DPZ
Deutsches Primatenzentrum
Leibniz-Institut für Primatenforschung

Opportunities and limitations of neural representations of observed action

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SfN annual meeting

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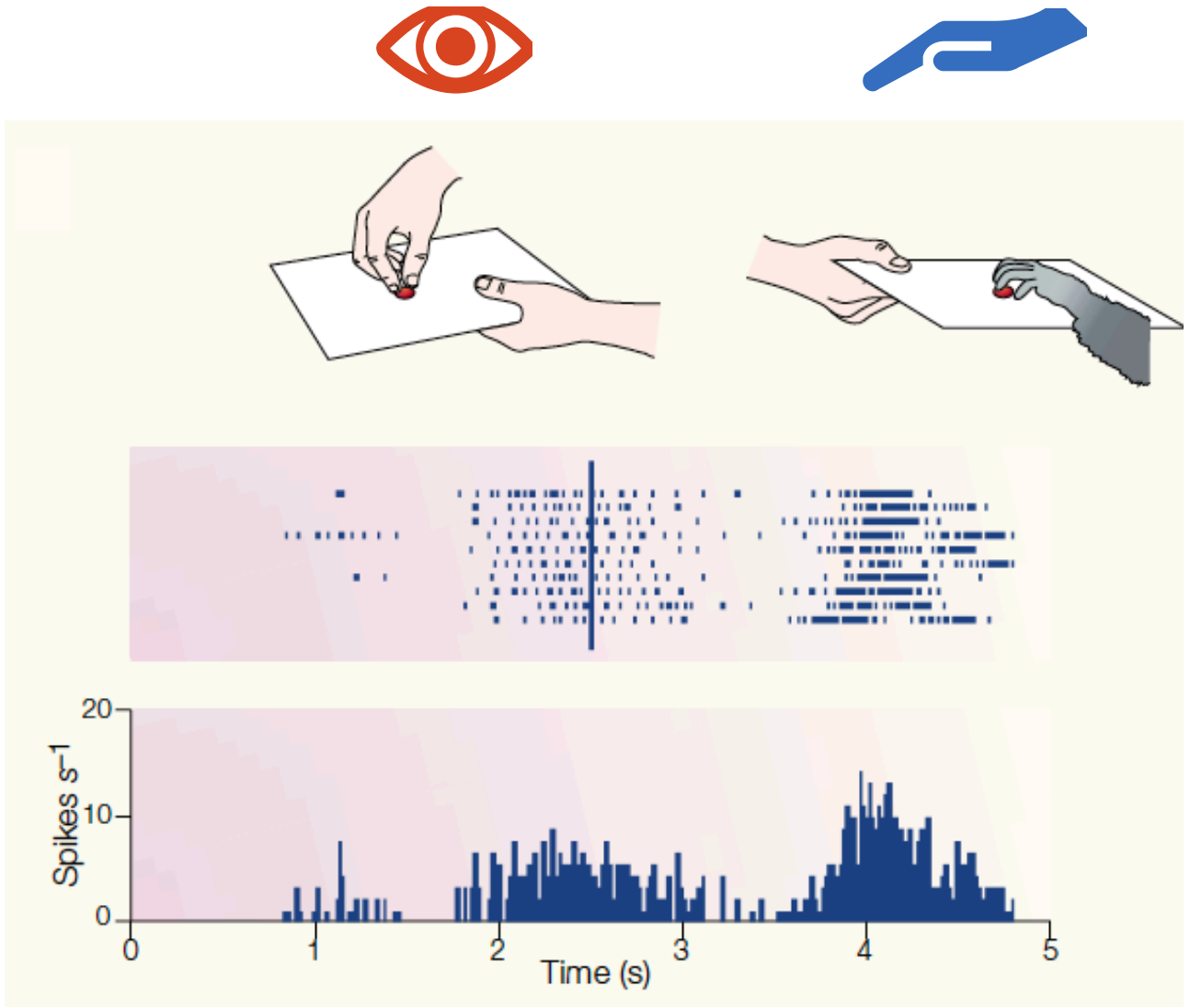
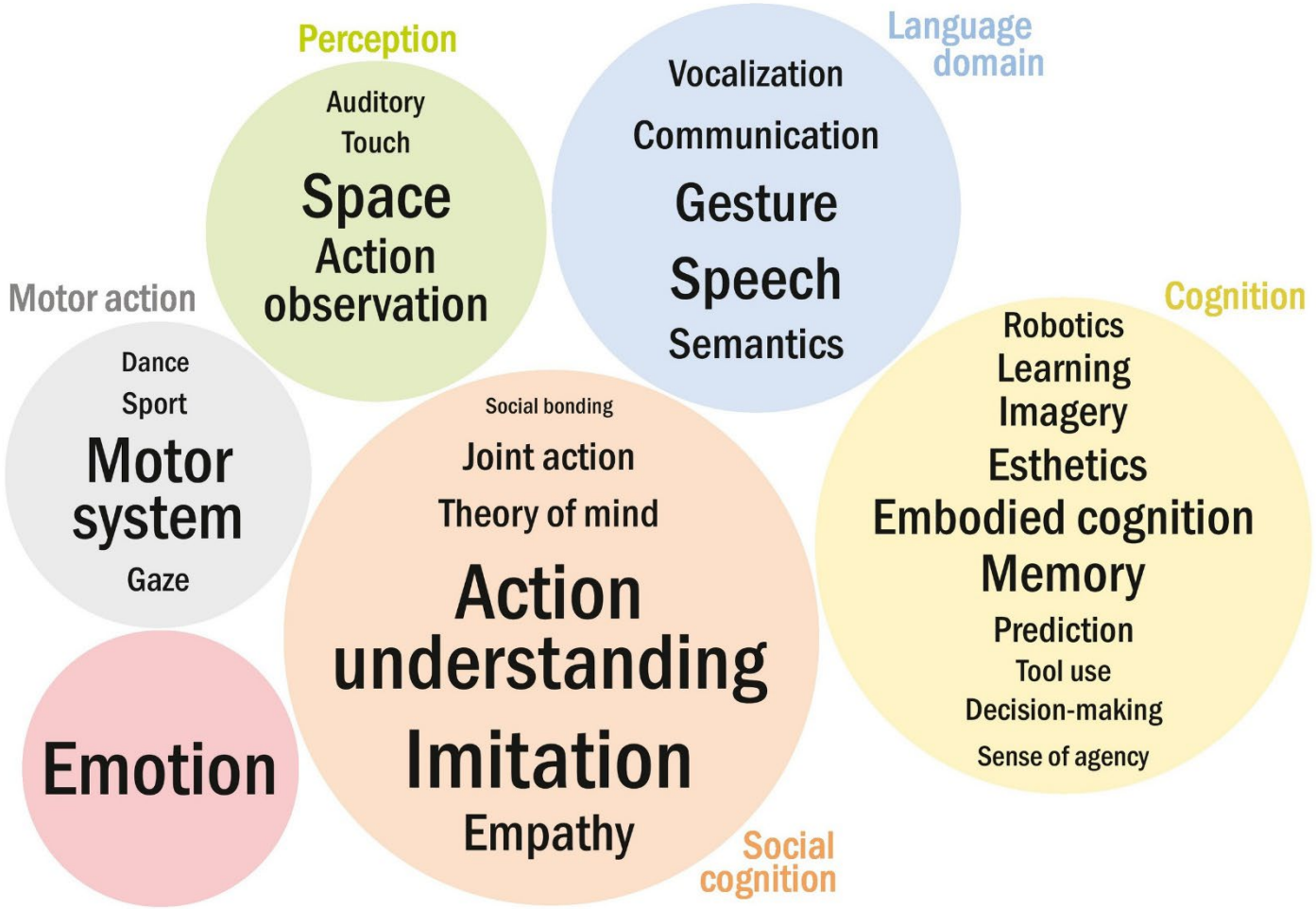
Mitglied der Leibniz-Gemeinschaft

