

Natural embodiment of microconnectome to bridge a scale gap.

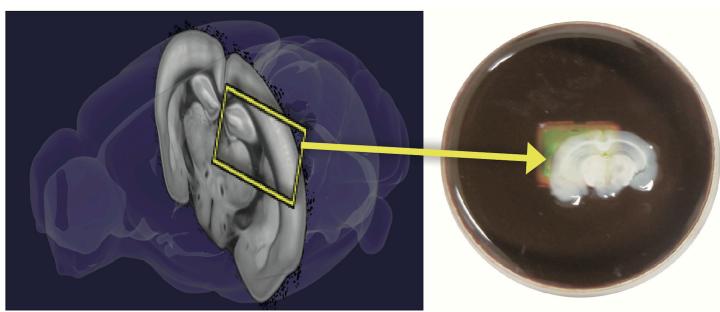


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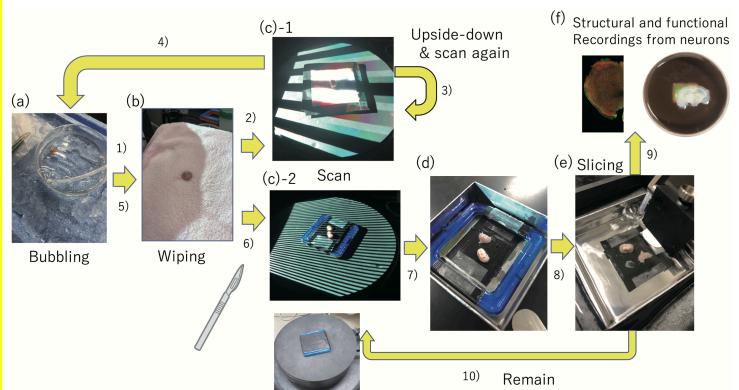
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■ Introduction

- **General purpose:** We hoped to reconstruct the original embodied positions of structural or functional microscopic architectures in the original global brain map.
- **Question:** How accurately can microscopic data be embedded?



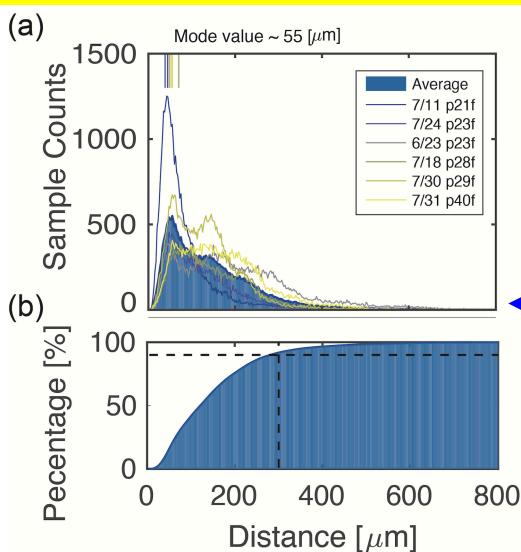
■ Methods



One experimental procedure:

- (a) Firstly, after extracting a brain from a mouse, we dropped the brain into a bubbled cutting solution.
(b) Wiping the cutting solution on a soft and highly absorbent towel,
(c) Scanning the brain on a turntable,
(d) Moving brain blocks from the scan base to the base for a vibratome (step 7,8).
(e) After we get enough slices for recording electrical activities or for staining of the cell distributions etc., we also scanned from the remained brain blocks again (step 10). The value provides additional important support information of where the slices were taken from.

■ Result



- (a) Histograms of distances between surfaces extracted by peeling from MRI volumes and surface came from 3D scan recordings. The main bar graph is the averaged histogram for all individuals, and other colored lines are results for individual mice ($N = 6$). We are able to find the general trend is stable for all individuals.
(b) The accumulated value of the histogram is shown as a bar graph. The accumulated percentage reaches 90% around at 300 μm (dotted lines).
(c) The symbolic illustration what accurate coregistration enable us to achieve (<https://scalablebrainatlas.incf.org/index.php>). Our technique will provide an strong objective evidence if slices are properly embodied into original whole brain maps.

(a) Striped MRI (b) Connected 3D scan

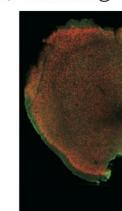
(c) Slicing with experimental record

Experiment ID (e.g.)	First cut or Slice #	Recording Slices	Left/Right Hemisphere	More Details (examples)
Age: 3 weeks, Male/Female Date (2018/4/1) Recording by Taro Kajiwara			Right Dorsal/Cerebral/Ventral	(c.g.) We took * mm to make individual slices. Comment: Especially Top part We also performed staining (GAD69+ NeuN).

(d) Neuronal recording



(e) Staining



■ References

- DeFelipe, J., Jones, E. G. Cajal on the Cerebral Cortex: An Annotated Translation of the Complete Writings. Oxford Univ. Press (1988).
- Schröter, M., Paulsen, O., Bullmore, E. T. Micro-connectomics: probing the organization of neuronal networks at the cellular scale. *Nature Reviews Neuroscience*, 18(3), 131 (2017).
- Shimono, M., Beggs, J. M. Functional clusters, hubs, and communities in the cortical microconnectome. *Cerebral Cortex*, 25(10), 3743–3757 (2014).
- Edelsbrunner, H. Surface reconstruction by wrapping finite point sets in space. In: J. P. B. Aronov, S. Basu and M. Sharir (eds), *Discrete and Computational Geometry – The Goodman-Pollack Festschrift*, Springer-Verlag, pp. 379–404 (2003).

■ Information list gathering into an unified informatic platform:

- (a) An example of cortical surface produced by stripping from a MRI volume.
(b) An example of cortical surface directly scanned by our 3D scanner system.
(c) An example of our memo summarizing the brain region from where we extracted individual brain slices.
(d) A photo when the cortical slice is on a electrode dish.
(e) A stained brain cortical slice by NeuN and GAD67.