

Discovering and Teaching Optimal Planning Strategies

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How should we think and decide, and how can we learn to make better decisions? To address these questions we formalize the discovery of cognitive strategies as a metacognitive reinforcement learning problem. This formulation leads to a computational method for deriving optimal cognitive strategies and a feedback mechanism for accelerating the process by which people learn how to make better decisions. As a proof of concept, we apply our approach to develop an intelligent system that teaches people optimal planning strategies. Our training program (see Figure 1a) combines a novel process-tracing paradigm that makes people's latent planning strategies observable with an intelligent system that gives people feedback on how their planning strategy could be improved. The pedagogy of our intelligent tutor is based on the theory that people discover their cognitive strategies through metacognitive reinforcement learning. Concretely, the tutor's feedback is designed to maximally accelerate people's metacognitive reinforcement learning towards the optimal cognitive strategy. A series of four experiments confirmed that training with the cognitive tutor significantly improved people's decision-making competency: Experiment 1 demonstrated that the cognitive tutor's feedback accelerates participants' metacognitive learning (Figure 1b). Experiment 2 found that this training effect transfers to simple training environment shown in Figure 1a more difficult planning problems in more complex environments shown in Figure 1c. Experiment 3 found that these transfer effects are retained for at least 24 hours after the training. These findings are summarized in Figure 1d. Finally, Experiment 4 found that practicing with the cognitive tutor has additional benefits over simply telling people the optimal planning strategy. The results suggest that promoting metacognitive reinforcement learning with optimal feedback is a promising approach to improving the human mind.

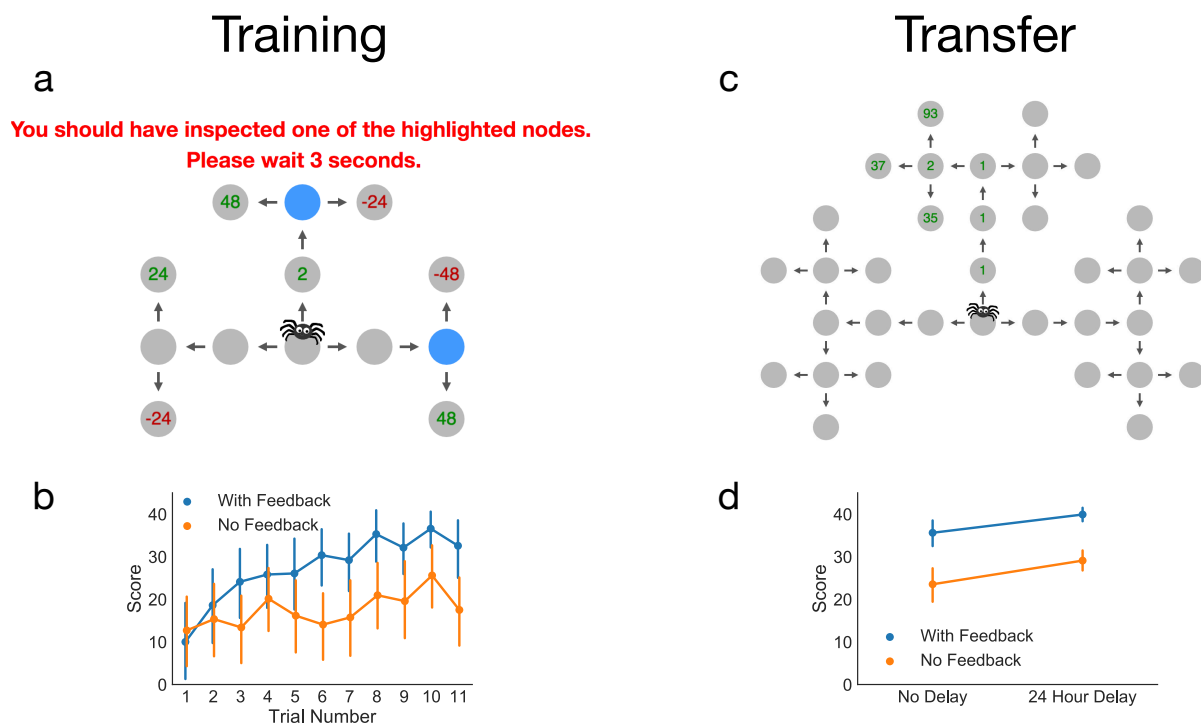


Figure 1: (a) Example feedback from the cognitive tutor in the training phase. (b) Participants learn to achieve high scores faster with the tutor's feedback. (c) A more difficult transfer problem. Feedback is not given in either condition. (d) Participants who received feedback in the training phase outperform control participants when tested immediately or after a 24 hour delay.