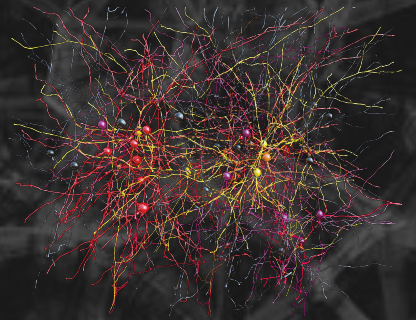
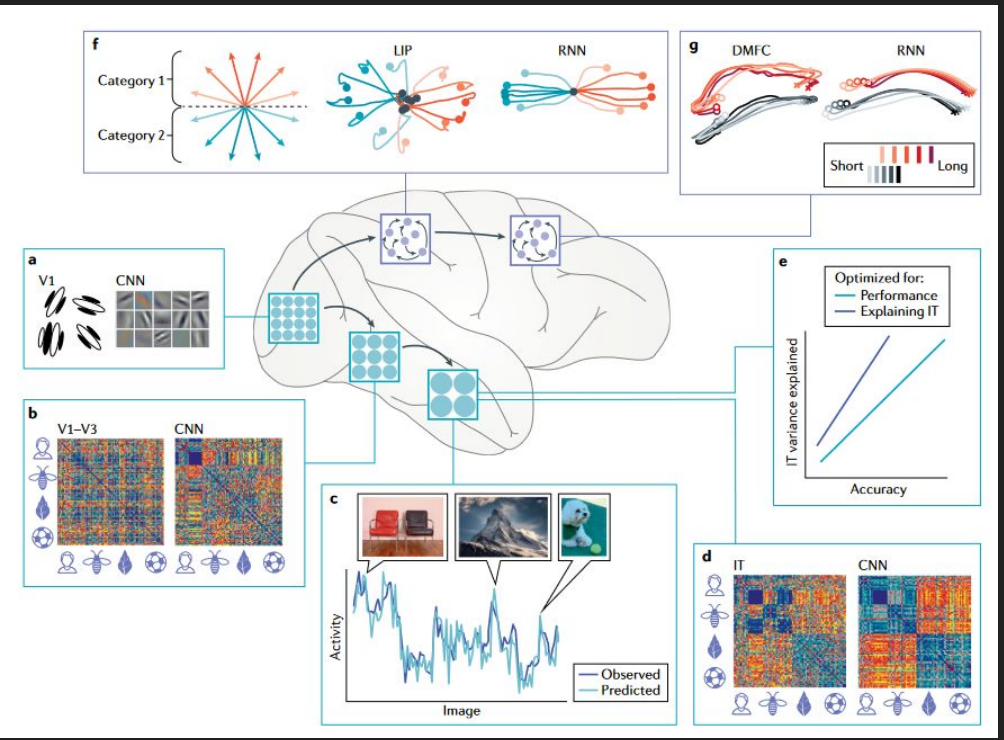
If Deep Learning is the Answer
What is the question?

Andrew Saxe et al. - 2021



Is deep learning useful for neuroscience?



A - cell receptive fields from mammal visual cortex compared with CNN first hidden layer

B - Representational similarity matrices in early visual areas of the primate brain (left) and first layers of CNN (right)

C - Simulated neural firing rates compared to linear transform of neural network activity

D - More representational similarity matrices from inferior temporal cortex and final layers of CNN

E - Relationship between variance explained in interior temporal cortex signal and classification accuracy for NN trained fro classification

F - State space analysis on macaque neural signals for dot motion categorization vs state space analysis in an RNN trained for same task

