Cross-site multiband fMRI signal comparison for cross-cultural neurocognitive studies

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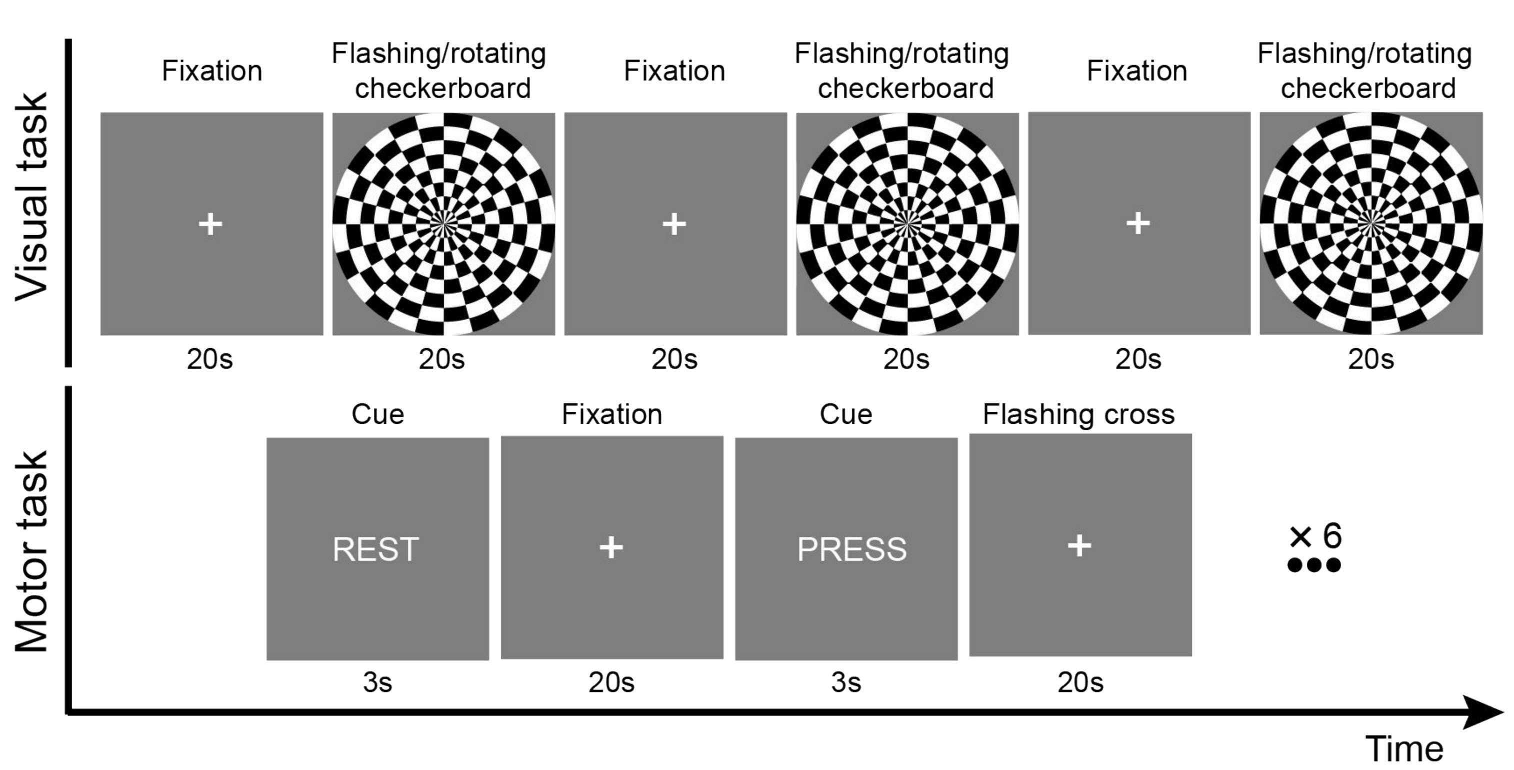
Introduction

- Cross-cultural neurocognitive studies face the challenge of comparing brain responses across different sites, hardware and software [1].
- Controlling MRI base systems, settings, functional tasks and human subjects, the current study compared the fMRI data acquired in Taiwan and the U.S.
- Effects of subject, task (visual and motor task), site and their interactions were evaluated.

