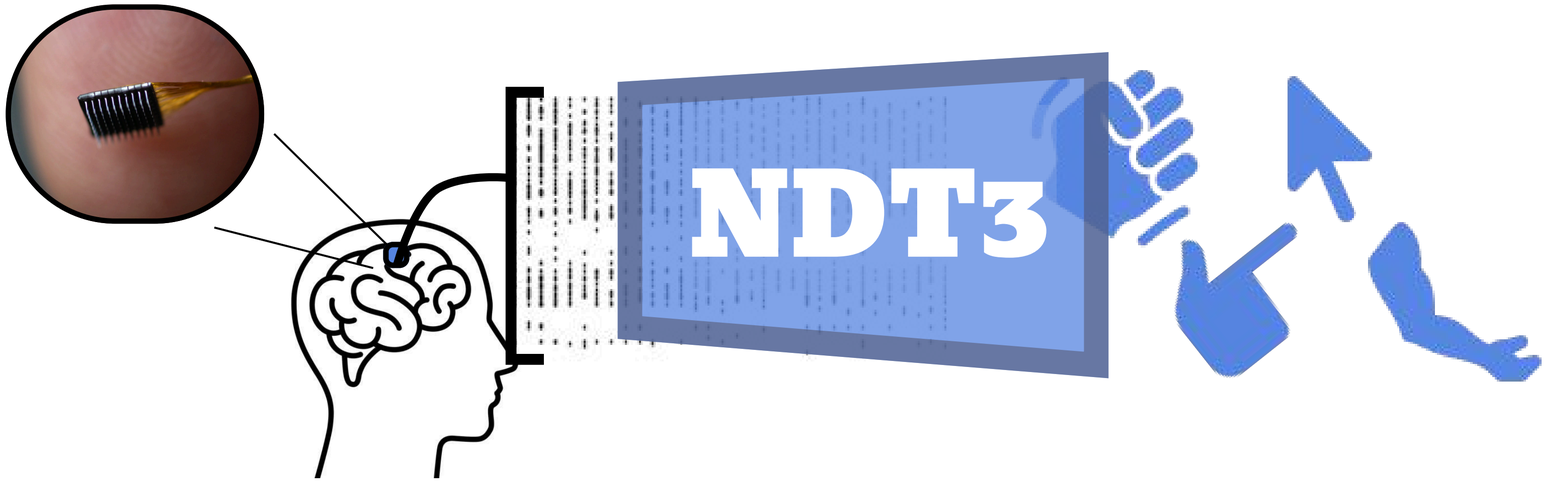
A generalist intracortical motor decoder



The Team

Joel Ye
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Xuan Ma
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Raeed Chowdhury
Dalton Moore
Gary Blumenthal
William Hockeimer
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J. Patrick Mayo
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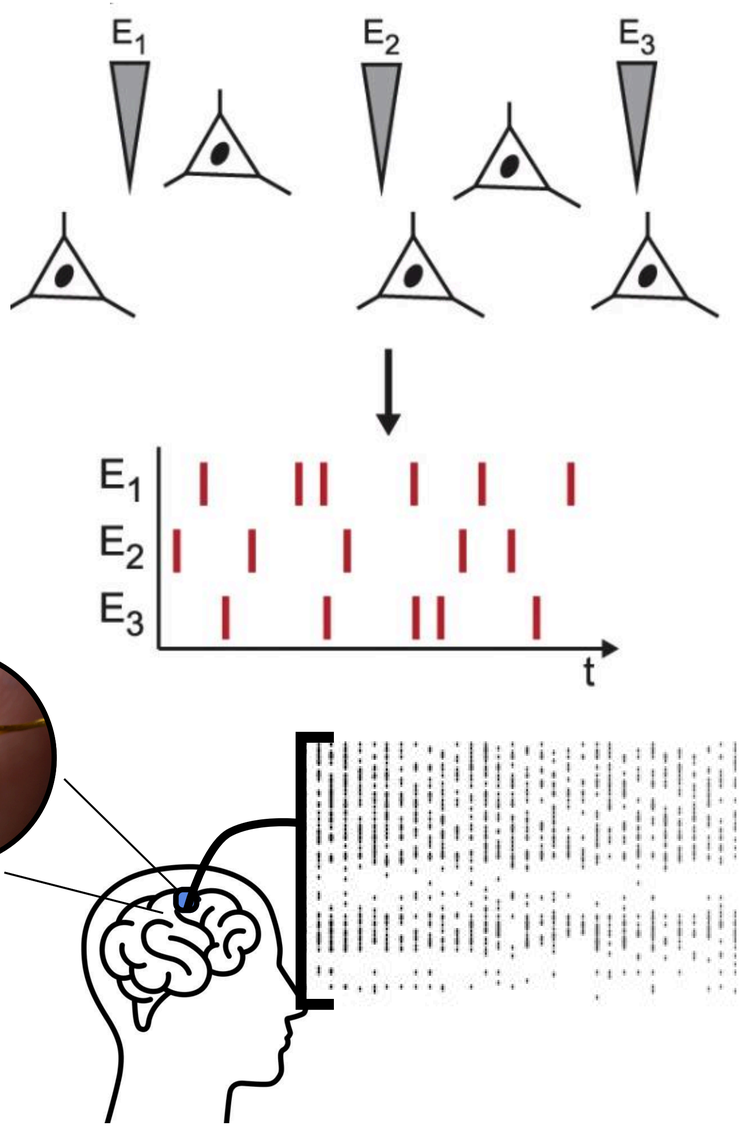
Aaron Batista
Steven Chase
Charles Greenspon
Lee E. Miller
Nicholas Hatsopoulos
Andrew Schwartz
Jennifer L. Collinger
Leila Wehbe
Robert A. Gaunt

