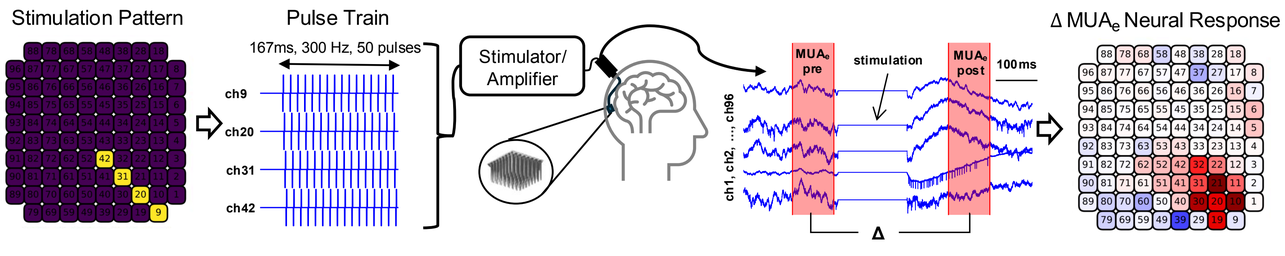
Control of Electrically Evoked Neural Activity in Human Visual Cortex using Deep Learning

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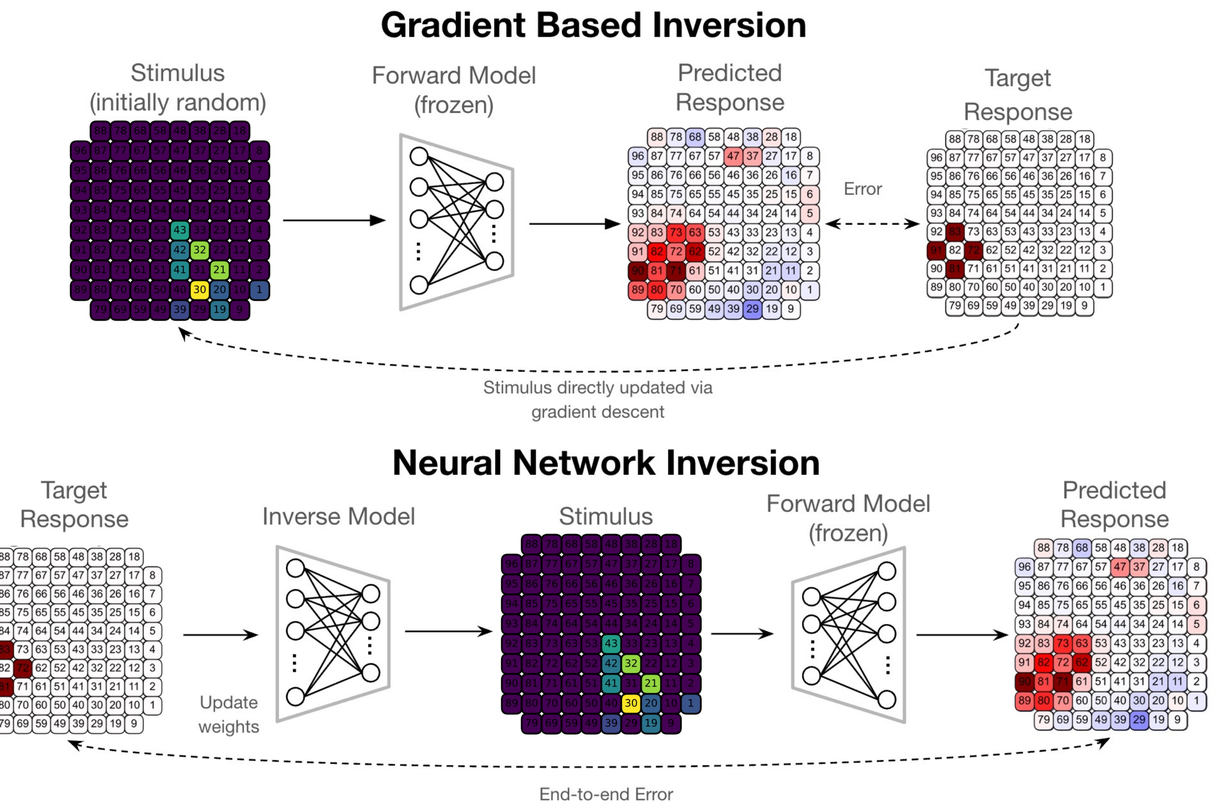
1 Introduction