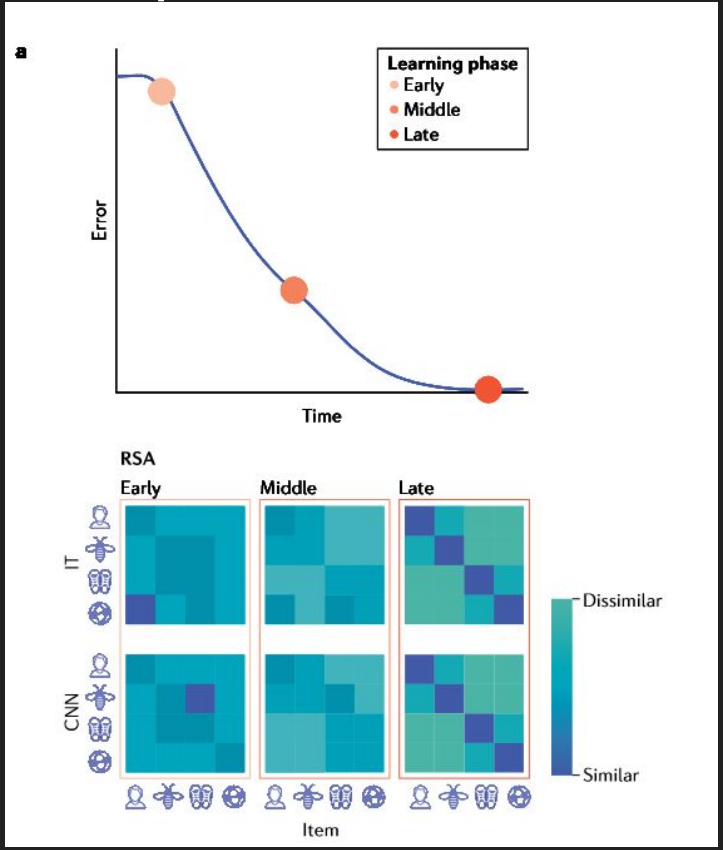
G - state space analysis on macaque dorsomedial prefrontal cortex during long-interval short in reproduction task

From Deep Learning Framework to Neuro Hypothesis

- Deep Learning provides a unified framework for studying neural computation

- BUT it suggests that computation emerges uncontrollably through blind optimization - we lack a clear road from optimization to neuroscience

Deep Neural Networks as Neural Models



Has the equivalence of deep networks to animal brains been overstated?

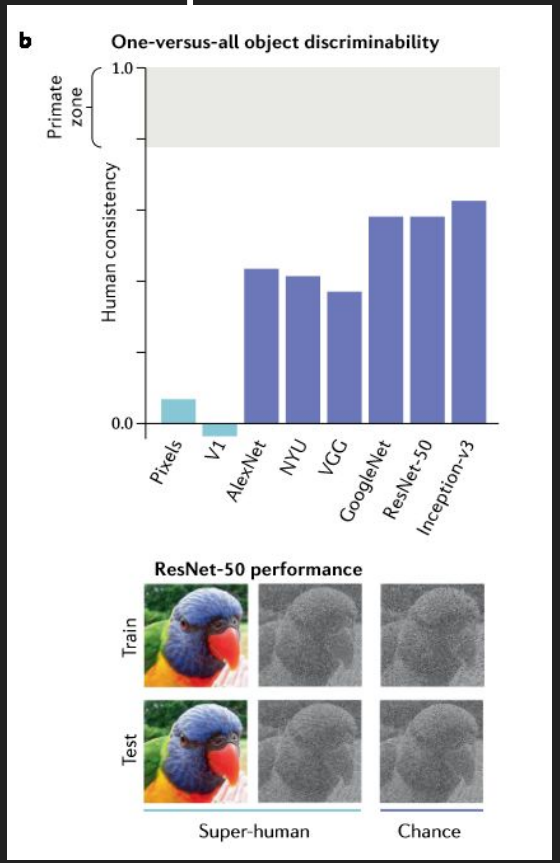
More work is needed!

Comparing representation change throughout learning - representational similarity matrices on a CNN compared with interior temporal cortex similarity

Linear transforms are a start but not complete.

We at TReNDS should ask what the relationship to FNC is for DNNs!!