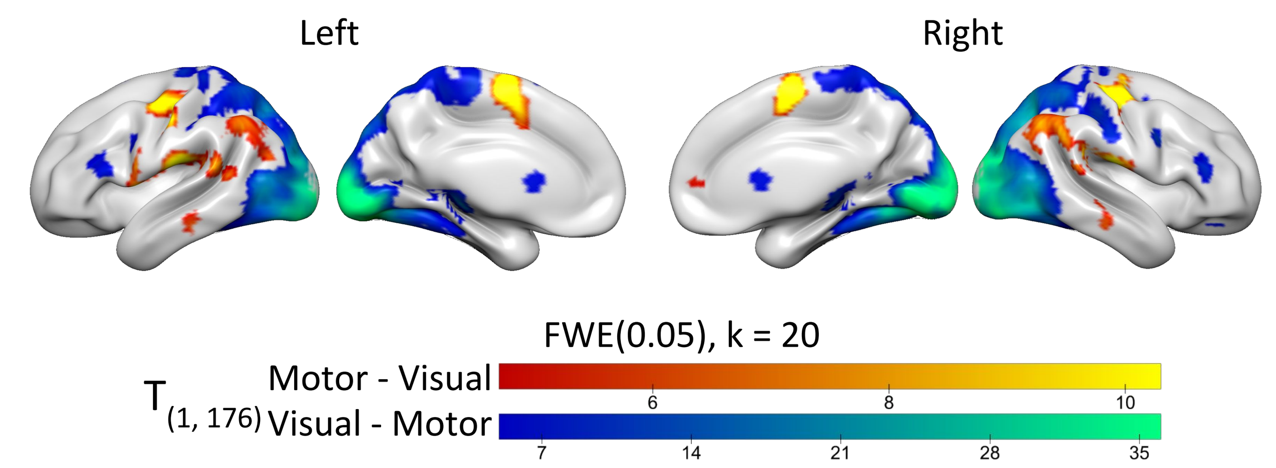
Methods

- **Locations**: Imaging Center for Integrated Body, Mind and Culture Research, National Taiwan University, Taipei, Taiwan and Center for Brain Science, Harvard University, Cambridge, MA, U.S.A.
- **Controlled factors across locations**: Siemens PRISMA 3T scanners; 64-channel head coils; back-projection of visual stimuli onto films from portable computers with the same brand and specifications; same experimental tasks; fixed visual angle of visual stimuli; all lights off in both scanner rooms. A customized MR-compatible lightmeter was made by the Taiwan Instrument Research Institute, National Applied Research Laboratories to access the luminance readings of the visual stimuli from both sites, and was transferred between sites.
- **Imaging acquisition settings on both sites**:
  Fieldmap: 64 axial slices; slice thickness = 2.3 mm; voxel size = 2.3*2.3*2.3 mm; TR = 282 ms; TE 1 = 4.12 ms; TE 2 = 6.58 ms; Flip Angle = 55 deg; Bandwidth = 1370; matrix size = 96*96.
  Multi-band [2] EPI: 64 axial slices; slice thickness = 2.3 mm; voxel size = 2.3*2.3*2.3 mm; TR = 670 ms; TE = 36 ms; Flip Angle = 50 deg; Pixel Bandwidth = 2265; matrix size =96*96; Multiband acceleration factor = 8.
  - A flashing checkerboard (visual) and a finger tapping (motor) task were used as base tasks.

