Cross session decoding accuracy

Can a model trained on motor execution predict motor imagery?

By: Anjali, Eduardo, Temgoua, Yigit
Recent Herons / ecog herons

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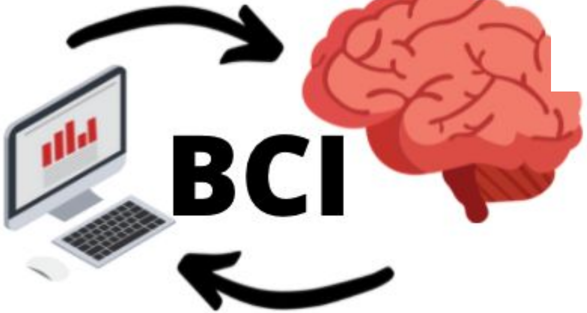
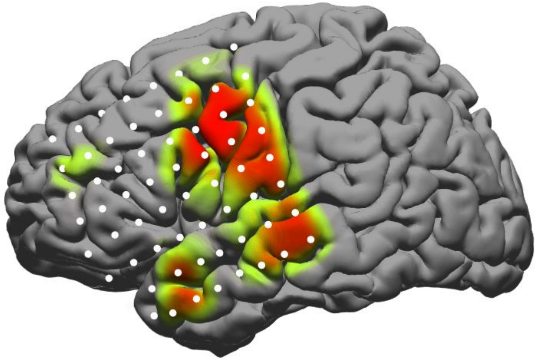
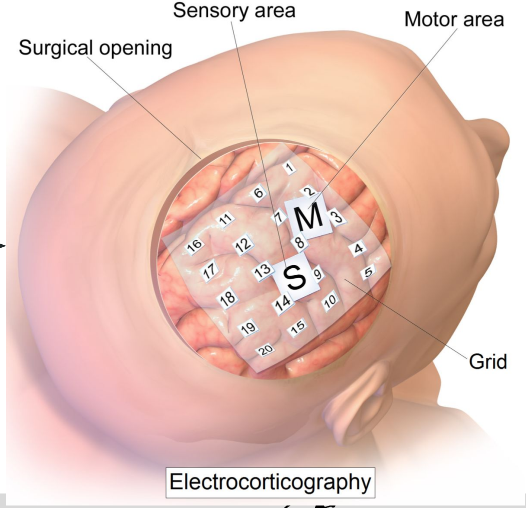
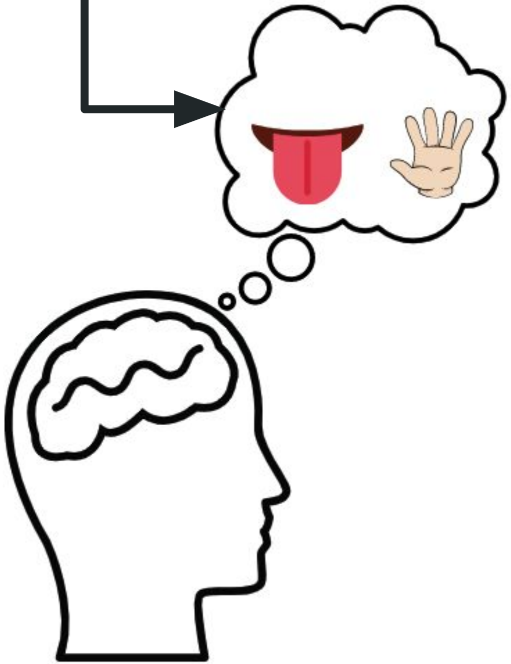
Introduction