Deep Neural Networks as Neural Models



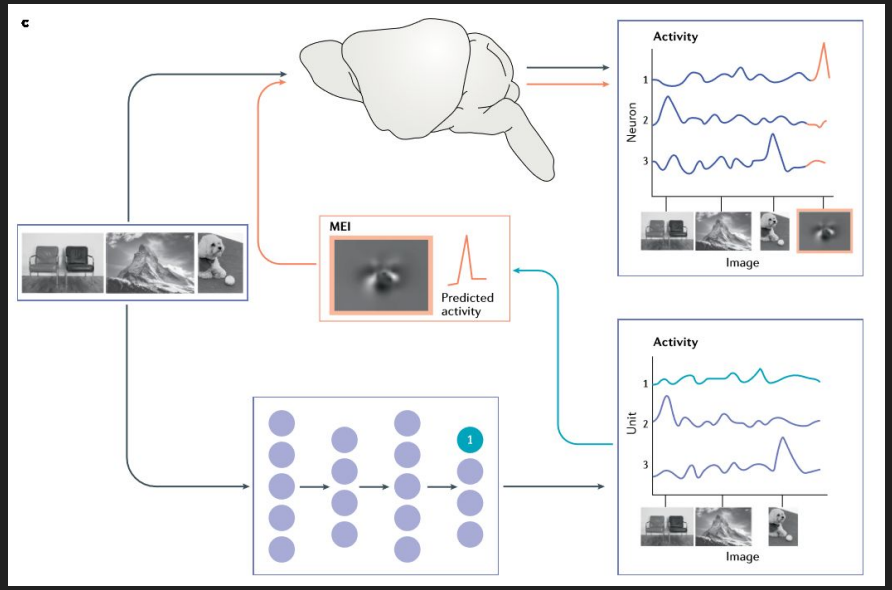
Studying patterns of response

The types of errors made by deep networks and animal network are very different!

Patterns of confusion among images were shared by humans and not macaques

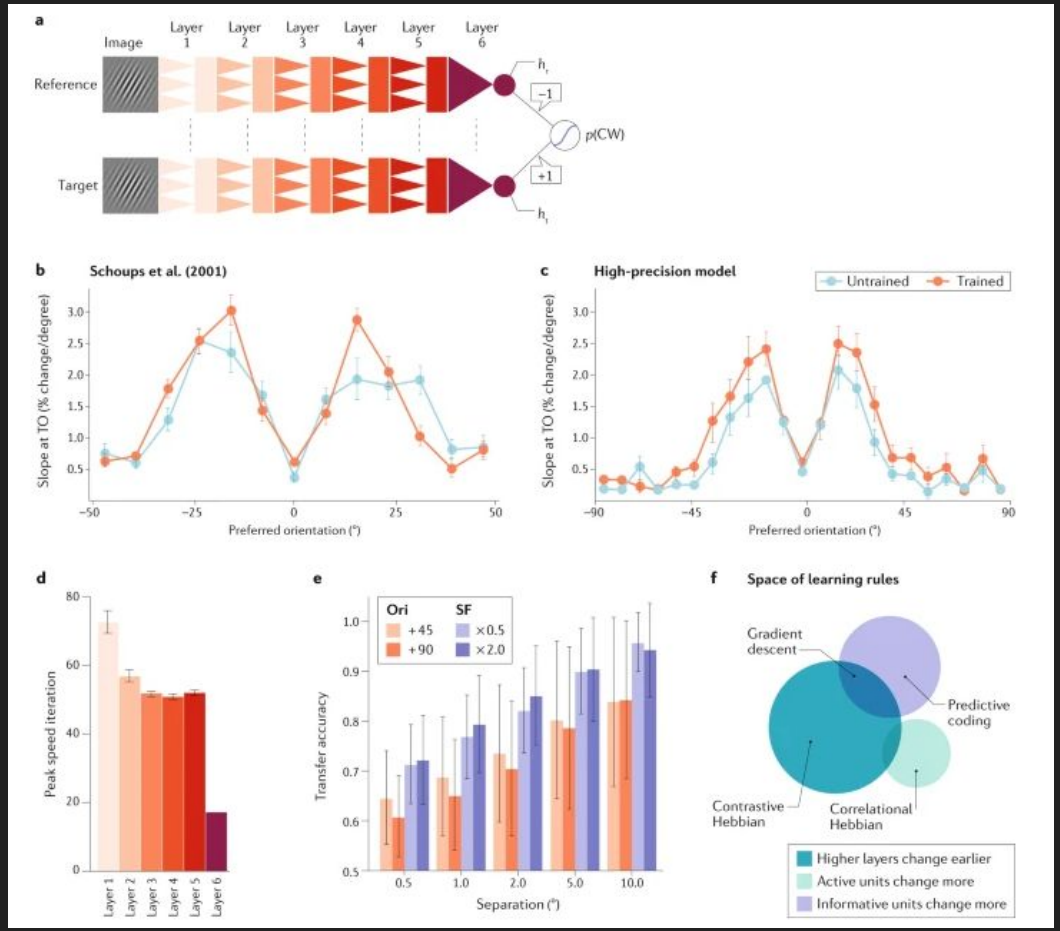
Humans generalize better than deep networks to images perturbed by noise

