

# Allen Brain Institute Showcase

## Highlights 2019

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Ellen Koch

PhD Candidate

Lynn Raymond lab

# B – SOiD: behaviour extraction and classifier

- “Behavioural Segmentation of Open Field”
- Eric Yttri
- Nature methods (In press)
- Pre-print on BioRxiv
- Uses data produced by Deep Lab Cut tracking software
- <https://github.com/YttriLab/B-SOiD>

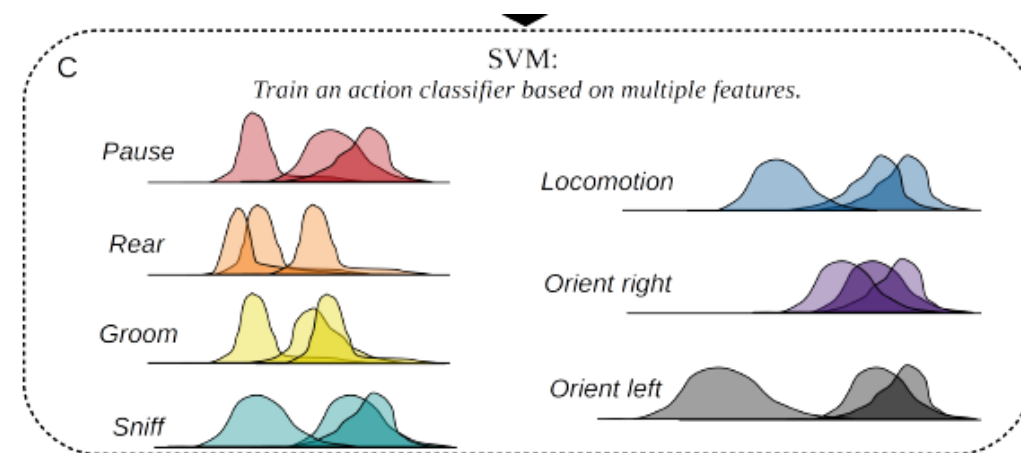
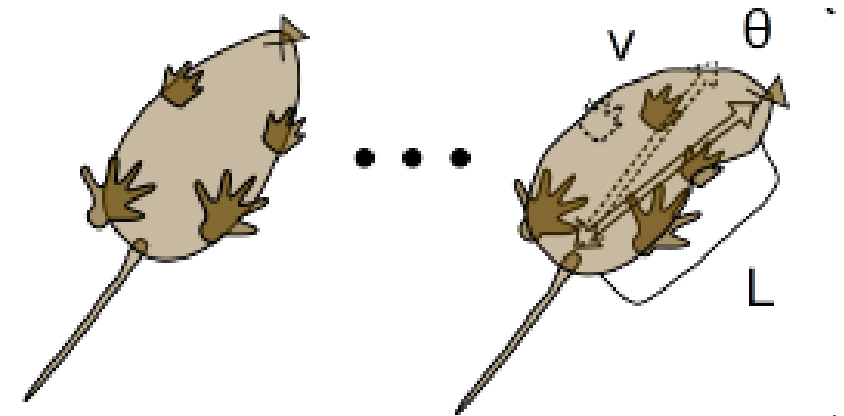
## **B-SOiD: An Open Source Unsupervised Algorithm for Discovery of Spontaneous Behaviors**

Alexander I. Hsu<sup>1</sup> and Eric A. Yttri<sup>1</sup>✉

<sup>1</sup>Department of Biological Sciences, Carnegie Mellon University, Pittsburgh, PA USA

# B – SOiD: behaviour extraction and classifier

- Clusters behaviour according to 3 main classes:
  - Speed
  - Angle
  - Length
- 7 features chosen to isolate rodent behaviours
  - 1 Feature: Body length
    - Example: This will appear shorter when rearing, scrunching, etc.
  - 3 Features: Relative positions of front paws, snout, tail, back paws
  - 2 Features: Speeds of the snout and the base of tail
  - 1 Feature: Body angles

