Overcoming Fixation: The Role for Incubation and Inhibition

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THESIS

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I dedicate my thesis to my parents, Ina and Dean. I could never have gotten through this without your continual support and encouragement. Additional thanks to my sister, Amanda, whose determination in her studies have inspired me.

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LIST OF ABBREVIATIONS

RAT	Remote Associates Task
RIF	Retrieval-Induced Forgetting

SUMMARY

Storm and Angello (2010) demonstrated that the inhibitory mechanism underlying retrieval-induced forgetting benefited performance on the Remote Associates Task (RAT; Mednick, 1962) under fixated conditions. They attributed better creative problem solving to the successful inhibition of misleading associates. The current study examined whether an incubation period, defined as a break from conscious problem solving, moderates the relationship between retrieval-induced forgetting and RAT performance. To see how incubation affected this relationship, we provided half of the participants with an incubation period for the RAT problems and tested individual differences in retrieval-induced forgetting. Half of the participants solved each problem continuously for 60 seconds, replicating Storm and Angello. Participants who exhibited more retrieval-induced forgetting solved more problems in the first 30 seconds, and retrieval-induced forgetting continued to predict the proportion of newly solved problems in the final 30 seconds. We also added another condition, in which the other half of the participants solved each problem for 30 seconds, and received a break before seeing all of the problems again for another 30 seconds each. Although participants who exhibited more retrieval-induced forgetting solved more problems in the first 30 seconds (replicating Storm & Angello's findings), retrieval-induced forgetting failed to predict the proportion of newly solved problems in the final 30 seconds. We theorize that incubation allows fixation to subside, thus reducing the need for the mechanism underlying retrieval-induced forgetting to help participants overcome fixation.

I. INTRODUCTION

We are often unable to think of desired information because incorrect information interferes. Sometimes, this incorrect information constrains or *fixates* the scope of our thinking. Fixation has profoundly negative implications across domains in the real world. An older adult may fail to retrieve the name of a new medication during a doctor's visit because they only remember their older medication. Even worse, the individual may not realize when an inappropriate medication name intrudes. A soldier in the field may be unable to recall a weapons technique they learned in training because they are fixated on a similar, but incorrect, technique. Both the older adult and soldier have succumbed to fixation. Although the initial effects of fixation may be inescapable, certain variables improve our ability to eventually overcome it.

Fixation during Problem Solving

Participants often become stuck during creative problem solving due to mental fixation, defined as "counterproductive adherence to a target or an approach" (Smith, p. 143). We can experimentally induce fixation by exposing participants to misleading associates prior to problem solving. Fixation induction increases the likelihood that misleading associates will interfere during problem solving because of their recency or their associations with contextual cues (Smith, 1995). Furthermore, Bristol and Viskontas (2006) suggested that misleading associates are more likely to interfere with the ability to recall remote associates if they are being repeatedly recalled.

Rebus problems are one kind of problem solving paradigm that demonstrate the constraining effects of fixation. Rebus problems are picture-word problems with solutions that

form common phrases or idioms. For instance, a participant may see the problem, *PAINS*, and then generate the common phrase (in this example, *growing pains)* that the problem represents. To generate a correct answer the participant must attend to characteristics of the text such as font size and word order. Rebus problems are especially difficult to interpret because we do not have prior experience focusing on aspects that lead to success. In fact, we learn that the meaning of a sentence is often independent from the way the text is presented. Prior knowledge of grammar, implicit assumptions, and non-dominant word meanings can all cause fixation.

Smith and Blankenship (1989) were able to exacerbate the effects of fixation on rebus problems by presenting misleading clues with the problems. For example, a participant would try to generate *just between you and me* when given the rebus "you just me" in the presence of either a helpful clue or a misleading clue. A helpful clue, such as seeing "between", steered participants closer to the target answer, but a misleading clue like "beside" diverted participants away from the target answer. Participants initially solved rebus problems presented with helpful clues and later solved a rebus problem with a misleading clue. Initially viewing helpful clues taught participants that using clues benefited problem solving. Of course, reliance on the clues induced fixation as soon as a rebus problem was paired with a misleading clue, thus impairing performance.

The constraining effects of fixation are also experienced in the Remote Associates Task (RAT). Mednick (1962) created the RAT to measure creative problem solving ability because he attributed creativity to the ability to access remote associates and combine them in novel ways. Participants solved Mednick's original RAT problems by generating a fourth word that formed a specific type of associative connection with the other three words. The fourth word's connection could be a synonym, common phrase, or closely related word. For example, a participant might

see *broken*, *crystal*, and *eye.* The correct answer, *glass*, forms the phrases *eye glass* and *broken glass,* and *crystal* is a type of glass. Smith and Blankenship (1991) provided evidence that prior exposure to a misleading associate like *ball* (which forms the phrases *crystal ball* and *eye ball*, but does not relate to *broken*), not only fixates participants on the misleading associate but also impairs the ability to generate remote associates. The participant is able to generate the appropriate answer, *glass*, only after distinguishing the correct solution from misleading and inappropriate associates.

Overcoming Fixation and Retrieval-Induced Forgetting

Retrieval-induced forgetting. Retrieval-induced forgetting demonstrates that forgetting information can often be a result of retrieving other information from memory. One explanation of retrieval-induced forgetting is that it is caused by inhibitory processes that act during retrieval. In retrieval-induced forgetting studies, participants learn a number of categories with multiple exemplars. Half of the exemplars from half of the categories are practiced. During retrieval practice, non-target exemplars that share the same category may become activated and compete for retrieval. To facilitate the retrieval of the specific exemplars from a category, a participant may inhibit other competing exemplars from that category. The inhibition of non-target exemplars from practiced categories makes them less recalled than non-target exemplars from non-practiced categories at a later test. Retrieval-induced forgetting is measured by this difference in recall.

Presumably, individual differences in retrieval-induced forgetting reflect individual differences in inhibitory functioning (see Storm & White, 2010; Soriano, Jimenez, Roman, & Bajo, 2009). However, non-inhibitory explanations of retrieval-induced forgetting, notably the blocking account, also exist. The blocking account of retrieval-induced forgetting posits that

target exemplars are strengthened during retrieval practice and, as a consequence, the targets are so strong at final test that they block the ability to recall the other exemplars from that category. It is important to note that the blocking account of retrieval-induced forgetting argues that non-target exemplars from practiced categories are less recalled because target items from that category are strengthened. Although the relative strength of non-target exemplars is weakened in comparison to target exemplars from practiced categories, the strength of the non-target exemplars themselves remains unaffected.

Evidence supports the inhibitory account over interference models of retrieval-induced forgetting. For example, the assumption of competition-dependence (Storm, 2011) posits that non-target competing exemplars are forgotten because they are inhibited during retrieval practice after being activated by a retrieval cue. If a retrieval cue does not activate non-target exemplars then their interference during retrieval is diminished, reducing the need for them to be inhibited. For instance, non-target exemplars that are low in taxonomic strength (e.g., Fruit: Lychee) interfere less during retrieval than those high in taxonomic strength (e.g., Fruit: Apple). Low frequency non-target exemplars like "Lychee" have a weaker association to the category "Fruit" than high frequency non-target exemplars like "Apple". Because low frequency non-target exemplars like "Lychee" are not prepotent responses, there is less need to inhibit them. Subsequently, these exemplars show less forgetting (Anderson, Bjork, & Bjork, 1994).

Retrieval-induced forgetting is also strength-independent, meaning the impairment of non-practiced competing exemplars is unrelated to the extent practiced exemplars are strengthened (Anderson et al., 1994; Anderson, Bjork, & Bjork, 2000; Bäuml, 2002). The activation of non-target exemplars in response to a retrieval cue creates competition, which inhibition is recruited to reduce. Bäuml (2002) found that generating practiced exemplars during

retrieval practice caused forgetting, but re-presenting practiced exemplars during retrieval practice did not. He argued that the lack of forgetting in the re-presentation condition occurred because re-presentation did not induce enough competition to elicit inhibition. Moreover, inhibition is contingent upon the retrieval attempt and is unrelated to the success of retrieval. Both successful and unsuccessful retrieval result in forgetting for non-practiced competing exemplars (Storm, Bjork, Bjork, & Nestojko, 2006). Unsuccessful retrieval predicts later forgetting just as well as successful retrieval because it is the *act* of attempting retrieval, not necessarily *successful* retrieval, which elicits inhibition to resolve competition.

Retrieval-induced forgetting and problem solving. Individuals who show more retrieval-induced forgetting have more success in problem solving under fixated conditions (Storm & Angello, 2010). Storm and Angello examined the relationship between individual differences in retrieval-induced forgetting and RAT performance under fixated and non-fixated conditions. In the first phase of the experiment, participants completed a variant of the retrieval-induced forgetting paradigm that required extra-list generation during retrieval practice (Bäuml, 2002; Storm, et al., 2006). Instead of retrieving exemplars from the original study phase during retrieval practice (as in the standard paradigm), participants generated exemplars for half of the categories when provided extra-list category-plus-two-letter-stem cues. This paradigm consistently demonstrates retrieval-induced forgetting. More importantly, the semantic generation (as opposed to retrieval) involved in retrieval practice is more similar to solution generation during problem solving.

In a separate phase of the experiment, participants solved RAT problems. Prior to attempting to solve the problems, fixation was induced for half of the participants by exposing them to misleading associates prior to the RAT. Participants had three minutes to study a sheet

of paper that included all 60 RAT cue words paired with 60 misleading associates. Following study, participants had three minutes to retrieve the misleading associates when given the RAT cue-plus-one-letter-stem of the misleading associate. The other half of participants was not exposed to any misleading associates. Then participants were given one sheet of paper with all 20 RAT problems. The participants had six minutes of problem solving followed by corrective feedback. The problem solving/feedback cycle occurred two more times.

