting the ROI-ROI correlation (negative or positive). Each ROI-ROI pair in the fc matrix has a correlation value associated with it (*e.g.*, within network connectivity demonstrates a strong positive ROI-ROI relationship along the matrix diagonal). That strong positive functional connectivity may be negatively correlated with behavior (plotted as a magenta line in above figure). Alternatively, positive ROI-ROI functional connectivity may be positively correlated with behavior (red line in figure). It is also possible for strong negative connectivity (*e.g.*, as is seen between networks such as the DMN and CO) to positively correlate with behavior (green line in figure). Finally, strong negative ROI-ROI connectivity can also negatively correlate with behavior (light blue line in figure). This complex relationship between behavior and ROI-ROI connectivity is used in Supplementary Figures S4 and S7. Line colors between ROI-ROI pairs reflects both a) the directionality of the fc z(r) (x-axis) and b) the correlation with behavior (y axis). A 'cheat-sheet' version of this color scale is included in Figure S4 and S5 for reference. fc, functional connectivity; Bx, behavior.

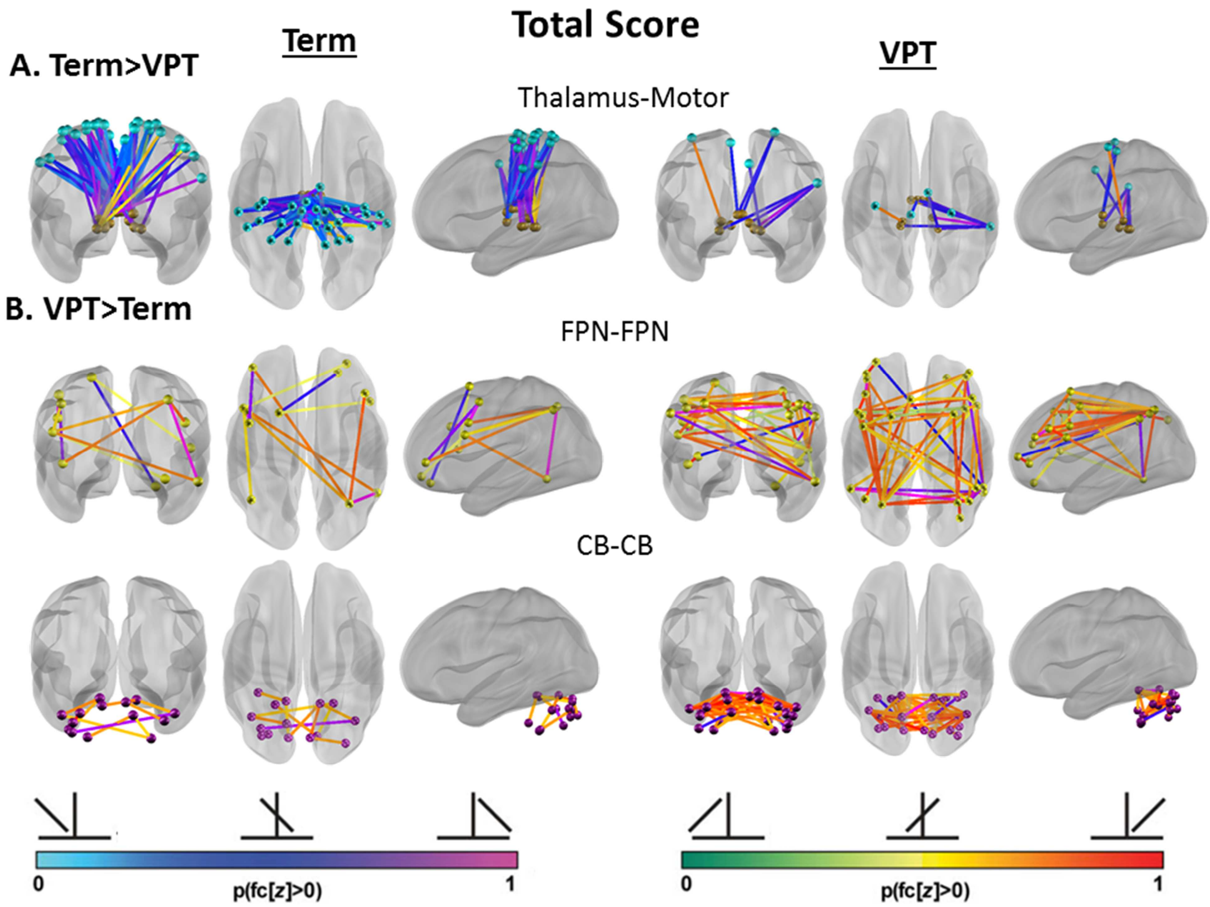


**Figure S4.** The same data from Figure 4 are displayed with respect to the directionality of the ROI-pair correlation. A) For most ROI-pair connections, as fc between thalamus and motor regions became less positively correlated at rest, motor total score increased. This relationship held for both very preterm and term children, though the number of brain-behavior correlations passing the p<0.05 threshold was significantly sparser for very preterm children. B) For the majority of ROI-pair connections, greater positive FPN-FPN and CB-CB connectivity positively correlated with motor Total score. FPN, frontoparietal Network; CB, Cerebellum.

