Feedforward Deep Neural Networks Diverge from Humans and Monkeys on Core Visual Object Recognition Behavior

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Presentation Abstract Summary A good model of human object recognition should mimic human behavioral responses at its output, including making the same pattern of errors over all images. We applied this straightforward visual Turing test to the leading feedforward computational models of human vision (hierarchical convolutional neural networks, HCNNs) and to a leading animal model (rhesus macaques) by comparing object identity reports for 240 images generated from 24 synthetic objects rendered with viewing parameter variation. Using high-throughput psychophysics in monkeys and humans, we tested all pairwise object discrimination tasks for each image. We observed that monkeys are highly consistent to humans in their image-level pattern of object confusions. Next, we found that all tested HCNNs were significantly less consistent with humans and with monkeys. This gap in consistency at the image level could not be rescued by primate-like retinal input sampling, choice of output decoders, or model training. Crucially, given that objects and images were in no way optimized to be adversarial to HCNNs, these results show that current HCNNs fail to replicate the image-level error patterns of primates. Going forward, high-resolution, image-level behavior could serve as a strong constraint for discovering models that more precisely capture the neural mechanisms of object recognition.

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