Storm and Angello (2010) reasoned that if retrieval-induced forgetting demonstrated the ability to inhibit non-target competing responses, individuals who exhibit more retrieval-induced forgetting would solve more problems. When misleading associates compete with other associates in memory during problem solving, inhibition can reduce the accessibility of misleading associates. Successfully inhibiting misleading associates may increase the probability of generating the correct answer. Similarly, during the retrieval practice phase of retrieval-induced forgetting, inhibition is assumed to reduce interference caused by non-target exemplars from practiced categories, making them less recallable than exemplars from non-practiced categories at final test. Retrieval-induced forgetting measures this difference in recall between non-target exemplars from practiced categories and exemplars from non-practiced categories. Thus, better RAT performance and retrieval-induced forgetting may be a result of inhibitory processes that reduce interference from inappropriate items during generation. Hence, individuals who demonstrate more retrieval-induced forgetting should also be more successful at overcoming fixation on the RAT.

Storm and Angello (2010) found that individuals who exhibited less retrieval-induced forgetting suffered more from fixation. They concluded that participants who exhibited more retrieval-induced forgetting solved more problems because they were better able to overcome

fixation. Additionally, a median split analysis that divided participants into those who exhibited the least and the most retrieval-induced forgetting revealed that as participants continued to try to solve RAT problems, those who exhibited the most retrieval-induced forgetting suffered increasingly less fixation than those who exhibited the least retrieval-induced forgetting. Importantly, more retrieval-induced forgetting did not benefit RAT performance under non-fixated conditions. Inhibition helps individuals overcome fixation, which is not necessarily useful if fixation is not induced.

Storm and Angello's (2010) arguments are bolstered by recent work done by Storm, Angello and Bjork (2011), which showed that attempting to solve a RAT problem caused the forgetting of previously-learned misleading associates. They found that participants recalled fewer items that served as misleading associates for RAT problems as compared to items that did not serve as misleading associates. The problem-solving-induced forgetting effect occurred when generating a solution caused the forgetting of previously learned misleading associates. Storm, Angello and Bjork proposed that participants inhibited competing misleading associates during problem solving to decrease fixation. The inhibition of related misleading associates remained at a later test, reducing their final recall. Moreover, Storm, Angello and Bjork showed that individual differences in problem-solving-induced forgetting predicted the number of valid solutions a participant generated on a separate set of RAT problems. Individuals who forgot the most misleading associates also solved the most RAT problems.

Overcoming Fixation and Incubation

The results of Storm and Angello (2010) and Storm, Angello and Bjork (2011) show superior RAT performance under fixated conditions for those who demonstrate more retrieval-induced forgetting and problem-solving-induced forgetting. However, we may be able to

decrease interference from misleading associates during the RAT so that individuals who demonstrate less retrieval-induced forgetting will not be at a disadvantage. For example, providing participants with a break during problem solving, known as an incubation period, may reduce the role that inhibition plays in the RAT under fixated conditions.

If a participant becomes fixated during the RAT, time away from the problem has been shown to promote solution generation (Smith & Blankenship, 1989, 1991; Choi & Smith, 2005). Taking a break from conscious problem solving is known as incubation (Wallas, 1926). Incubation effects refer to newly solved problems following incubation (Smith & Blankenship, 1991). The proportion of newly solved problems is generally greater after an incubation period than after a continuous problem solving attempt (Smith & Blankenship, 1991, 1989; Choi & Smith, 2005; but see Jamieson, 1999, for a study where incubation did not benefit problem solving). Moreover, two recent reviews examining incubation and problem solving (Sio & Ormerod, 2009; Dodds, Ward, & Smith, 2003) concluded that incubation benefits problem solving.

The literature is divided regarding the mechanisms responsible for incubation effects. For example, Browne and Cruse (1988) hypothesized that incubation effects are a result of actively working on the problem during the break. Participants consciously decide to covertly solve and think about the problems during the off-task time. Conversely, participants may choose to reduce mental fatigue during incubation by not working on the problem (Posner, 1973).

An incubation period may also work by increasing the "relative activation" of overlooked solutions (Bowers, Regehr, Balthazard, & Parker, 1990; Smith, 1995; Smith & Blankenship, 1991). The forgetting fixation hypothesis (Smith & Blankenship, 1991) theorizes that incubation

effects occur because incubation allows us to forget fixations present in the initial problem representation by weakening the fixed mental set (Smith, 1995; Smith & Blankenship, 1991). Smith bases this theory on the idea that inappropriate, competing solutions become activated and block access to the correct solutions. The only way to generate viable answers is to decrease fixation from blockers; fixation will dissipate when the problem representation changes, in this case, by being forgotten during incubation. In 1998, Smith, Sifonis and Tindell's set-change theory proposed a similar idea. The set-change theory hypothesizes that if the first context is useful for the task, there is a greater probability that the problem will be solved. However, if the first context is less useful, a change in mental context introduces more potential cues and associations. Having available cues dissimilar from the initial, unproductive context increases the probability of completing the task.

Logic of the Current Study

We expect that participants who exhibit more retrieval-induced forgetting will initially perform better on RAT problems under fixated conditions, replicating Storm and Angello (2010). This prediction is based on the theory that the mechanism underlying retrieval-induced forgetting helps individuals overcome fixation. However, the benefit of retrieval-induced forgetting should decrease after incubation. If given an incubation period, the fixation will attenuate, thus reducing the need for the mechanism underlying retrieval-induced forgetting to help individuals overcome fixation. Consequently, individual differences in retrieval-induced forgetting will not predict RAT performance after an incubation period. In fact, for individuals who demonstrate less retrieval-induced forgetting, an incubation period may bring their RAT performance up to the level of individuals who demonstrate more retrieval-induced forgetting.

II. METHOD

Participants

We recruited 128 undergraduates from the Introductory Psychology subject pool at University of Illinois at Chicago. Course credit was given for participation. However, data from 22 participants were not analyzed because they were non-native English speakers (defined as individuals who have not spoken English fluently since before age 6). Non-native English speakers were removed because we wanted all participants to know enough vocabulary and commonly spoken phrases to successfully solve the RAT problems. Additionally, 6 participants were removed from analyses due to prior participation in a different experiment involving the RAT.

Thus, the final sample included 100 native English speakers. Later analysis revealed that participants did not significantly differ on ACT scores or retrieval-induced forgetting by condition (See Table 1).

Design

This experiment examined if the distribution (incubated, non-incubated) of a problem solving attempt moderated the relationship between retrieval-induced forgetting and RAT performance under fixated conditions. Retrieval-induced forgetting was the individual differences measure and distribution was the between-subject variable. Retrieval-induced forgetting scores were collected for all participants. For the distribution of the problem solving attempts, half of the participants solved the RAT problems continuously for 60 seconds (non-incubated condition). The other half of the participants solved each RAT problem for 30 seconds, and received a break before seeing all of the problems again for another 30 seconds each (incubated condition). There were three dependent variables of interest: the proportion of RAT problems solved after 60 seconds, the proportion of RAT problems solved in the first 30

seconds, and improvement scores (the proportion of newly solved RAT problems in the final 30 seconds, as done by Smith & Blankenship, 1991).

Materials

RIF. Storm and Angello's (2010) adapted version of Anderson et al.'s (1994) retrieval-induced forgetting task was used. The study phase included six exemplars from each of eight categories (e.g., Fruit: Apple, Weapon: Gun, Fruit: Lemon, Weapon: Sword), and exemplars belonging to a specific category began with different first letters. The 48 category-exemplar pairs were viewed at a rate of one pair every four seconds. During retrieval practice, each participant generated six new exemplars for each of four categories. In total, 24 extra-list category-plus-two-letter-stem cues (e.g., Fruit: Ba_____) were provided. Thus, each participant had 24 non-practiced exemplars from practiced categories (Rp- items), and 24 non-practiced exemplars from non-practiced categories (Nrp items). Exemplars were counterbalanced such that each exemplar had the same chance of being in each experimental condition across participants.

RAT. Like Storm and Angello (2010), this study used 20 RAT problems (shown in Appendix A) from Mednick's (1962) version of the RAT task. Participants viewed problems on a computer using Microsoft PowerPoint. Each RAT problem contained three cue words that were a synonym, formed a common phrase, or were closely related word to a target response. There were four orders of the RAT problems using blocked randomization with counterbalancing of position.

Fixation induction. Prior to problem solving, fixation was induced for all RAT problems by presenting misleading associates to participants (see Appendix A). The 60 misleading associates were taken from Storm and Angello (2010) or created by the experimenter. All misleading associates had high forward associative strength with the RAT cue words (M = .21,

SD = .17, Nelson, McEvoy, & Schreiber, 1998), but never served as target responses. Importantly, none of the misleading associates were stimuli in the RAT or retrieval-induced forgetting phases of the experiment. Participants received one sheet of paper with all 60 RAT cue words paired with the 60 misleading associates (see Appendix B).

The misleading associates recall material was also based on Storm and Angello (2010), except this study added an extra round of recall to maximize fixation induction. Two sheets of paper were used to induce fixation. The first sheet presented the RAT cue words in alphabetical order; each RAT cue word was paired with the two-letter stem of its misleading associate (see Appendix C). The second sheet was the same as the first but only presented the RAT cue words (see Appendix D).

Incubation tasks.

Card rotations test. Parts 1 and 2 of the card rotations task (Kit of Factor-Referenced Cognitive Tasks; Ekstrom, French, Harman, & Dermen, 1976) were administered. Each part is comprised of 10 items presented on a sheet of paper. Participants were instructed to determine whether a shape was the same or different than other rotated shapes. (See Appendix E for exact Instructions and Parts 1 and 2.)

Paper folding task. Part 1 of the paper folding task (Kit of Factor-Referenced Cognitive Tasks; Ekstrom, French, Harman, & Dermen, 1976) was administered. The part is comprised of 10 items presented on a sheet of paper. Participants were instructed to determine what a hole-punched, folded sheet of paper would look like unfolded. (See Appendix F for exact Instructions and Part 1.)

Procedure

A script of the full procedure is included in Appendix H. Before beginning the experiment, all participants completed the Informed Consent. Participants then took part in the retrieval-induced forgetting paradigm. This was followed by RAT problem solving, which included fixation induction, RAT problems and incubation tasks (see Figure 1 for a schematic of the experiment).