Deep Neural Networks as Neural Models

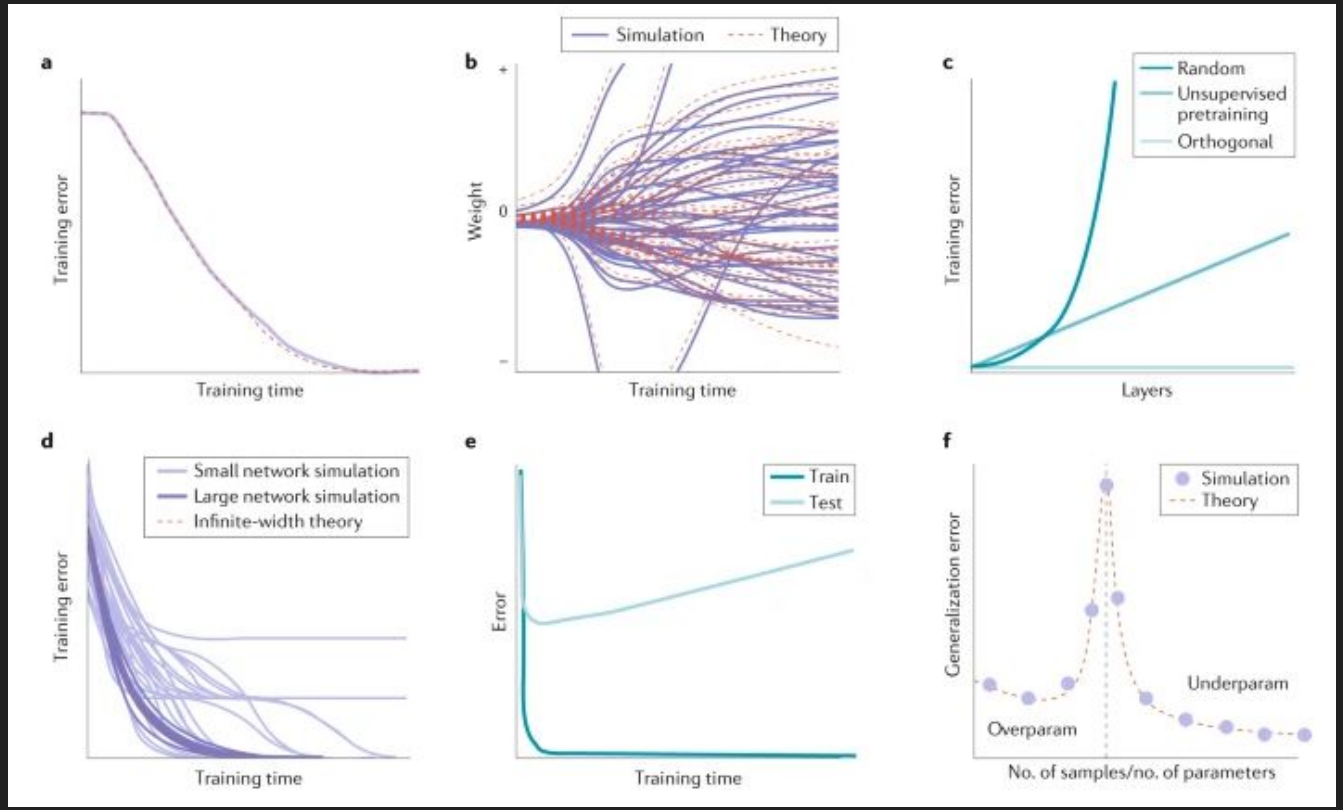


Causal tests of deep learning methods, presenting images to mice to evoke neural activity, and using dnns to predict this activity, then using DNNs to generate the maximally exciting input mage

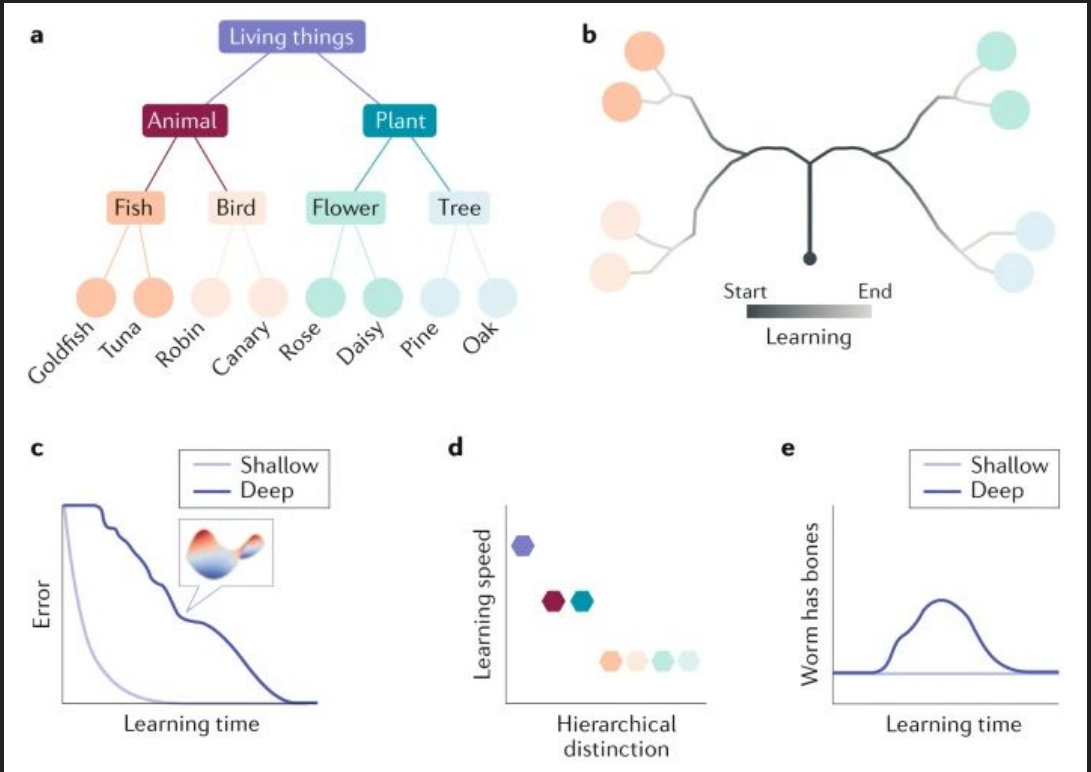
Perceptual Learning



Idealized Models



Developmental Trajectories



Reflections

A lot to be gained, but major work needed on both sides to address gaps!

A rich vein of research, and we are in a wonderful position for it!

Caution against overly complex models and broad conclusions!