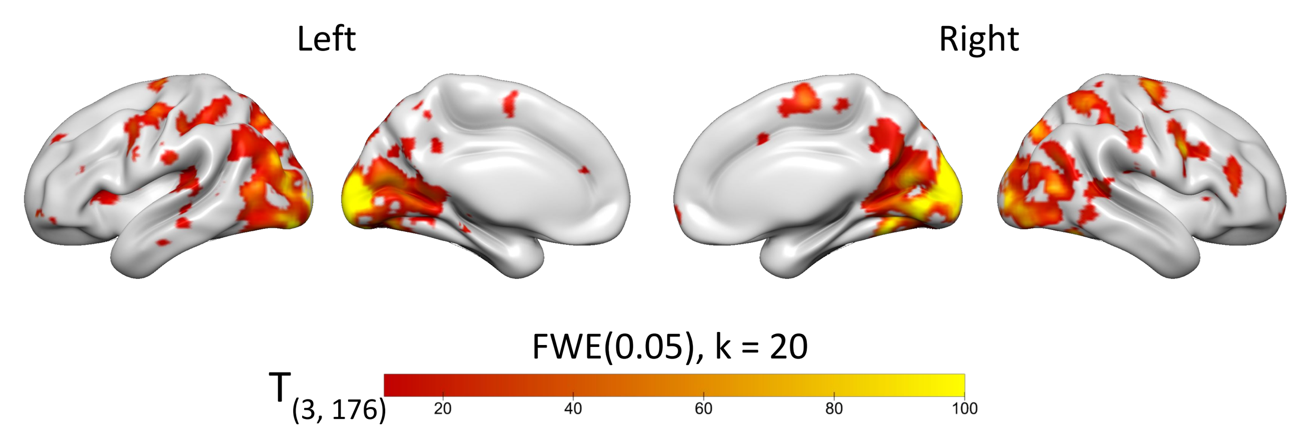


- Four subjects (1 male, 3 females; 2 Caucasians, 2 East Asians) each completed 12 independent runs of both visual and motor base tasks over 3 days at each site.
- Between each run the head coil was removed, subjects sat up or walked around, then subjects re-entered with head coil back on.

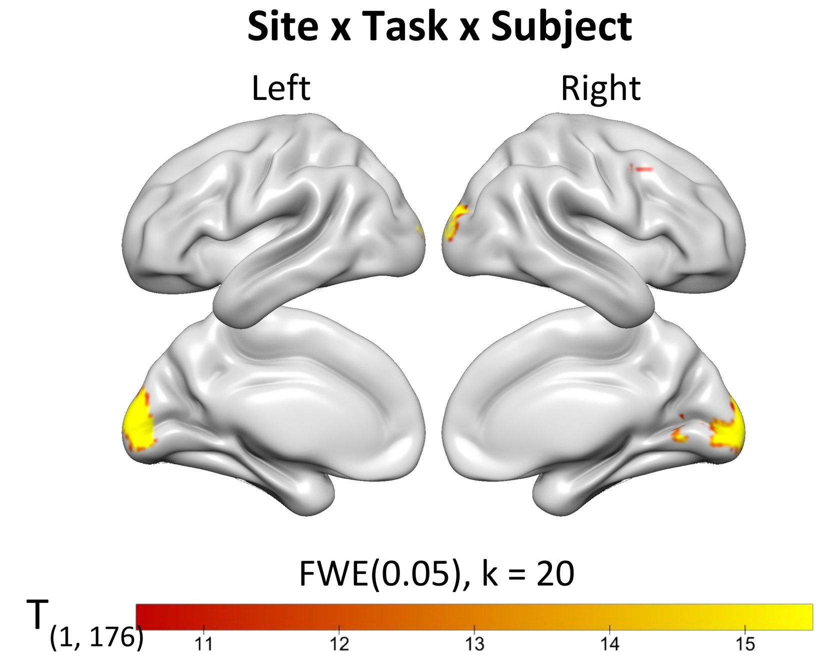
Base tasks showed expected brain activation in visual and motor areas

