

Supporting information for Storm & Angello, “Overcoming Fixation: Creative Problem Solving and Retrieval-induced Forgetting”

*Method*

Seventy-two undergraduate students from the University of Illinois at Chicago participated for course credit in an introductory psychology course. A variant of the retrieval-practice paradigm (Anderson, Bjork, & Bjork, 1994) was administered in the first phase of the experiment to measure retrieval-induced forgetting. The Remote Associate Test (RAT) was administered in the second phase of the experiment to measure creative problem solving. Fixation was manipulated between subjects: half of the participants were exposed to misleading cue-response pairs prior to attempting to solve the RAT problems (fixation condition); half were not (baseline condition).

*Retrieval-induced Forgetting.* The retrieval-practice paradigm involved three phases: study, retrieval practice, and test. In the study phase, participants were presented a list of 48 category-exemplar pairs consisting of six exemplars from each of eight categories (e.g., *fruit: lemon, weapon: rifle, fruit: banana, weapon: sword*). The pairs were presented in a randomized order for 4 s each. Retrieval practice immediately followed. Unlike most studies of retrieval-induced forgetting, retrieval practice did not require the retrieval of exemplars from the original study phase. Rather, participants were required to generate new exemplars associated with four of the studied categories. Participants were shown 24 extra-list category-plus-two-letter-stem cues (e.g., *fruit: ki \_\_\_\_\_*) and were asked to generate exemplars associated with those cues. Retrieval-induced forgetting is consistently observed with this type of semantic generation task (e.g., Bäuml, 2002; Storm, Bjork, Bjork, & Nesotjko, 2006) and, more importantly, this version

of the task more closely resembles the conditions present during problem solving, where one must generate—and not simply retrieve—new and viable solutions. There were three blocks of retrieval practice, with a 1-min interval separating each block. Finally, participants were tested on their ability to retrieve exemplars from the original study phase. All 48 items were tested via category-plus-one-letter-stem retrieval-cues (e.g., *fruit: l\_\_\_\_\_*), presented in random order and for 3 s each. Exemplars associated with practiced categories are referred to as Rp- items and exemplars associated with non-practiced categories are referred to as Nrp items. Retrieval-induced forgetting was measured by comparing the proportion of Rp- items correctly recalled with the proportion of Nrp items correctly recalled.

*Remote Associates Test.* Twenty RAT problems were selected from Mednick and Mednick (1967) and Bowers, Regehr, Balthazard, and Parker (1990). Participants were informed of the nature of the task, given several examples, and were then given 6 min to solve as many problems as possible. The problems were listed on a single sheet of paper, and participants were asked to write their solutions beneath each problem. After 6 min of problem solving, the experimenter collected the sheet and marked those problems that had been answered correctly. Participants were then given a fresh sheet consisting of the same 20 problems, with the problems that had been answered correctly checked off. Participants were told that any prior answers to the non-checked problems were incorrect, and that they would have an additional 6 min to solve those problems. This procedure was repeated for a third block, giving each participant a total of 18 min to solve the problems.

Half of the participants were assigned to the baseline condition, whereas half were assigned to the fixation condition. Participants in the baseline condition simply completed the task described above. Participants in the fixation condition were exposed to cue-response pairs

prior to problem solving. The cue-response pairs were created by taking each of the 60 cue words from the 20 RAT problems and pairing them with a response word of high forward associative strength ( $M = .26$ ,  $SD = .16$ , Nelson, McEvoy, & Schreiber, 1998). Fixation participants studied the 60 cue-response pairs for 3 min and then practiced retrieving the response words given cue-plus-one-letter-stem retrieval cues for an additional 3 min. Participants then attempted to solve the 20 RAT problems as described above. The participants were warned that the previously studied response words would never serve as viable solutions to the RAT problems.

### *Results*

*Fixation.* An independent samples  $t$ -test confirmed that exposure to cue-response pairs caused fixation, impairing performance on the RAT task,  $t(70) = 3.41$ ,  $prep > .99$ ,  $d = .81$ . Participants in the fixation and baseline conditions solved 24% ( $SE = 2\%$ ) and 36% ( $SE = 2\%$ ) of the problems, respectively.

