

**Supplementary Table 1: Neonatal MRI protocol**

| Sequence | Plane | Acquisition time | TR (ms) | TE (ms) | Voxel (mm)  | FOV (mm)    | Matrix (slices) |
|----------|-------|------------------|---------|---------|-------------|-------------|-----------------|
| T1 SE    | Ax.   | 3:07             | 400     | 15      | 0.83x1.05x3 | 120x120x90  | 144x115x30      |
| T2 TSE   | Ax.   | 1:48             | 3000    | 140     | 0.94x1.06x3 | 120x120x102 | 128x113x34      |
| T2 TSE   | Cor.  | 1:48             | 3000    | 140     | 0.94x1.06x3 | 110x110x108 | 116x103x36      |
| T2 TSE   | Sag.  | 1:48             | 3000    | 140     | 0.94x1.06x3 | 120x120x108 | 128x113x36      |
| DWI      | Ax.   | 1:34             | 4066    | 90      | 1.14x1.15x3 | 200x200x92  | 176x170x28      |
| SWI      | Ax.   | 3:35             | 51      | 12      | 0.85x1x2    | 170x139x90  | 200x138x90      |
| T1 3D    | Sag.  | 3:46             | 25      | 7.6     | 0.75x0.75x2 | 120x120x99  | 160x160x99      |
| MDME     | Ax.   | 5:24             | 3309    | 13; 100 | 0.9x1x4     | 200x165x109 | 224x159x22      |

DWI: Diffusion-weighted imaging

FOV: Field-of-view

MDME: Multi-dynamic multi-echo

SE: Spin echo

SWI: Susceptibility-weighted imaging

TE: Echo time

TR: Repetition time

TSE: Turbo spin echo

**Supplementary Table 2:** Semi-quantitative myelin scoring

|   | <b>syWMSS</b>                     | <b>T1-weighted</b>                 | <b>T2-weighted</b>                |
|---|-----------------------------------|------------------------------------|-----------------------------------|
| <b>Myelin scoring per region<sup>a, b</sup></b> |                                   |                                    |                                   |
| <b>0</b>  | Isointensity to DWM               | Isointensity to DWM                | Isointensity to DWM               |
| <b>1</b>  | Slight hypointensity to DWM       | Slight hyperintensity to DWM       | Slight hypointensity to DWM       |
| <b>2</b>  | Hypointensity to DWM              | Hyperintensity to DWM              | Hypointensity to DWM              |
| <b>3</b>  | Clear hypointensity to DWM        | Clear hyperintensity to DWM        | Clear hypointensity to DWM        |
| <b>4</b>  | Considerable hypointensity to DWM | Considerable hyperintensity to DWM | Considerable hypointensity to DWM |

<sup>a</sup> According to Schmidbauer et al.<sup>8</sup>

<sup>b</sup> Final results by totaling of points allocated for each assessed region

DWM: Deep white matter

syWMSS: Synthetic MR-based *White Matter Signal Suppression*

**Supplementary Table 3:** Assessment of brainstem pathway anatomy

|                                   | DSCP   | Left ML (midbrain) | Right ML (midbrain) | Left ML (pons) | Right ML (pons) | ML (dec.) | Left CTT <sup>a</sup> | Right CTT <sup>a</sup> | Left MLF <sup>a</sup> | Right MLF <sup>a</sup> |
|-----------------------------------|--------|--------------------|---------------------|----------------|-----------------|-----------|-----------------------|------------------------|-----------------------|------------------------|
| <b>syWMSS</b>                     |        |                    |                     |                |                 |           |                       |                        |                       |                        |
| Total agreement <sup>b</sup>      | 100%   | 80.65%             | 74.19%              | 100%           | 96.77%          | 96.77%    | 77.42%                | 80.65%                 | 96.77%                | 96.77%                 |
| Correctly identified <sup>c</sup> | 31/31  | 22/31              | 18/31               | 31/31          | 30/31           | 30/31     | 19/31                 | 20/31                  | 30/31                 | 30/31                  |
| <b>Conventional T1-weighted</b>   |        |                    |                     |                |                 |           |                       |                        |                       |                        |
| Total agreement <sup>b</sup>      | 48.39% | 58.06%             | 58.06%              | 80.65%         | 58.06%          | 77.42%    | 70.97%                | 58.06%                 | 64.52%                | 61.29%                 |
| Correctly identified <sup>c</sup> | 14/31  | 0/31               | 0/31                | 22/31          | 16/31           | 21/31     | 1/31                  | 1/31                   | 9/31                  | 8/31                   |
| <b>Conventional T2-weighted</b>   |        |                    |                     |                |                 |           |                       |                        |                       |                        |
| Total agreement <sup>b</sup>      | 93.55% | 61.29%             | 54.84%              | 54.84%         | 45.16%          | 58.06%    | 74.19%                | 58.06%                 | 51.61%                | 48.39%                 |
| Correctly identified <sup>c</sup> | 28/31  | 6/31               | 3/31                | 16/31          | 12/31           | 6/31      | 23/31                 | 18/31                  | 15/31                 | 14/31                  |

<sup>a</sup> For the readers to identify at the level of the pons<sup>b</sup> Percentage value of inter-rater agreement (i.e., total agreement regardless of whether tracts had been correctly/not correctly identified)<sup>c</sup> Total number of tracts correctly identified by observer 1 and observer 2 (i.e., only the number of tracts that had been correctly identified by both raters) (included sample:  $n=31$ )

CTT: Central tegmental tract

dec.: Decussation

DSCP: Decussation of superior cerebellar peduncle

MDME: Multi-dynamic multi-echo

ML: Medial lemniscus

MLF: Medial longitudinal fascicle

syWMSS: Synthetic MR-based *White Matter Signal Suppression*