Retrieval-induced forgetting. After completing the informed consent, the participant experienced the same retrieval-induced forgetting paradigm Storm and Angello (2010) administered (see Appendix I for instructions and example stimuli). In the study phase, the participant learned 48 category-exemplar pairs on the computer screen at a rate of one pair every four seconds. The pairs were presented in a randomized order, but two consecutive pairs were always from a different category.

Immediately following the study phase, participants generated six exemplars for each of four categories during retrieval practice. The participant said their answer out loud to the experimenter, who recorded the answers. The participant had 5 seconds to generate an extra-list exemplar when given a category-plus-two-letter stem cue; there were three blocks of this retrieval practice. Each block immediately followed the preceding block and contained a different randomized presentation order of cues.

After retrieval practice, the participant immediately took a category-plus-one-letter-stem cued-recall test for all 48 category-exemplar pairs from the study phase. The cued-recall test controlled for output interference. The participant had 3 seconds to respond to each cue out loud. Retrieval-induced forgetting was calculated by comparing the difference in recall between non-

practiced exemplars from practiced categories and non-practiced exemplars from non-practiced categories. More retrieval-induced forgetting was indicated by positive numbers.

RAT problem solving.

Fixation induction. After the retrieval-induced forgetting paradigm all participants underwent fixation induction, which involved learning and being tested on misleading associates. Participants learned one misleading associate for each RAT cue word and were then tested on their memory for all the misleading associates. They were told that they had four minutes to study the cue-response pairs in preparation for a later test. Immediately following the learning phase, there were two rounds of recall. In the first round, the participant had three minutes to recall as many responses as possible when given the cues plus two-letter stems of the associated responses. The participant immediately began the second round and had two minutes to recall all of the misleading associates using only the RAT cue word. No feedback was provided.

RAT. Immediately following fixation induction participants began the RAT phase of the experiment. Storm and Angello's (2010) procedure may have allowed participants to take breaks while problem solving, thus, we changed the presentation format of the RAT. First, the participant received instructions on how to solve RAT problems (see Appendix J for instructions and examples). The participant was told that each RAT problem consists of three words. They must generate an answer that is a synonym, forms a common phrase, or is a closely related word to each RAT word. For example, a participant might see *mouse, sharp,* and *blue* simultaneously on the computer screen. The correct answer, *cheese,* makes the phrase *blue cheese, sharp* is a type of *cheese*, and a *mouse* is associated with *cheese.* The participant was told to say the best possible answer at any time out loud to the experimenter, who recorded all responses and their corresponding response times using a separate computer program. The participant was told how

much time each RAT problem would be on the screen and to continue to think of alternative solutions until time ran out. Participants were also told that the experimenter would not say whether their response was correct or incorrect because they did not know the answers. The instructions were followed by one example of a RAT problem accompanied by the correct answer and explanation. Then the participant attempted to solve three practice RAT problems with feedback. Finally, participants were told that the words they were about to see were from earlier studied word pairs, but the correct answer was never one of the learned word pairs.

After their introduction to RAT problems, the participant viewed all 20 RAT problems one at a time. If a participant was in the non-incubated condition, they saw each of the 20 RAT problems on a computer screen for 60 seconds. If a participant was in the incubated condition, they saw each of the 20 RAT problems for 30 seconds. A RAT problem disappeared from the screen and the next problem appeared regardless of whether a participant generated the correct response. No feedback was provided.

After viewing the 20 RAT problems, all participants had a 12 minute period filled with a card rotation test and a paper folding task. First participants had 3 minutes to complete Part 1 and then 3 more minutes to complete Part 2 of the card rotations test after reading the instructions for 1.5 minutes. Then participants read instructions for 1.5 minutes for the paper folding task; this was followed by 3 minutes to work on Part 1. The length of the delay and the interpolated tasks were based on Wiley's (1998) study which found significant incubation effects during RAT problem solving using a mental rotation task, anagrams, and gestalt completion. It is important to note that the exact duration of the delay between the first and second presentation of a RAT problem was 22 minutes. This included 12 minutes of incubation tasks and 10 minutes of problem solving.

If a participant was in an incubated condition, they unexpectedly received a second chance to solve each RAT problem. Specifically, they were told they would have 30 more seconds to generate the best solution for each RAT problem and that the additional solution time was unrelated to previous performance. The RAT problems were presented in the same order as the first problem solving attempt to control for the time between the first and second problem solving attempts. No feedback was provided.

Participant information. Finally, the participant was asked for demographic information including their age, native language, second language experience and ACT or SAT scores. Other information pertaining to the experiment was also collected (see Subject Information sheet in Appendix G for exact questions). This was followed by debriefing.

III. RESULTS

The current study examined whether the distribution (incubated, non-incubated) of a problem solving attempt moderated the relationship between retrieval-induced forgetting and RAT performance. To determine how individual differences in retrieval-induced forgetting predicted RAT performance, we examined this relationship after 60 seconds of problem solving, after the first 30 seconds of problem solving, and in the final 30 seconds of problem solving. Analyses examining response times and intrusions as dependent variables were not significant (refer to Appendix K for a brief analysis and discussion of this data).

Retrieval-Induced Forgetting

Participants exhibited a significant amount of retrieval-induced forgetting such that Rp- items (M = 32.9%, SE = 1.3%) were recalled significantly less than were Nrp items (M = 39.6%, SE = 1.2%), $t(99) = 5.47$, $p < .001$, $d = .55$.

Additionally, a correlational analysis examined the relationship between ACT composite scores and retrieval-induced forgetting scores to ensure that differences in retrieval-induced forgetting did not reflect a difference in academic ability. Results did not indicate a significant correlation between ACT composite scores and retrieval-induced forgetting, $r = .11$, $p = .30$, such that participants who exhibited more retrieval-induced forgetting received similar ACT composite scores as participants who exhibited less retrieval-induced forgetting.

Problem Solving Performance

In the non-incubated condition, participants solved significantly more RAT problems after the final 30 seconds of problem solving ($M = 30.6\%$, $SE = 2.41\%$) than after the first 30 seconds of problem solving ($M = 24.7\%$, $SE = 2.42\%$), $t(98) = 7.60$, $p < .001$, $d = 1.08$. This pattern was also present in the incubated condition because participants solved more RAT problems after the final 30 seconds of problem solving ($M = 35.1\%$, $SE = 2.09\%$) than after the first 30 seconds of problem solving ($M = 23.7\%$, $SE = 1.89\%$), $t(98) = 10.05$, $p < .001$, $d = 1.45$.

Problem Solving Improvement

Improvement scores analyzed the proportion of newly solved problems during the final 30 seconds of the RAT (as done by Smith & Blankenship, 1991). Improvement scores were significantly greater in the incubated condition ($M = 15.2\%$, $SE = 1.5\%$) than in the non-incubated condition ($M = 8.0\%$, $SE = 1.0\%$), $t(98) = 9.95$, $p < .001$, $d = .55$, thus replicating prior work that an incubation period benefits problem solving more than continuously working.

Retrieval-Induced Forgetting and Problem Solving

Overall problem solving performance. A regression analysis examined the amount of variance in the number of RAT problems solved (after 60 seconds) that was explained by retrieval-induced forgetting, being in an incubated or non-incubated condition, and the Retrieval-

Induced Forgetting x Condition interaction. The full model was significant $F(3, 96) = 4.07$, $p = .009$, $R^2 = .11$. Although retrieval-induced forgetting predicted a significant amount of the variance in problem solving performance, $\beta = .40$, $t(96) = 2.83$, $p = .006$, the condition did not, $\beta = .17$, $t(96) = 1.56$, $p = .12$. Moreover, the Retrieval-Induced Forgetting x Condition interaction (entered separately into the model as a second step) did not account for additional variance, $F(3, 96) = 1.13$, $p = .29$, $\Delta R^2 = .01$.

A correlational analysis further examined the relationship between the number of RAT problems solved after 60 seconds and retrieval-induced forgetting. Results showed that in the non-incubated condition, participants who exhibited more retrieval-induced forgetting solved more RAT problems than participants who exhibited less retrieval-induced forgetting, $r = .37$, $p < .01$. However, in the incubated condition, there was no relationship between RAT performance and retrieval-induced forgetting, $r = .21$, $p = .14$. Overall RAT performance is shown in Figure 2 as a function of retrieval-induced forgetting for each condition.

First 30 seconds of problem solving. A regression analysis examined the amount of variance in the number of RAT problems solved in the first 30 seconds that was explained by retrieval-induced forgetting, being in an incubated or non-incubated condition, and the Retrieval-Induced Forgetting x Condition interaction. The full model was significant, $F(3, 96) = 2.75$, $p = .047$, $R^2 = .08$. Additionally, retrieval-induced forgetting explained a significant amount of the variance in problem solving performance, $\beta = .32$, $t(96) = 2.26$, $p = .03$. However, being in an incubated or non-incubated condition did not explain a significant amount of variance in problem solving performance, $\beta = -.03$, $t(96) = .31$, $p = .76$. The Retrieval-Induced Forgetting x Condition interaction (entered separately as a second step) also did not account for any additional variance, $F(3, 96) = .19$, $p = .67$, $\Delta R^2 = .002$.

A correlational analysis examined the relationship between the number of RAT problems solved in the first 30 seconds and retrieval-induced forgetting. Replicating Storm and Angello (2010), the results showed that participants who exhibited more retrieval induced forgetting solved more RAT problems than participants who exhibited less retrieval-induced forgetting in the non-incubated condition, $r = .28$, $p < .05$, and in the incubated condition, $r = .28$, $p = .05$. RAT performance for the first 30 seconds is shown in Figure 3 as a function of retrieval-induced forgetting for each condition.

Final 30 seconds of problem solving. A regression analysis examined the amount of variance in improvement scores that was explained by retrieval-induced forgetting, being in an incubated or a non-incubated condition, and the Retrieval-Induced Forgetting x Condition interaction. The full model was significant $F(3, 96) = 6.35$, $p = .001$, $R^2 = .17$. Also, being in an incubated or non-incubated condition explained a significant amount of the variance in the number of RAT problems solved, $\beta = .43$, $t(96) = 4.03$, $p < .01$. Retrieval-induced forgetting trended toward predicting a significant amount of the variance in problem solving performance, $\beta = .24$, $t(96) = 1.81$, $p = .07$. However, the Retrieval-Induced Forgetting x Condition interaction (entered separately as a second step) did not account for a significant amount of variance, $F(3, 96) = 1.82$, $p = .18$, $\Delta R^2 = .02$.