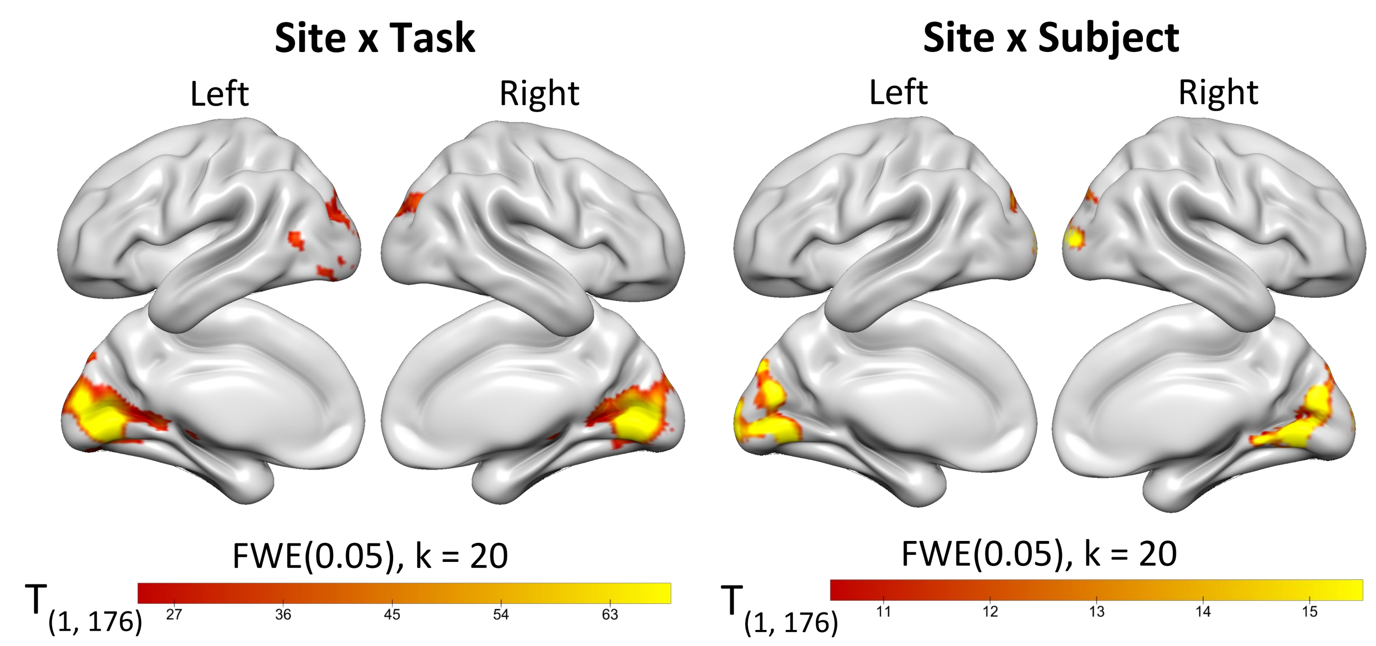


Task x Subject interactions throughout whole brain

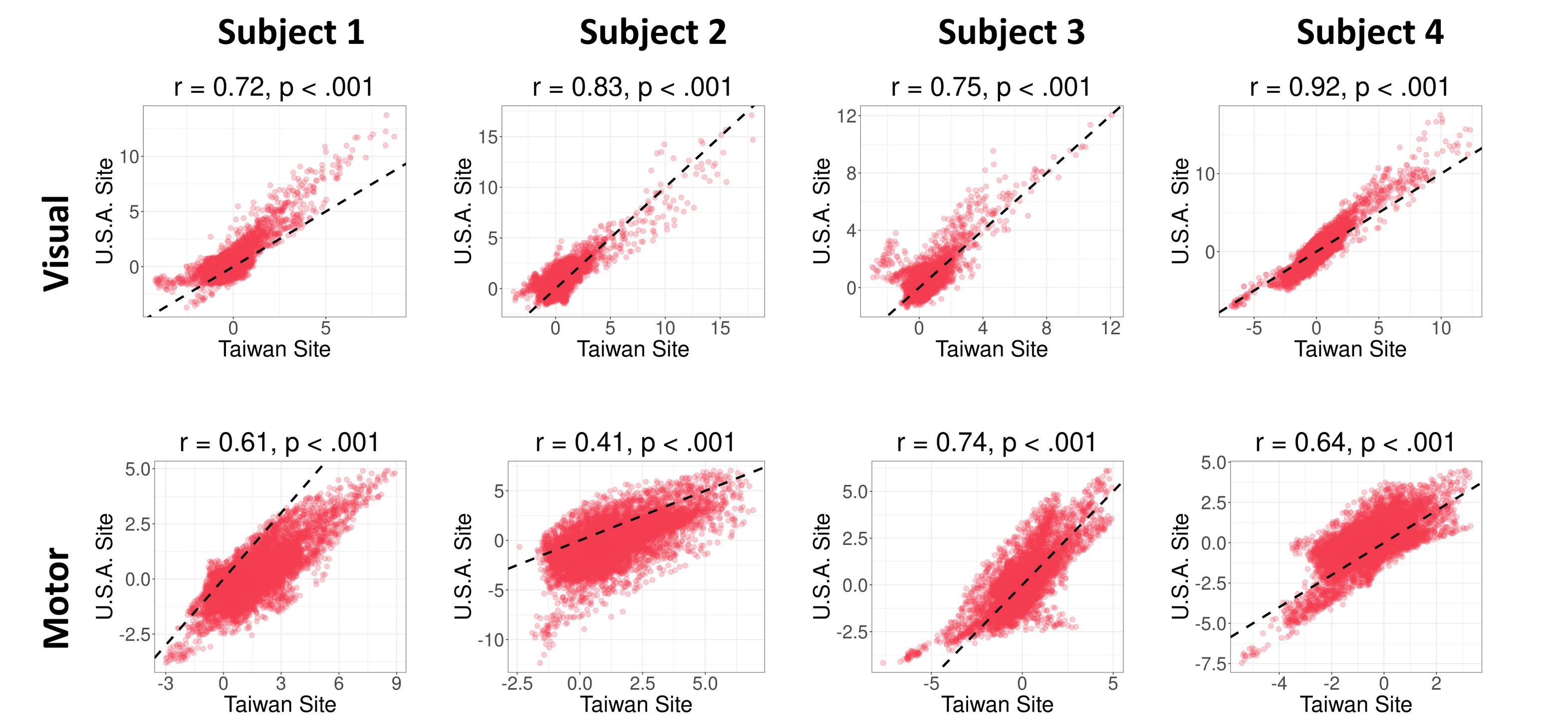