Visual cortical prostheses are promising for sight restoration, yet precise control of stimulation induced neural activity to produce naturalistic perception remains a major challenge. Perceptions produced are often distorted, difficult to interpret, and inconsistent.



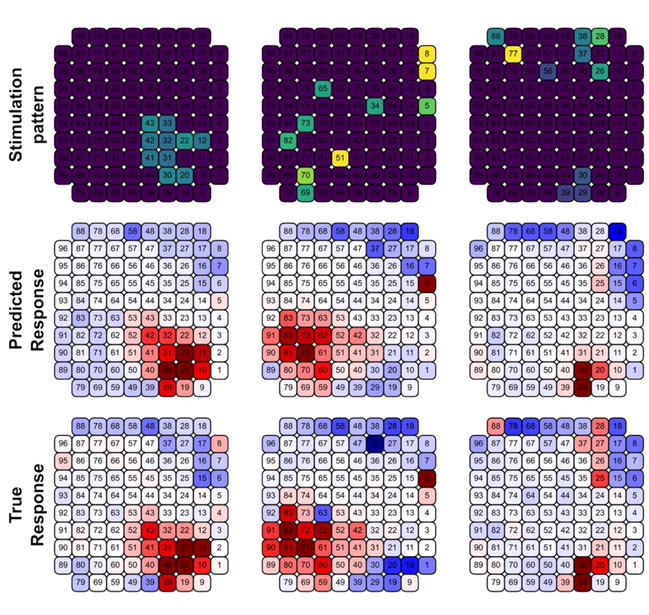
2 Method Overview

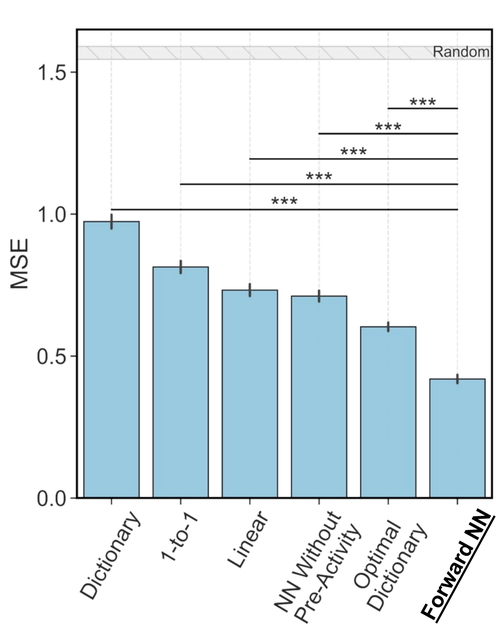
- Forward deep neural network trained to predict post-stimulation neural responses recorded on a Utah electrode array implanted in the occipital cortex of a participant with complete blindness
- Two novel strategies for stimulus generation: Inverse neural network and gradient based - inversion