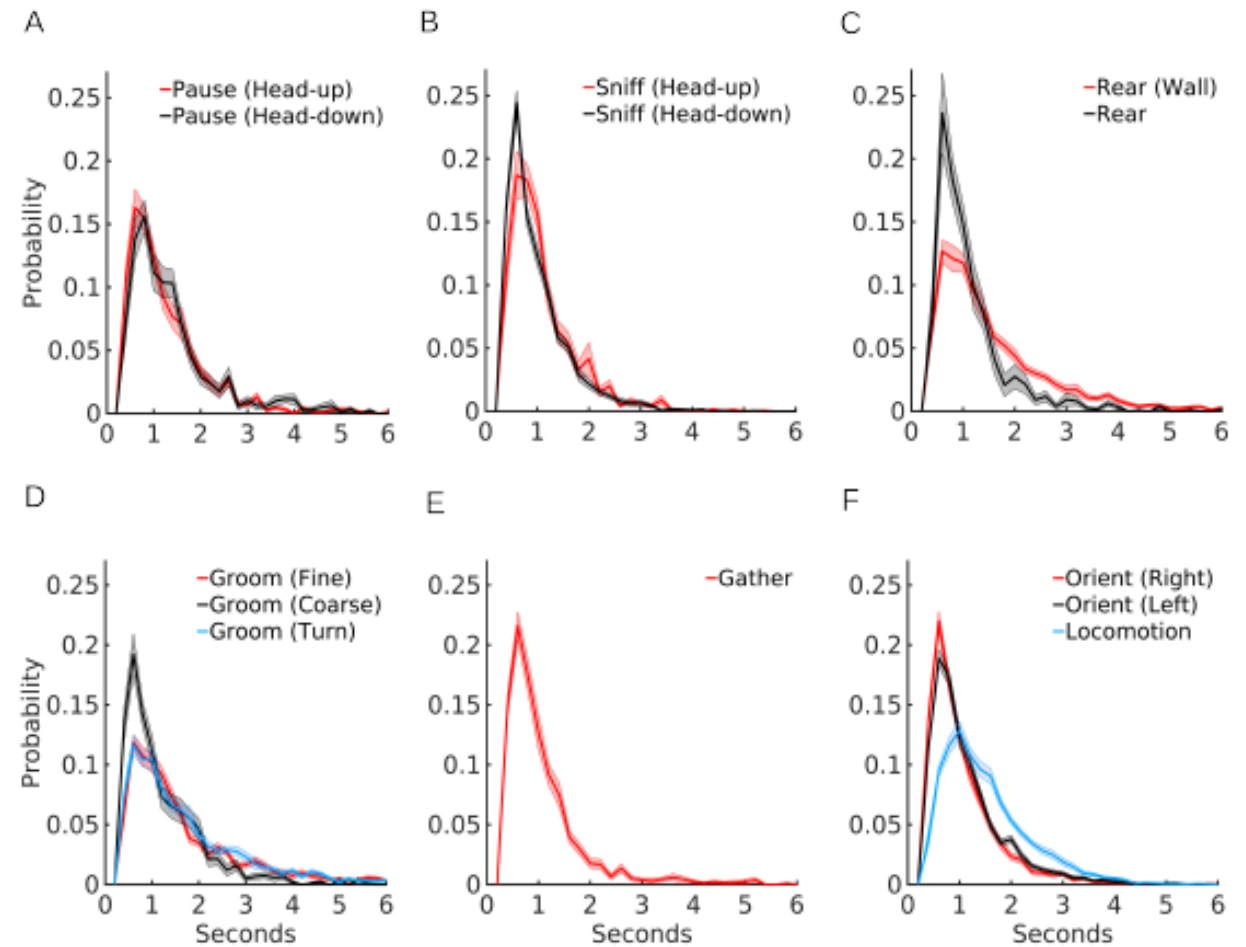


## Training

## Predict



Probability of behaviours within 30 minutes in an open field (data from 10 mice)





# B - SOiD

- **Benefits**

- Works easily with Deeplabcut data
- The only technique to provide individual movement kinematics for behaviours
  - For grooming, features such as stride length and arm extension speed
- Training on animals seems to generalize well to other animals (even different strains and animals with optogenetic fibers)
- If you have an animal model, they will process your videos for free!

- **Drawbacks**

- Only for open field (and videos from below)

# CMU Arrays: 3D nano-printed multi-electrode probes

- Eric Yttri lab as well
- Saleh et al. – Nature Neurotechnology in press
- BioRxiv pre-print
- Microelectrode arrays with high-density of channels and completely customizable