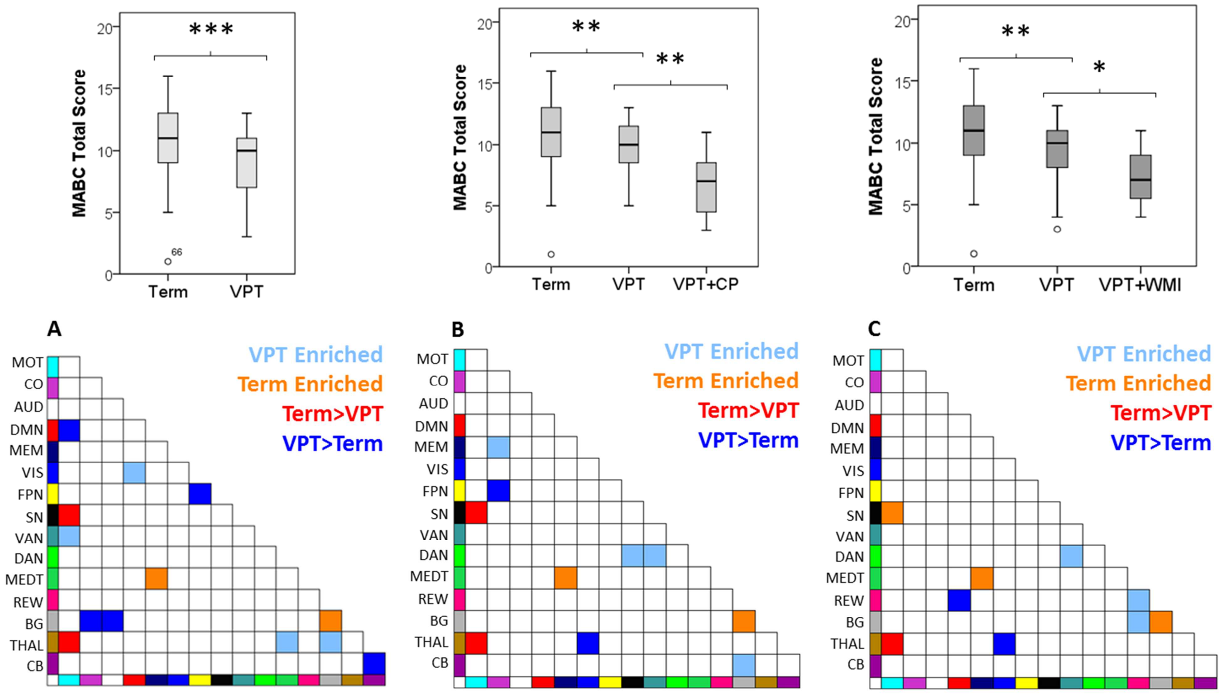


**Figure S5.** Exploratory analyses assessing brain-behavior relationships between MABC Total score and functional connectivity after excluding very preterm (VPT) children with 1) GMFCS scores of I/II and 2) moderate white matter injury (WMI). A) In order to fully explore patterns of brain-behavior relationships, results from an analysis of the entire cohort (VPT N=58; term N=65) using a McNemar $\chi^2$ threshold of p<0.05 are displayed. In these results, within group network enrichment results that did not significantly differ between groups are plotted in orange and light blue for term and VPT children, respectively. Networks which are significantly enriched and differ between groups are plotted in red and dark blue for Term>VPT and VPT>Term, respectively. B) In order to assess the impact of including children with motor deficits in the primary analysis, VPT children with GMFCS scores of I/II (N=11) were excluded from analyses, leaving N=47 VPT children. Primary findings of reduced enrichment of thalamus-motor and salience-motor connectivity in VPT children persists, with the motor and frontoparietal networks, basal ganglia, thalamus, and cerebellum continuing to demonstrate brain-behavior enrichment in VPT children after excluding children with motor deficits. C) In a subsequent analysis, VPT children with moderate WMI at birth (N=7) were excluded from analyses, leaving N=51 VPT children compared to N=65 term children. Of note, four of the children with motor deficits also have moderate WMI and were subsequently excluded from the analyses for both B and C. In these results, the primary finding of greater enrichment of thalamus-motor network connectivity in term more than VPT children was again observed, along with enrichment