Interactive effects involving Site largely restricted to the primary visual area

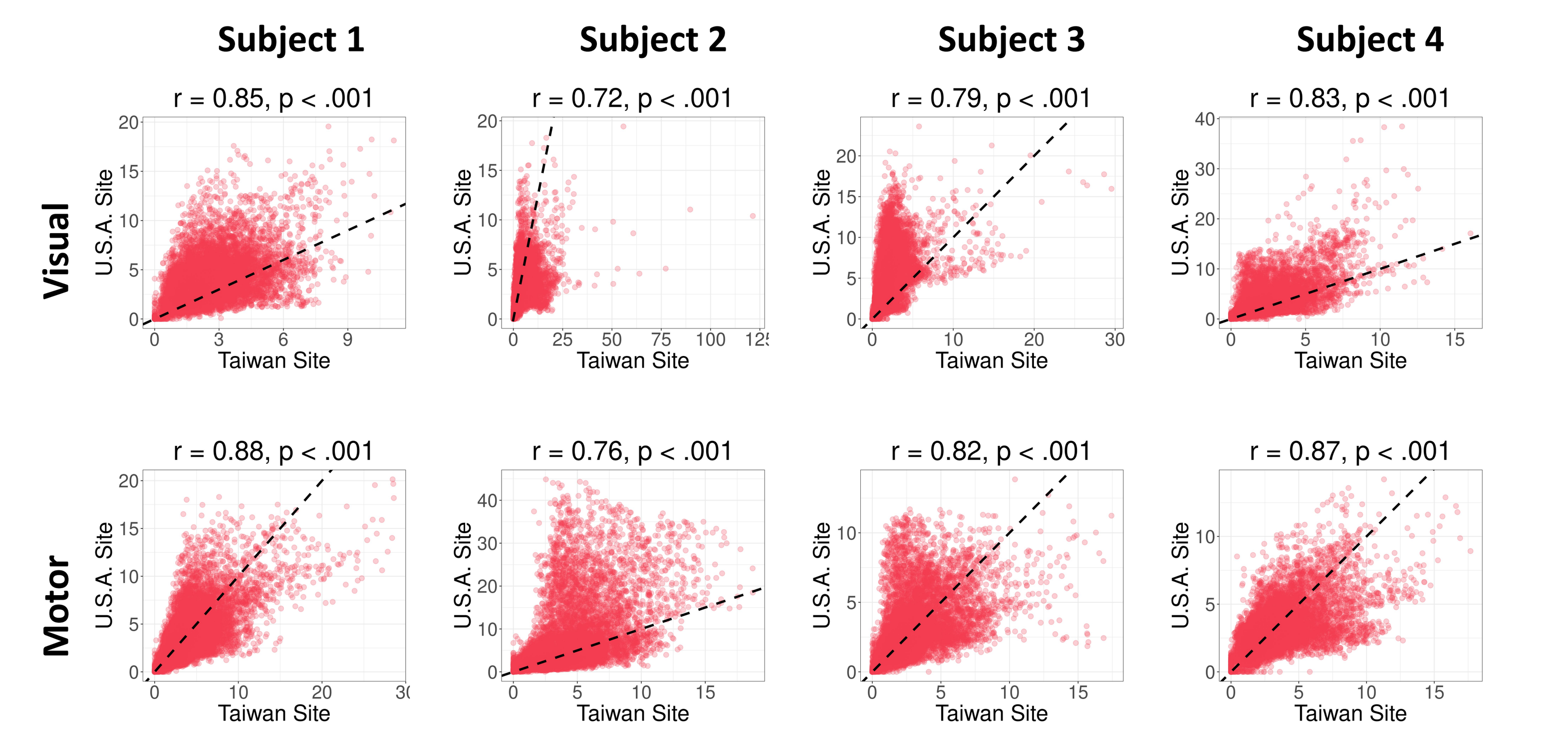