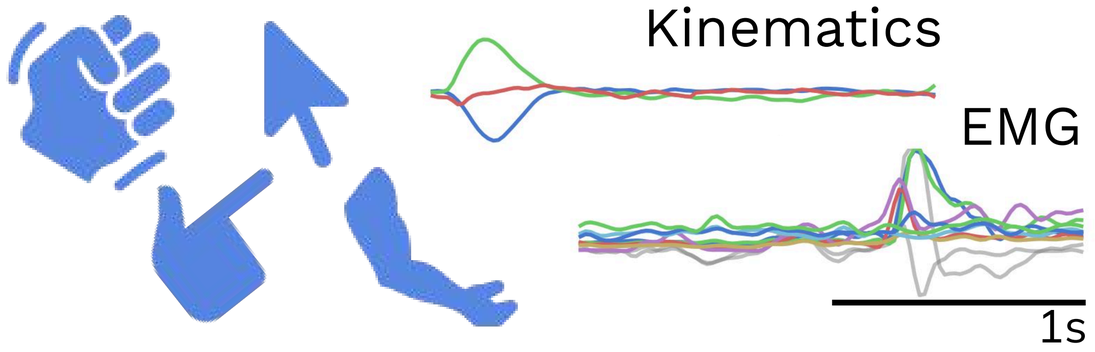


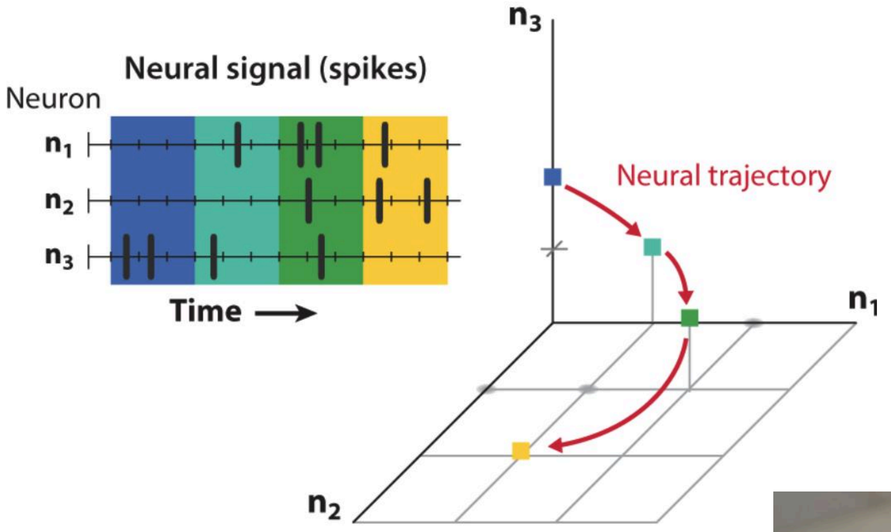
There are many datasets of

Neural Activity

+

Behavior

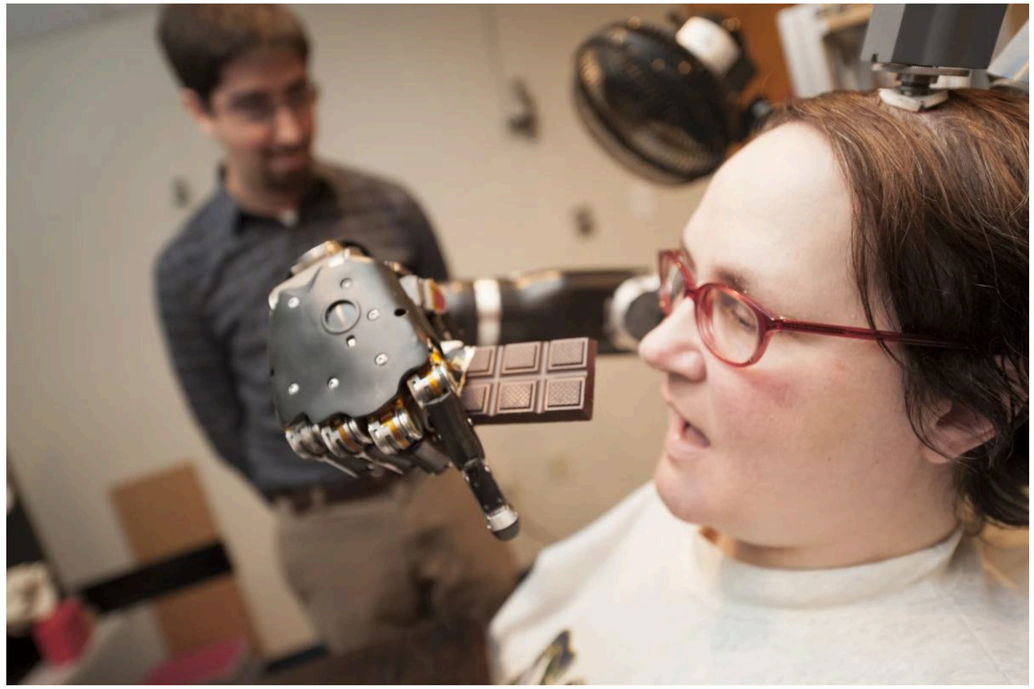




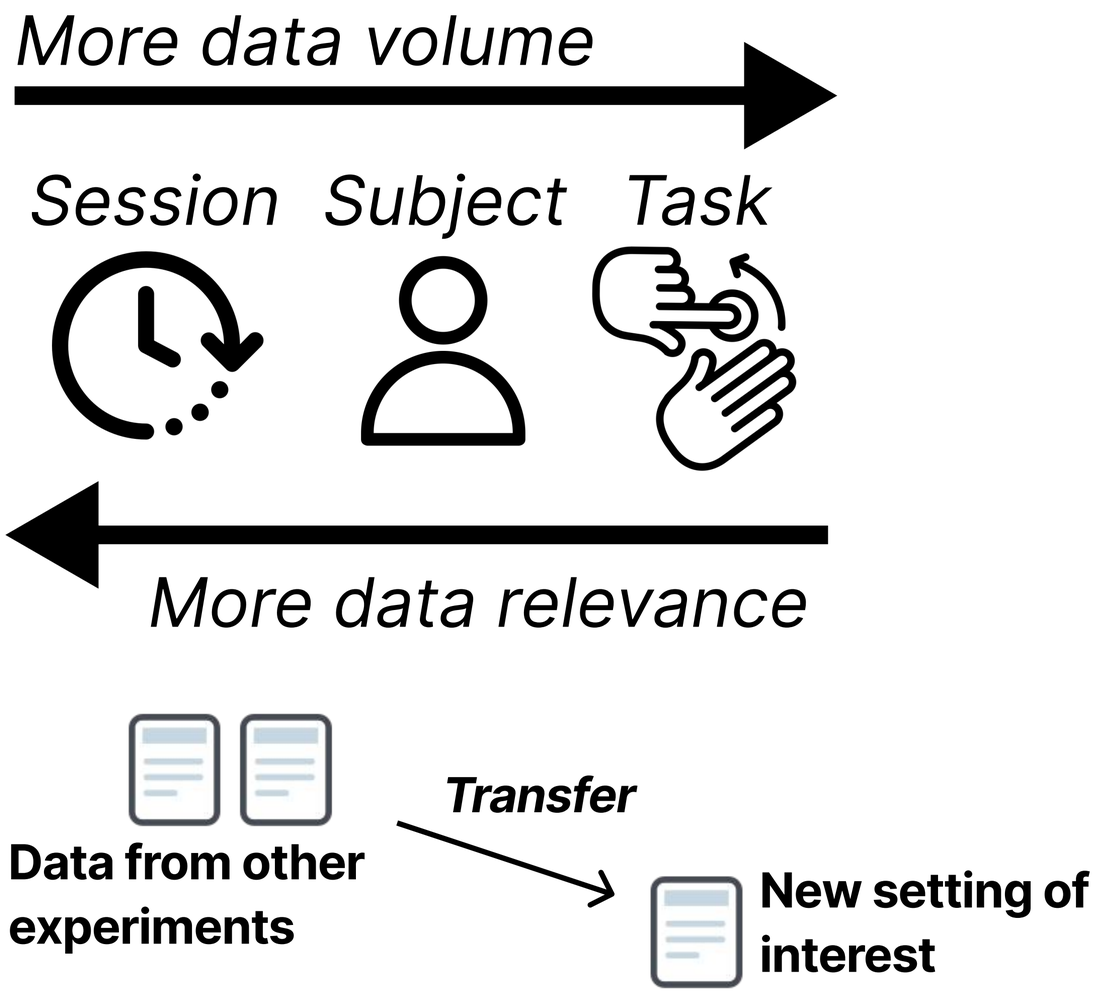
Neural Activity