in term children between the motor-salience networks and within the basal ganglia network. Further, enriched networks in the VPT group again centered upon the basal ganglia and thalamus, with greater enrichment in VPT than term children in thalamus-basal ganglia connectivity. While overall the findings are similar across A-C, the variability in results may be due to: 1) reduced power and/or uneven r thresholds due to reduced sample sizes for the VPT group; 2) exclusion of children demonstrating lower motor total scores; 3) contributions of children with motor disability and moderate WMI to between group differences. MOT, Motor;

CO, cingulo-opercular; AUD, Auditory; DMN, Default Mode Network; MEM, Memory; VIS, Visual; FPN, Frontoparietal Network; SN, salience network; VAN, ventral attention network; DAN, dorsal attention network; MEDT, medial temporal; REW, reward; BG, Basal Ganglia; THAL, Thalamus; CB, Cerebellum.

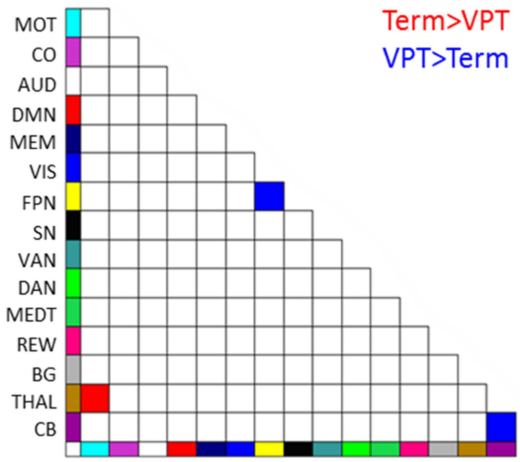


**Figure S6.** Due to differing sample sizes between groups (term N=65, VPT N=58), enrichment analyses were repeated using an identical Spearman rho threshold (rho≥0.2587) for both term and VPT groups. Results for brain-behavior differences between term and VPT children for MABC Total score are depicted here. Importantly, thresholding groups at $p<0.05$ (Fig. 3 in the main text) or imposing a rho threshold ≥0.2587 generated identical patterns of differences in brain-behavior enrichment between the term and VPT groups. MOT, Motor; CO, cingulo-opercular; AUD, Auditory; DMN, Default Mode Network; MEM, Memory; VIS, Visual; FPN, Frontoparietal Network; SN, salience network; VAN, ventral attention network; DAN, dorsal attention network; MEDT, medial temporal; REW, reward; BG, Basal Ganglia; THAL, Thalamus; CB, Cerebellum.

