Recurrent Convolutional Neural Networks Suppress Occluders and Enhance Targets in Occluded Object Recognition

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Presentation Abstract Summary Feedforward neural networks provide the dominant model of how the brain performs visual object recognition. However, these networks lack the lateral and feedback connections, and the resulting neuronal dynamics, present in the brain. Here we investigate recurrent convolutional neural networks with bottom-up (B), lateral (L), and top-down (T) connections. Combining these types of connections yields four architectures (B, BT, BL, and BLT), which we systematically compare. We find that recurrent neural networks outperform feedforward control models at recognizing objects under varying levels of occlusion. It has been hypothesized that recurrent processing completes feedforward responses that are missing as a result of occlusion. We find that the enhancement of target representations is not explained by completing missing feedforward responses to the target. Instead, our results are consistent with the networks learning dynamics that, after multiple steps of recurrent processing, converge to a response that is invariant to amount of occlusion present in the image. Recurrent neural networks are not only more neurobiologically plausible in their architecture; their dynamics also afford superior task performance. This work shows that computer vision can benefit from using recurrent convolutional architectures and suggests that the ubiquitous recurrent connections in biological brains are essential for task performance.

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