can be related to

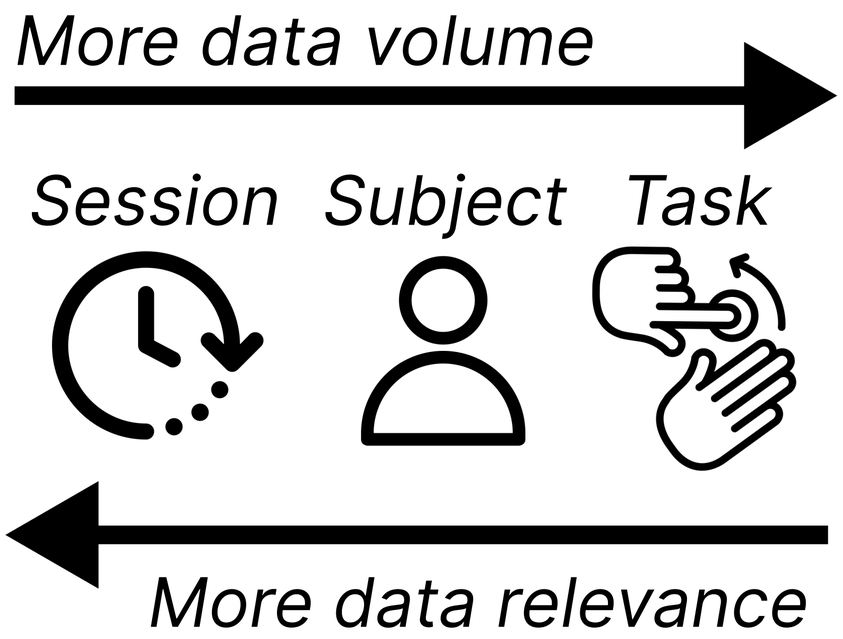
Behavior



Vyas 20
Collinger 13

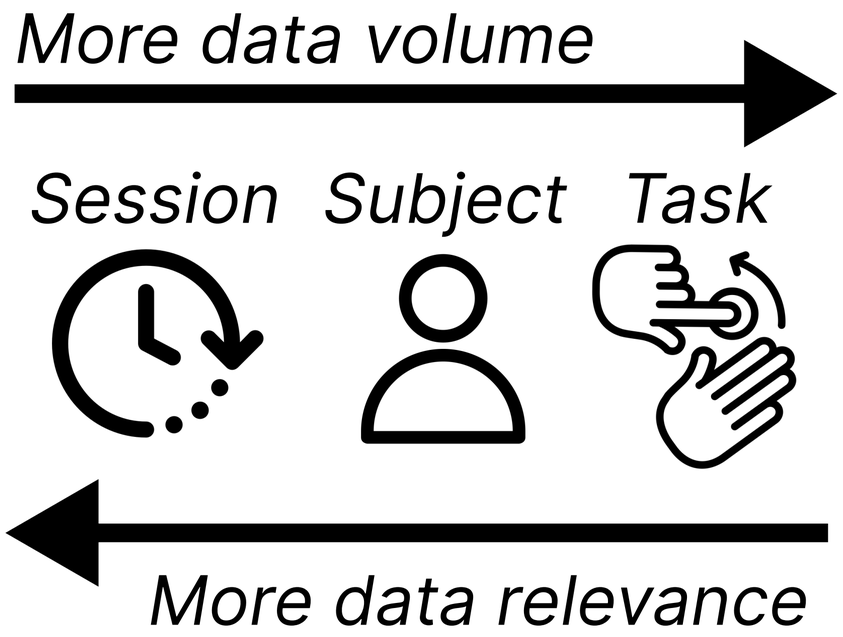


Gallego 18
Gallego 20
Safaie 23



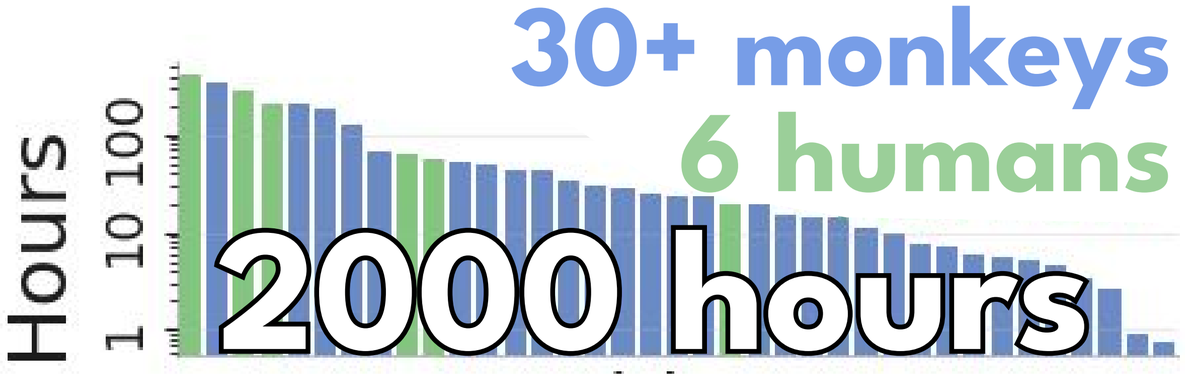
Foundation model?