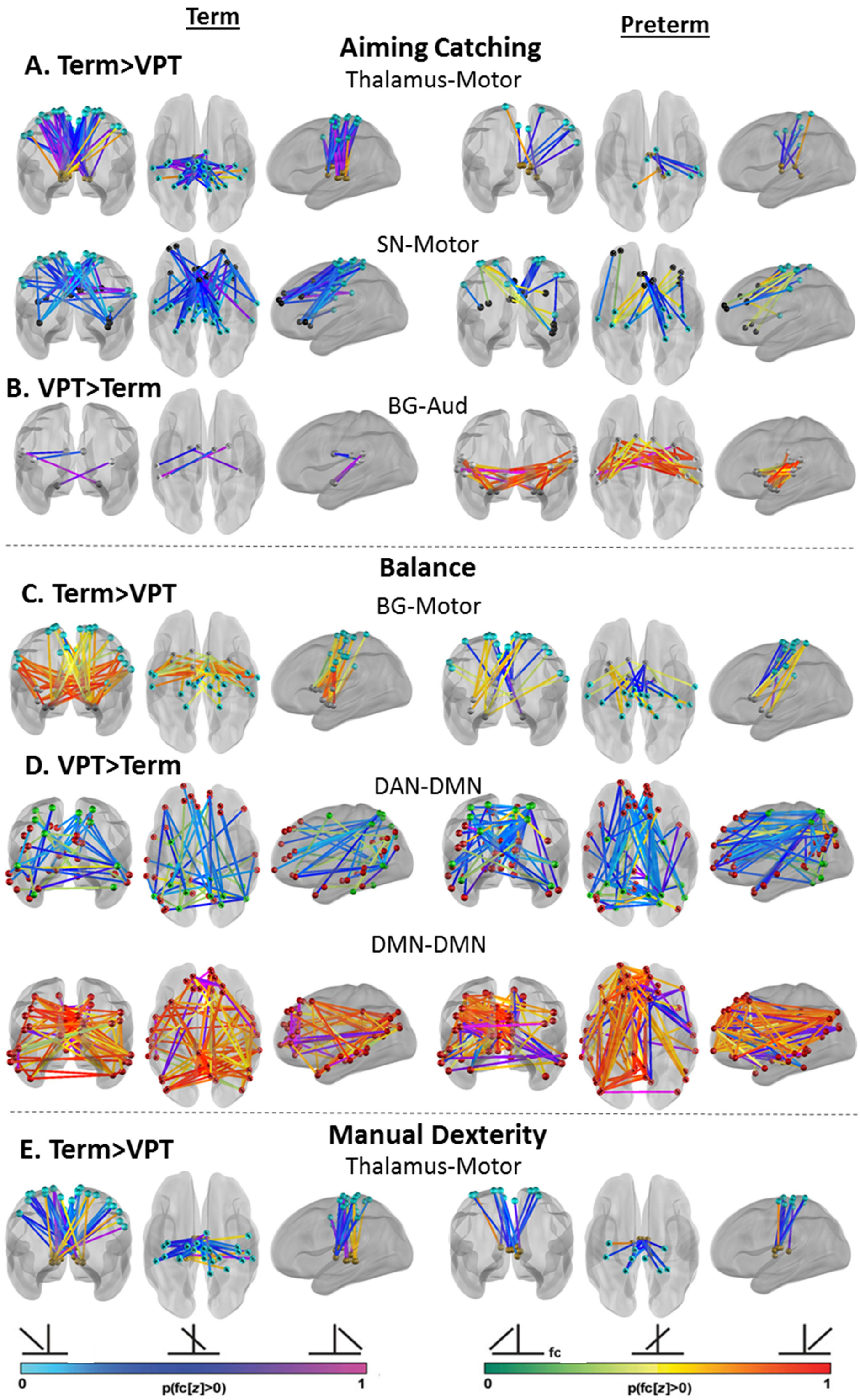


**Figure S7.** The same data from Figure 5 in the manuscript are displayed with respect to the directionality of the ROI-ROI correlation. SN, Salience Network; BG, Basal Ganglia; Aud, Auditory; DAN, Dorsal Attention Network; DMN, Default Mode Network.

**Table S1:** Neonatal clinical and family social characteristics of the preterm sample included and excluded from this analysis