Mean voxel T-value correlations between sites



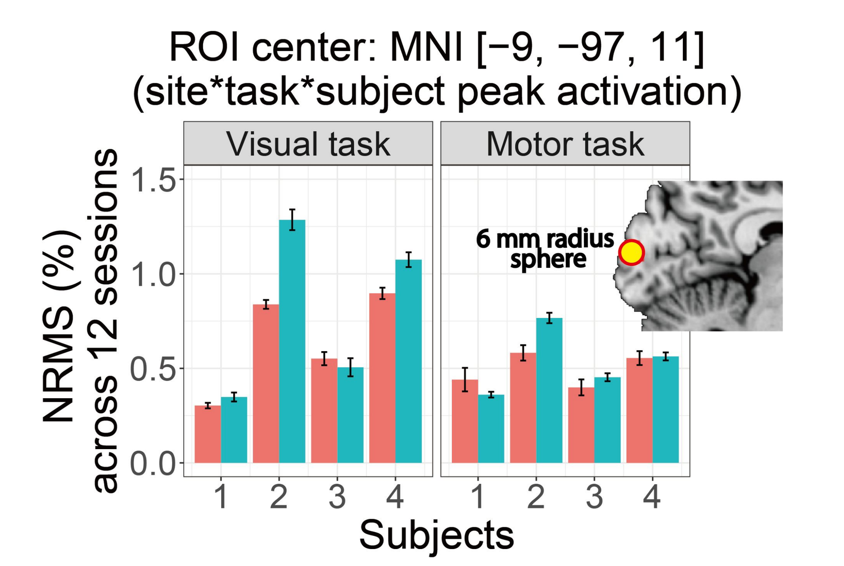
Voxel T-value variance correlations between sites

