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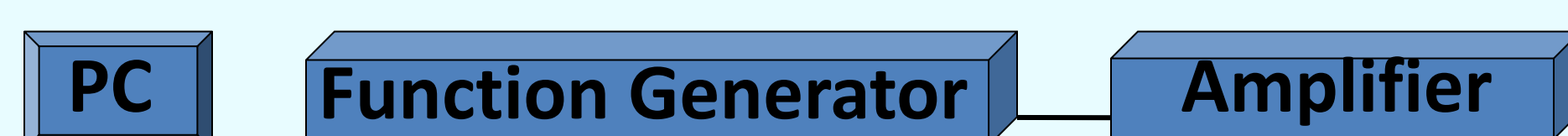
INTRODUCTION

- Evaluation of primary somatosensory cortex (SI) response to vibrotactile stimuli has been advanced by recent technology, which incorporates MRI-compatible piezoelectric devices into the functional MRI (fMRI) setting.
- A flexible, multi-finger stimulation device would greatly improve the feasibility of somatotopic mapping for patients with suspected disorder in SI response.
- Carpal tunnel syndrome (CTS) is a median nerve entrapment neuropathy characterized by paresthesias and pain over median nerve innervated fingers, and altered cortical activation and somatotopy (1-3).
- We have constructed a MRI-compatible device delivering vibrotactile stimulation to the volar surface of up to four fingers.

METHODS

Piezo electric device and system

Our MR-compatible device was constructed in conjunction with Cortical Metrics (Chapel Hill, NC) and consists of four independently rotating cylindrical rings (130mm diameter) with recessed openings for fingertips. A piezoelectric transducer (T220-A4NM-303Y, Piezo Systems Inc.) with a rough plastic probe (5mm diameter) is mounted under each ring opening. Piezo movement is controlled by custom software (Labview 7.1, National Instruments) in order to achieve 30Hz vibrotactile stimulation synchronized to fMRI signal acquisition

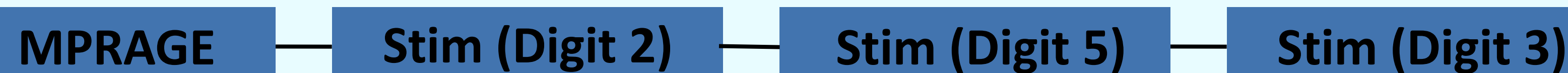


Subjects

10 healthy control (HC, 46.1±3.5 years, 7F)
3 CTS patients (CTS, 51±6 years, 3F)

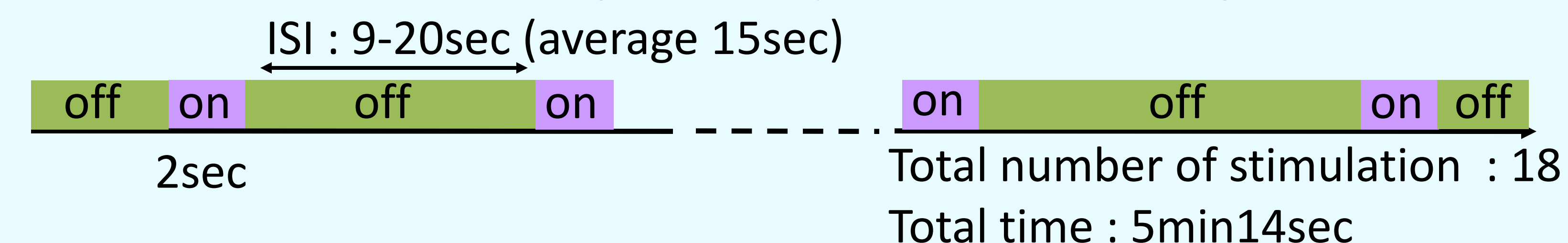
fMRI protocol

fMRI data were acquired using a gradient echo BOLD T2*-weighted pulse sequence (TR/TE = 2000/30ms, FOV = 200x200mm, 32 axial slices, voxel size = 2.1x2.1x2.5mm, flip angle = 90°) on a 3.0T Siemens Trio equipped with 32-channel head coil. Slices were oriented to be roughly parallel with the contralateral central sulcus, thus maximizing spatial resolution along the dimension of expected shift for different fingers (ventral-dorsal). Each of three fingers (2nd, 3rd, 5th) was stimulated in separate runs.