A correlational analysis further examined the relationship between improvement scores and retrieval-induced forgetting. Results showed that in the non-incubated condition, participants who exhibited more retrieval induced forgetting had greater improvement scores than individuals who exhibited less retrieval-induced forgetting, $r = .32$, $p = .03$. However, in the incubated condition, there was no relationship between improvement scores and retrieval-induced forgetting; participants who exhibited more retrieval-induced forgetting did not have

greater improvement scores than participants who exhibited less retrieval-induced forgetting, r = -.01, p = .96. Improvement scores are shown in Figure 4 as a function of retrieval-induced forgetting for each condition.

Factors Predicting Performance in the Final 30 Seconds

In a final analysis, a hierarchical regression analysis examined which factors predicted a significant amount of the variance in improvement scores for non-incubated and incubated conditions. Specifically, we wanted to know whether performance during the first 30 seconds or retrieval-induced forgetting was a better predictor of the proportion of newly solved problems during the final 30 seconds. To evaluate the contribution of each predictor, improvement scores were regressed onto RAT performance in the first 30 seconds and retrieval-induced forgetting. Two separate regressions were run for the non-incubated and incubated conditions.

In the non-incubated condition, the total model (both predictors combined) trended toward accounting for a significant amount of the variance, $F(2, 47) = 2.635$, $p = .08$, $\Delta R^2 = .10$. More importantly, retrieval-induced forgetting explained a significant amount of the variance in improvement scores, $\beta = .31$, $t(47) = 2.12$, $p = .04$, but performance during the first 30 seconds of problem solving did not, $\beta = .04$, $t(47) = .24$, $p = .81$. Thus, retrieval-induced forgetting is a better predictor of improvement scores than is success during the first 30 seconds of problem solving in the non-incubated condition. This finding is surprising because a participant's prior performance is less predictive of their later performance on the *same* task than is retrieval-induced forgetting.

By contrast, in the incubated condition, both predictors did not account for a significant amount of the variance, $F(2, 47) = .47$, $p = .62$, $\Delta R^2 = .02$. Moreover, neither retrieval-induced forgetting, $\beta = .05$, $t(47) = .321$, $p = .75$, nor performance during the first 30 seconds, $\beta = .15$,

$t(47) = .97$, $p = .34$, explained unique variance in the improvement scores. It is noteworthy that an incubation period wiped out any variance in the improvement scores explained by retrieval-induced forgetting. Retrieval-induced forgetting only predicted improvement scores in the non-incubated condition; an incubation period attenuated fixation, thus decreasing the need to use the mechanism underlying retrieval-induced forgetting to overcome fixation.

IV. DISCUSSION

Fixation constrains the scope of cognition and hinders the ability to think of creative solutions. Problem solvers have particular difficulty escaping the consequences of fixation, as seen in the RAT when misleading associates interfere with solution generation. However, manipulating and measuring the memory dynamics of creative problem solving informs us of ways to overcome fixation. For example, Bristol and Viskontas (2006) argue that creative problem solving is enhanced by the ability to access and recombine remote associates in memory, but this becomes difficult when stronger, misleading associates interfere. Thus, creativity may be enhanced by attenuating interference from stronger associates. The inhibitory mechanism underlying retrieval-induced forgetting is one mechanism that has been shown to facilitate this process (Storm & Angello, 2010).

An incubation period is another mechanism that has been shown to facilitate this process. Providing an incubation period reduces fixation for all problem solvers, thereby decreasing the need to inhibit misleading associates. Under fixated conditions, an incubation period eliminates the disadvantage for individuals who demonstrate less retrieval-induced forgetting during problem solving. After 60 seconds of problem solving, we found that individuals who exhibit less retrieval-induced forgetting solved fewer RAT problems than individuals who exhibit more retrieval-induced forgetting when there was no incubation period, but they solved a similar

number of problems in the presence of incubation. Incubation presumably equalized performance because individuals who exhibit less retrieval-induced forgetting were able to benefit more from an incubation period. This argument is supported by examining how the distribution of a problem solving attempt affects the relationship between retrieval-induced forgetting and RAT performance in the first 30 second and final 30 seconds of problem solving.

In the non-incubated condition, individuals who exhibited more retrieval-induced forgetting solved more RAT problems in the first 30 seconds than individuals who exhibited less retrieval-induced forgetting. This relationship persisted such that individuals who exhibited more retrieval-induced forgetting had greater improvement scores. In the incubated condition, individuals who exhibited more retrieval-induced forgetting still solved more RAT problems in the first 30 seconds than individuals who exhibited less retrieval-induced forgetting. However, after an incubation period individual differences in retrieval-induced forgetting did not predict RAT performance. In other words, individuals who exhibited more retrieval-induced forgetting did not have greater improvement scores.

Retrieval-induced forgetting may not predict improvement scores after incubation because fixation subsides during the incubation period, reducing interference while problem solving. Incubation attenuates fixation for unsolved problems via an external manipulation that decreases interference from misleading associates; this may occur by providing a change in context, supplying time to forget fixation, etc. Inserting an incubation period in problem solving reduces fixation, mitigating the relationship between individual differences in retrieval-induced forgetting and problem solving. Because the benefits of retrieval-induced forgetting diminish after an incubation period, individuals who exhibit less retrieval-induced forgetting benefit more from incubation than individuals who exhibit more retrieval-induced forgetting.

Retrieval-Induced Forgetting

It is important to note that a blocking account of retrieval-induced forgetting predicts that individuals who exhibit more retrieval-induced forgetting should actually solve *fewer* RAT problems under fixated conditions. The blocking account contends that impaired recall of non-practiced exemplars from practiced categories is caused by strengthened practiced target exemplars blocking the recall of non-practiced exemplars from that category at final test. If blocking underlies retrieval-induced forgetting, individuals who exhibit more retrieval-induced forgetting should also demonstrate more interference from fixation and solve less RAT problems. Individuals who exhibit less retrieval-induced forgetting should solve more problems because they experience less blocking from misleading associates, thus improving their ability to generate viable solutions. However, the results of this experiment illustrated the opposite effects (replicating Storm & Angello, 2010), supporting the inhibitory account of retrieval-induced forgetting over the blocking account.

Research in the literature investigating the competition-dependent nature of retrieval-induced forgetting parallels this study. In retrieval-induced forgetting, inhibition reduces interference from studied exemplars during extra-list retrieval practice (generating new exemplars from studied categories). However, reducing interference from studied exemplars prior to retrieval practice protects studied exemplars from being forgotten! Storm, Bjork and Bjork (2007) used a list-method directed forgetting paradigm and sometimes instructed participants to forget the studied exemplars before retrieval practice. They found that to-be-forgotten exemplars suffered less from retrieval-induced forgetting than to-be-remembered exemplars. Participants who were instructed to forget studied exemplars experienced less interference during retrieval practice, thereby reducing the need to inhibit them. Thus, directed

forgetting protected the to-be-forgotten exemplars from being inhibited because interference during retrieval practice was already attenuated. Similarly, incubation may improve problem solving by reducing interference from previously learned items. Any mechanism that reduces fixation presumably decreases the need for inhibition to overcome fixation.

Future Direction

One follow-up for this study will examine the effect of fixating participants again following incubation. If incubation works by causing individuals to forget fixation then re-exposure to misleading associates should increase interference during the second round of problem solving. Therefore, we expect the positive relationship between retrieval-induced forgetting and problem solving to reappear if participants are re-exposed to misleading associates prior to problem solving after incubation. On the contrary, if incubation does not work by attenuating fixation, re-exposure to misleading associates should not influence improvement scores. That is, incubation may improve problem solving by affecting aspects of the problem that are unrelated to fixation. For example, incubation may improve problem solving by increasing the strength of viable solutions relative to misleading associates. Re-fixation may increase interference from misleading associates, but not enough to compete with strengthened viable solutions. Therefore, the inhibitory mechanism underlying retrieval-induced forgetting would not be needed.

Concluding Comments

Understanding how people are able to overcome fixation is a critical issue in memory research. One way to facilitate memory retrieval is by forgetting inappropriate responses. Storm and Angello (2010) demonstrated that the inhibitory mechanism underlying retrieval-induced forgetting enhances creative problem solving performance under fixated conditions. This is

interesting because inhibition is often judged to *impair* creativity in non-fixated situations (Carson, Peterson, & Higgins, 2003). The juxtaposition of these arguments illustrates the extent to which fixation can dramatically alter memory dynamics. Fixation is damning and extremely harmful to creativity and memory. Mechanisms that reduce interference (e.g., incubation or the inhibitory mechanism underlying retrieval-induced forgetting) alleviate fixation. Exploring the relationship between inhibition and incubation is imperative for enhancing our knowledge about the memory dynamics involved in thinking and remembering.

TABLE I

Retrieval-Induced Forgetting Scores and ACT Composite Scores for Participants in Incubated and Non-Incubated Conditions

Condition	*M (SE)*	*t*	*p*	*d*
Retrieval-Induced Forgetting				
Non-Incubated (n=50)	.06 (.02)	0.89	0.38	0.18
Incubated (n=50)	.08 (.02)			
ACT Composite				
Non-Incubated (n=44)	24.00 (.50)	-0.41	0.68	-0.09
Incubated (n=49)	24.31 (.54)			

Note. Retrieval-induced forgetting is indicated by positive scores. ACT scores are out of a possible 36 points. Statistics (*p-value, t-value* and Cohen's *d* effect size) show the difference between the incubated and non-incubated condition.