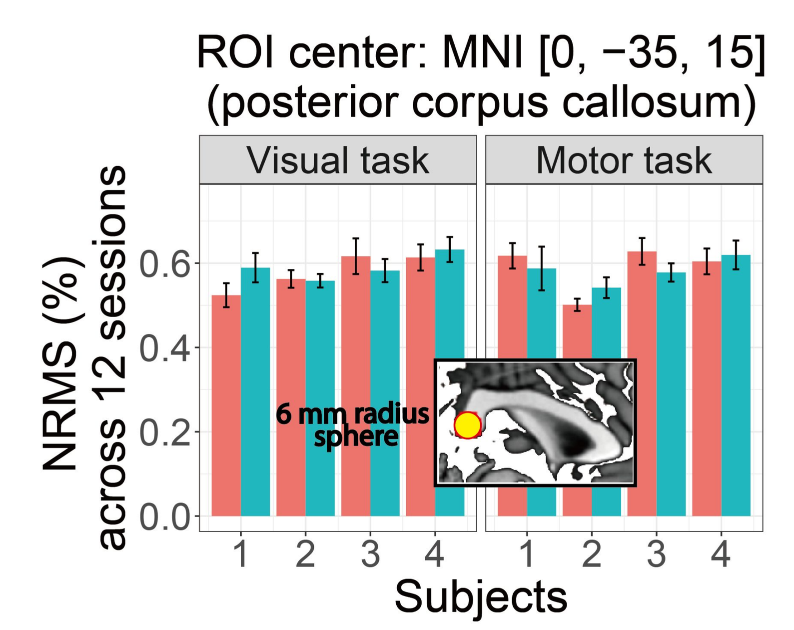


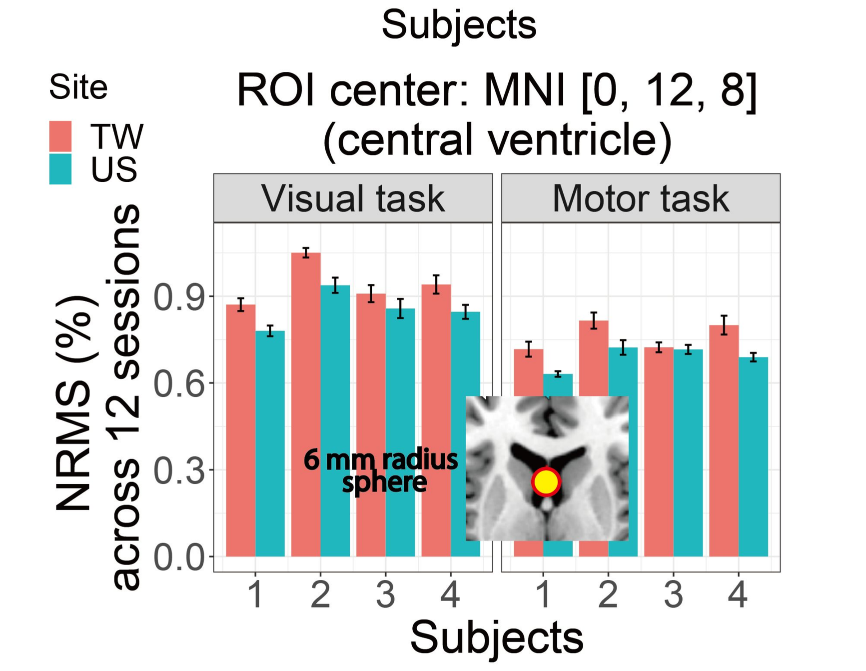
Comparison of normalized root mean square signal between sites

ANOVA results

- Task grey matter ROI: Subject x Task ($F(1, 182) = 32.84$, $p < .001$).
- White matter ROI: n. s. effects.
- Ventricle ROI: Site ($F(1, 182) = 8.54$, $p = .004$) and Task ($F(1, 182) = 39.51$, $p < .001$).







Conclusion

- Observed site difference in signal likely came from psychological and perceptual processing in subjects, such as screen luminance.
- Cross-site comparisons of functional neural responses are feasible, particularly for tasks that do not focus on low-level visual processing areas.

Reference

[1] Sutton, B.*, Goh, J., Hebrank, A., Welsh, R. C., Chee, M. W. L., Park, D., (2008). Investigation and validation of intersite fMRI studies using the same imaging hardware. Journal of Magnetic Resonance Imaging, 28(1), 21-28.

[2] Moeller S, Yacoub E, Olman CA, Auerbach E, Strupp J, Harel N, Ugurbil K. Multiband multislice GE-EPI at 7 tesla, with 16-fold acceleration using partial parallel imaging with application to high spatial and temporal whole-brain fMRI. Magn. Reson. Med. 63:1144-1153 (2010).

Acknowledgement

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