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Topographical functional connections between the brain and the cervical spinal cord the brain and the cervical spinal cord

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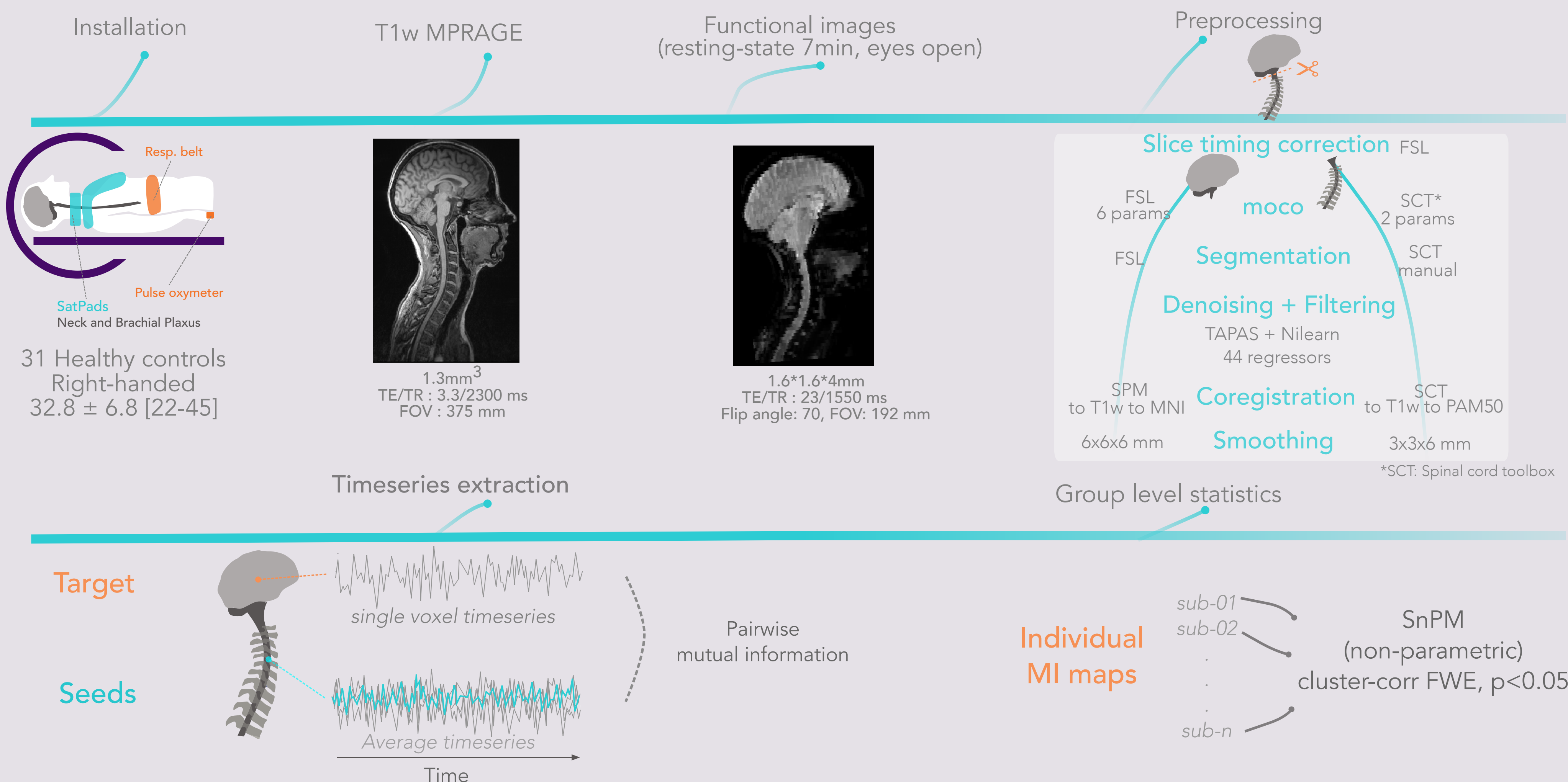
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Rationale & methods