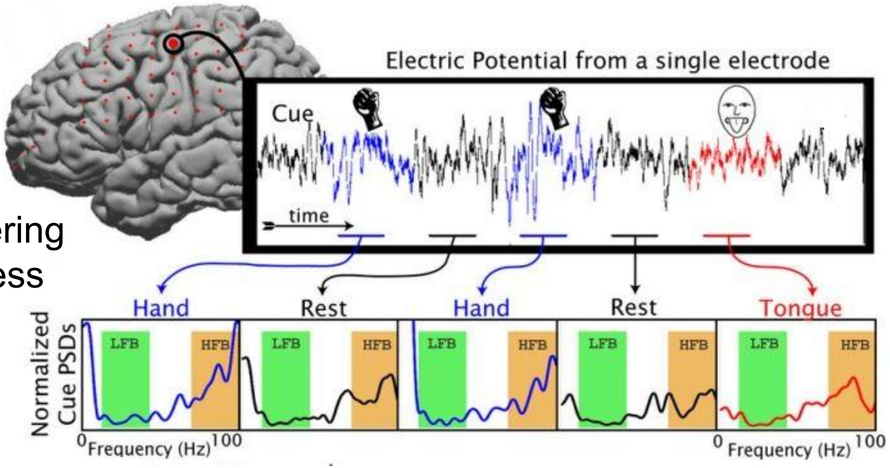




Dataset Analysis

ECoG Motor_Imagery datasets from Miller 2019 available at: https://searchworks.stanford.edu/view/zk881ps0522