Representations of action execution and observation appear to be linked



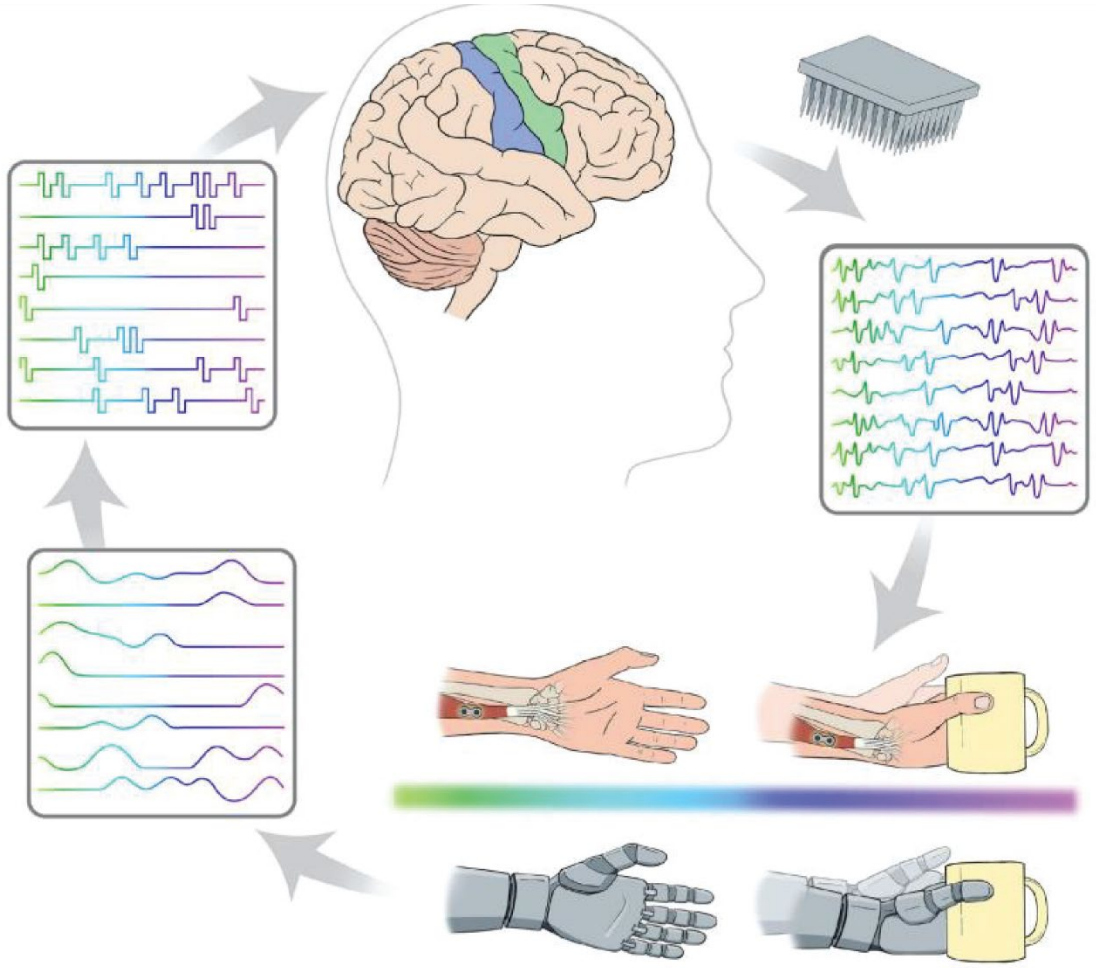
Rizzolatti et al. 2001 Nat. Rev. Neuro

Mirror neuron activity has many hypothesized roles



Bonini et al. 2022 TiCS

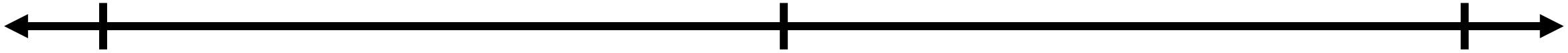
Activity during observation influences BCI decoders



Pandarinath & Bensmaia 2022

Are there fine or coarse representations of observed movements?

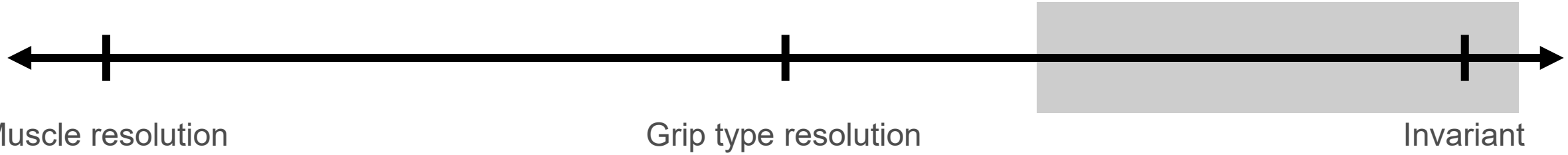
Hypothesis space:



Muscle resolution — Grip type resolution — Invariant

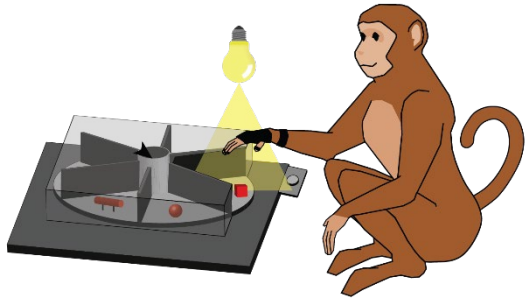
Are there fine or coarse representations of observed movements?