*Retrieval-induced Forgetting.* A significant retrieval-induced forgetting effect emerged such that Rp- items ( $M = 33\%$ ,  $SE = 2\%$ ) were recalled less often than Nrp items ( $M = 39\%$ ,  $SE = 1\%$ ),  $t(71) = 4.33$ ,  $prep > .99$ ,  $d = .51$ . Participants were divided into two groups via median split: the 36 participants (18 fixation; 18 baseline) who demonstrated the most retrieval-induced forgetting (high-RIF), and the 36 participants (18 fixation; 18 baseline) who demonstrated the least retrieval-induced forgetting (low-RIF). Whereas high-RIF participants demonstrated substantial retrieval-induced forgetting ( $M = 16.3\%$ ,  $SD = 7.5\%$ ),  $t(35) = 13.09$ ,  $prep > .99$ ,  $d = 2.18$ , low-RIF participants actually demonstrated significant retrieval-induced *facilitation* ( $M = 3.6\%$ ,  $SD = 7.5\%$ ),  $t(35) = 2.09$ ,  $prep = .97$ ,  $d = 0.49$ .

*Fixation and Retrieval-induced Forgetting.* A regression analysis examined the proportion of RAT problem solving variance explained by fixation, RIF, and the fixation X RIF interaction. The main effects were entered first to assess whether the interaction term could account for significant additional variance. The complete model was significant,  $F(3, 68) = 6.78$ ,  $prep = .99$ ,  $R^2 = .23$ , and, more importantly, so was the fixation X RIF interaction,  $F(1, 68) = 6.97$ ,  $prep = .97$ ,  $\Delta R^2 = .08$ . Thus, the effect of fixation on problem solving was moderated by differences in retrieval-induced forgetting. A 2 (fixation vs. baseline) x 2 (low-RIF vs. high-RIF) between subjects Analysis of Variance (ANOVA) also revealed a significant interaction,  $F(1, 68) = 8.88$ ,  $prep = .99$ ,  $\eta^2 = .12$ . As measured by the difference in performance in the fixation and baseline conditions, low-RIF participants demonstrated a whopping 21% fixation effect,  $t(34) = 4.38$ ,  $prep > .99$ ,  $d = 1.47$ ; whereas high-RIF participants demonstrated a non-significant 2% fixation effect,  $t(34) = 0.45$ ,  $prep = .62$ ,  $d = 0.15$ .

Next we examined performance across the three blocks of problem solving. Cumulative performance on the three blocks is shown in Table 1 as a function of fixation condition for both high-RIF and low-RIF participants. A 2 (high-RIF vs. low-RIF) X 2 (fixation vs. baseline) X 3 (block 1 vs. block 2 vs. block 3) mixed design ANOVA revealed a significant three-way interaction,  $F(2, 136) = 8.50$ ,  $prep > .99$ ,  $\eta^2 = .11$ . The fixation effect became smaller with each successive block of problem solving for high-RIF participants, whereas it became larger with each successive block of problem solving for low-RIF participants. A correlational analysis revealed that, in the fixation condition, the more a participant demonstrated retrieval-induced forgetting, the more that participant increased performance over the final two blocks of problem solving,  $r = .58$ ,  $prep > .99$ . No such correlation was found in the baseline condition,  $r = -.11$ ,  $prep = .67$ .

## References

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Table 1

Cumulative percentage of RAT problems solved correctly (and standard errors) after 6, 12, and 18 min for high-RIF and low-RIF participants as a function of fixation condition.

Fixation Condition Group	Problem Solving Block		
	6 min	12 min	18 min
Baseline			
Low-RIF	23% (2%)	33% (3%)	41% (3%)
High-RIF	18% (2%)	26% (3%)	32% (3%)
Fixation			
Low-RIF	11% (2%)	16% (3%)	19% (3%)
High-RIF	12% (2%)	20% (3%)	30% (3%)