Repetitive Negative Thinking Naturally Emerges in a Model that Learns to Gate Affective Content into Working Memory

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Abstract

Why do we sometimes fall into repetitive negative thinking (RNT) patterns, such as rumination and worry? To address this question, I trained a meta-control model (Todd et al., 2008) on affective working memory (WM) content by providing a reward signal when items (representing thoughts) were gated into WM. The model still facilitated adaptive motor action, as in the original implementation, yet it also exhibited the defining characteristics of RNT. Specifically, its thought became repetitive (because it learned to selectively gate items into working memory); negative (because it persisted in, and only slowly extinguished, gating into WM negatively valenced on-theme and distractor items, respectively); and difficult to control (because, after extensive learning, it had a high chance of selecting the most probable WM gating strategy, irrespective of the value of an exploration parameter). Germane to clinically relevant RNT, such as pathological rumination and worry, the model's thinking was more unproductive when the valence of one thought sequence strongly biased the next one. This work helps to establish meta-control as a formal algorithmic framework for RNT. It may catalyze clinical research on RNT by providing a bridge to computational findings.

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