Data gathering Process



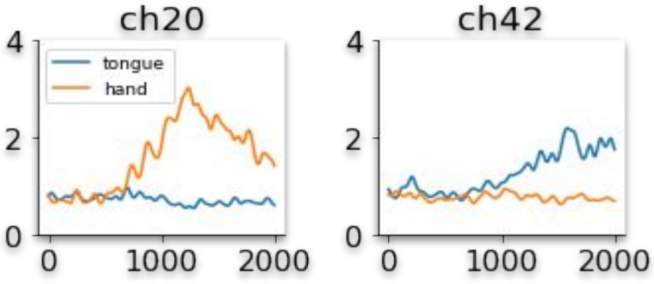
Filtering

Safgol

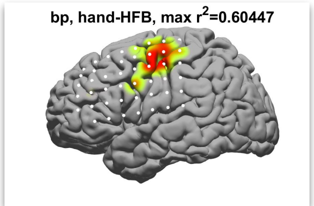
Visualization

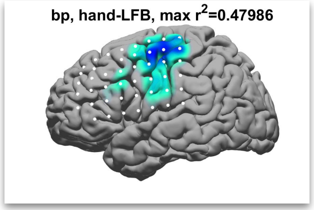
Plots

Voltages



Power Spectrum





Features

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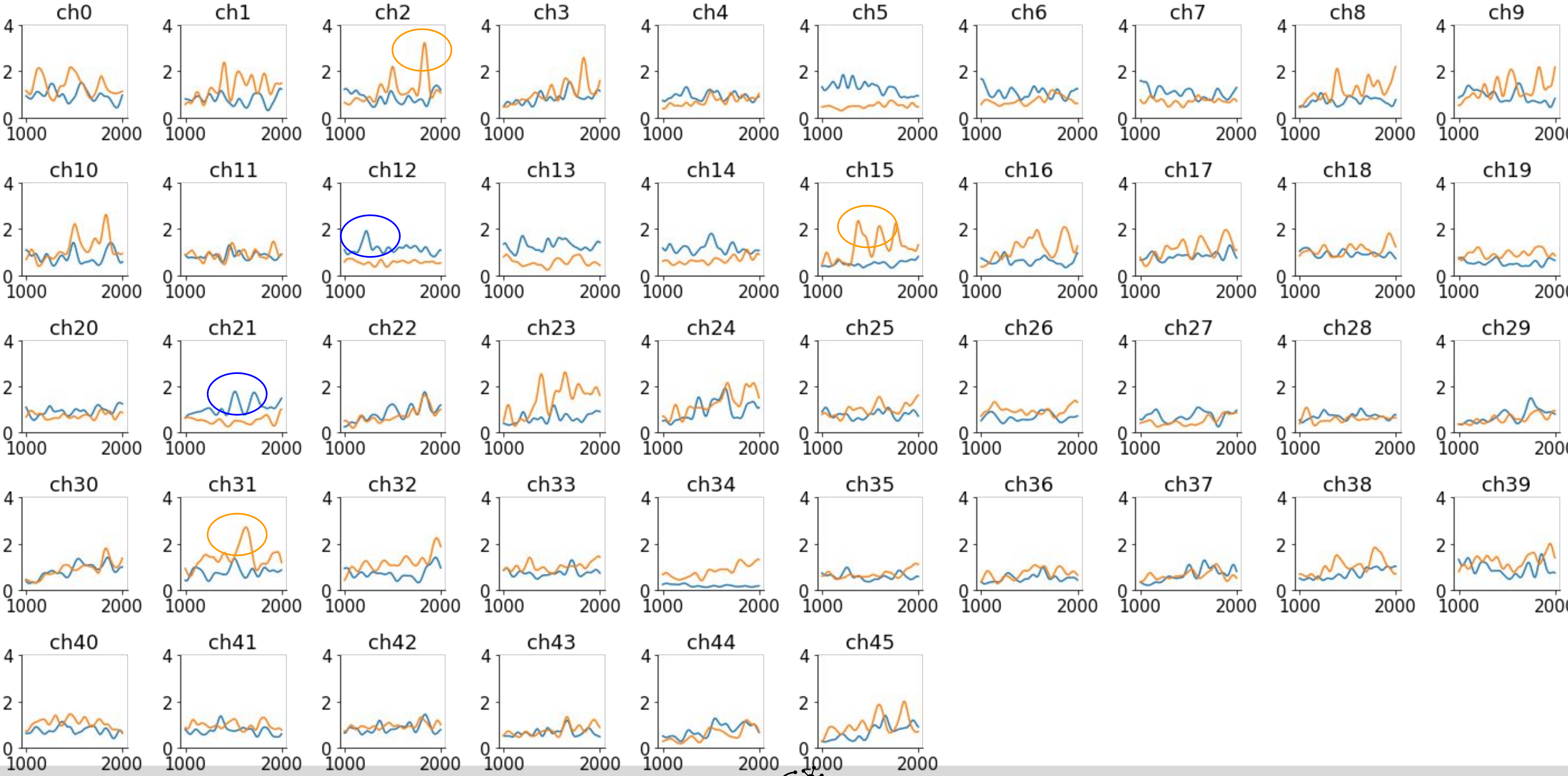
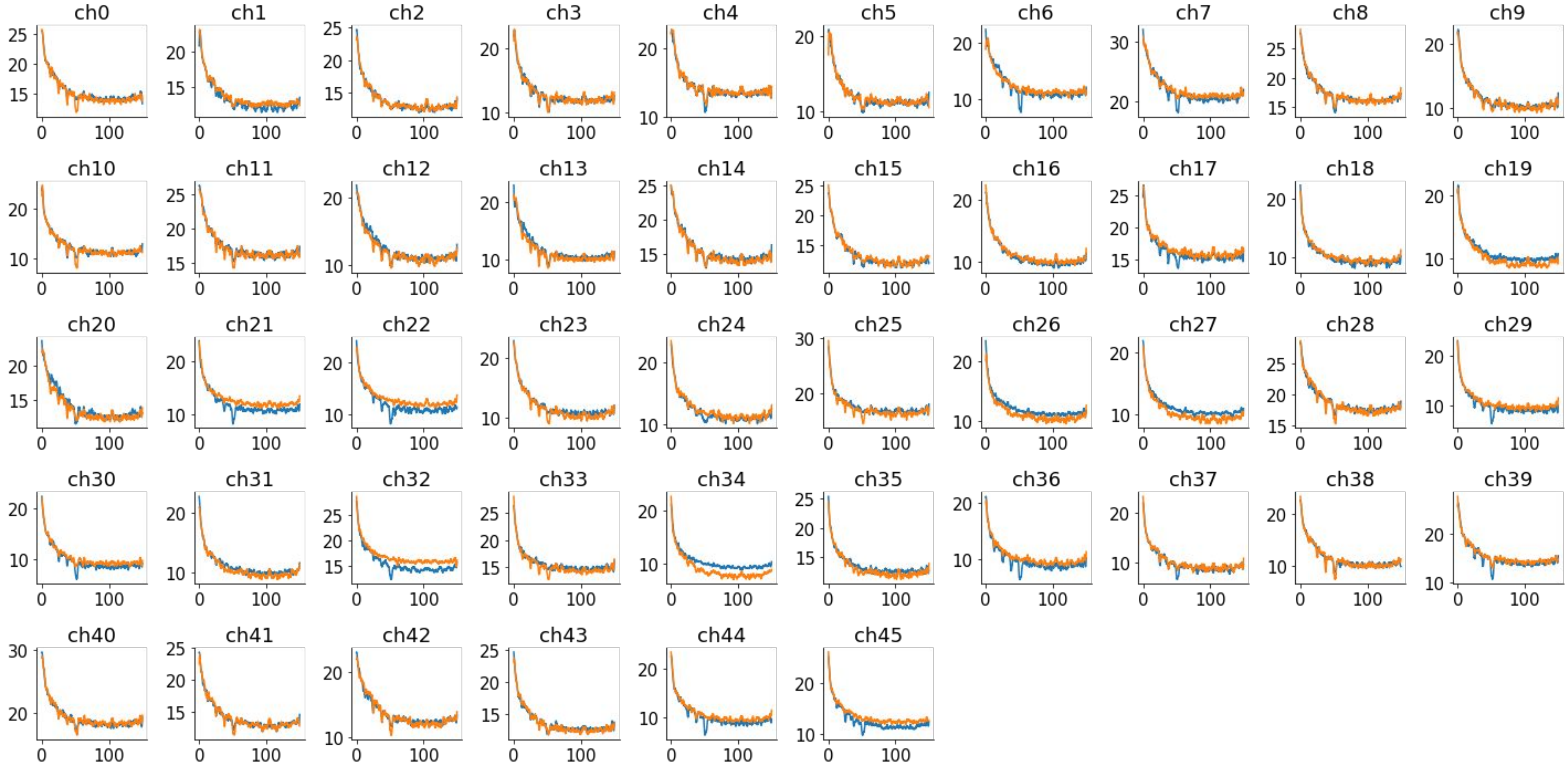
Power Vs Time/Samples