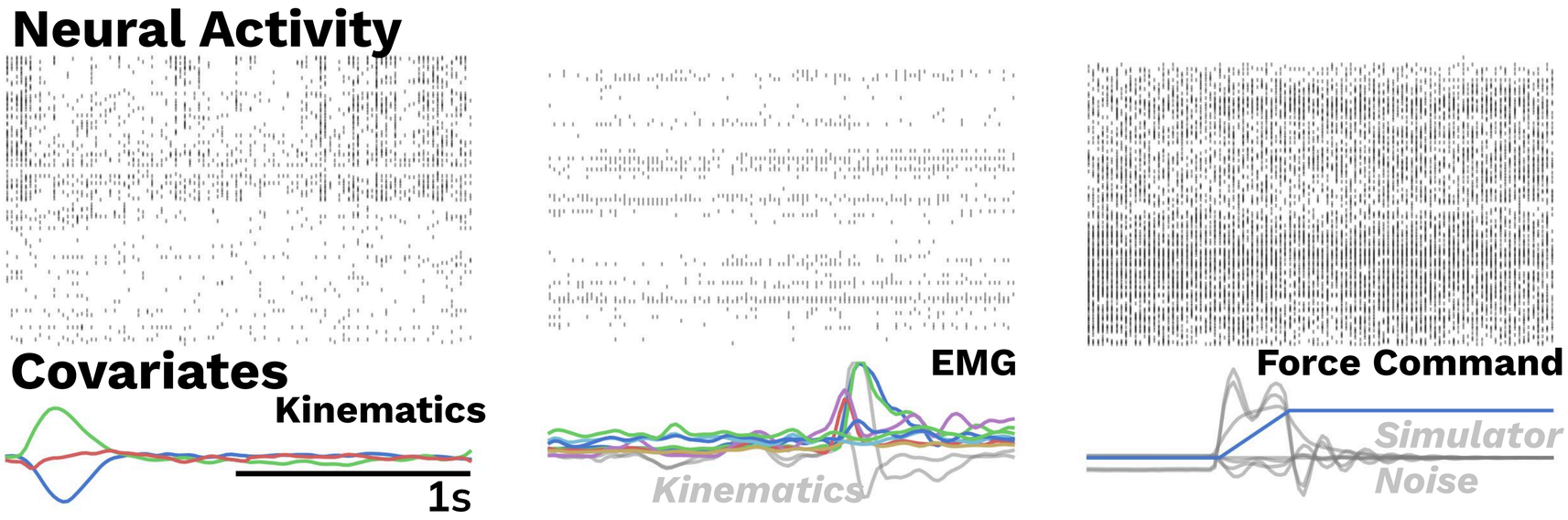
Gallego 18
Gallego 20
Safaie 23

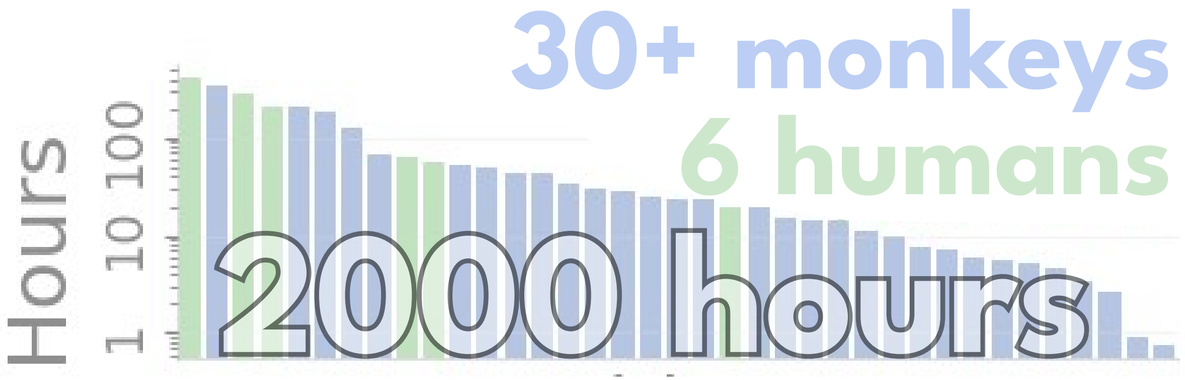


Neural Data Transformer 3 (NDT3)

Gallego 18
Gallego 20
Safaie 23


30+ monkeys
6 humans
2000 hours
Hours
1
10
100


Neural Activity
Covariates
Kinematics
1s
EMG
Kinematics
Force Command
Simulator
Noise