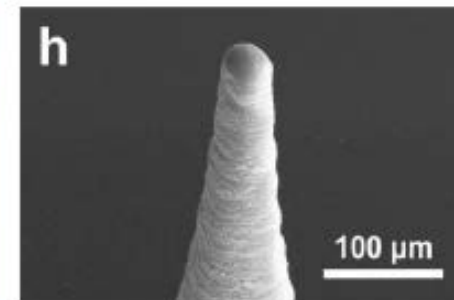
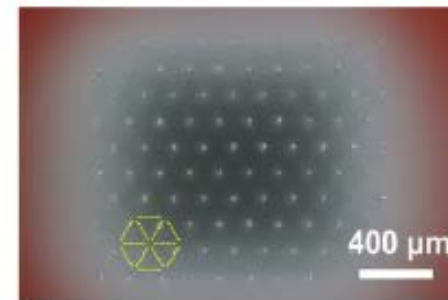
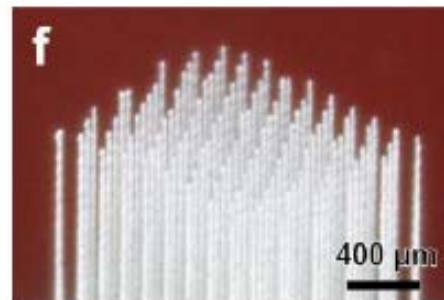
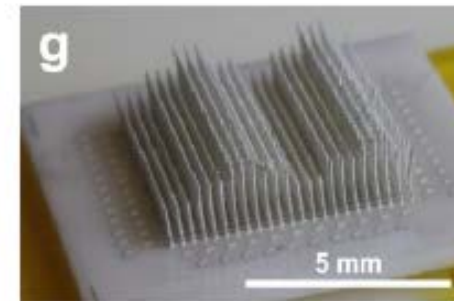
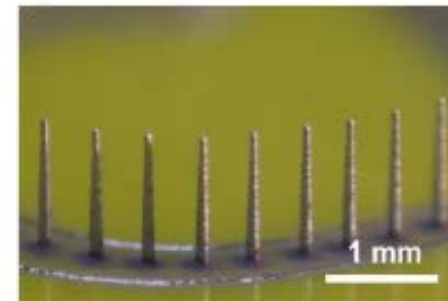
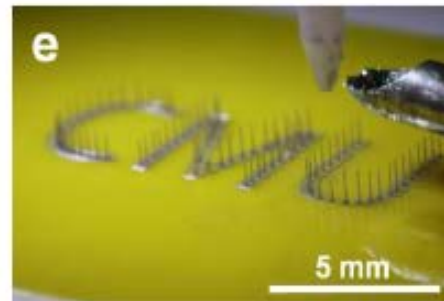
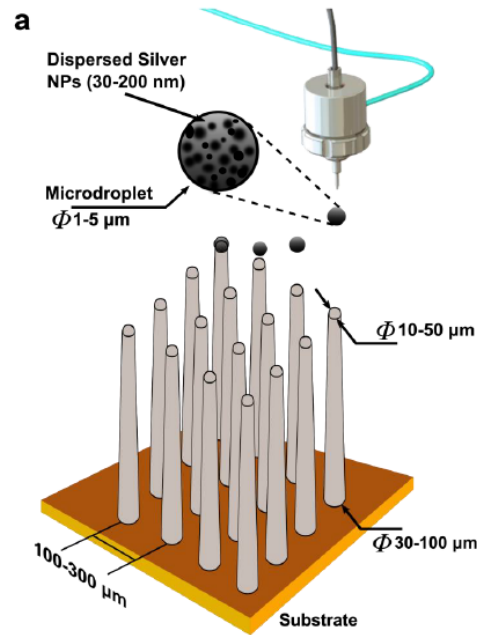
**CMU Array: A 3D Nano-Printed, Customizable Ultra-High-Density Microelectrode Array Platform**

**Authors:**

Mohammad Sadeq Saleh<sup>1</sup>, Sandra M. Ritchie<sup>1</sup>, Mark A. Nicholas<sup>2</sup>, Riddhiman Bezbaruah<sup>1</sup>, Jay W. Reddy<sup>3</sup>, Maysamreza Chamanzar<sup>3</sup>, Eric A. Yttri<sup>2,†,\*</sup>, Rahul P. Panat<sup>1,†,‡,\*</sup>