Log Power Vs Frequency



Results

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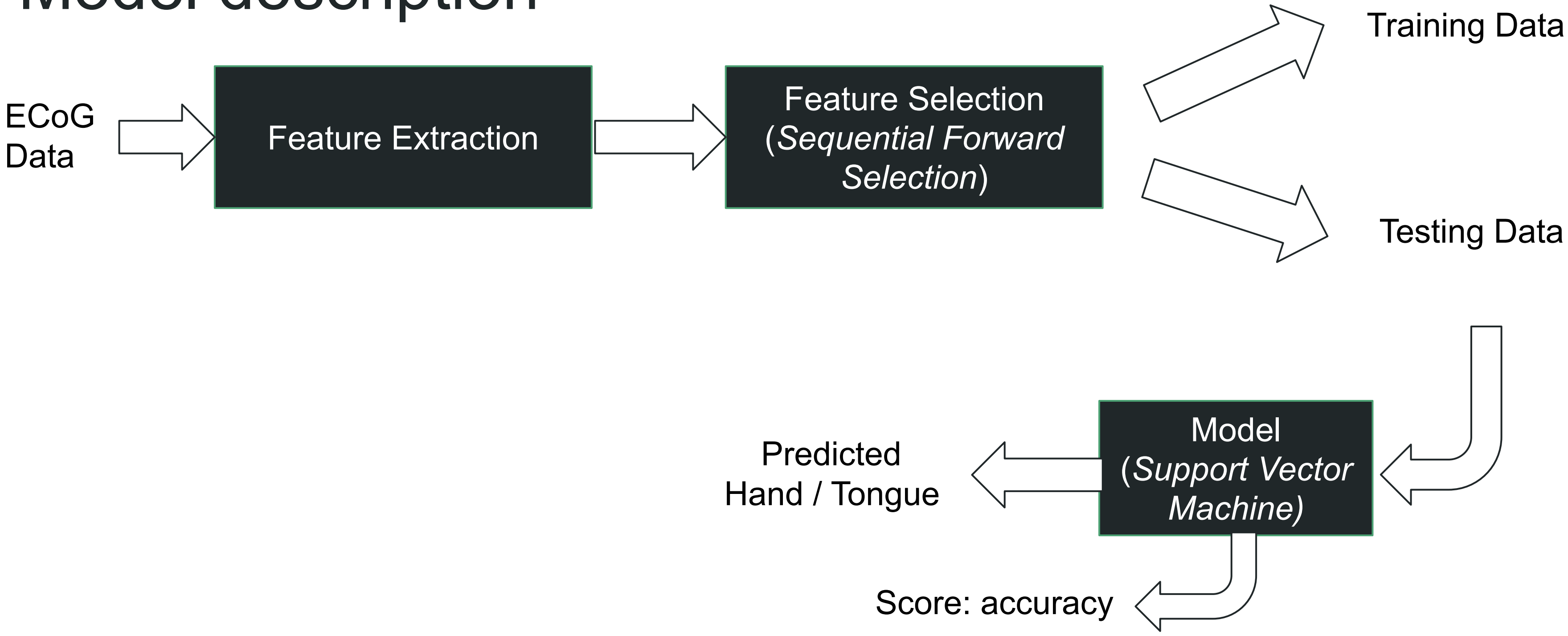
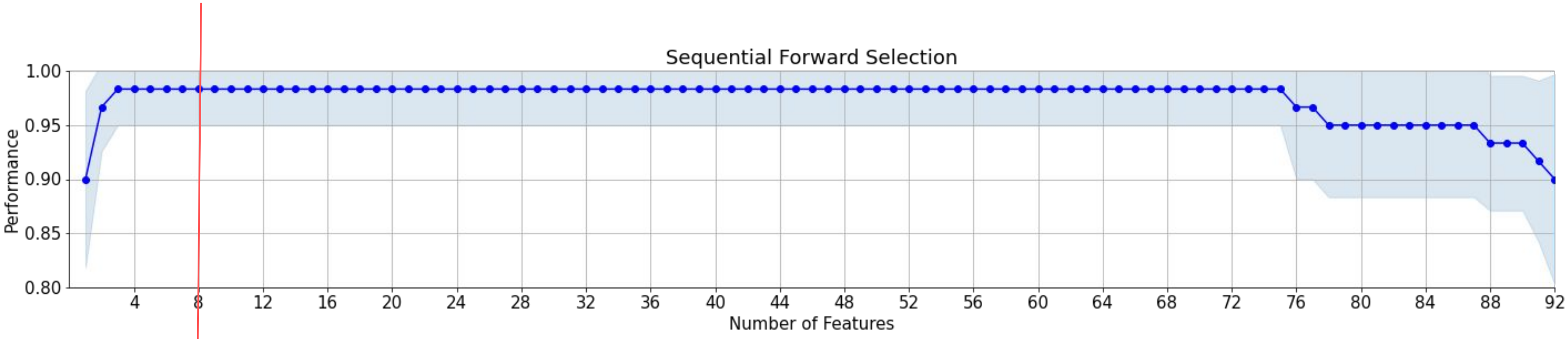
Model description