Finger stimulation protocol

We used an event-related design with a separate run for each digit.



Analysis

fMRI data were transformed to surface space (Freesurfer, MGH), smoothed on a spherical cortical surface (fwhm = 3mm) and analyzed using a general linear model. Group maps were created for HC and CTS subjects, respectively (threshold at p < 0.001). Activation in contralateral SI, BA 3b was extracted for analyses of somatotopy.

Acknowledgements

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RESULTS

Figure 1 – HC group maps for finger stimulation (n=10)

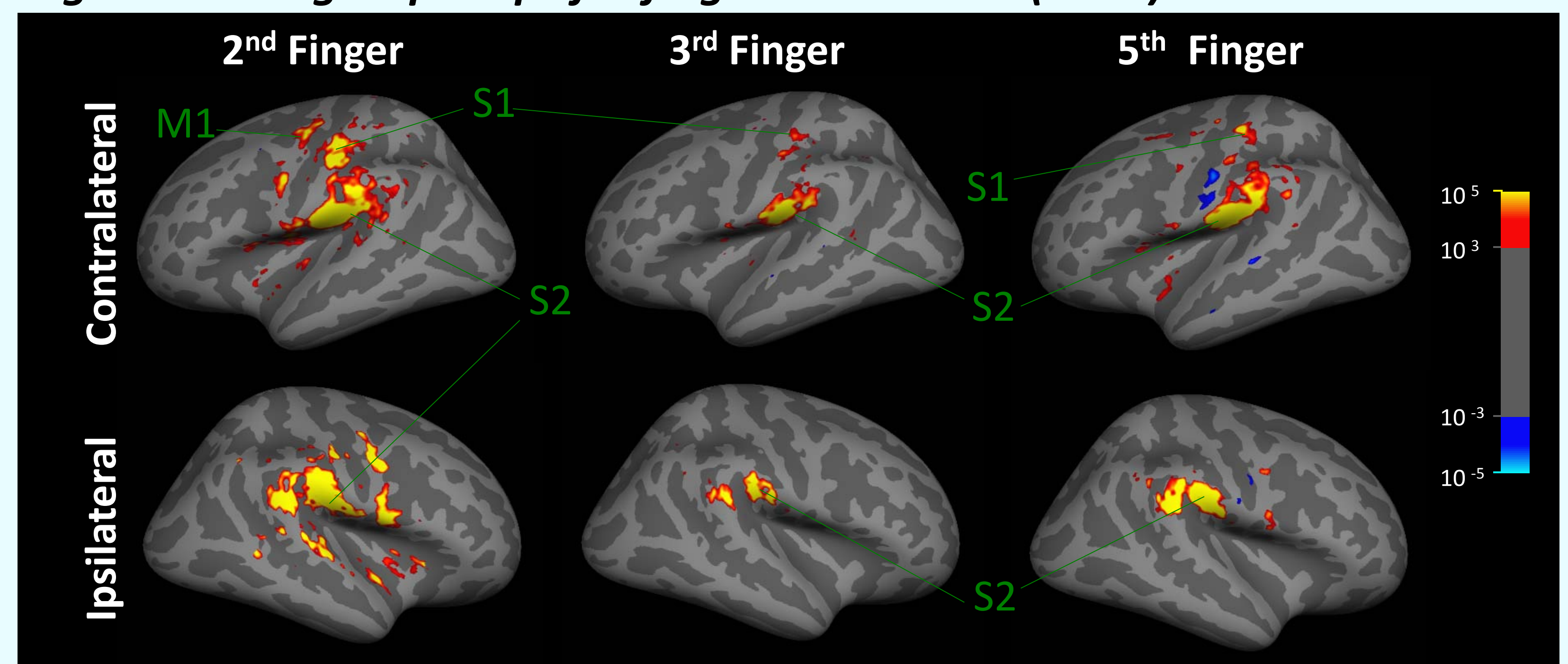
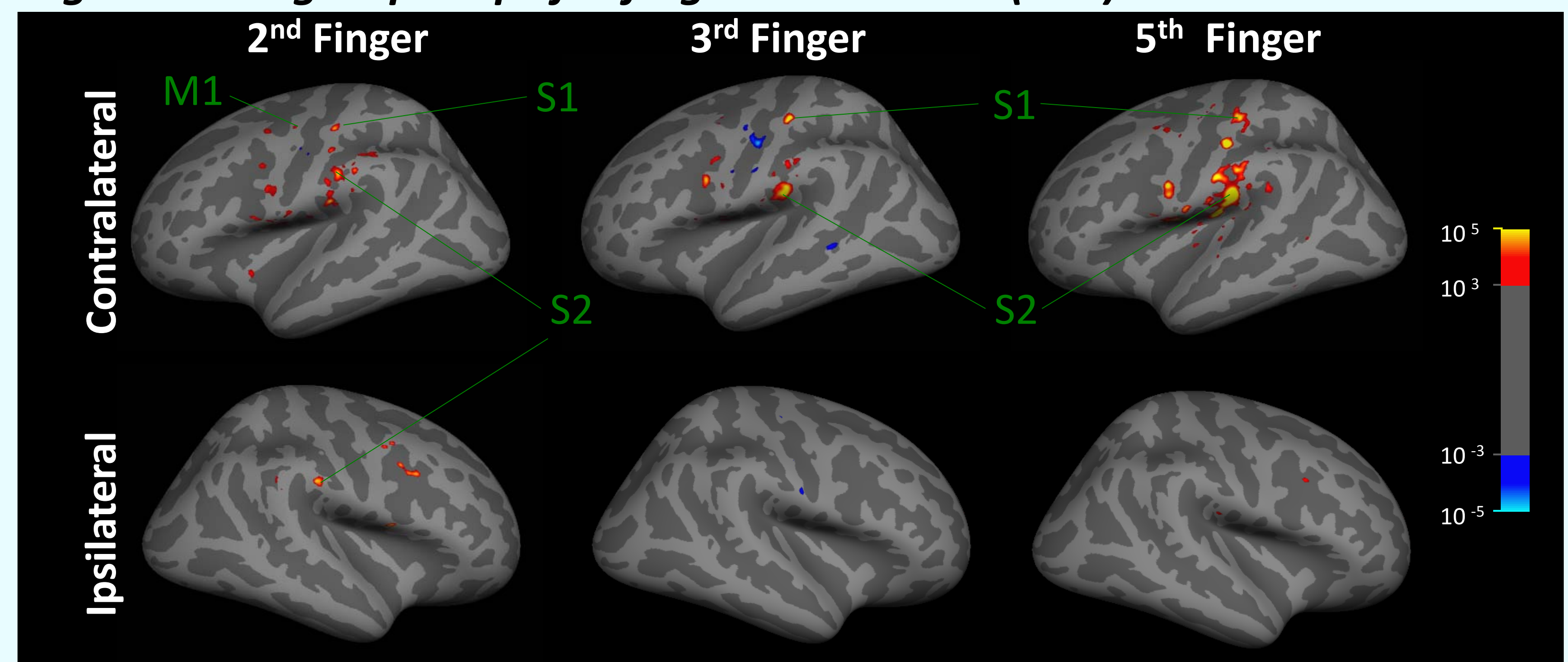


Figure 2 CTS group maps for finger stimulation (n=3)



Activation was observed in contralateral M1 and SI, as well as bilateral S2 for both HC and CTS.

Figure 3 – Analysis of somatotopy: BA 3b ROI for HC and CTS

Group	Finger	x	y	z	cluster
HC	2 nd Finger	-48	-20	54	280
	3 rd Finger	-49	-23	57	40
	5 th Finger	-44	-26	61	101
CTS	2 nd Finger	-47	-20	56	39
	3 rd Finger	-48	-22	58	90
	5 th Finger	-46	-25	60	102

Group SI ROIs in HC showed a clear shift from ventral to dorsal. While Group ROI in CTS tended to have more overlapped digit representations, more patients will be needed for definitive results.

CONCLUSIONS

We have established a laptop-controlled piezoelectric MRI-compatible vibrotactile stimulation device and applied it successfully to CTS patients, who are known to have altered cortical finger representations. Focal activation was noted in the hand area for contralateral SI.

References

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