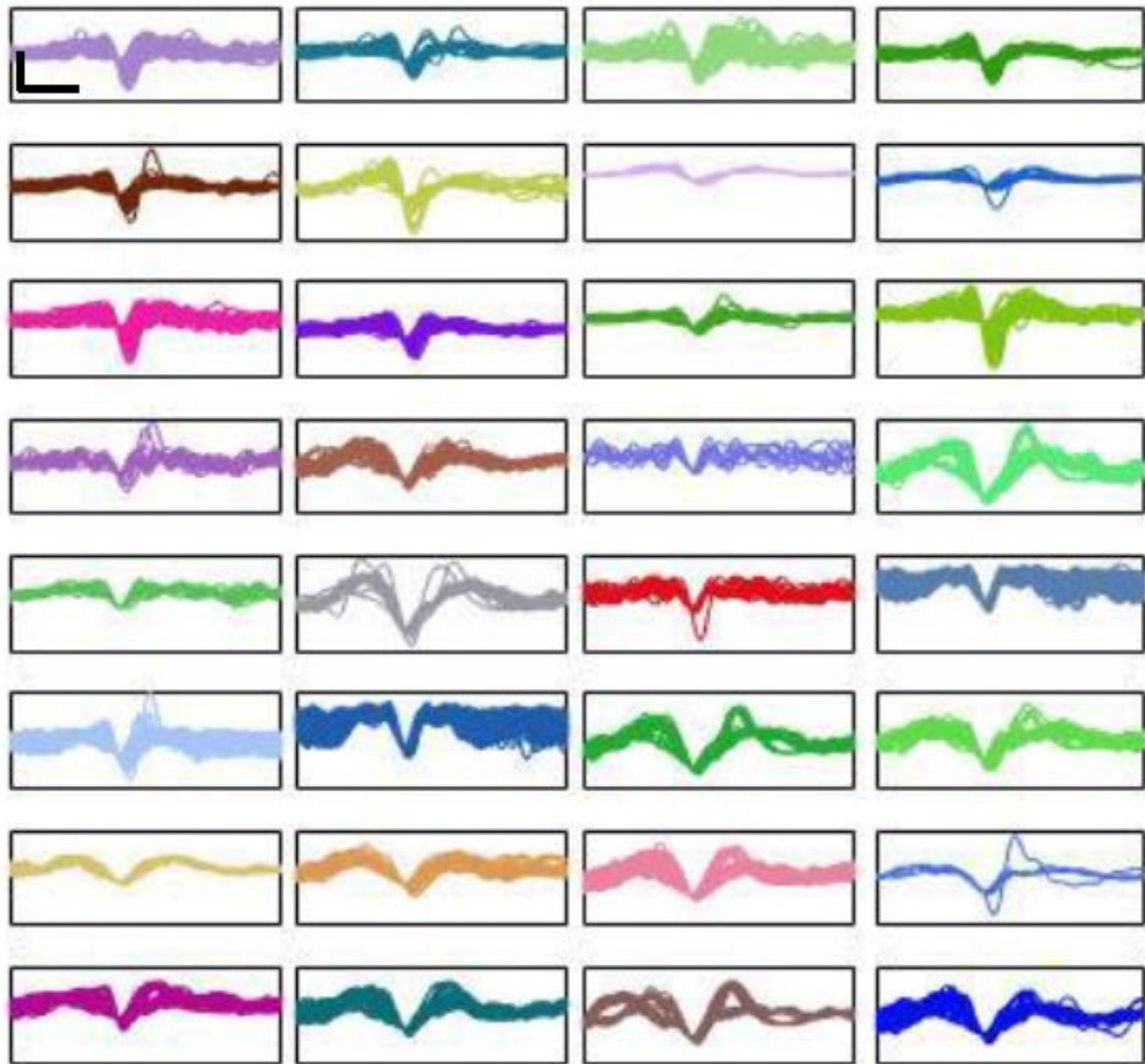
# CMU Arrays

- Nano-particle 3D printing
- Super high density:
- 6400 shanks/cm<sup>2</sup>
- Shanks fully customizable, trace out shapes and depths that you want
- Hollow electrodes for drug delivery while recording
- Cheaper in theory than current options but no price yet





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# Neuropixel probes to look at many brain areas during goal-directed behaviours and choices

- Neuropixel probes
  - Silicon probes for in vivo recordings
  - 70  $\mu\text{m}$  cross-section
  - 960 electrodes along a 10 mm shank
  - 12x12  $\mu\text{m}$  electrodes