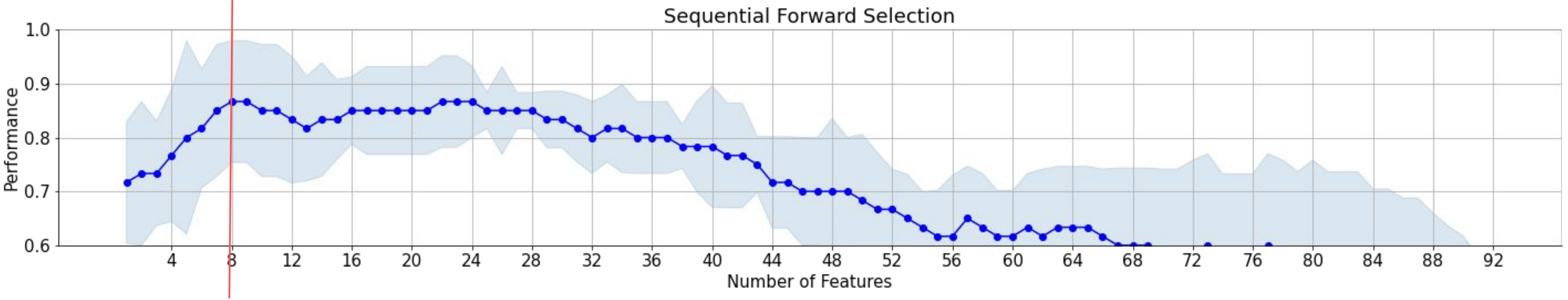
Feature Selection

Selected features

Real Movement



Imagined Movement



Cross-Validation Results (5-Fold) - Subject 1

Real Movement

Train Accuracy: 98.4%

Test Accuracy: 96.7%

Imagined Movement

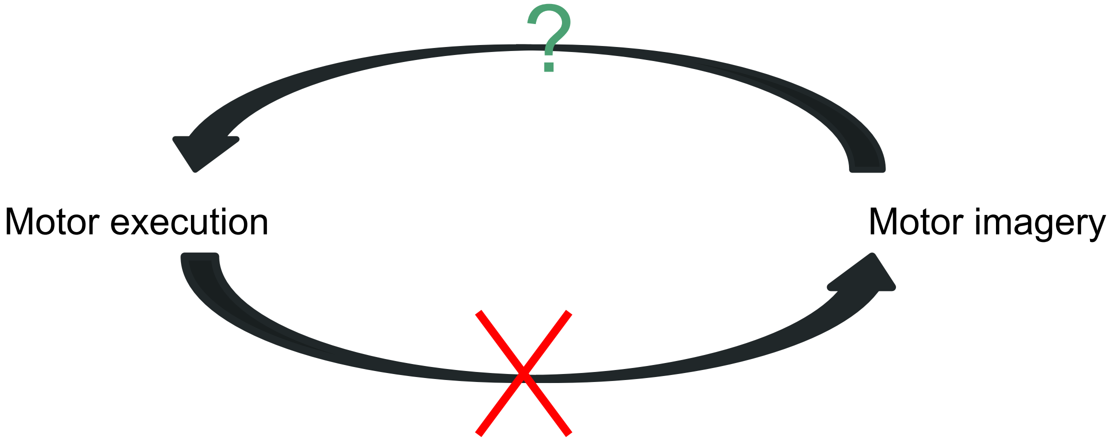
Train Accuracy: 92%

Test Accuracy: 87%

Cross-session validation

Train on real movement and test on imagined movement: 57%

Conclusion



- More data? Better models?
- All trials vs trial by trial?
- Other movement types?

Thanks!