- ✓ Sensorimotor processes take place at each level of the central nervous system
- ✓ Little is known about the spontaneous brain/spinal cord functional communication

Simultaneous fMRI acquisition of the brain and whole cervical spinal cord^{2,7}

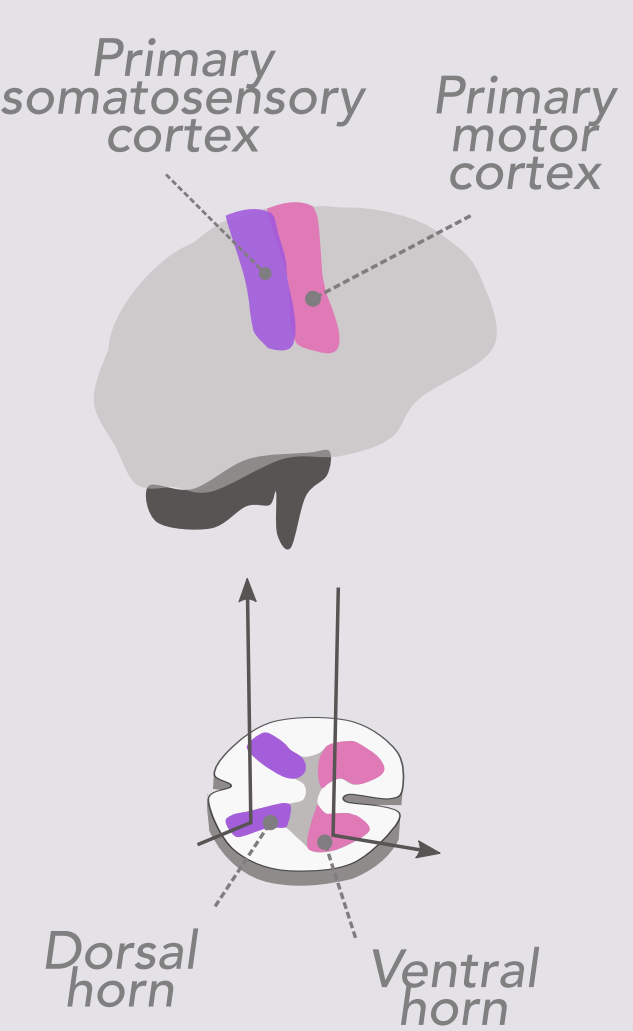
- ✓ Brain and spinal cord were preprocessed and denoised separately using in-house pipeline⁴
- ✓ Seed to voxels analyses were run:
 - ✓ **Seeds:** several spinal cord regions
 - ✓ **Targets:** whole brain or sensorimotor cortex
- ✓ Functional connectivity (FC) was captured using **mutual information** metric (MI)



Results

- ✓ Significant FC between the cervical spinal cord and cortical and subcortical sensorimotor regions