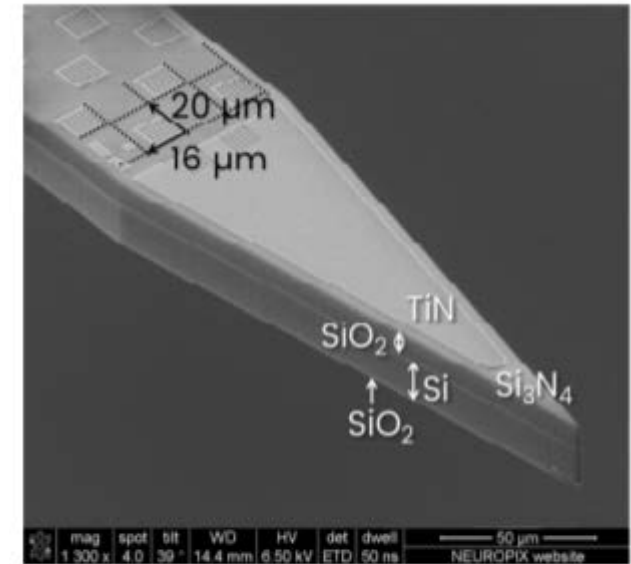
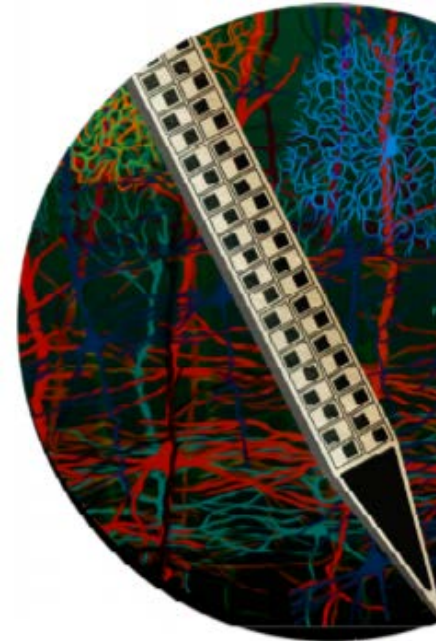
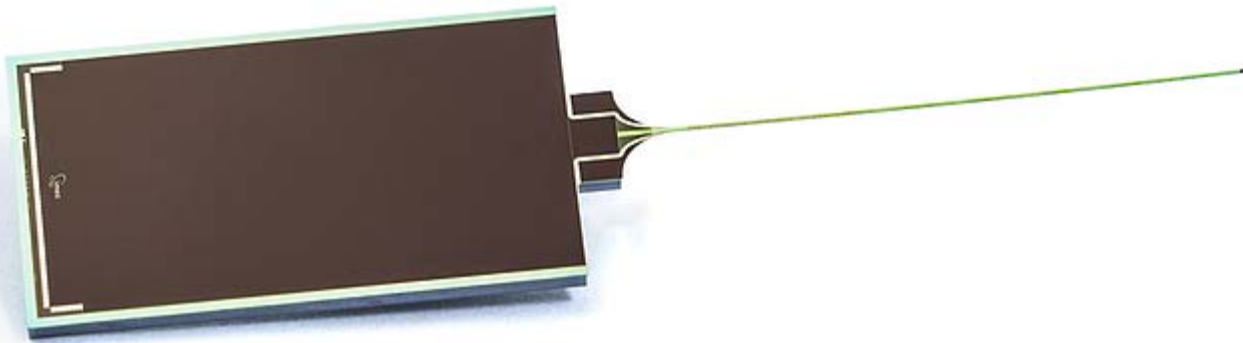
