Coordinate Frames in Human Cortex During an Imagined Reaching Task

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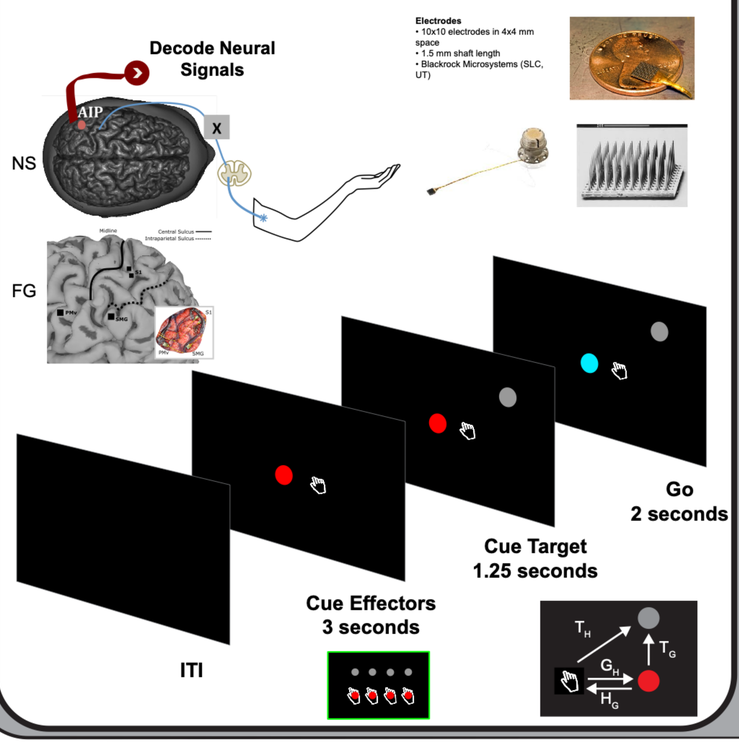
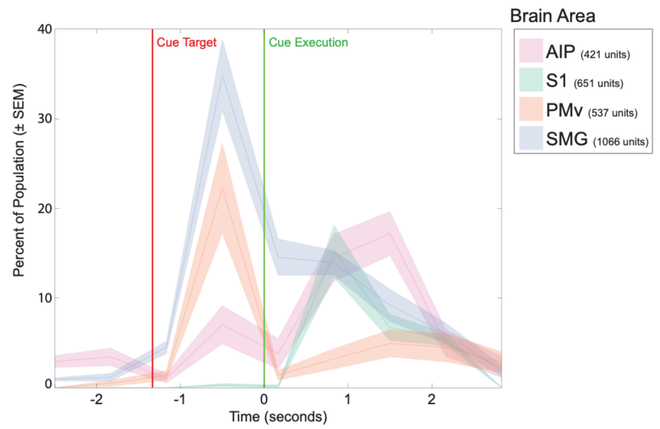
Introduction

We have shown that motor intentions can be decoded from human posterior parietal cortex (PPC) to enable a brain-machine interface. However, we have yet to determine the coordinate frames in which these intentions are encoded. Are intentions coded with respect to the subject's gaze, current imagined limb position, intended target location, or a combination of these. Or, is it encoded in world or body coordinates in which case gaze and imagined limb position have no effect. Knowing the answers to these questions has the potential to improve implementations of closed-loop neural prosthetic applications by ensuring that neural decoding algorithms are tailored to the way intention related information is actually encoded in the neural population. Here we explored the reference frames of imagined motor intentions in neural populations recorded in parietal cortex (AIP and SMG), primary somatosensory cortex (S1), and an area near ventral premotor cortex (PMv) of two tetraplegic subjects participating in a human clinical study.