30+ monkeys
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2000 hours
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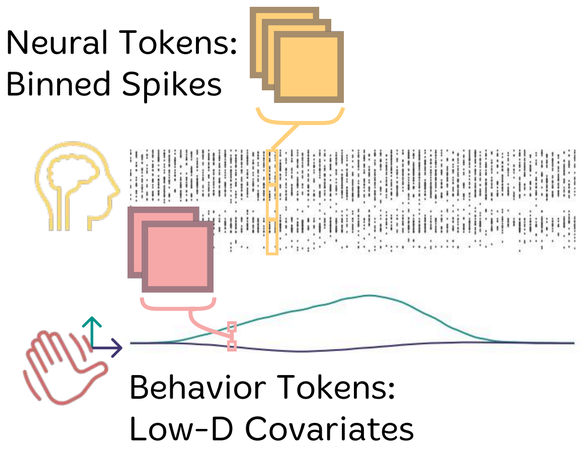
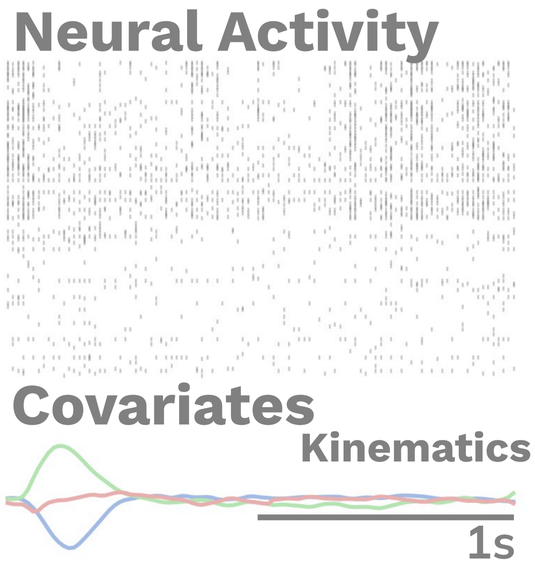
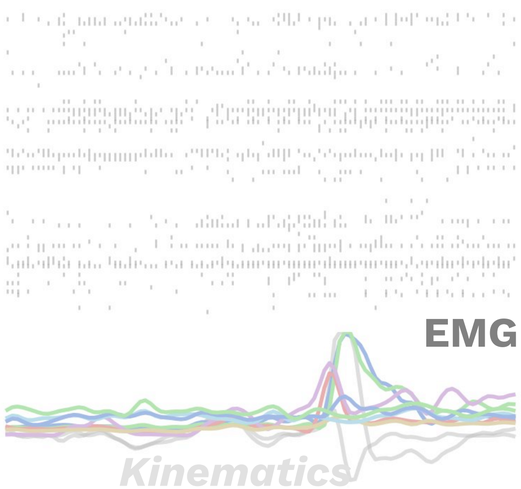
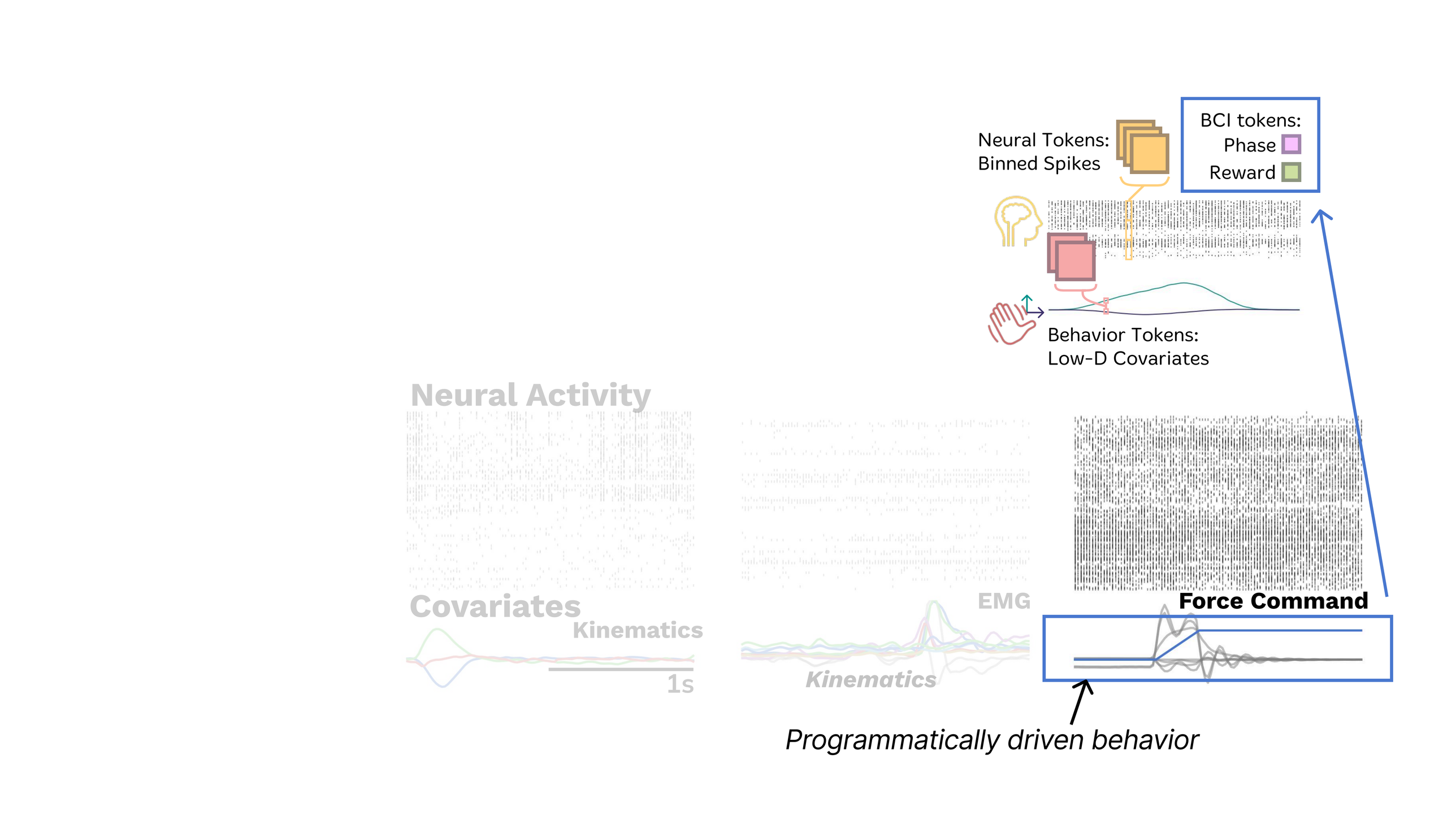
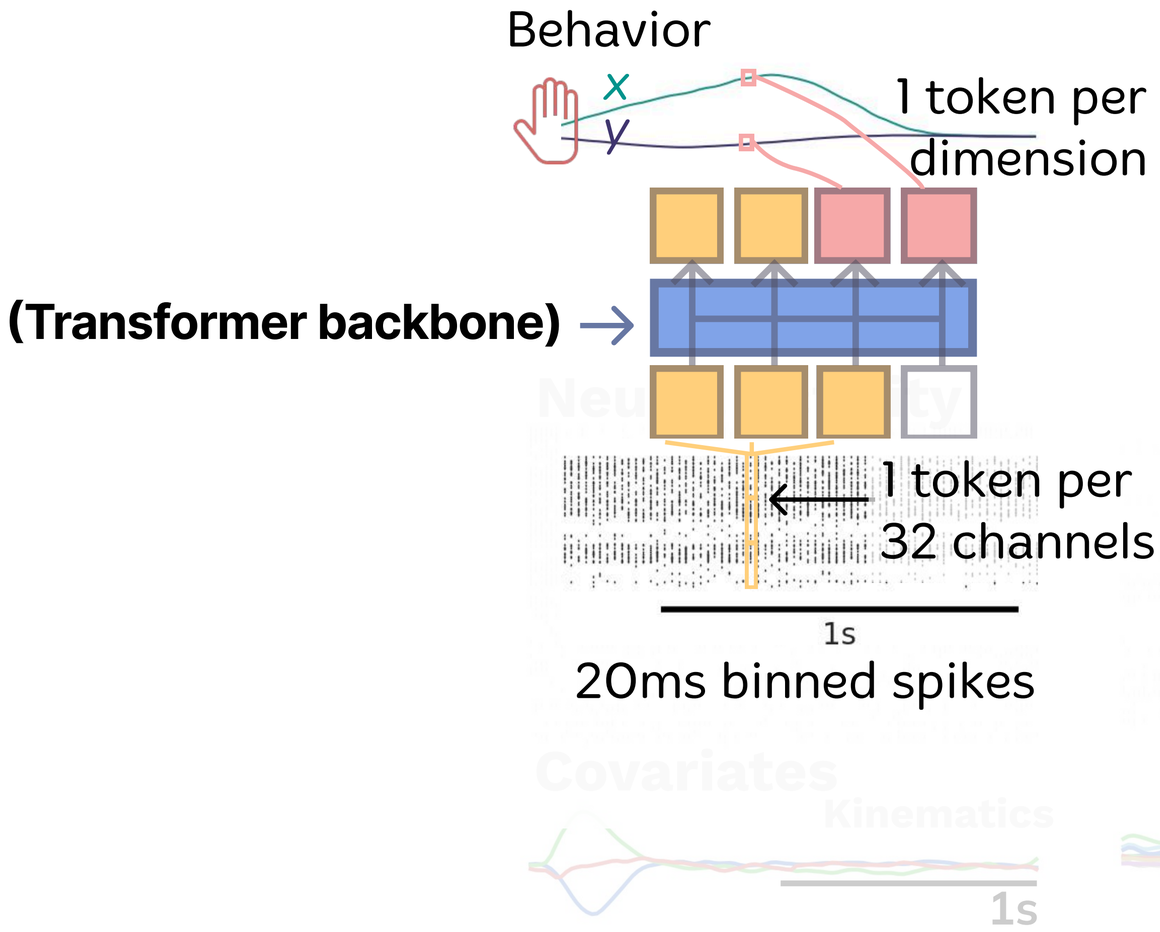