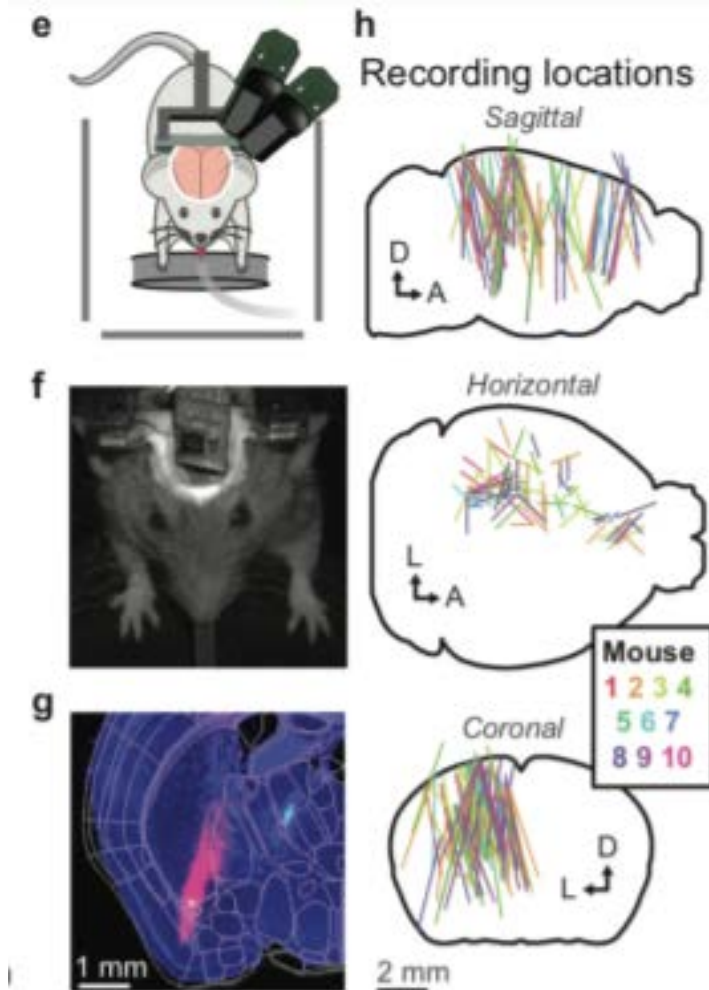
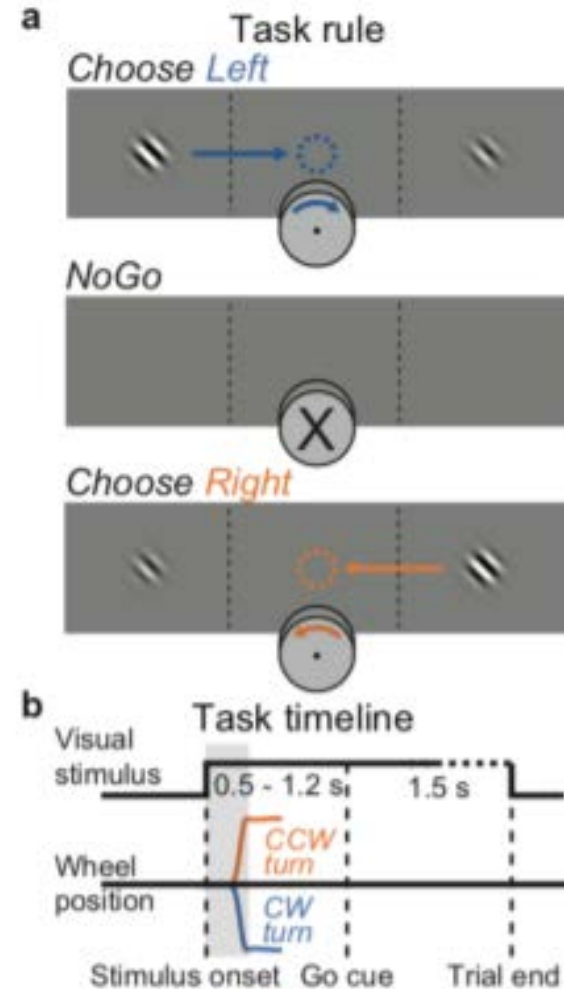