Spinal cord transmits motor and somatosensory signals from and to the brain

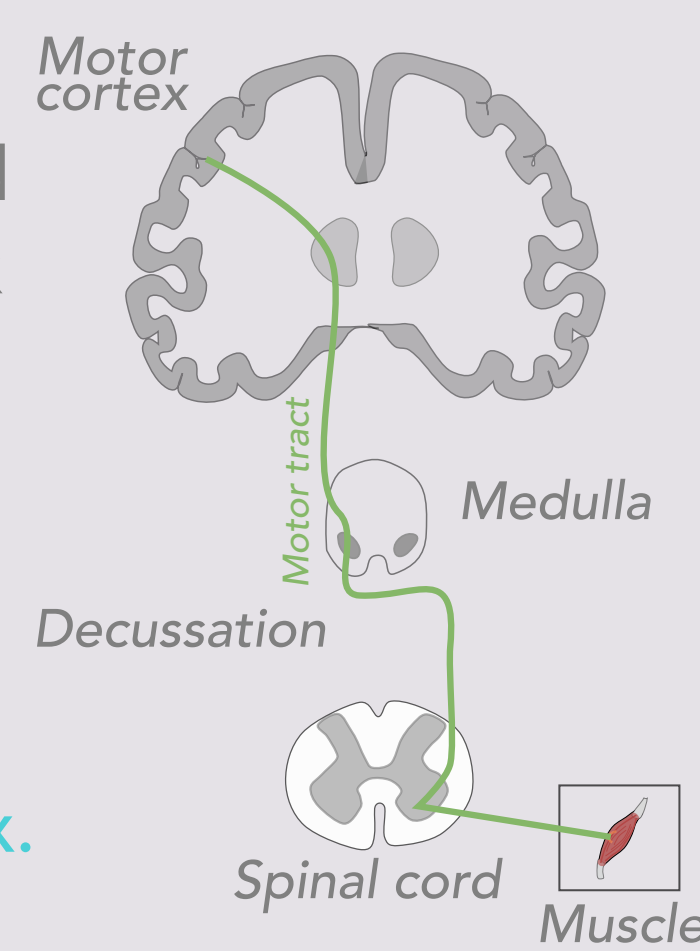


- ✓ Ventral spinal cord is strongly connected to motor related brain regions
- ✓ Dorsal spinal cord is strongly connected to somatosensory related brain regions

Likely underlying corticospinal pathway (motor tract), transmitting signals from motor cortex to muscles, and dorsal column pathway (sensory tract), sending information from body periphery to somatosensory cortex

- ✓ Right spinal cord is more connected to contralateral sensorimotor cortex than left spinal cord

Spinal cord is primarily connected to contralateral sensorimotor cortex. Emphasise hand dominance



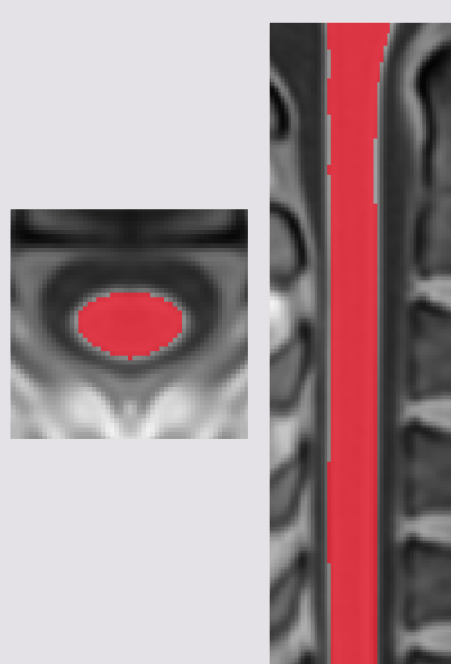
- ✓ The different spinal levels, known to innervate distinct body parts, are connected to different parts of the left M1 and S1 cortex

Rostro-caudal spinal gradient^{1,5} of functional connectivity aligns with Penfield's cortical sensory body space representation⁶ and matches even closer to the updated version of the motor homunculus (Gordon et al. 2023)³

Conclusion

fMRI revealed topographical communication between the spinal cord and the brain. Functional connectivity follows key features of the sensorimotor system: lateralization and somatotopy.