| **Measure** | **Excluded (*N*=35)** | **Included (*N*=58)** | ***p*** |
|---|---|---|---|
| **Neonatal clinical characteristic** | | | |
| Gestational age at birth, *M* ± *SD*, weeks | 28 ± 2 | 28 ± 2 | 0.72 |
| Birthweight, *M* ± *SD*, grams | 1118 ± 302 | 1046 ± 288 | 0.25 |
| Male sex, % | 60 | 45 | 0.16 |
| Twin birth, % | 31 | 33 | 0.89 |
| Small for gestational age, % | 0 | 14 | 0.02 |
| Antenatal corticosteroid use, % | 91 | 83 | 0.36 |
| Postnatal dexamethasone use, % | 6 | 7 | 1.0 |
| Oxygen therapy at 36 weeks, % | 34 | 31 | 0.75 |
| Necrotizing enterocolitis, % | 6 | 12 | 0.48 |
| Confirmed sepsis, % | 23 | 26 | 0.75 |
| Intraventricular hemorrhage grade III/IV, % | 9 | 3 | 0.36 |
| Cystic periventricular leukomalacia, % | 11 | 2 | 0.07 |
| White matter abnormalities on term-equivalent MRI | | | |
| None, % | 21 | 21 | |
| Mild, % | 47 | 67 | |
| Moderate, % | 23 | 12 | |
| Severe, % | 9 | 0 | 0.04 |
| **Social background characteristic** | | | |
| Maternal age, *M* ± *SD*, years | 30 ± 5 | 31 ± 6 | 0.20 |
| Mother not a high school graduate, % | 46 | 41 | 0.68 |
| Single parenthood, % | 26 | 17 | 0.33 |
| Minority ethnicity, % | 14 | 12 | 0.76 |
| Lower family socioeconomic status, % | 37 | 28 | 0.34 |

**Table S2. MABC scores comparing preterm with usable MRI and excluded from the study due to high motion MRI.**

| Measure | Preterm usable MRI (N=58) | Preterm non-usable MRI (N=33) | df | *t* | *p* |
|---|---|---|---|---|---|
| Manual Dexterity | 8.2 ± 0.3 | 6.8 ± 0.5 | 89 | 2.383* | 0.021 |
| Aiming Catching | 9.8 ± 0.4 | 9.2 ± 0.7 | 50.62 | 0.865 | 0.389 |
| | **Median** | **Median** | **U** | **Z** | ***p*** |
| Balance | 10 | 10 | 748 | -1.761 | 0.078 |
| Total Standard | 10 | 8 | 734 | -1.848 | 0.065 |

*Welch's t used, equal variance not assumed

Two VPT children with non-usable MRI data are missing MABC scale data, therefore N=33.

**Table S3. Regions of interest in each network**

| Network | # ROI |
|---|---|
| Motor | 37 |
| Cingulo Opercular | 14 |
| Auditory | 12 |
| Default Mode | 55 |
| Memory | 5 |
| Visual | 34 |
| Frontoparietal | 27 |
| Salience | 14 |
| Ventral Attention | 9 |
| Dorsal Attention | 14 |
| Medial Temporal | 6 |
| Reward | 8 |
| Basal Ganglia | 14 |
| Thalamus | 12 |
| Cerebellum | 27 |

**Table S4. MABC Scores for Term vs VPT Children without Motor Deficits**

| Measure | Term (M ± SD) N=65 | VPT no CP (M ± SD) N=47 | df | *t* | *p* |
|---|---|---|---|---|---|
| Manual Dexterity | 9.6 ± 2.3 | 8.5 ± 2.1 | 110 | 2.602 | 0.011 |
| Aiming Catching | 11.2 ± 2.7 | 10.3 ± 2.9 | 110 | 1.758 | 0.082 |
| | **Median** | **Median** | **U** | **Z** | ***p*** |
| Balance | 14 | 11 | 1270 | -1.650 | 0.099 |
| Total Standard | 11 | 10 | 1090 | -2.602 | 0.009 |

**Table S5. MABC Scores for Term vs VPT Children without Moderate White Matter Injury**

| **Measure** | **Term (M ± SD) N=65** | **Preterm (M ± SD) N=51** | **df** | ***t*** | ***p*** |
|---|---|---|---|---|---|
| Manual Dexterity | 9.6 ± 2.3 | 8.3 ± 2.1 | 114 | 3.031 | 0.003 |
| Aiming Catching | 11.2 ± 2.7 | 10.1 ± 2.9 | 114 | 2.138 | 0.035 |
| | **Median** | **Median** | **U** | **Z** | ***p*** |
| Balance | 14 | 11 | 1235 | -2.514 | 0.012 |
| Total Standard | 11 | 10 | 1120 | -3.015 | 0.003 |