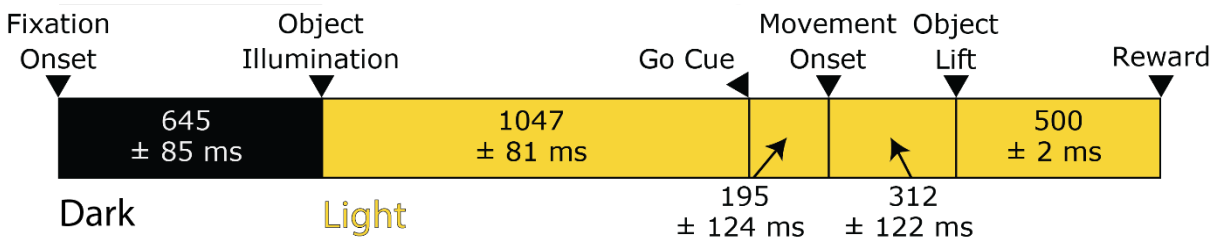
Hypothesis space:



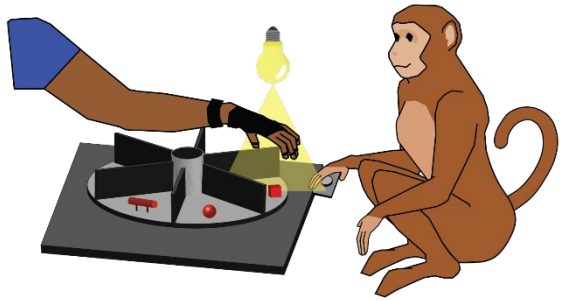
Turntable experiment samples a wide variety of grips

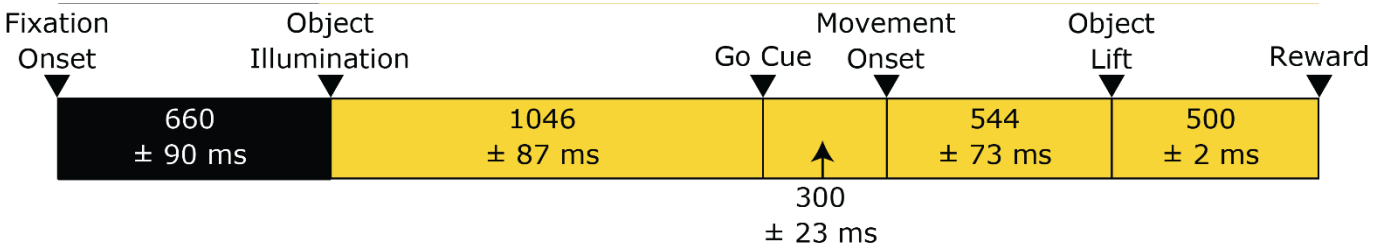
VGG

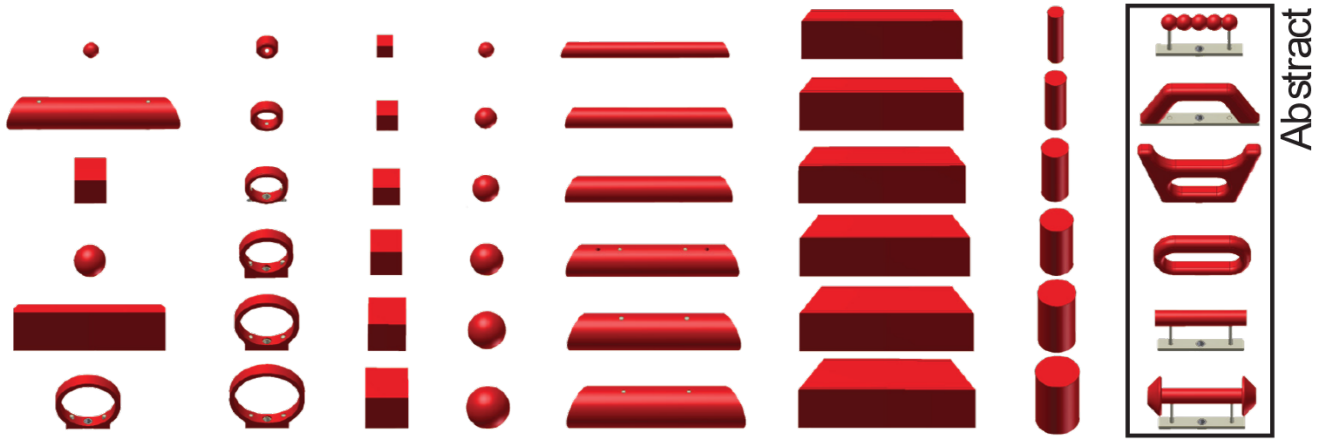




Obs.







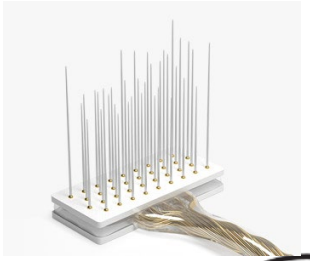
Turntable methodology:

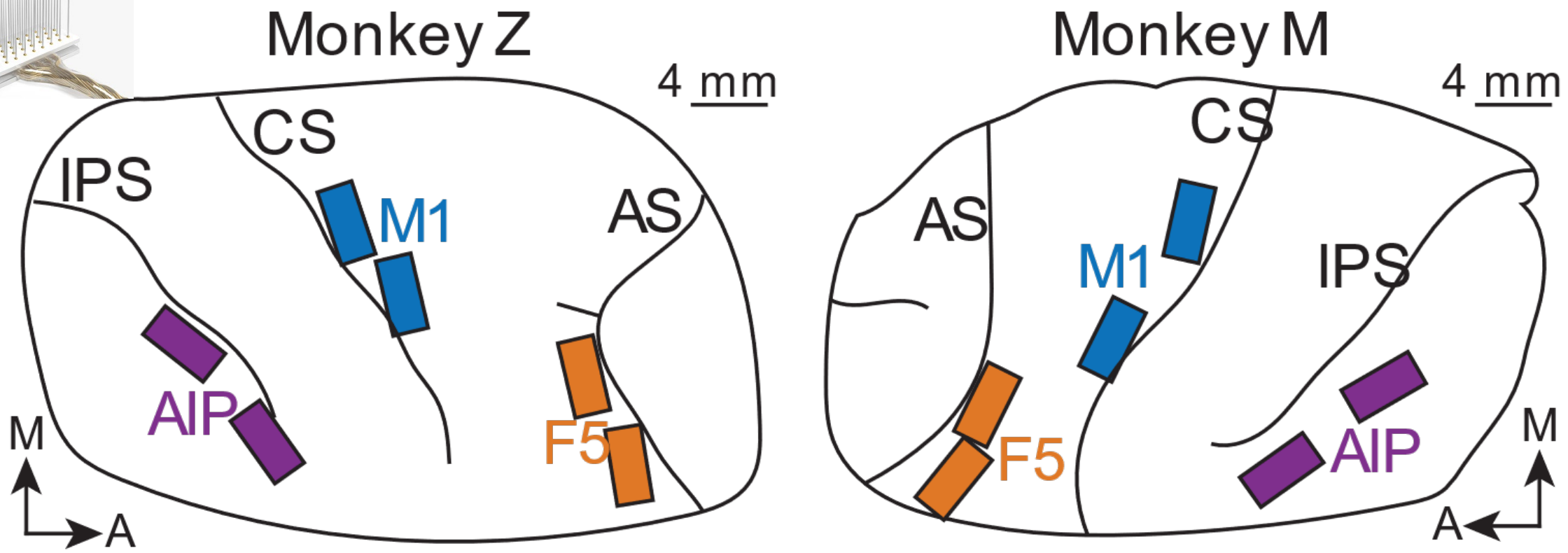
Schaffelhofer & Scherberger 2012 *JNE*

Schaffelhofer et al. 2015 *J Neurosci*

Schaffelhofer & Scherberger 2016 *eLife*

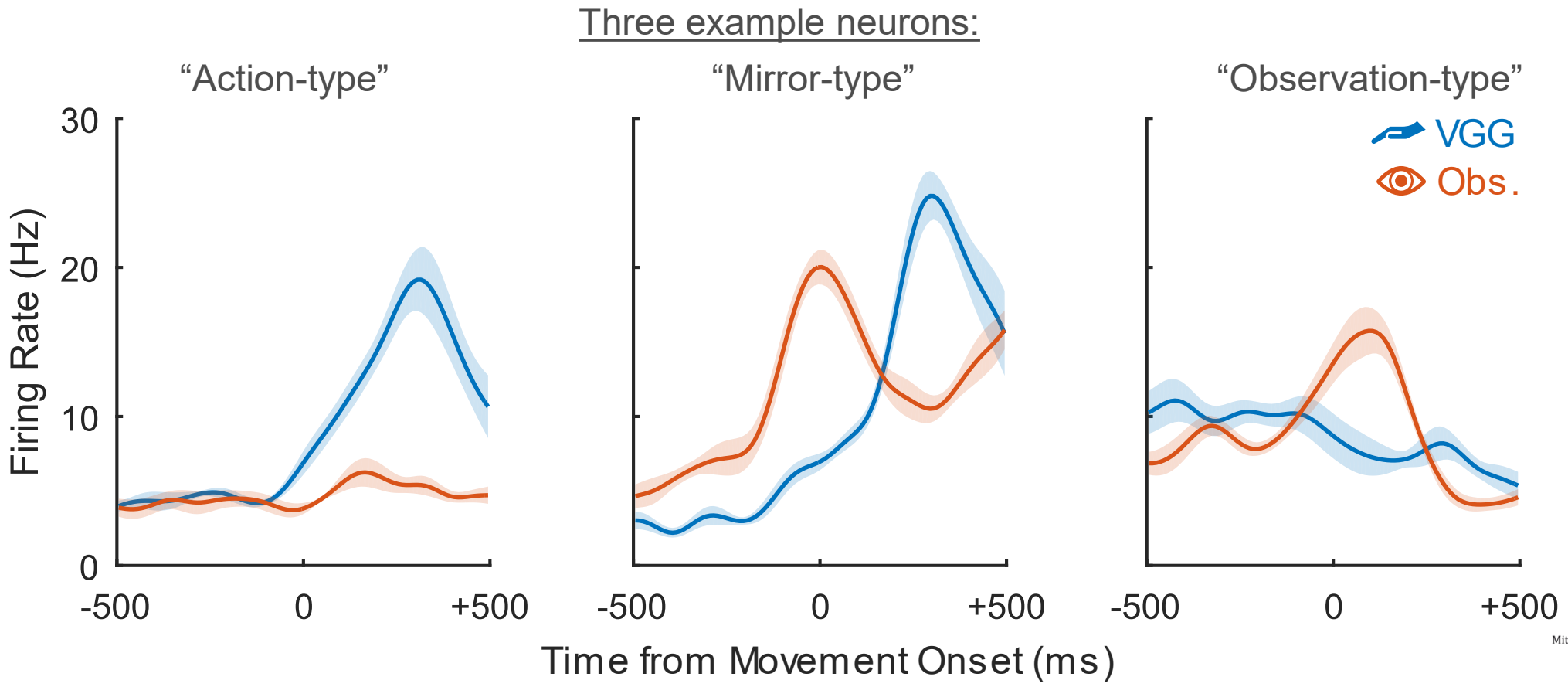
Floating microelectrode array (FMA) implants record populations from the three main areas in the grasping network



