**Supplement 1: Methods**

**Robotic assessment of motor control**

*Visually guided reaching task*

Eleven parameters were used to quantify the visually guided reaching task 1. The *no initial stabilization* parameter counts the number of trials where the subject failed to stabilize at the starting target. *No end movement* is the number of trials for which movement offset is not detected before the end of trial (does not include false starts). *Posture speed* is the median hand speed, at rest, for 500ms before the peripheral target illuminates. *Reaction time* is the time between end target illumination and movement onset. *Initial movement direction error* is the angular deviation between the (a) a straight line between the central to peripheral target and (b) the participant’s hand path in the initial phase of movement. *Initial distance ratio* is the ratio of (a) the distance the hand travelled during the participant’s initial phase of movement to (b) the distance the hand travelled between movement onset and offset. *Speed maxima count* is the number of hand speed maxima between movement onset and offset. *Min-max speed* is the mean difference between pairs of adjacent local hand speed minima and maxima, for all such pairs between the time of Max Speed, and movement offset. *Total movement time* is the total time elapsed from movement onset to offset. *Path length ratio* is the ratio of (a) the distance travelled by the hand between movement onset and movement offset and (b) the straight line distance between those two hand positions. Finally, *max speed* is the maximum hand speed between movement onset and offset.

**Robotic assessment of proprioception**

*Position matching task*

Three parameters quantified position sense within the position matching task 1. The *variability* parameter measured the trial to trial variability of the matching hand’s position to each target location. *Variability* was calculated by taking the standard deviation of the x, y position matched for each target and averaging across all nine targets. *Contraction/expansion* measured the subjects’ perceived workspace area. To calculate contraction/expansion, the area subtended by the subject’s matching movements was divided by the area of the outer 8 targets made by the robot. Finally, *spatial shift* parameter quantified the perception of workspace location. To calculate spatial shift, the mean error between the matching and passive hand was calculated to indicate whether the subject perceived a shift in the x, y, or xy directions of the workspace.

**Robotic Task Score calculation from normative data**

First, each parameter was normalized to a z-score based on healthy control data that account for age, sex and handedness 2,3. Normative data were previously collected on 178 individuals for VGR and 494 individuals for PM. These control data sets were transformed to normal distributions using a Box-Cox transformation (Box and Cox, 1964). Outliers (identified as beyond ±3.29 standard deviations and equated to ~1% of controls subjects per parameter) were removed from the control data set 1,2. Z-scores were generated for each parameter and an overall task score for each task was calculated by determining the root-mean-square of all parameter z-scores for a given task and then re-normalized based on healthy control performance. A task score near zero denotes best performance and larger values denote worse performance using standard-deviation units. Task scores >1.96 indicates that performance is 1.96 standard deviations from the best performance and is considered abnormal.1,4

**Diffusion MRI Preprocessing and Tractography**

FMRIB Software Library (FSL; www.fmrib.ox.ac.uk/fsl) tools were used for preprocessing and tractography. The susceptibility induced off-resonance field was calculated using TOPUP.5,6 Corrections for susceptibility, head motion and eddy currents were completed using EDDY. Bedpostx modelled diffusion distributions at each voxel. This information was used by Probtrackx7,8 to generate probabilistic streamlines (curvature threshold = 0.2; number of steps per sample = 2000; step length 0.5mm) between subject-specific primary motor cortex (M1) and pontine CST masks. M1 masks were derived from the Harvard-Oxford Cortical Structural Atlas and transformed to each individual’s diffusion space. Pontine CST masks were manually defined using each individual’s colour-coded FA map using known anatomy as has been done previously. 9 The FLIRT tool was used to register between diffusion space and the MNI 152 2mm template.

**PLIC mask definition**

For each subject, the PLIC was defined on their FA map. The PLIC was defined medially by the thalamus, anteriorly by the genu, and posteriorly by a line from the posterior putamen to the thalamus 10.

**References**

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