FIGURE 1

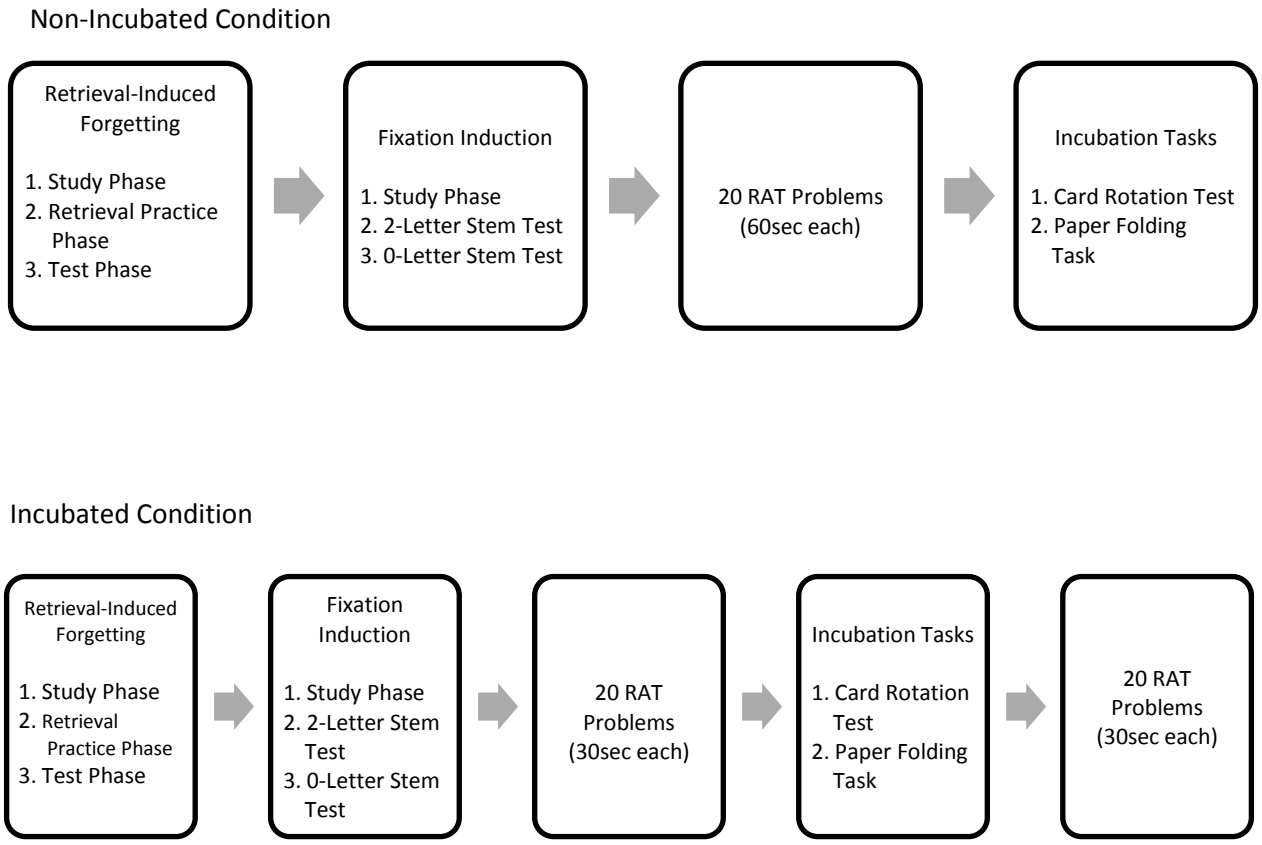

Figure 1. Schematic of the experimental procedure. The top schematic shows the procedure for a participant in the non-incubated condition. The bottom schematic shows the procedure for a participant in the incubated condition.

FIGURE 2

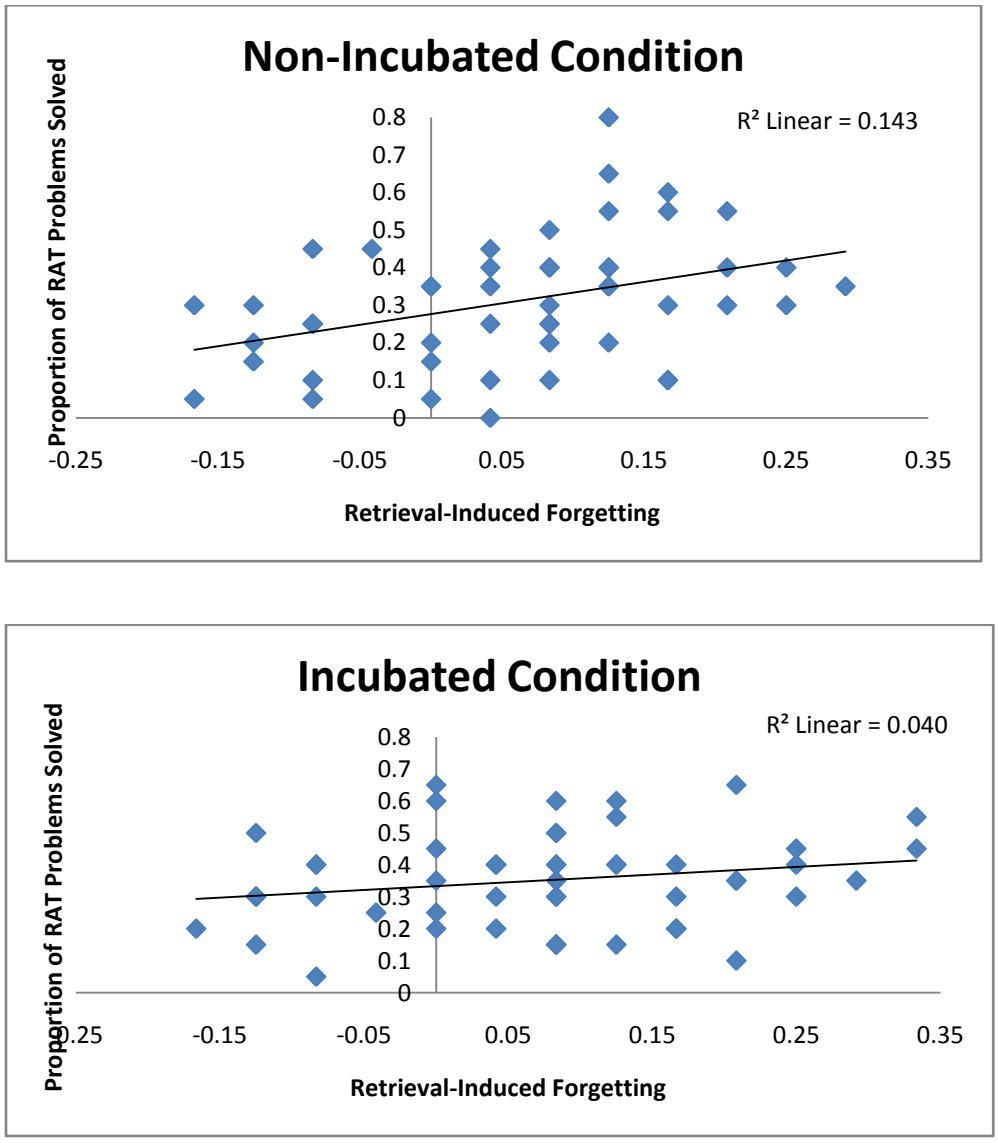

Figure 2. Overall RAT performance as a function of retrieval-induced forgetting. The top panel shows the correlation for the non-incubated condition and the bottom panel shows the correlation for the incubated condition (n = 50). Positive retrieval-induced forgetting numbers indicate more forgetting. Line shows the best fitting linear regression.

FIGURE 3

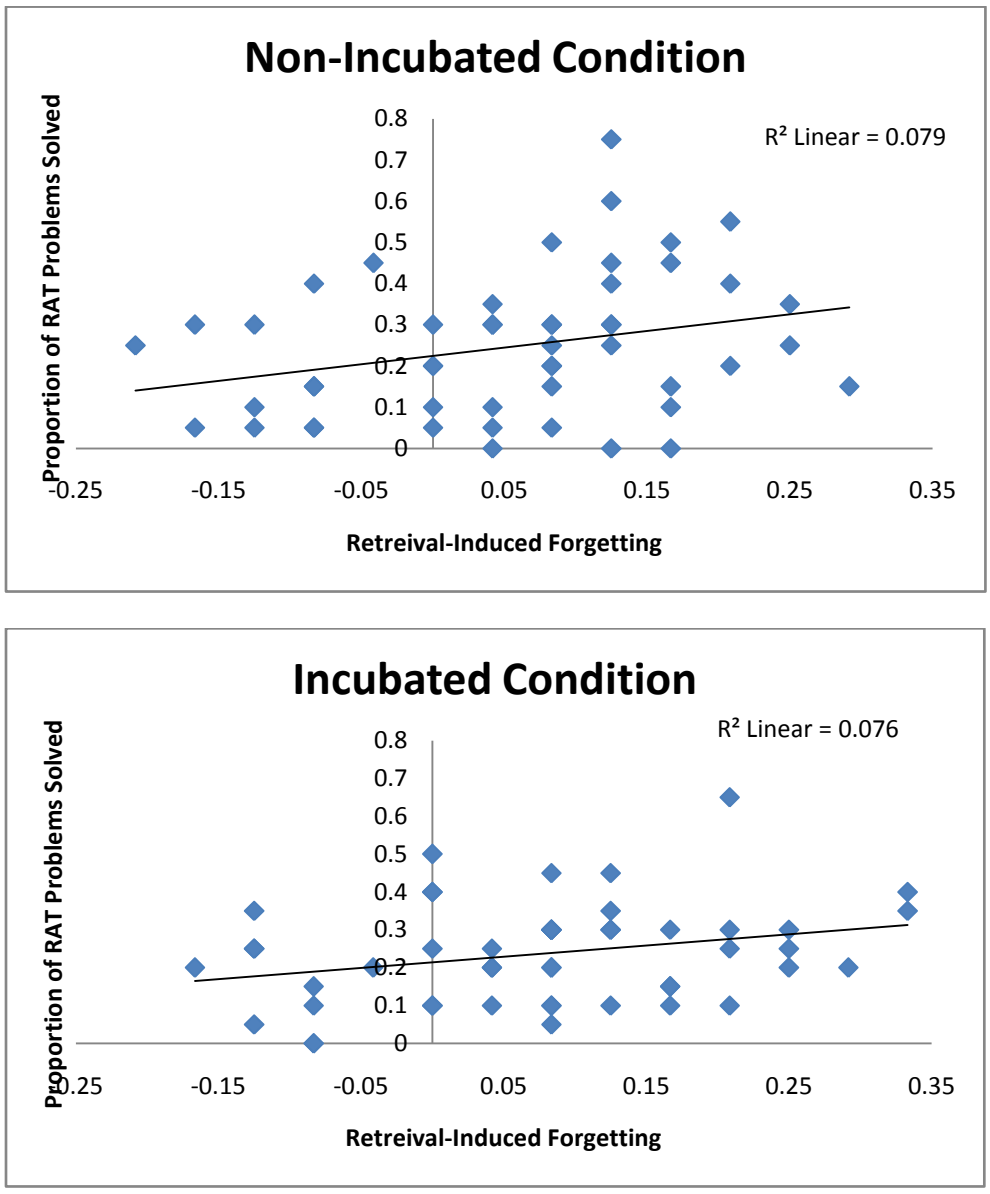

Figure 3. RAT performance in the first 30 seconds of problem solving as a function of retrieval-induced forgetting. The top panel shows the correlation for the non-incubated condition and the bottom panel shows the correlation for the incubated condition (n = 50). Positive retrieval-induced forgetting numbers indicate more forgetting. Line shows the best fitting linear regression.

