Learning imposes a bottleneck beyond anatomical constraints: a computational investigation into the nature of WM capacity limits

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Abstract

Human working memory (WM) is central to our complex cognitive capacities. Famously, it is limited, and much debate surrounds the nature of this limitation. Anatomical evidence reveals strongly-connected neural populations in PFC allowing robust maintenance. Past work implicates a basal ganglia circuit in WM management. There remain open questions about whether, aside from anatomical 'hard' limits, there are computational 'soft' limits that arise from learning/management bottlenecks. Here, we use computational modeling to tease apart these factors by considering them in isolation: we allow a transformer model trained to do a symbolic WM management task full access to past context, manipulating only the number of concurrent symbols it needs to learn to maintain, controlling for surface complexity. We find that despite having no 'hard' limits, the model shows difficulty in learning that scales with the computational demand, suggesting WM limits in humans may have arisen due to a learning bottleneck.

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