Neural Tokens:
Binned Spikes
Behavior Tokens:
Low-D Covariates

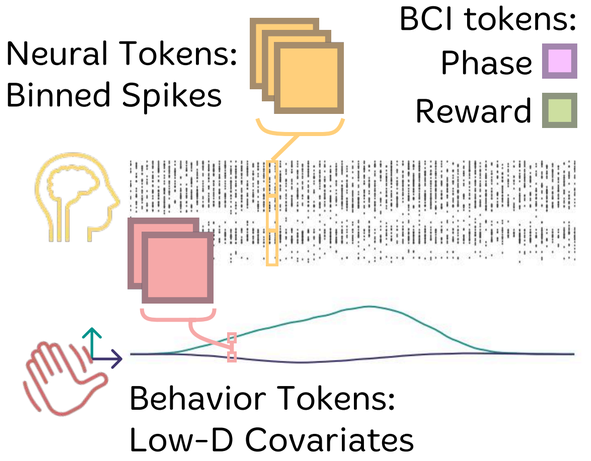

Neural Activity
Covariates
Kinematics
1s


EMG
Kinematics

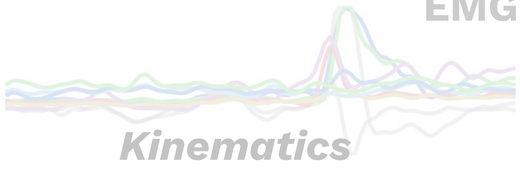

Force Command
Simulator
Noise

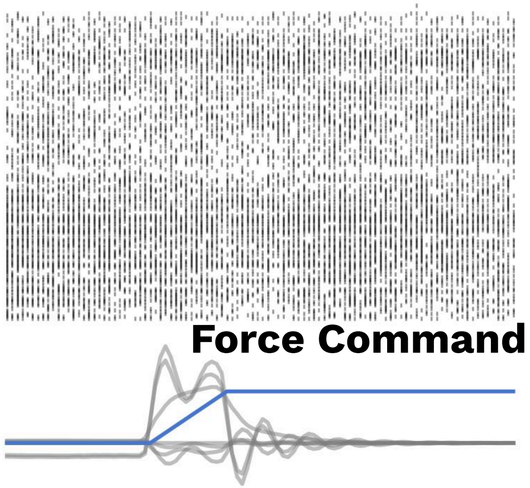

Neural Tokens:
Binned Spikes
BCI tokens:
Phase
Reward
Behavior Tokens:
Low-D Covariates
Neural Activity
Covariates
Kinematics
1s
EMG
Kinematics
Force Command
Programmatically driven behavior


Behavior
x
y
1 token per
dimension
(Transformer backbone)
1 token per
32 channels
1s
20ms binned spikes


Neural Tokens:
Binned Spikes
BCI tokens:
Phase
Reward
Behavior Tokens:
Low-D Covariates

Covariates
Kinematics
1s


EMG
Kinematics


Force Command

Downstream evaluation datasets

Monkey Movement
- 1D Critical Stability Task
- 2D Finger Pose
- 2D Self-paced reach
- 16D Reach / Grasp EMG

Human iBCI (Open-Loop)
- 1D Grasp Force
- 2D Cursor + Click
- 4D Bimanual Cursor
- 7D Reach / Grasp Kinematics

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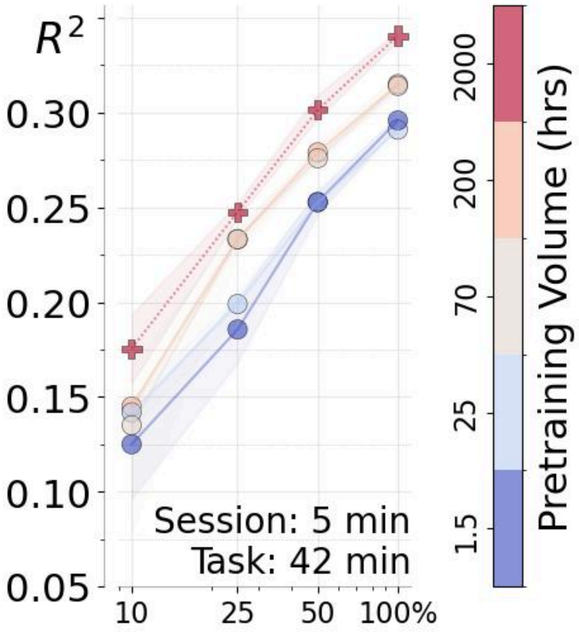
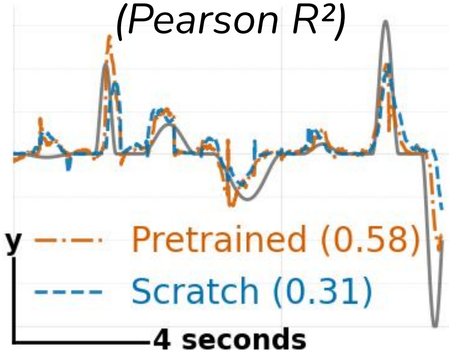
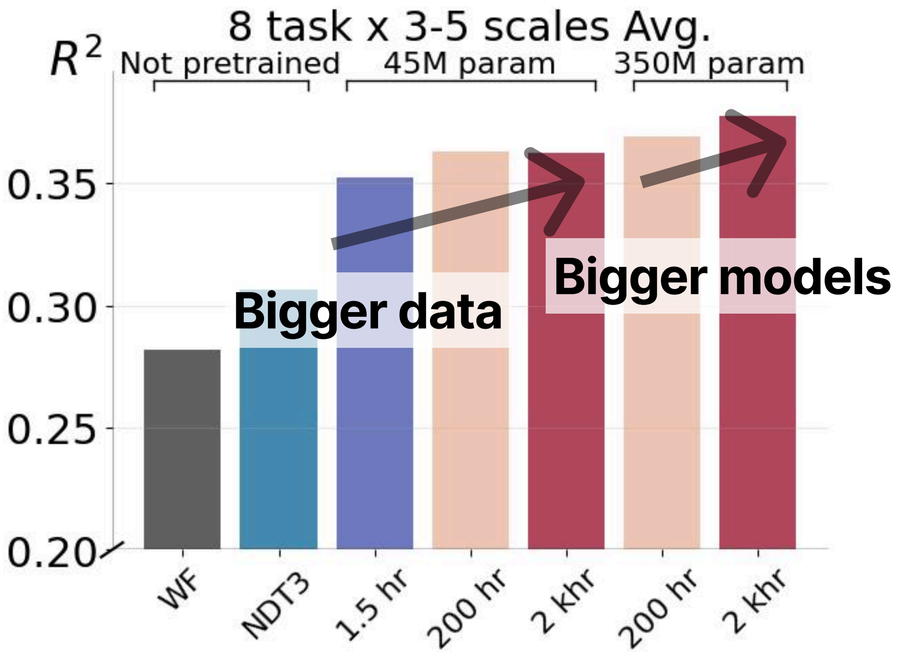
Each downstream dataset is evaluated at **multiple task data scales**.