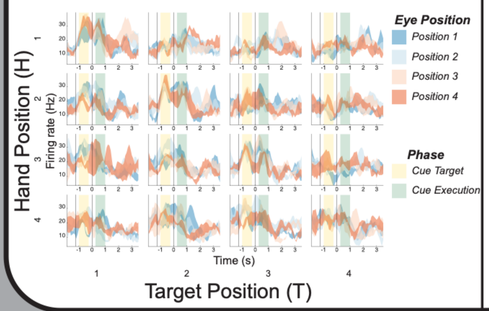
Methods and Task Paradigm

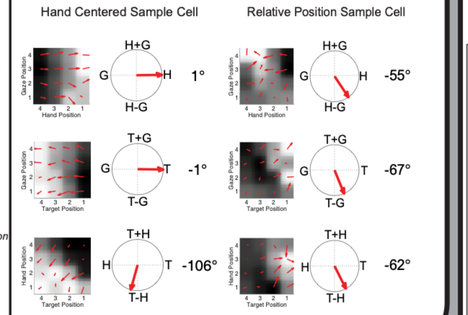


Results

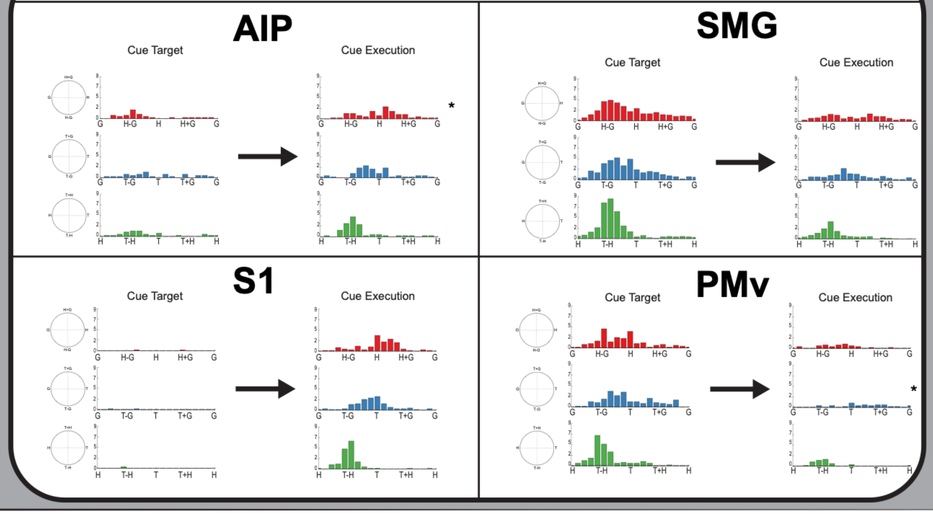


Sample Cell (64 x 3 trials)

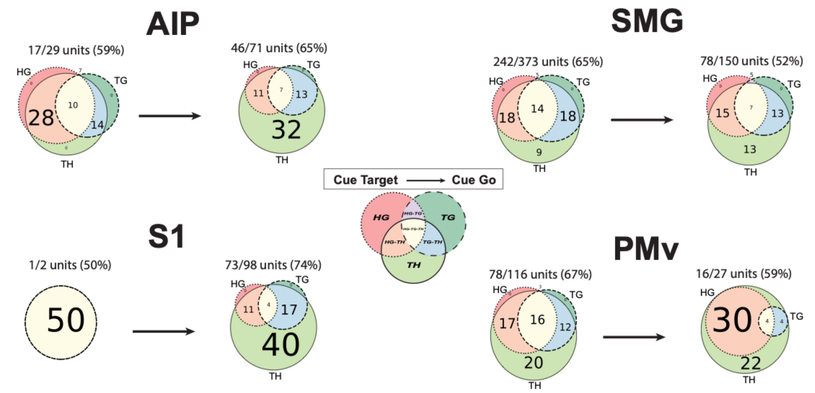




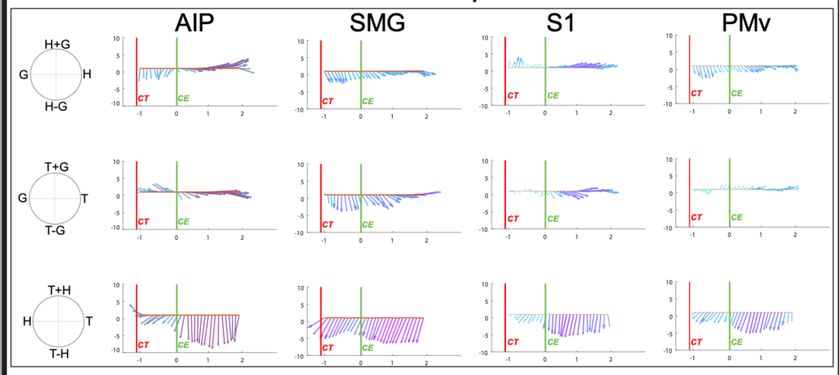
Population Level Reference Frames



Percent of Population Tuned to Each Vector



Reference Frame Temporal Evolution



• Common modes of tuning across all units can be found utilizing dimensionality reduction techniques (complex pca)

Conclusions

• No tuning in S1 during cue target

• PPC (AIP and SMG) shows slightly different modes of tuning throughout a delayed-imagined reaching task

• Evidence of mixed representations

• Complex PCA can be utilized to determine the main modes of tuning across different brain areas.

References:
1. Pesaran B, Nelson MJ, Andersen RA. Dorsal premotor neurons encode the relative position of the hand, eye, and goal during reach planning. Neuron. 2006;51(1):125-34.
2. Buneo CA, Jarvis MR, Batista AP, Andersen RA. Direct visuomotor transformations for reaching. Nature. 2002;416(6881):632-6.