FIGURE 4

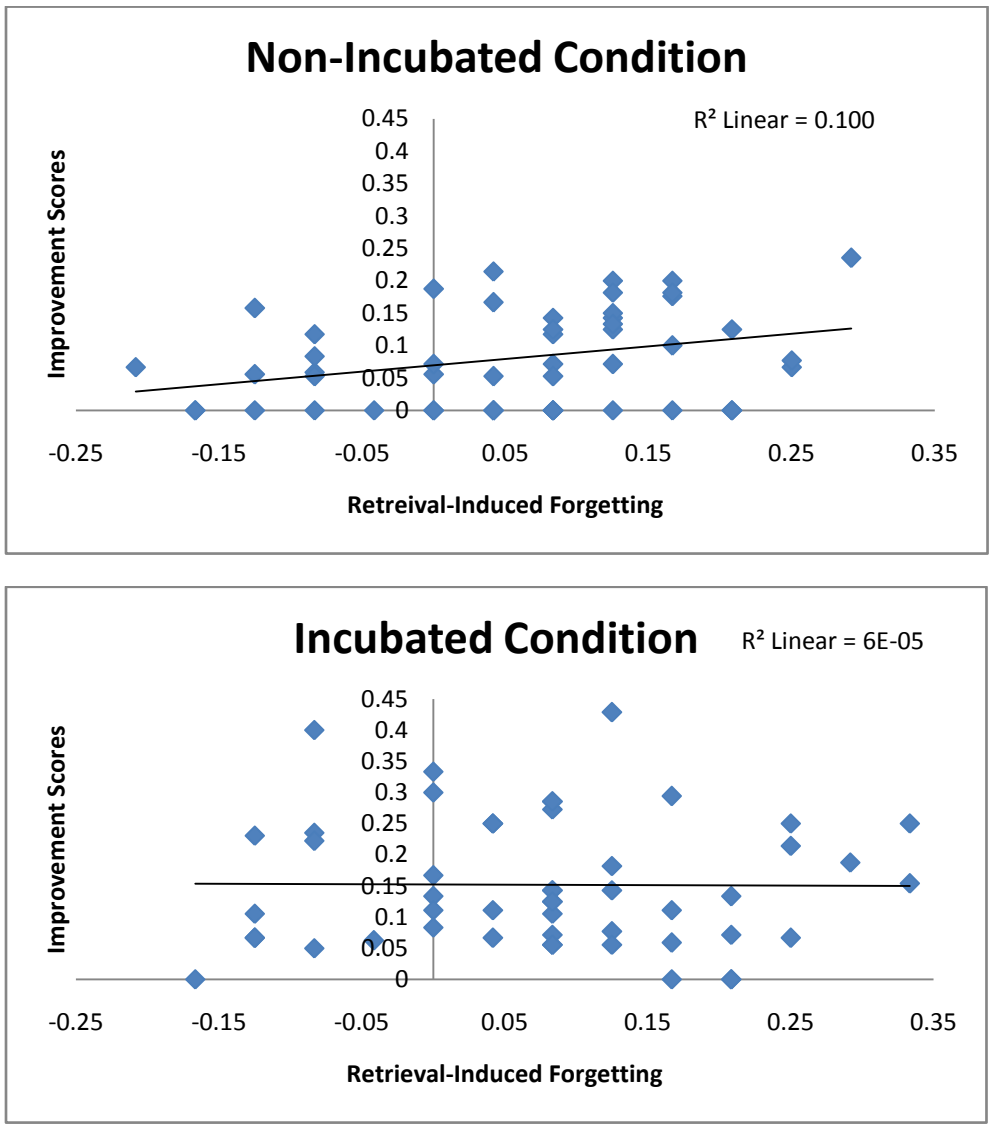

Figure 4. Improvement scores as a function of retrieval-induced forgetting in the non-incubated and incubated conditions. Improvement scores represent the proportion of newly solved problems in the final 30 seconds of problem solving. The top panel shows the correlation for the non-incubated condition and the bottom panel shows the correlation for the incubated condition (n = 50). Positive retrieval-induced forgetting numbers indicate more forgetting. Line shows the best fitting linear regression.

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Appendix A

Remote Associates Task and Paired Associates Stimuli

RAT words, paired associates in parentheses and bolded solutions

Word 1	Word 2	Word 3	Solution
1. Manners (Polite)	Round (Circle)	Tennis (Ball)	**Table**
2. Gold (Jewel)	Stool (Chair)	Tender (Soft)	**Bar**
3. Bald (Hair)	Screech (Yell)	Emblem (Symbol)	**Eagle**
4. Falling (Trip)	Actor (Actress)	Dust (Dirt)	**Star**
5. Chamber (Dungeon)	Staff (Faculty)	Box (Shoe)	**Music**
6. Chocolate (Candy)	Fortune (Rich)	Tin (Can)	**Cookie**
7. Big (Small)	Leaf (Green)	Shade (Color)	**Tree**
8. Widow (Sad)	Bite (Dog)	Monkey (Ape)	**Spider**
9. Walker (Runner)	Main (Gate)	Sweeper (Broom)	**Street**
10. Bass (Fish)	Complex (Hard)	Sleep (Dream)	**Deep**
11. Notch (Belt)	Flight (Airplane)	Spin (Turn)	**Top**
12. Lick (Tongue)	Sprinkle (Rain)	Mines (Rock)	**Salt**
13. Board (Skate)	Magic (Wand)	Death (Life)	**Black**
14. Mouse (Cat)	Sharp (Point)	Blue (Sky)	**Cheese**
15. Cracker (Saltine)	Union (Together)	Rabbit (Bunny)	**Jack**
16. Playing (Fun)	Credit (Hours)	Report (Paper)	**Card**
17. Water (Drink)	Tobacco (Smoke)	Stove (Hot)	**Pipe**

18. Inch (Measure)	Deal (Agreement)	Peg (Leg)	**Square**
19. Broken (Heart)	Clear (Foggy)	Eye (See)	**Glass**
20. Coin (Money)	Quick (Fast)	Spoon (Fork)	**Silver**

Appendix B

RAT words and misleading associates study sheet

Please study the following cue-response pairs. You will later be asked to recall the response word, given the associated cue word.

actor	actress	eye	see	round	circle
bald	hair	falling	trip	screech	yell
bass	fish	flight	airplane	shade	color
big	small	fortune	rich	sharp	point
bite	dog	gold	jewel	sleep	dream
blue	sky	inch	measure	spin	turn
board	skate	leaf	green	spoon	fork
box	shoe	lick	tongue	sprinkle	rain
broken	heart	magic	wand	staff	faculty
chamber	dungeon	main	gate	stool	chair
chocolate	candy	manners	polite	stove	hot
clear	foggy	mines	rock	sweeper	broom
coin	money	monkey	ape	tender	soft
complex	hard	mouse	cat	tennis	ball
cracker	saltine	notch	belt	tin	can
credit	hours	peg	leg	tobacco	smoke
deal	agreement	playing	fun	union	together
death	life	quick	fast	walker	runner
dust	dirt	rabbit	bunny	water	drink
emblem	symbol	report	paper	widow	sad

Appendix C

RAT cue word plus two-letter-stem

Please write down the missing response words...

Pin #: _____

actor	ac_____	eye	se_____	round	ci_____
bald	ha_____	falling	tr_____	screech	ye_____
bass	fi_____	flight	ai_____	shade	co_____
big	sm_____	fortune	ri_____	sharp	po_____
bite	do_____	gold	je_____	sleep	dr_____
blue	sk_____	inch	me_____	spin	tu_____
board	sk_____	leaf	gr_____	spoon	fo_____
box	sh_____	lick	to_____	sprinkle	ra_____
broken	he_____	magic	wa_____	staff	fa_____
chamber	du_____	main	ga_____	stool	ch_____
chocolate	ca_____	manners	po_____	stove	ho_____
clear	fo_____	mines	ro_____	sweeper	br_____
coin	mo_____	monkey	ap_____	tender	so_____
complex	ha_____	mouse	ca_____	tennis	ba_____
cracker	sa_____	notch	be_____	tin	ca_____
credit	ho_____	peg	le_____	tobacco	sm_____
deal	ag_____	playing	fu_____	union	to_____
death	li_____	quick	fa_____	walker	ru_____
dust	di_____	rabbit	bu_____	water	dr_____
emblem	sy_____	report	pa_____	widow	sa_____

Appendix D

RAT cue word without stems

Please write down the missing response words...