A. Cord seeds



B. Mutual information maps

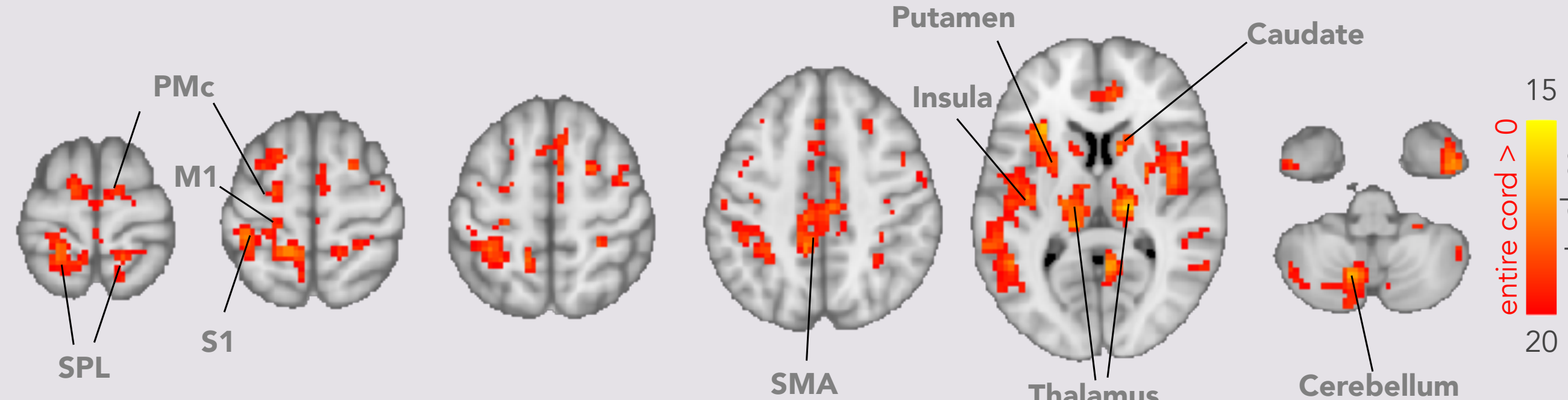
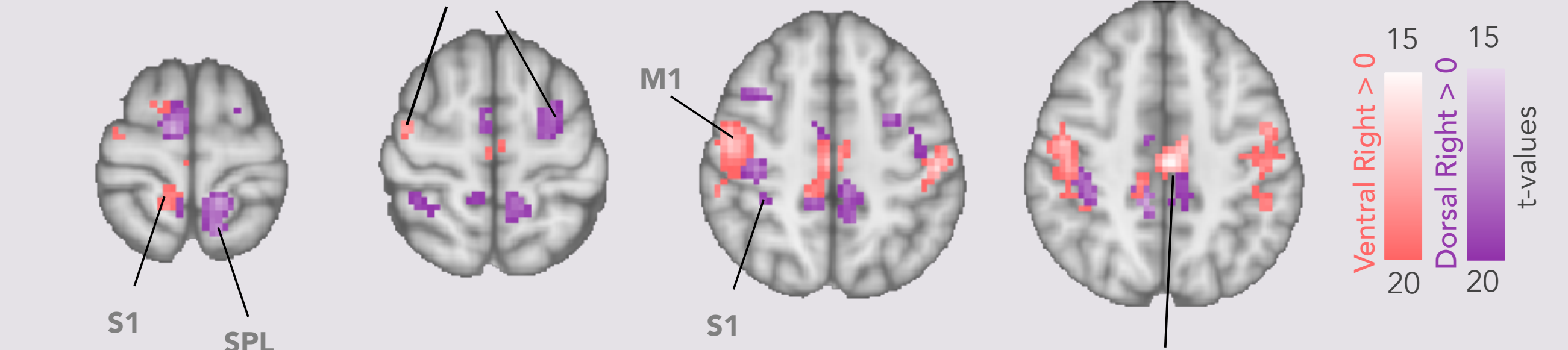
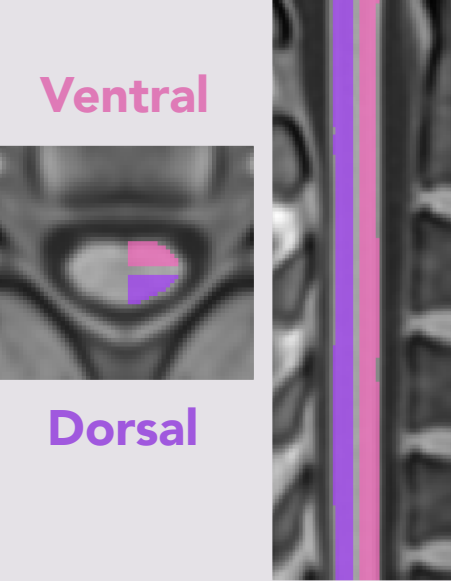


