Using DNNs as a Yardstick for Estimating the Representational Value of Oscillatory Brain Signals.

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Presentation Abstract Summary Cognitive neuroscience must evaluate the information content and representational complexity of each brain signal: does it covary with physical attributes of sensory inputs (e.g. contrast, orientation), or with more elaborate attributes such as an object's category? Comparing response patterns between brain regions and/or recording modalities (e.g. MEG, fMRI) is a useful approach, but somewhat limited by the complexity of brain dynamics (e.g. "low-level" brain regions initially respond according to physical attributes, but are later affected by object category). Here, we followed recent studies that used feed- forward deep neural networks (DNNs) as a yardstick for the representational content of brain signals. We analyzed MEG oscillations, recorded while human subjects viewed images from different object categories. The multivariate response pattern for phase and amplitude signals in each oscillatory band (theta, alpha, beta, gamma) was compared with each layer of two standard DNNs (GoogLeNet, VGG) presented with the same object images. Overall, these large-scale oscillatory brain signals tended to coincide better with higher DNN processing layers; this was most evident for phase compared to amplitude, and for lower frequencies (<13Hz, theta and alpha). In contrast, high-frequency (~40Hz, beta and gamma) amplitude was the only oscillatory signal that best matched lower DNN layers.

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