3 Forward Model: Stimulation to Neural Response

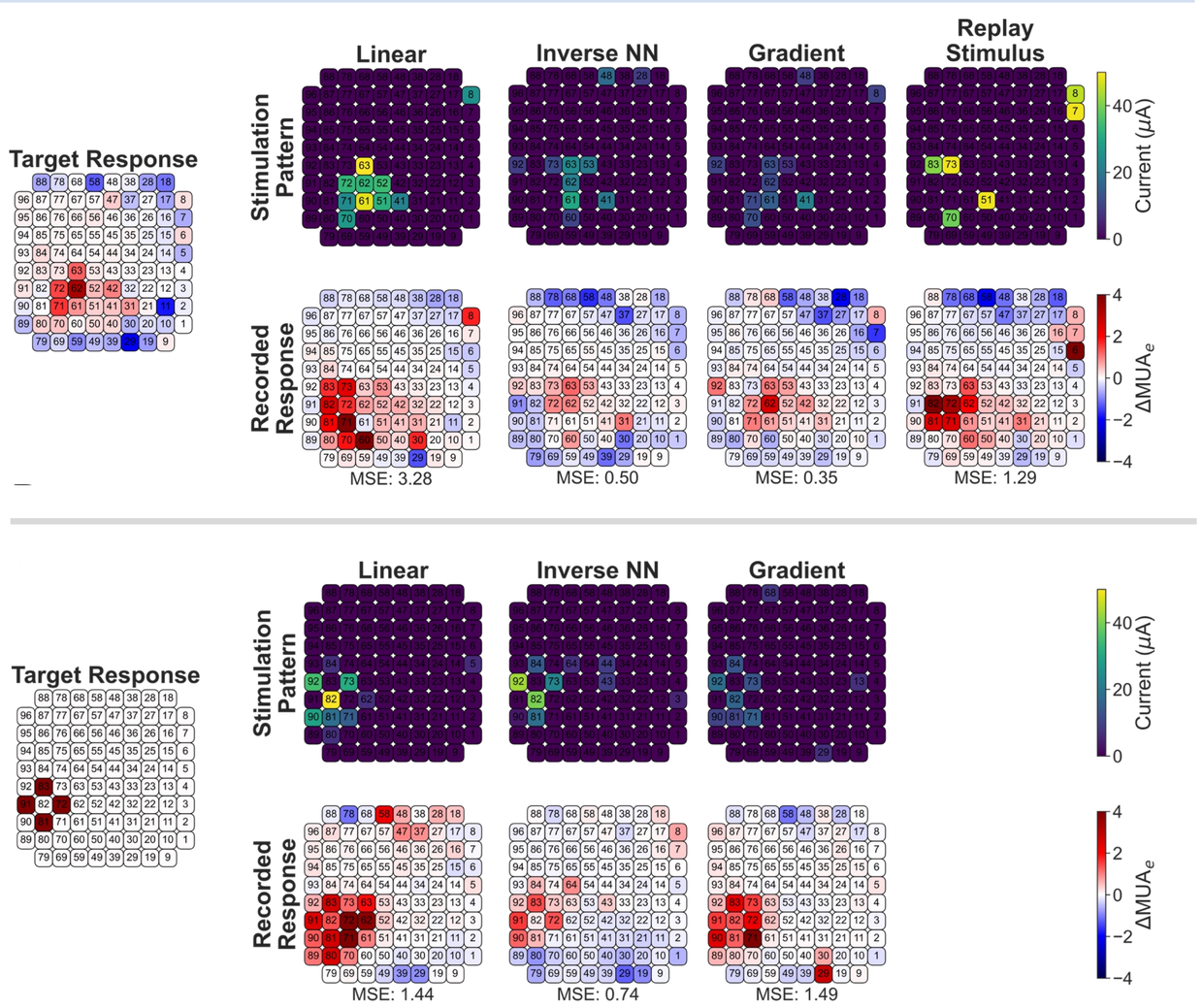
- Neural responses exhibited decreased variability across days when using change in envelope multi-unit spiking activity (ΔMUA_e)
- Forward neural network significantly outperformed all baseline models including linear approaches and dictionary methods