Fig.1 | Functional connectivity between the cervical spinal cord and whole brain. (A) C1 to C7 spinal cord levels were used as seed and a mask of the whole brain GM as target. (B) Voxels of the statistical maps (one sample-test) were thresholded at $t=15$ and a FWE cluster correction was applied ($p < 0.05$).

Right seeds



Left seeds

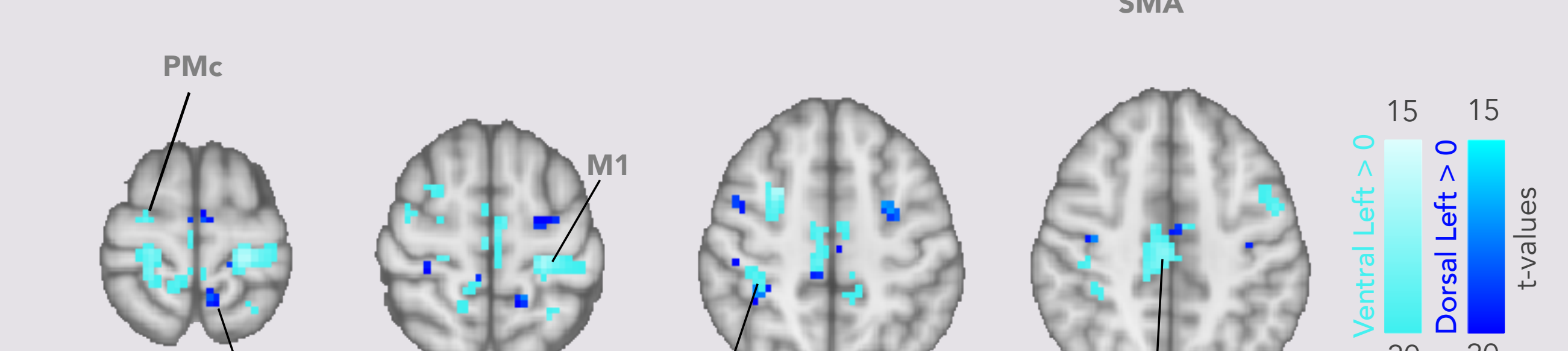
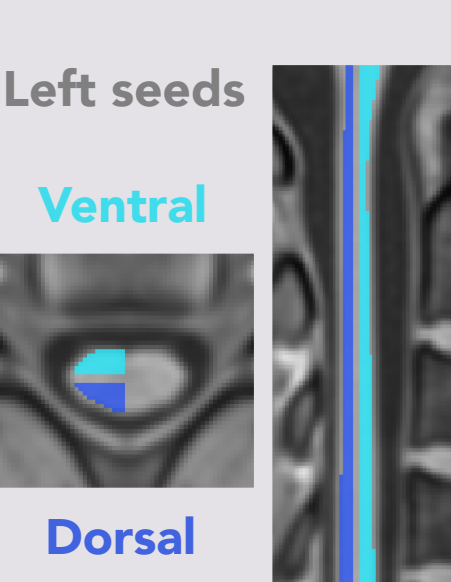


Fig.2 | Functional connectivity between the cervical spinal cord quadrants and sensorimotor cortex. (A) Ventral right (pink) dorsal right (violet), ventral left (light blue) and dorsal left (blue) quadrants from C1 to C7 cord were used as seeds and a mask of the sensorimotor cortex as target. (B) Voxels of the statistical maps (one sample t-tests) were thresholded at $t=15$ and a FWE cluster correction was applied ($p < 0.05$).