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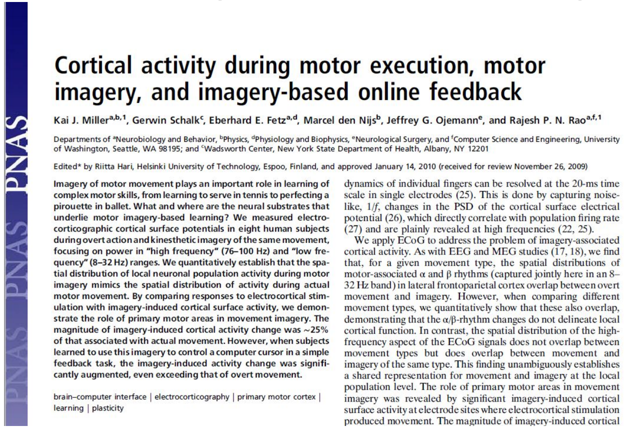
Literature Review

- Studies revealed that imaginary motor tasks caused cortical activity in primary motor areas of the brain albeit at a 25 % reduce voltage rate (Miller et al., 2010)
- Even higher rates when provided with a feedback based training method that allowed them to move a cursor with imaginary movement (Miller et al.,2010)
- Hand and tongue movements, decoding?
- A stable and a reliable model?



PNAS PNAS PNAS

Cortical activity during motor execution, motor imagery, and imagery-based online feedback

Kai J. Miller[a,b,1], Gerwin Schalk[c], Eberhard E. Fetz[a,d], Marcel den Nijs[b], Jeffrey G. Ojemann[e], and Rajesh P. N. Rao[a,f,1]

Departments of [a]Neurobiology and Behavior, [b]Physics, [d]Physiology and Biophysics, [e]Neurological Surgery, and [f]Computer Science and Engineering, University of Washington, Seattle, WA 98195; and [c]Wadsworth Center, New York State Department of Health, Albany, NY 12201

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Imagery of motor movement plays an important role in learning of complex motor skills, from learning to serve in tennis to perfecting a pirouette in ballet. What and where are the neural substrates that underlie motor imagery-based learning? We measured electrocorticographic cortical surface potentials in eight human subjects during overt action and kinesthetic imagery of the same movement, focusing on power in "high frequency" (76–100 Hz) and "low frequency" (8–32 Hz) ranges. We quantitatively establish that the spatial distribution of local neuronal population activity during motor imagery mimics the spatial distribution of activity during actual motor movement. By comparing responses to electrocortical stimulation with imagery-induced cortical surface activity, we demonstrate the role of primary motor areas in movement imagery. The magnitude of imagery-induced cortical activity change was ~25% of that associated with actual movement. However, when subjects learned to use this imagery to control a computer cursor in a simple feedback task, the imagery-induced activity change was significantly augmented, even exceeding that of overt movement.

brain–computer interface | electrocorticography | primary motor cortex | learning | plasticity

dynamics of individual fingers can be resolved at the 20-ms time scale in single electrodes (25). This is done by capturing noise-like, $1/f$, changes in the PSD of the cortical surface electrical potential (26), which directly correlate with population firing rate (27) and are plainly revealed at high frequencies (22, 25).

We apply ECoG to address the problem of imagery-associated cortical activity. As with EEG and MEG studies (17, 18), we find that, for a given movement type, the spatial distributions of motor-associated α and β rhythms (captured jointly here in an 8–32 Hz band) in lateral frontoparietal cortex overlap between overt movement and imagery. However, when comparing different movement types, we quantitatively show that these also overlap, demonstrating that the α/β-rhythm changes do not delineate local cortical function. In contrast, the spatial distribution of the high-frequency aspect of the ECoG signals does not overlap between movement types but does overlap between movement and imagery of the same type. This finding unambiguously establishes a shared representation for movement and imagery at the local population level. The role of primary motor areas in movement imagery was revealed by significant imagery-induced cortical surface activity at electrode sites where electrocortical stimulation produced movement. The magnitude of imagery-induced cortical