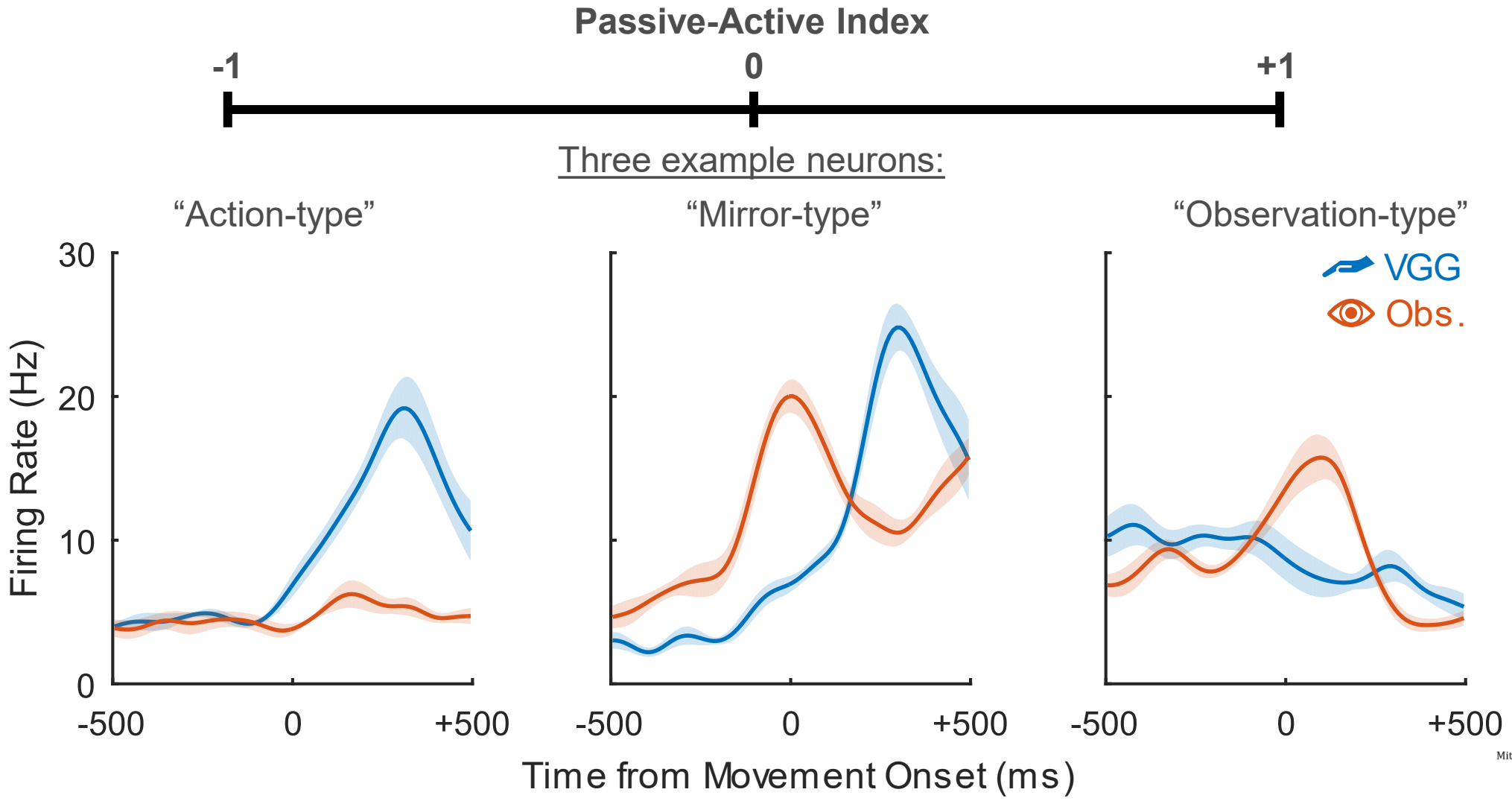


IPS: Intraparietal sulcus
CS: Central sulcus
AS: Arcuate sulcus
M1: Primary motor cortex
F5: Rostroventral premotor cortex
AIP: Anterior intraparietal area
M: Medial
A: Anterior

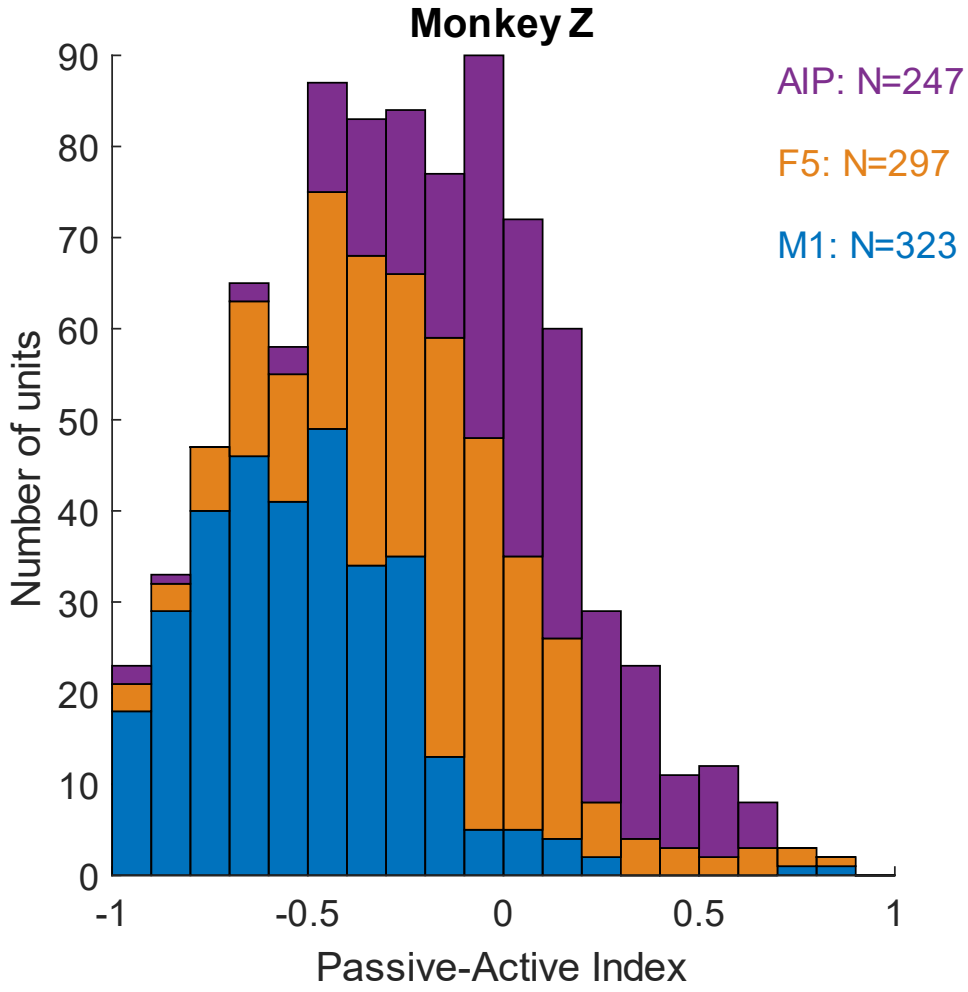
A continuum of preference for observed action emerges