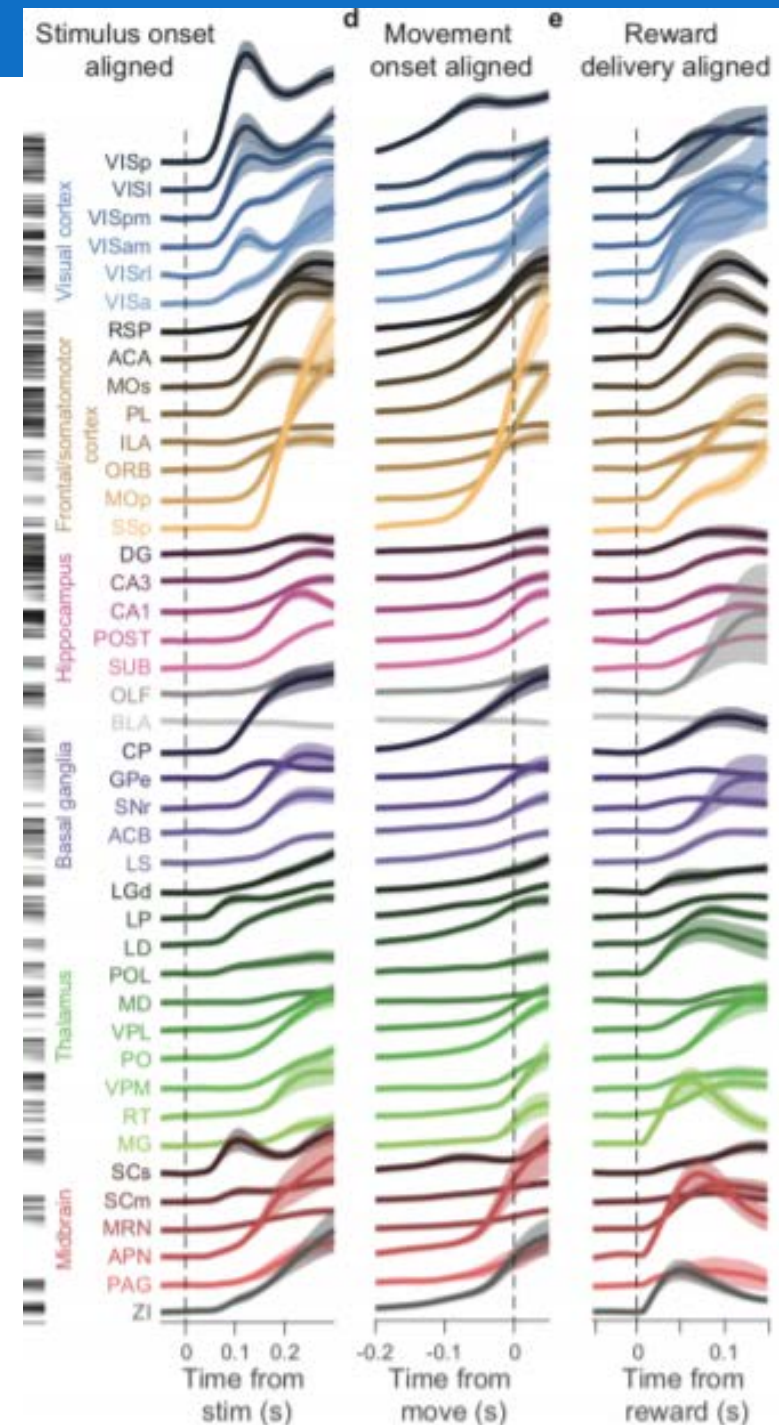
Figure 1: SEM image of the shank tip. Indicated are the electrode pitch and exposed materials.