Pin #: _____

actor	_____	eye	_____	round	_____
bald	_____	falling	_____	screech	_____
bass	_____	flight	_____	shade	_____
big	_____	fortune	_____	sharp	_____
bite	_____	gold	_____	sleep	_____
blue	_____	inch	_____	spin	_____
board	_____	leaf	_____	spoon	_____
box	_____	lick	_____	sprinkle	_____
broken	_____	magic	_____	staff	_____
chamber	_____	main	_____	stool	_____
chocolate	_____	manners	_____	stove	_____
clear	_____	mines	_____	sweeper	_____
coin	_____	monkey	_____	tender	_____
complex	_____	mouse	_____	tennis	_____
cracker	_____	notch	_____	tin	_____
credit	_____	peg	_____	tobacco	_____
deal	_____	playing	_____	union	_____
death	_____	quick	_____	walker	_____
dust	_____	rabbit	_____	water	_____
emblem	_____	report	_____	widow	_____

Appendix E

Card Rotations Test

Name _____

CARD ROTATIONS TEST — S-1 (Rev.)

This is a test of your ability to see differences in figures. Look at the 5 triangle-shaped cards drawn below.

All of these drawings are of the same card, which has been slid around into different positions on the page.

Now look at the 2 cards below:

These two cards are not alike. The first cannot be made to look like the second by sliding it around on the page. It would have to be flipped over or made differently.

Each problem in this test consists of one card on the left of a vertical line and eight cards on the right. You are to decide whether each of the eight cards on the right is the same as or different from the card at the left. Mark the box beside the S if it is the same as the one at the beginning of the row. Mark the box beside the D if it is different from the one at the beginning of the row.

Practice on the following rows. The first row has been correctly marked for you.

Your score on this test will be the number of items answered correctly minus the number answered incorrectly. Therefore, it will not be to your advantage to guess, unless you have some idea whether the card is the same or different. Work as quickly as you can without sacrificing accuracy.

You will have 3 minutes for each of the two parts of this test. Each part has 1 page. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

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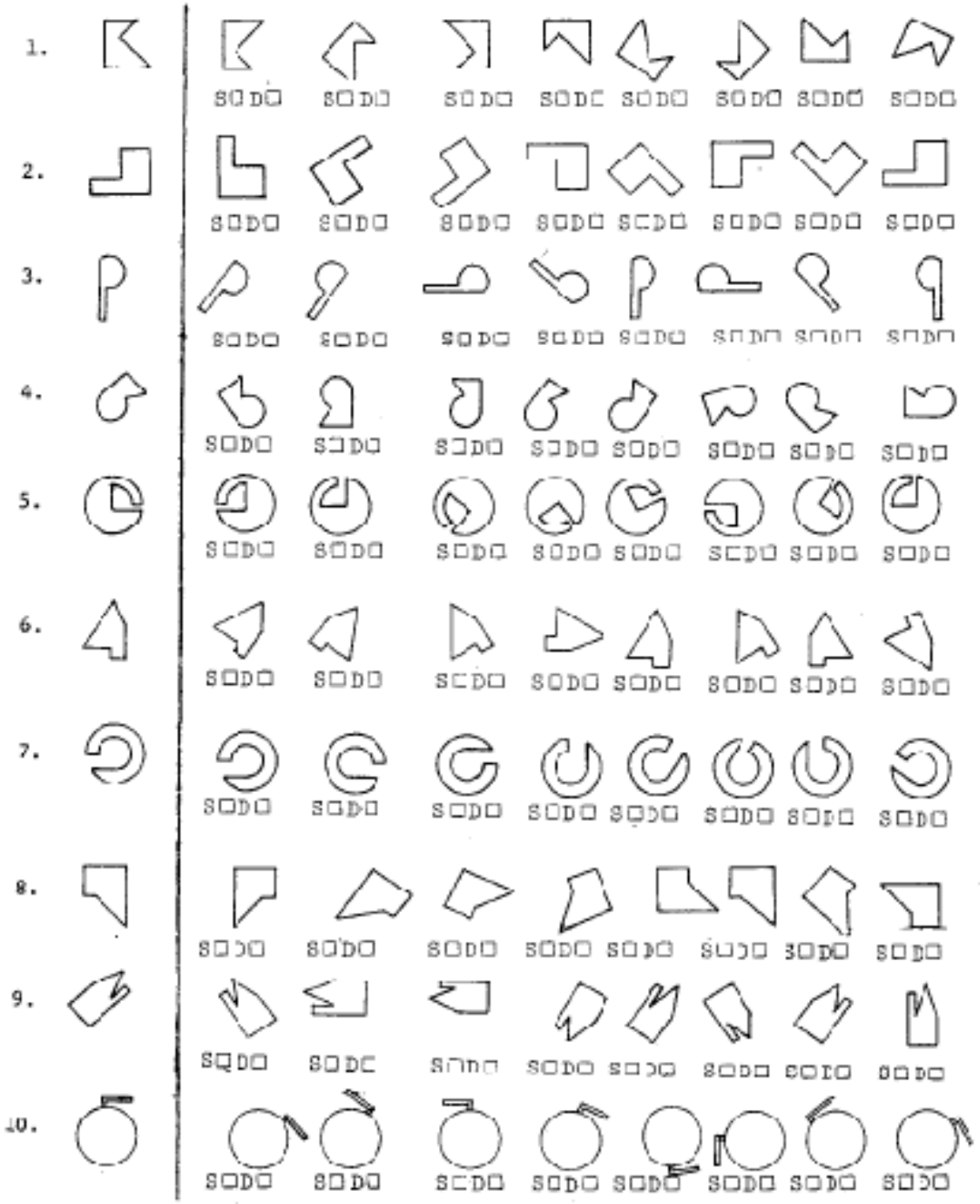
Part 1 (3 minutes)



DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

STOP.

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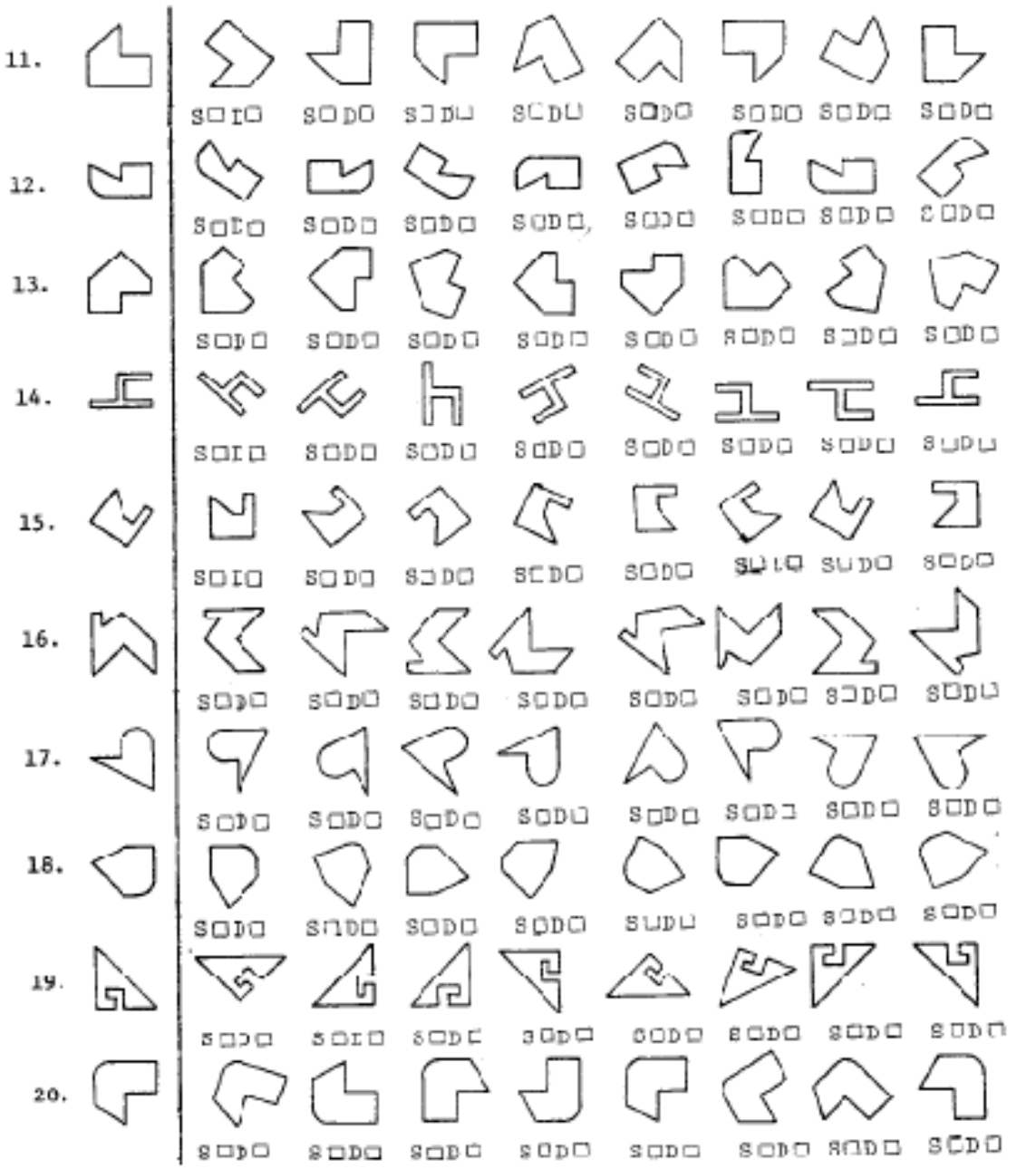
Part 2 (3 minutes)



DO NOT GO BACK TO PART 1 AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO. STOP.