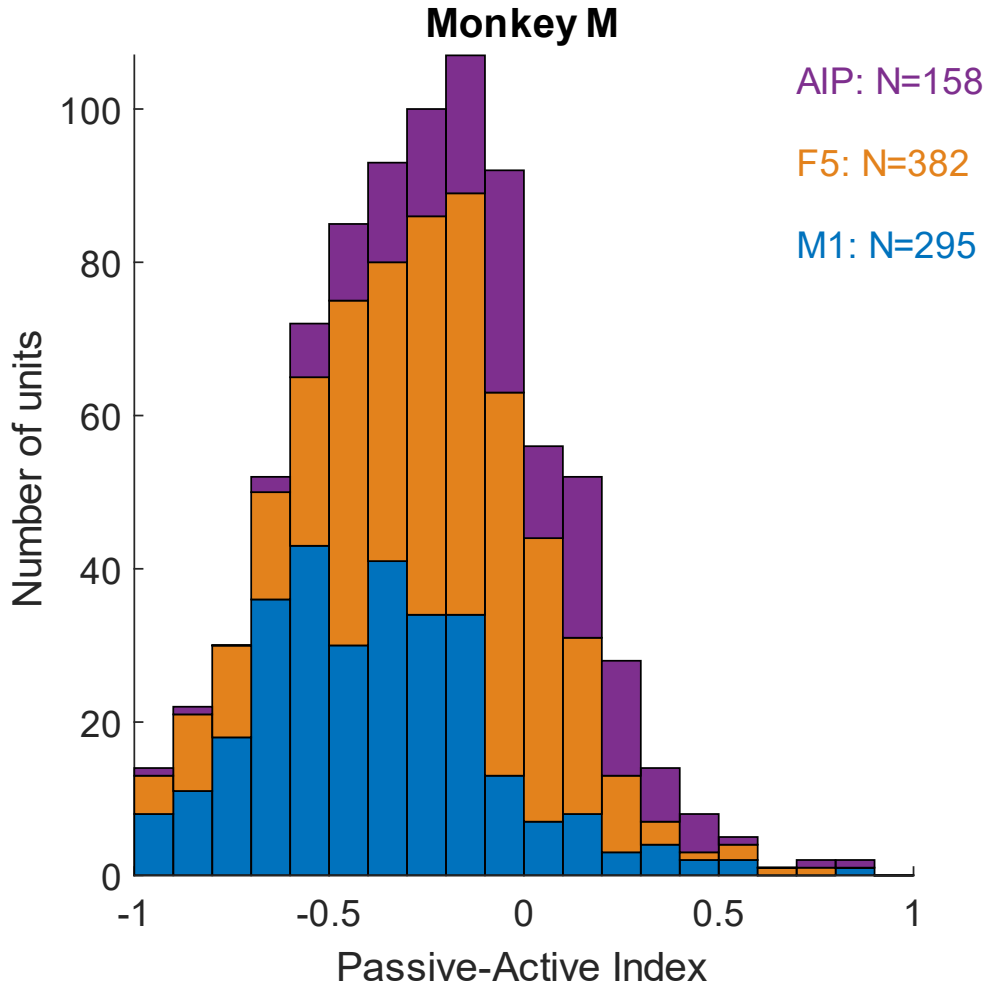


A continuum of preference for observed action emerges

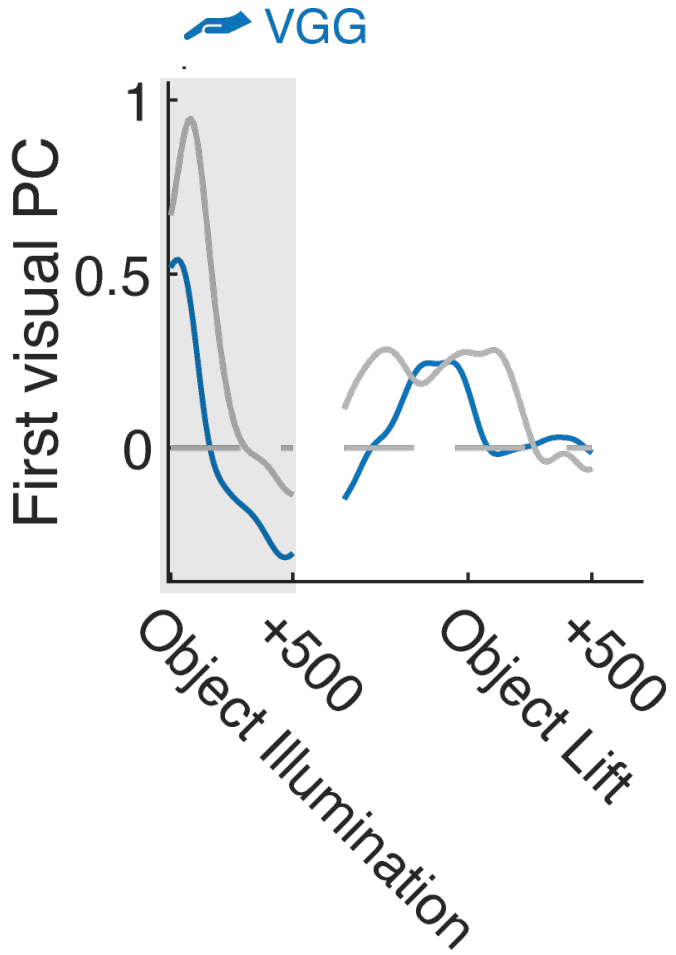


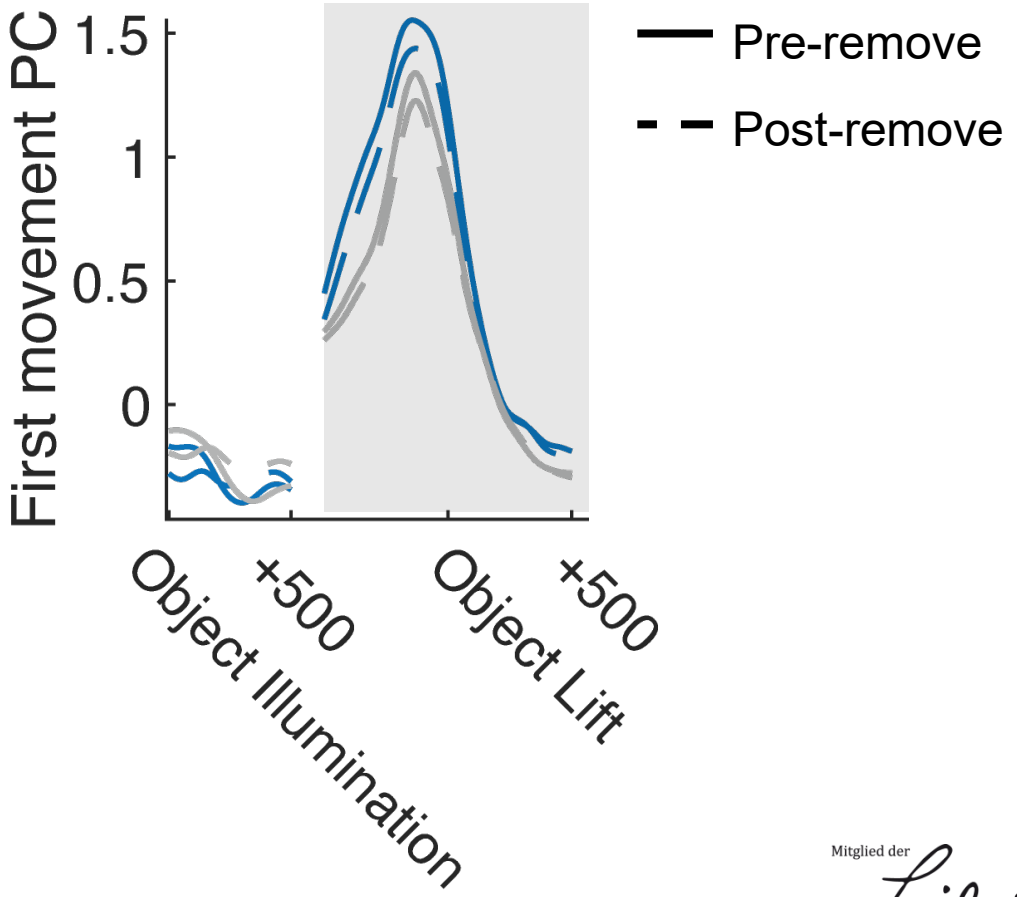
An observation-preferring neuron class does not emerge





Activity related to object vision confounds many analyses, but can be surgically removed



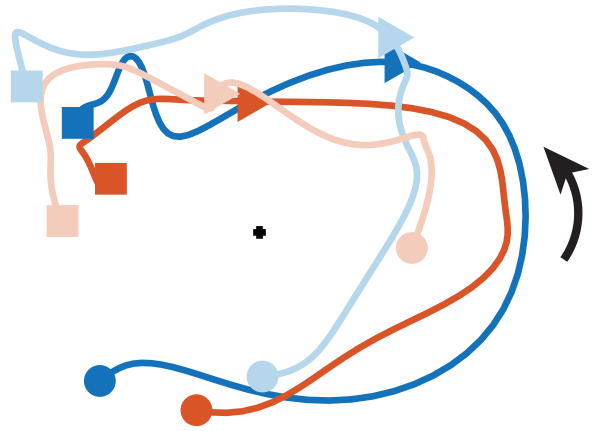


Shared population activity is substantial, but invariant to grip

VGG
Obs.