Right vs. Left seeds

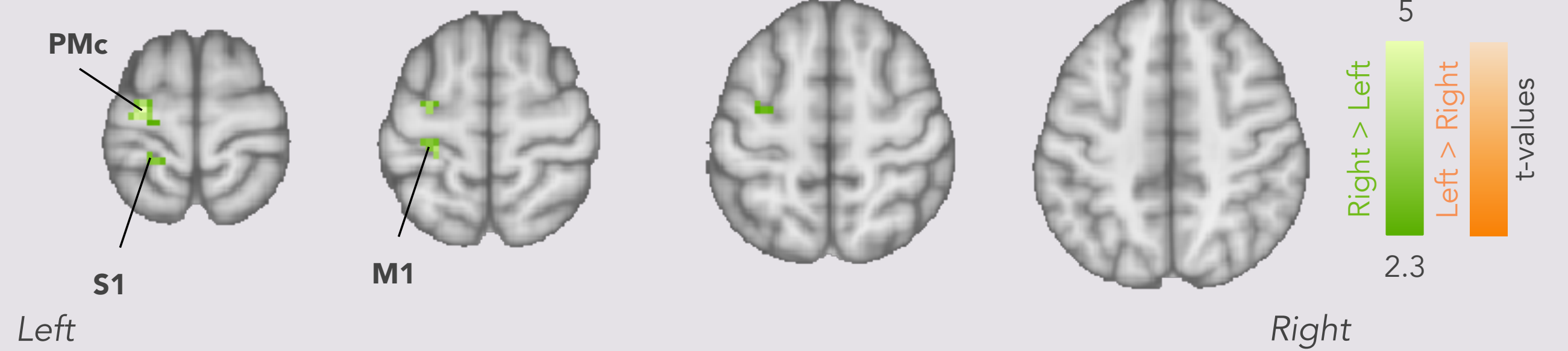
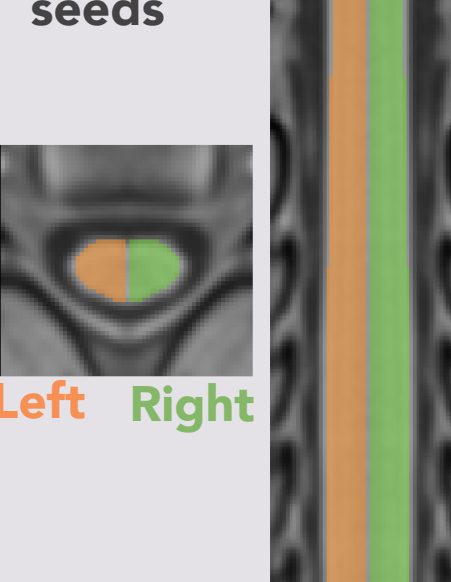


Fig.3 | Comparison of functional connectivity between the right and the left hemicords with the sensorimotor cortex. (A) Right (green) and left (orange) hemicords were used as seeds and a mask of the sensorimotor cortex as target. (B) Contrasts maps (paired-t-tests) were corrected at the cluster level (FWE $p < 0.05$). Note that no significant differences were observed for the [left>right] contrast.