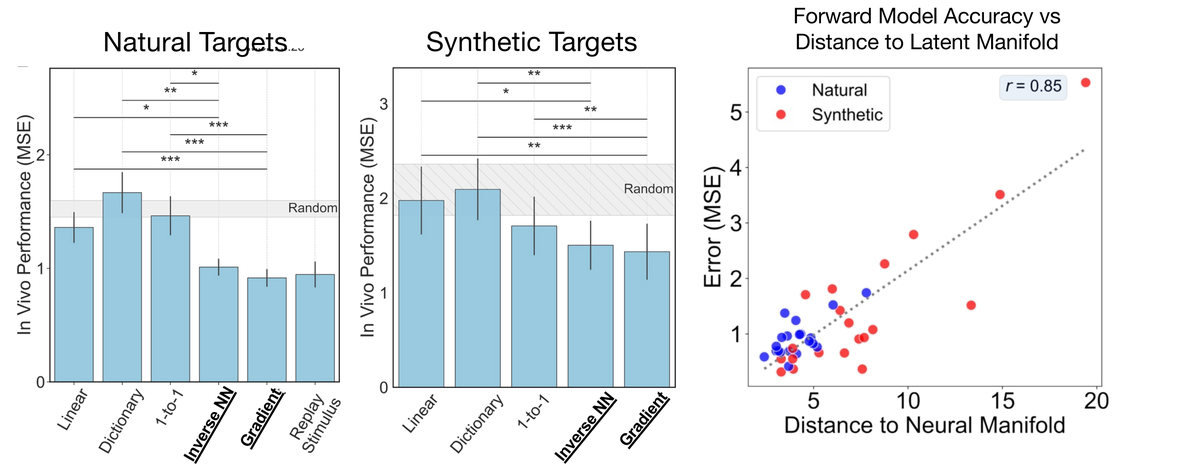




4 Model Inversion: Generating Stimulations for Target

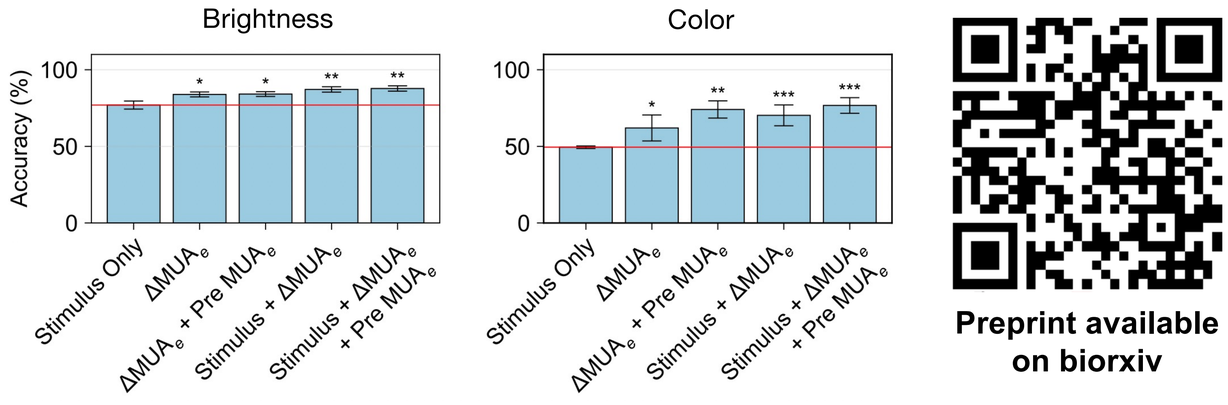
- Both of our methods significantly outperformed all previous methods ($p<0.005$), with gradient optimization performing best but requiring more compute (10-20s vs 50µs for inverse network)
- Performance strongly tied to distance from neural manifold ($r=0.85$) with natural targets more controllable than synthetic targets





5 Perceptual Relevance

- Neural activity significantly outperformed stimulation parameters alone in predicting brightness and color ratings ($p<0.05$)
- These findings support the use of neural response modeling as critical component for optimizing perceptual outcomes in cortical visual prostheses



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