Ring 60 mm
Ring 10 mm

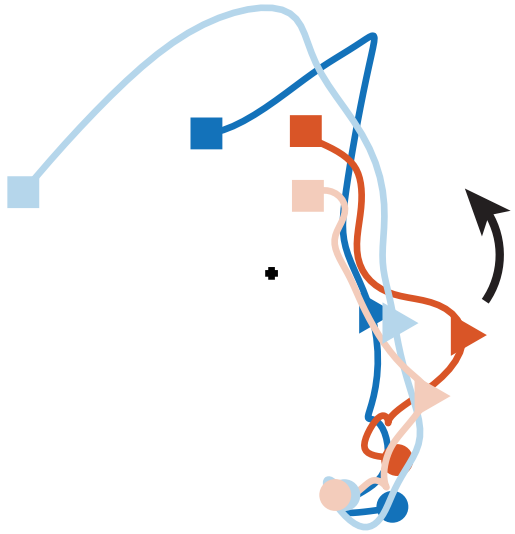
Monkey Z



18% variance capture

Ring 10 mm
Cube 20 mm

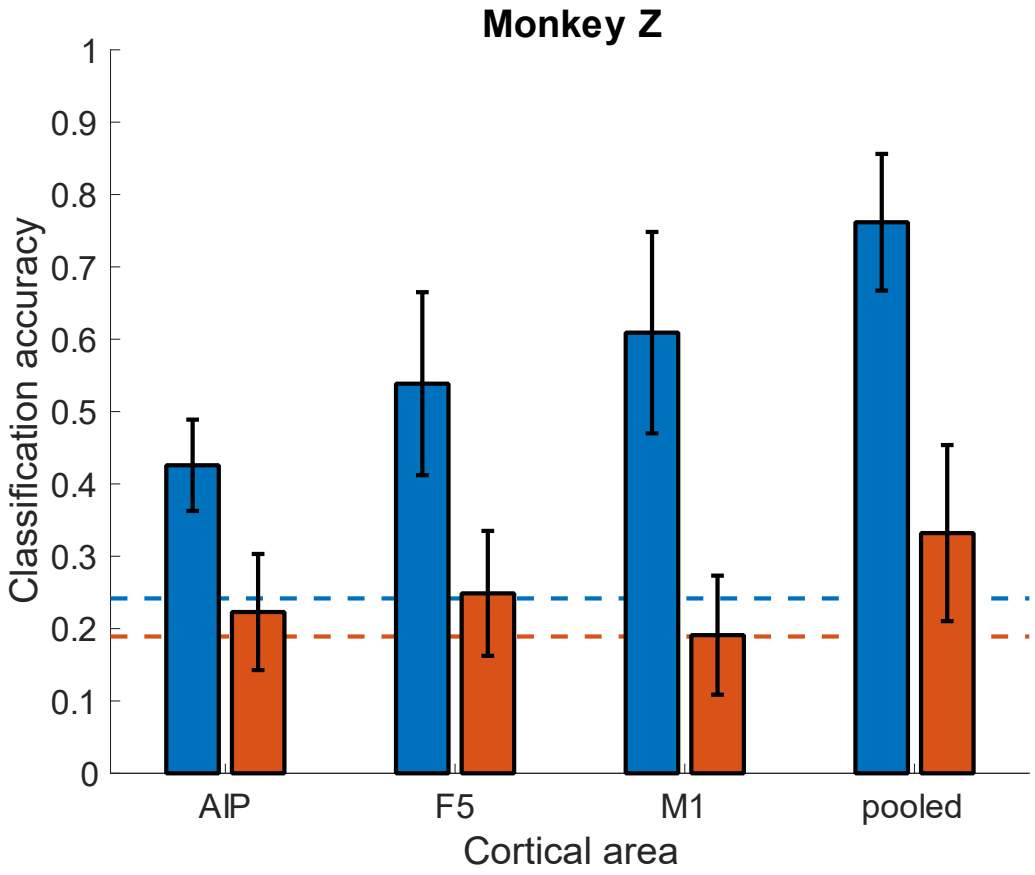
Monkey M

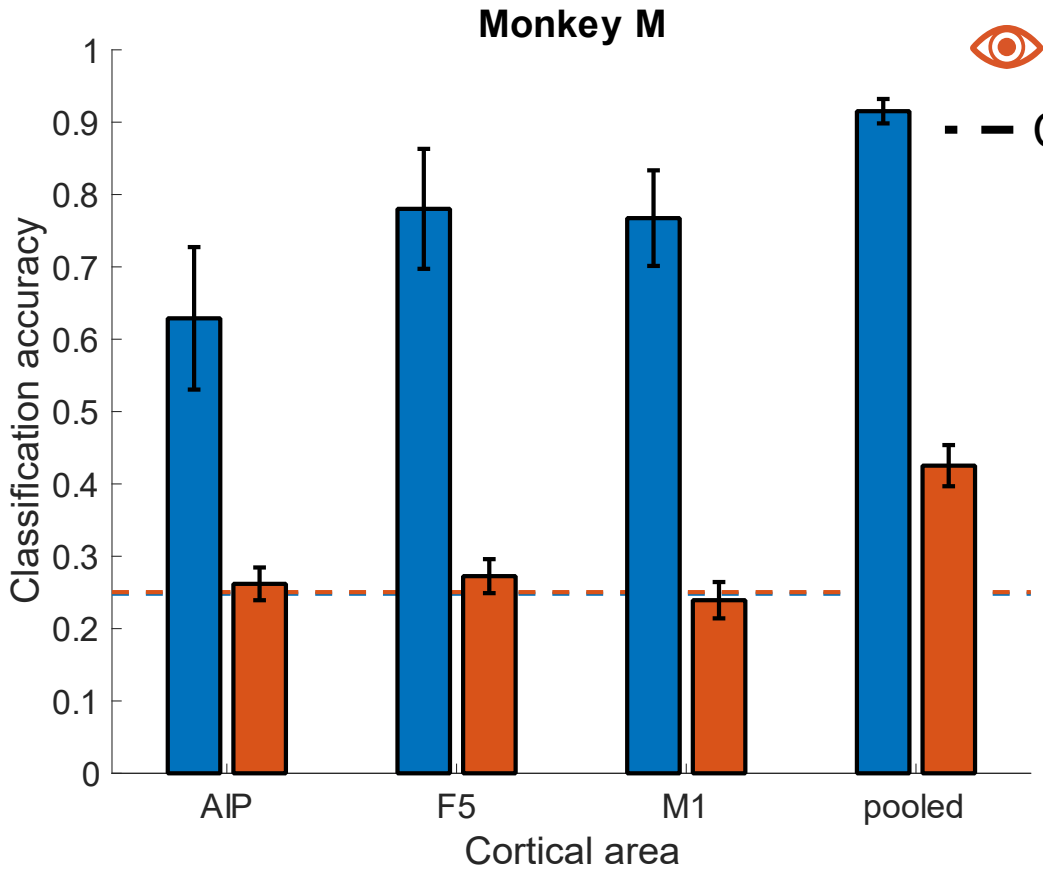


13% variance capture

-500 ms Movement onset +500 ms

Representation of observed grips is weaker than expected





VGG
Obs.
Chance

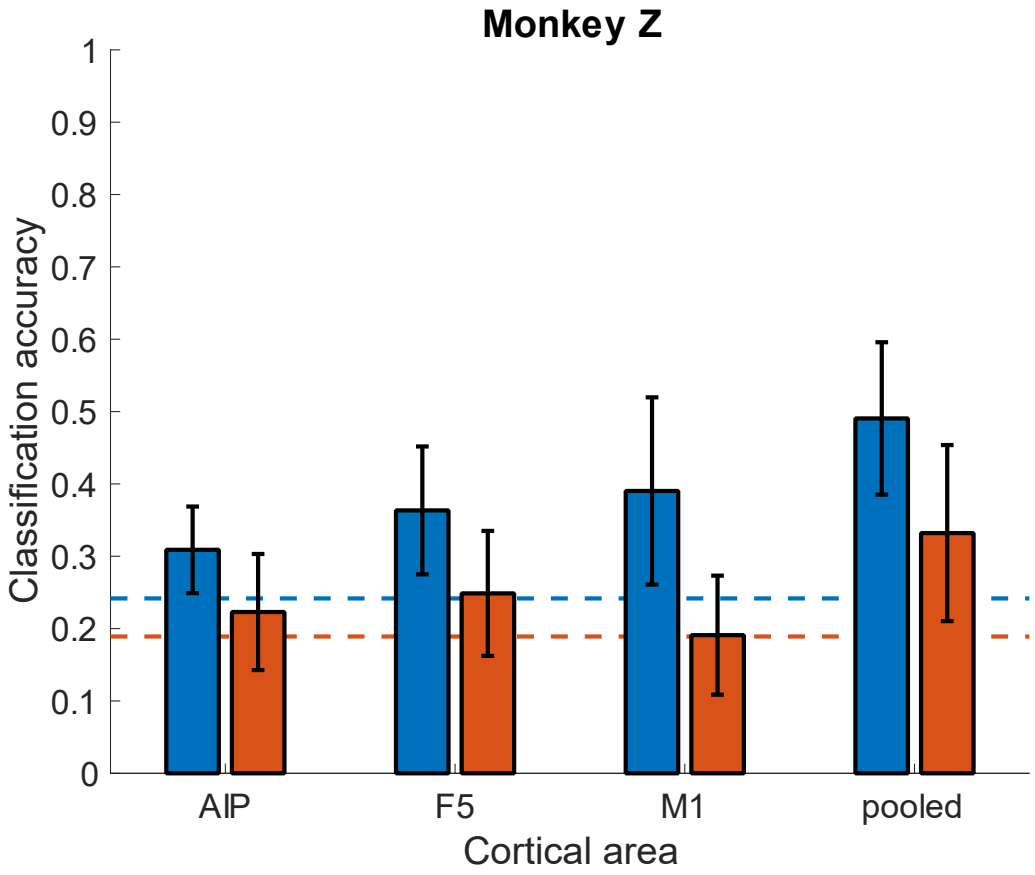
Representation of observed grips is weaker than expected

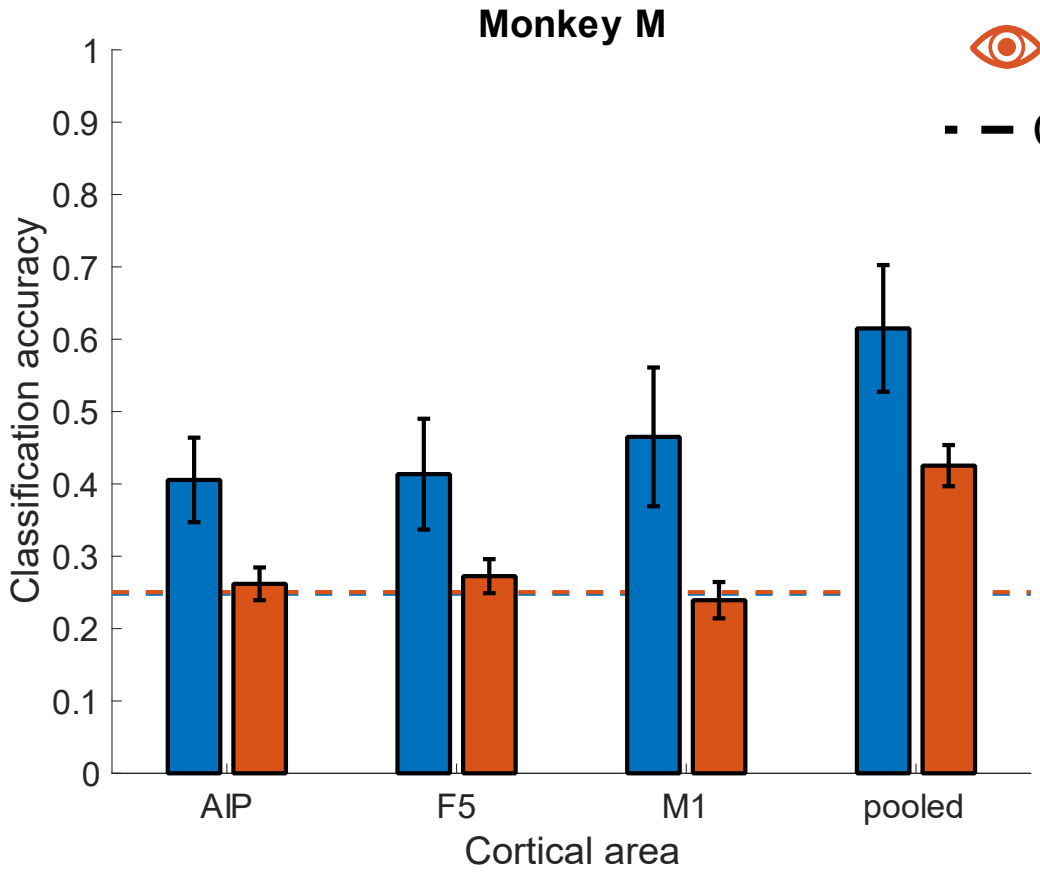
(10% subsample)

VGG

Obs.

Chance





Summary & Conclusions

- There is a substantial activity pattern in F5 and AIP shared between action execution and observation contexts
- This shared activity is not grip-specific
- Observation-related activity is less grip-selective than predicted by classical hypotheses about the prevalence of congruent mirror neurons
- This implies distinct representations for action execution and fine-resolution action understanding
- In a BCI context, the helpful training signal is almost certainly explicit rehearsal, rather than resonant activation triggered by pure observation

Acknowledgments

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