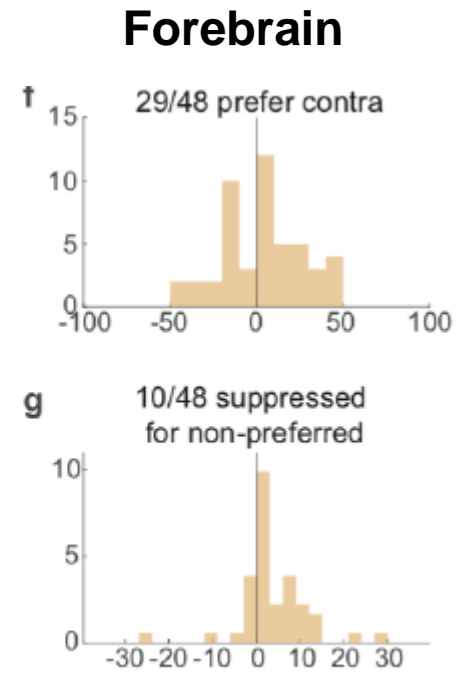
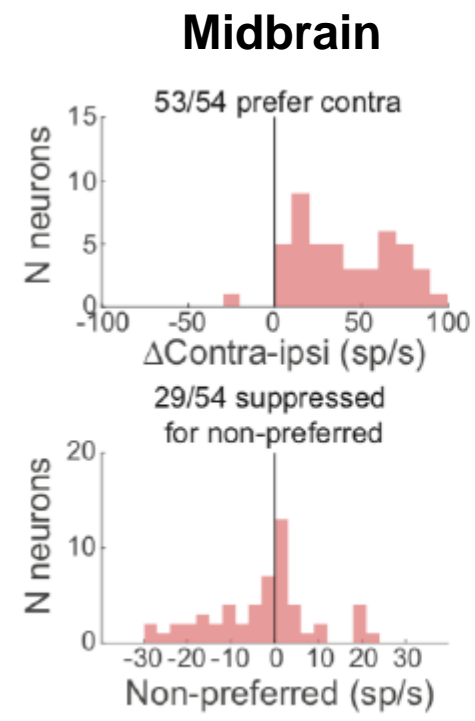
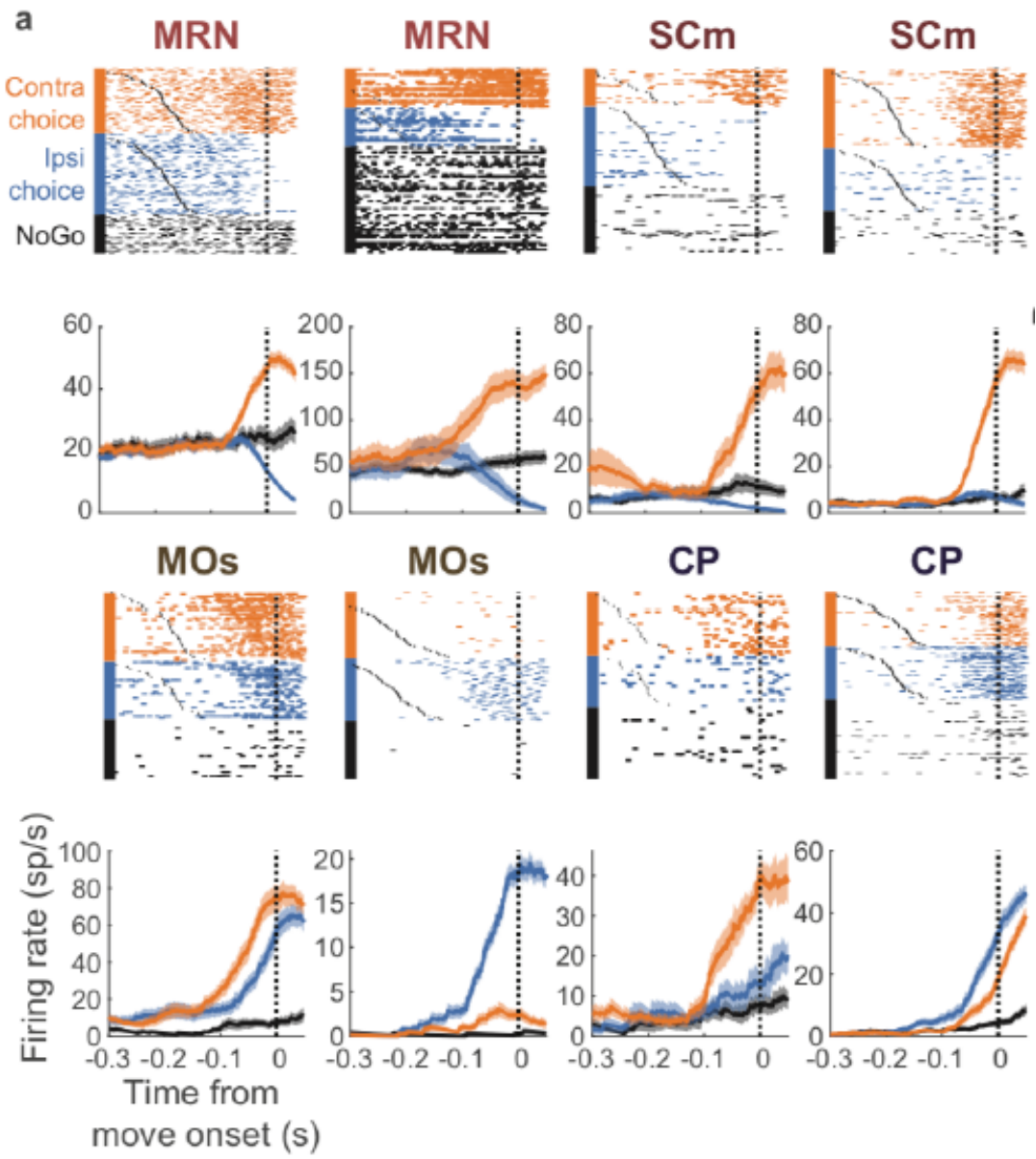
# Neuropixel probes to look at many brain areas during goal-directed behaviours and choices

- Nick Steinmetz BioRxiv 2018 preprint
- Goal-directed behavioural task: visual stimulus cues guided response in animal
  - Access to 30,000; analyzed data from ones that were active (~14,000)
  - 42 brain regions including striatum, thalamus, midbrain areas etc.



- The visual stimuli activate brain regions in the visual pathway
- Movement in a goal directed action activates neurons from most brain regions studied
- A few brain regions were choice dependent
  - Motor cortex and striatum showed neurons preferential for contralateral or ipsilateral choice
  - Midbrain regions usually increased in firing for contralateral choice





# Neuropixel Ultra

- More densely packed sites
- 5x5 um sites with 1 um between sites (compared to 12x12 um sites in original probes)
- Goal is to be able to detect small neurons as well as large neurons

# International Brain Laboratory

**Officially launched on Sept 19th 2017**

Experimental & theoretical neuroscientists collaborating to understand brainwide circuits for complex behavior

*The International Brain Laboratory will release all data sets within 12 months of collection, or upon acceptance for publication of an associated manuscript, whichever comes first.*

*The first public release of our brain-wide electrophysiological activity map, along with behavioral data, is planned for Sept 2020.*