Functional spinal segments as seeds

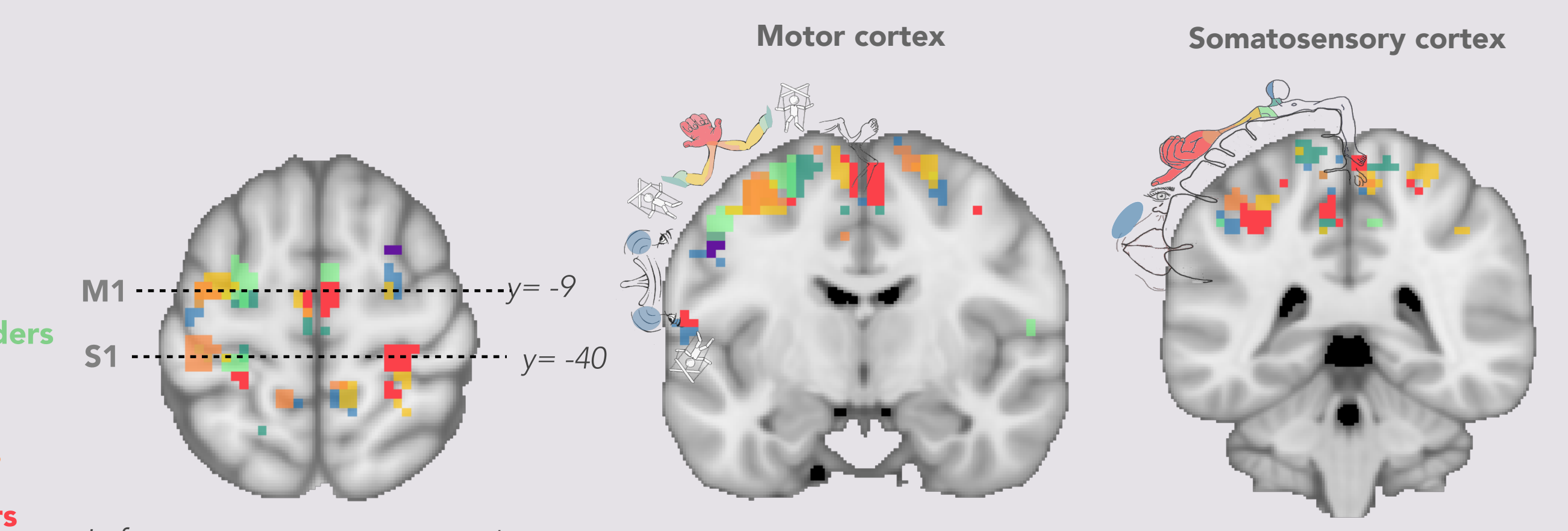
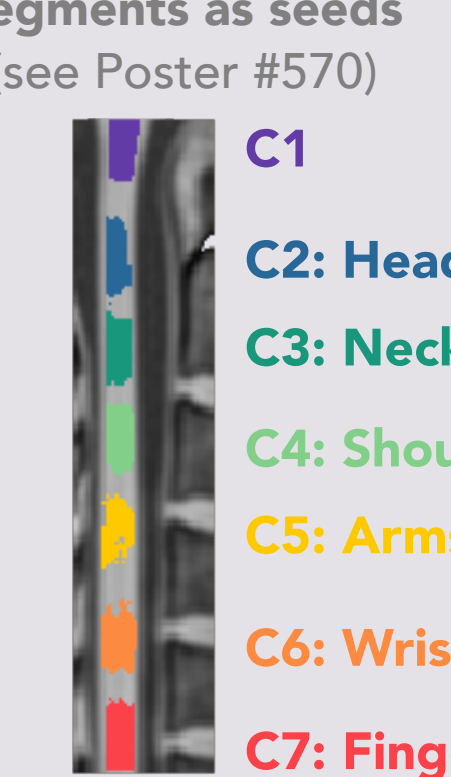


Fig.4 | Topographic functional connectivity between spinal cord levels and primary sensorimotor cortices. (A) Functional spinal cord levels were defined using a data-driven approach (for details see poster#570). Each color represents a distinct segment and the innervated dermatome has been specified. (B) Statistical maps (one sample t-tests) were corrected at the cluster level (FWE $p < 0.05$). motor³ and sensory⁶ homunculus are illustrated for comparison.

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