Example predictions (Pearson R^2)





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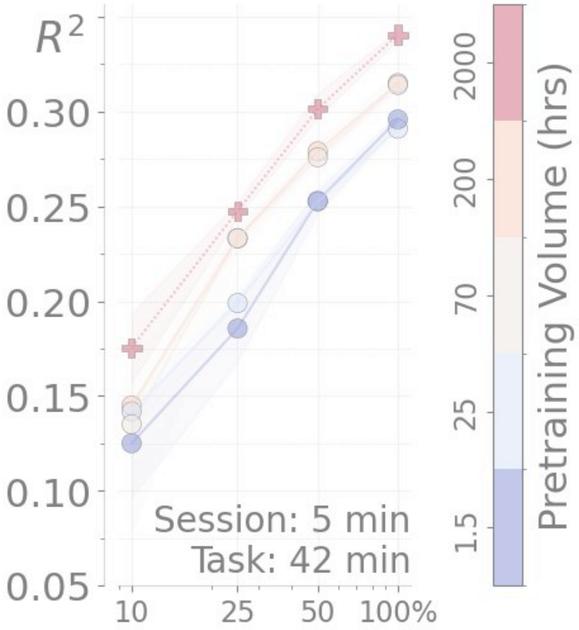

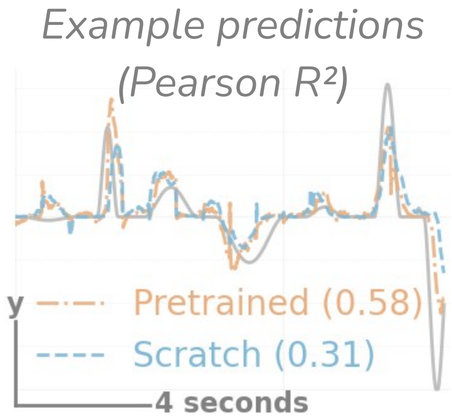

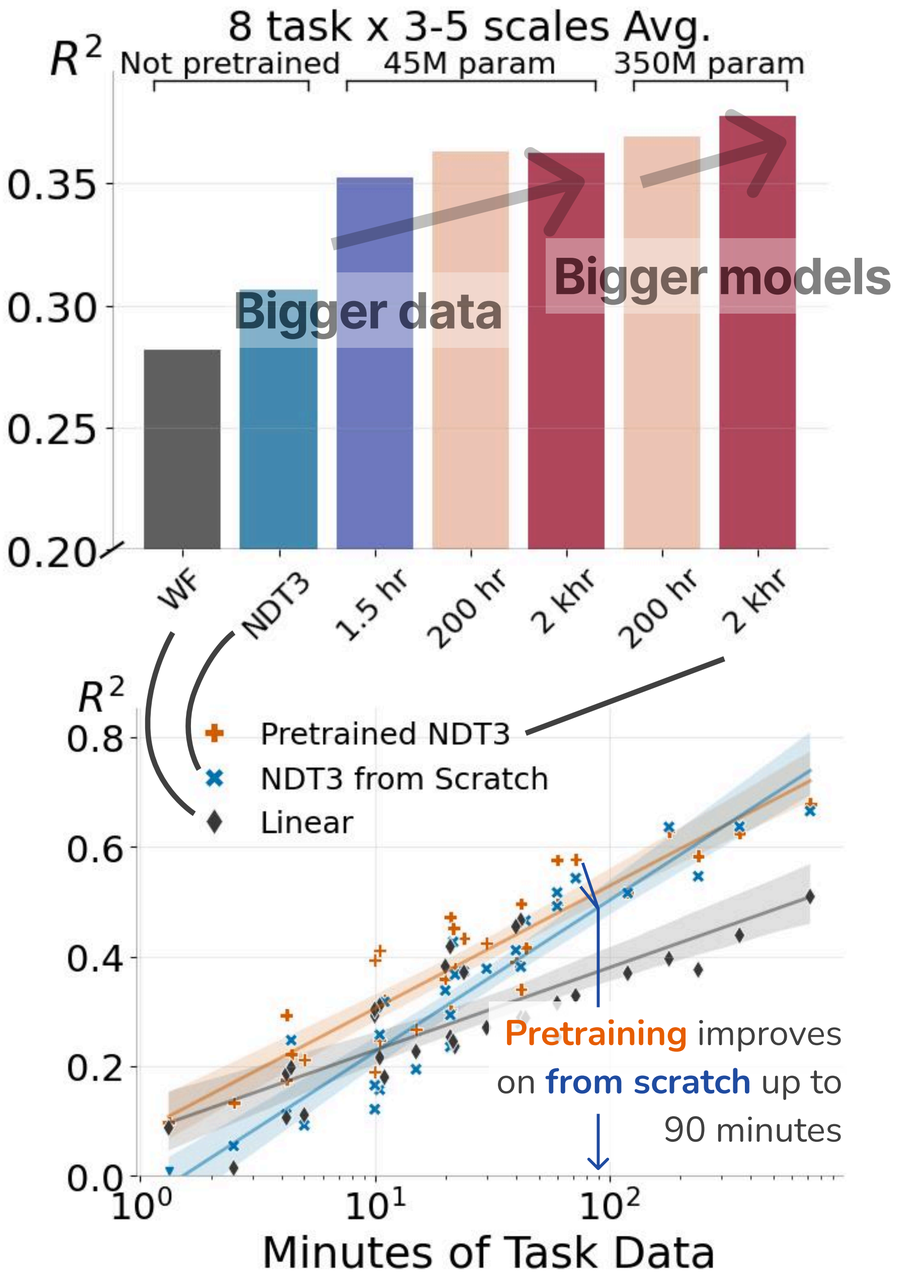

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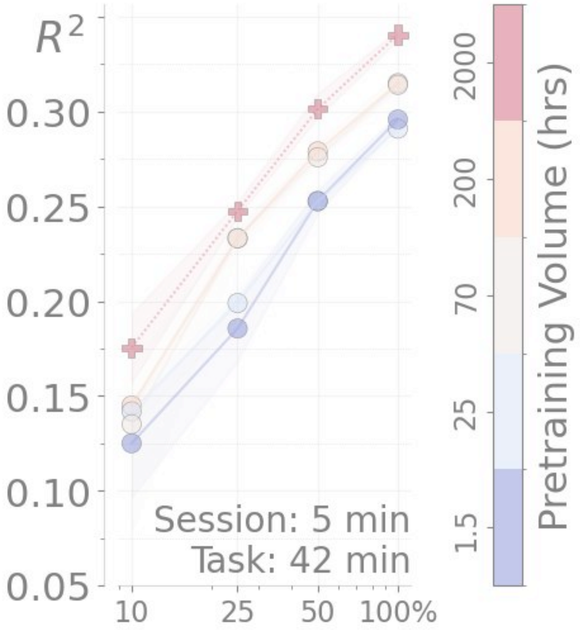
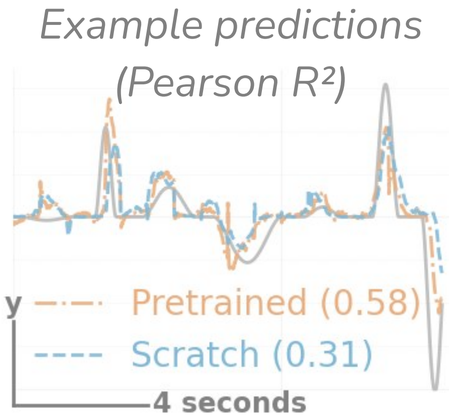
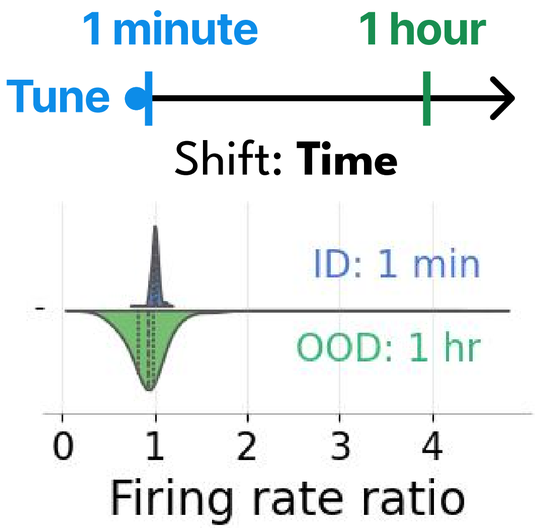




Pretraining provides a degree of generalized benefit.

Pretraining gains persist through changes in neural firing patterns in reaching tasks.



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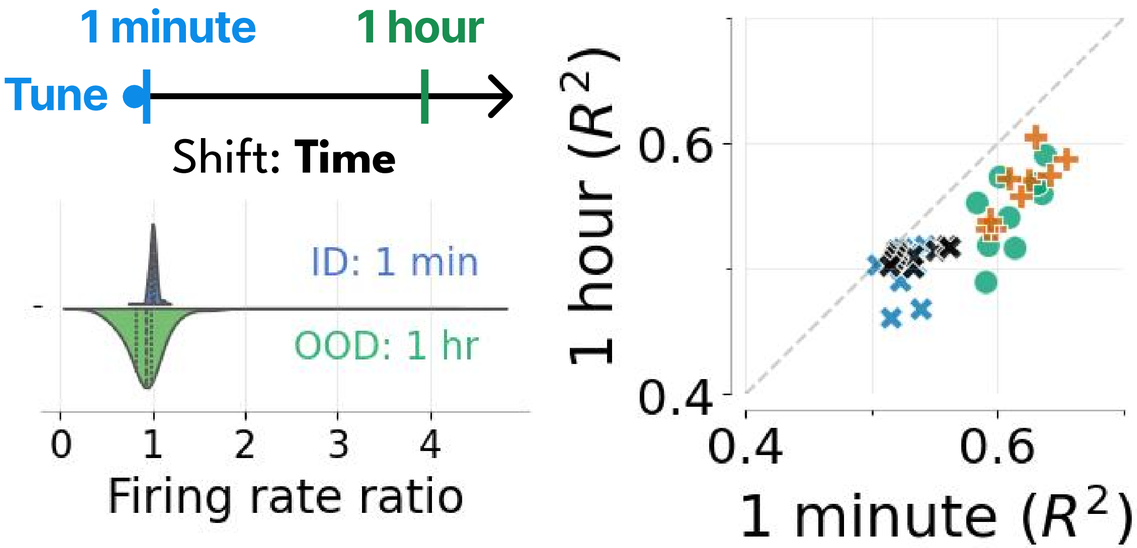

Wiener Filter | Scratch | 200hr 45M | 2khr 350M

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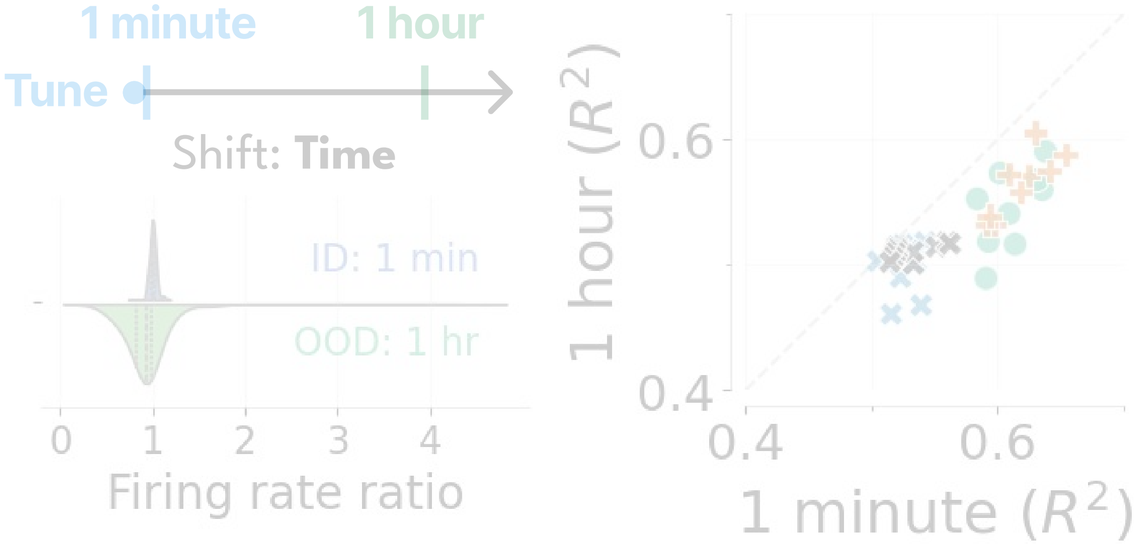
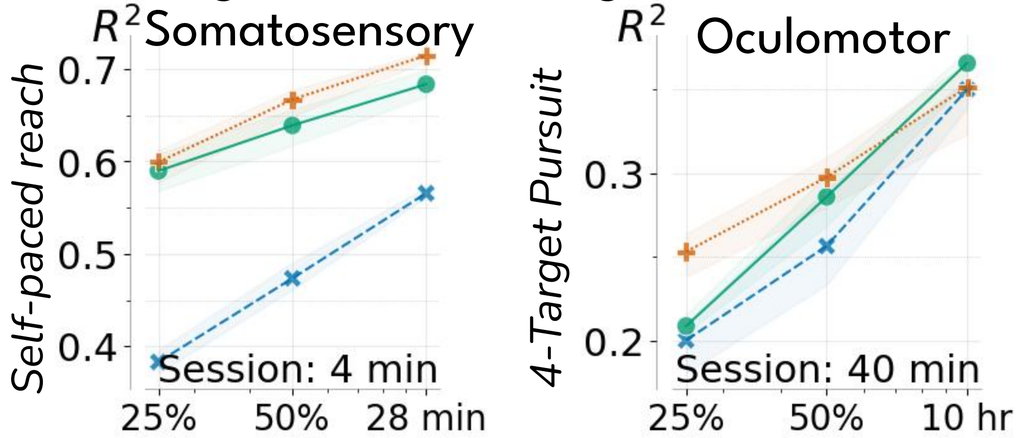


Pretraining benefits decoding outside motor cortex



✖ Wiener Filter ✖ Scratch ● 200hr 45M ✚ 2khr 350M

NDT3 provides a generally useful pretrained model for use across intracortical motor decoding tasks.