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Appendix F

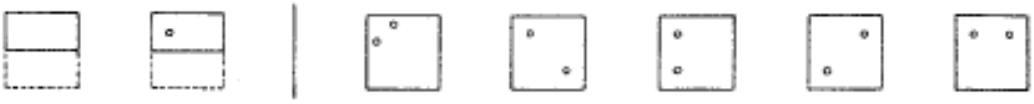
Paper Folding Test

Name _____

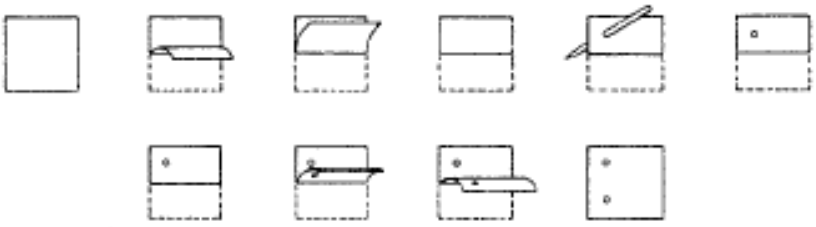
PAPER FOLDING TEST — VZ-2

In this test you are to imagine the folding and unfolding of pieces of paper. In each problem in the test there are some figures drawn at the left of a vertical line and there are others drawn at the right of the line. The figures at the left represent a square piece of paper being folded, and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point. One of the five figures at the right of the vertical line shows where the holes will be when the paper is completely unfolded. You are to decide which one of these figures is correct and draw an X through that figure.

Now try the sample problem below. (In this problem only one hole was punched in the folded paper.)



The correct answer to the sample problem above is C and so it should have been marked with an X. The figures below show how the paper was folded and why C is the correct answer.



In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.

Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 3 minutes for each of the two parts of this test. Each part has 1 page. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

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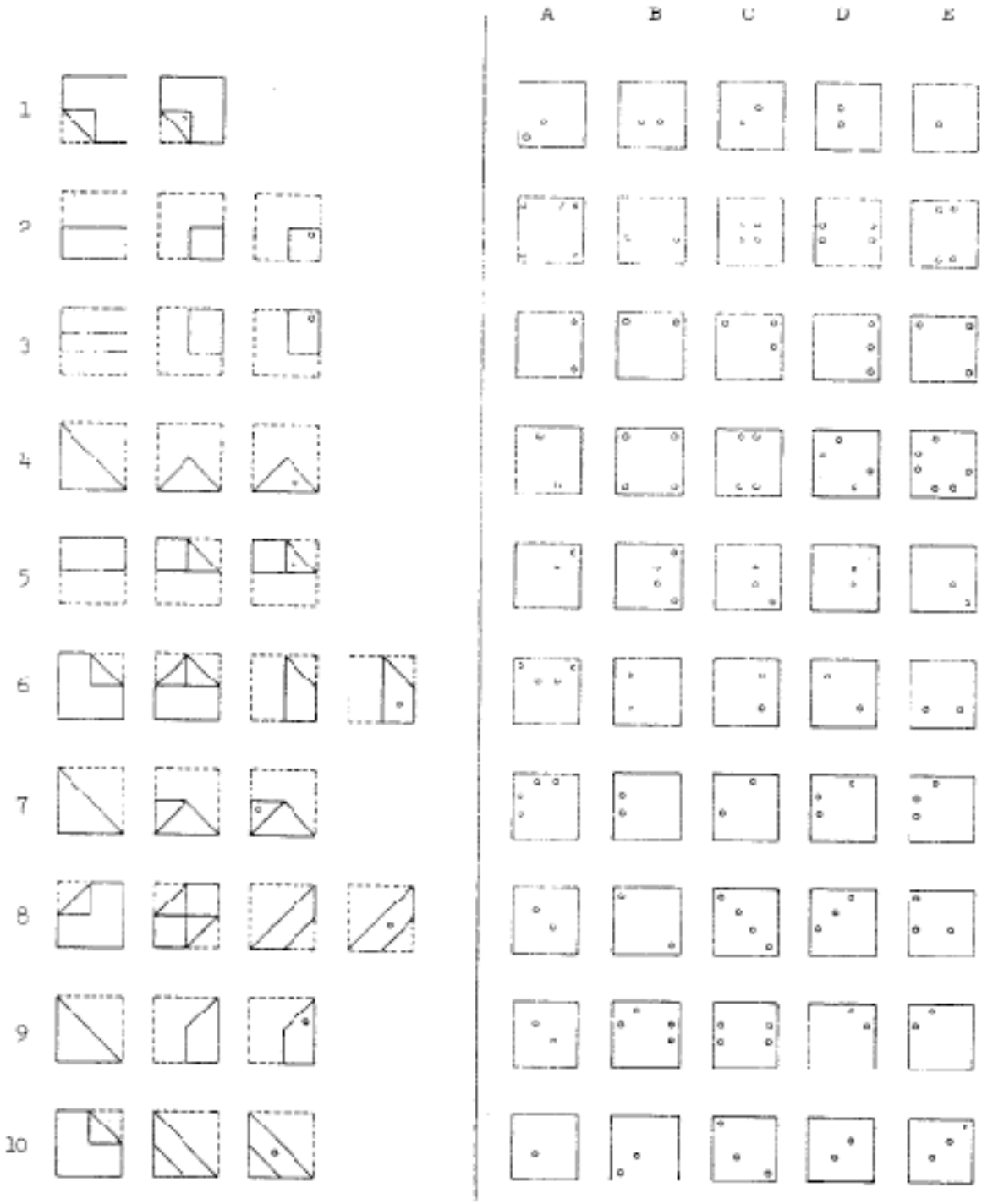
Part 1 (3 minutes)



DO NOT GO ON TO THE NEXT PAGE UNTIL ASKED TO DO SO.

STOP.

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Appendix G

Subject Information

Year/Semester: _____

Sex: m f Age: _____

Year in School: (Freshman, Sophomore, Junior, Senior?) _____

Answer the following to the best of your knowledge:

ACT COMPOSITE Score _____ (0-36) SAT VERBAL Score _____ (0-800)

ACT MATH Score _____ (0-36) SAT MATH Score _____ (0-800)

ACT SCIENCE Score _____ (0-36)

Questionnaire

1. Have you participated in other experiments in this lab? If so, which?

2. Is English the first language you spoke as a child? _____
    a. If not, what is the first language you spoke as a child? _____
    b. How long have you spoken English fluently? _____
    c. What would you rate your English proficiency on a scale of 1-10? _____
    d. Are there any other languages you have spoken since you were a child? If so, which language? _____
    e. Do you speak any other languages? If so, which? _____ ; _____
        i. How long have you spoken this language? _____
        ii. What is your proficiency in this language on a scale of 1-10? _____

3. What did you think about the second time you saw some of the word problems?

4. If you had to guess, what do you think this experiment was about?

Comments:

_____

_____

_____

_____

Appendix H

Master's Project (Spring 2011) Instructions

Setup:

1. Try to arrive 5-10 minutes early to set up the experiment.
2. Get each of the following and put them on a clipboard for yourself:
    a. Top experiment packet in the RIF-RAT drawer (includes subject information sheet, the 3 misleading associates cue-response sheets and the 6 incubation tasks sheets.)
    b. Informed Consent (on the right wall of the main lab)
    c. Debriefing Sheet (also on the right wall of the main lab)
3. Make sure you have the second screen in the room pointed toward you so the participant cannot see it. On this screen, open up the "RIF-RAT" folder and then open the RAT timer. Set the timer from 0sec to 61sec for the "60" condition, or 0sec to 31sec for the "30" condition. Make sure the "Repeat" button is clicked on.
4. Log onto the computer. Open up the Experiment folder. Turn on/up the sound.
5. Double check the participant information on Pecolsus before the participant arrives.
    a. Log onto Pecolsus. In the first screen, type "rrr" for the NetID and "rrr" for the Password. In the second screen (Researcher's Log-In) type "rkoppe2" for the NetID and "forgetting" for the Password. Make sure you are looking at Study #228.

After the participant arrives:

6. Check the PIN number with Pecolsus. Make sure we are running the correct person ☺
7. Give Informed Consent sheet. Go over what it means. Double check if they understand that the Informed Consent tells them the rights they have as a participant. Have them sign/print and date. Then, you sign and date the sheet. Then, write an 'R' and the date in the bottom right hand corner of the top sheet, in case I need to quickly identify my sheets later on. Also mark F (female) or M (male) and 1.5 on the front of the packet. Put the Informed Consent in the bottom drawer labeled "Rebecca's Informed Consents" to the right of the main computer.
8. Ask the participant politely if they will turn off their cell phone for the duration of the experiment.

Starting the Experiment:

RIF

1. Go to the "RIF-RAT" folder in the "Running Experiments" folder.
2. Right click and select "Show" on the "**RIF Learning"** phase PowerPoint.
3. Walk through the instructions with the participant. Read the slides slowly and press the spacebar to go onto the next direction slide. When you get to the example, the computer will move the slide after 3 seconds. However, following this slide you will need to press the spacebar to continue the instructions. Really be certain that the participant has no questions when the "Do you have any questions?" slide pops up. If not, the "Get Ready" slide will appear and you can let the computer continue without any help. Make sure the participant is not within reach of the

keyboard. You may leave the room for the next couple of minutes. As soon as you hear the chime (signaling the end of the PowerPoint) go back in the room.

4. Then, look at the **RIF Retrieval Practice Sheet** and see which condition is marked at the top. Depending on what condition the participant is in, right click and select "Show" on "RIF RP A" or "RIF RP B".
5. Like before, walk through the instructions with the participant. Read the slides slowly and press the spacebar to go onto the next direction slide. When you get to the example, the computer will move the slide after 3 seconds. However, following this slide you will need to press the spacebar to continue the instructions. Really be certain that the participant has no questions when the "Do you have any questions?" slide pops up. If not, the "Get Ready" slide will appear and you can let the computer continue without any help. Make sure the participant is not within reach of the keyboard.
6. Then, you will write down the participant's responses on the Retrieval Practice Sheet in front of you. If they do not say anything, do not mark anything. Otherwise, write down whatever the participant says. If you are ever unsure about something, please write it down and I figure out what to do. The chime will signal the end of the Retrieval Practice phase.
7. Finally, right click and select "Show" on "**RIF Test**" for all participants.
8. Again, walk through the instructions with the participant. Read the slides slowly and press the spacebar to go onto the next direction slide. When you get to the "Get Ready" slide, you can let the computer continue without any help.
9. Then, you will mark down the participant's responses on the RIF Test Sheet in front of you. If the participant correctly retrieves the word, please put a check mark next to it. If they do not say anything, do not mark anything. If they say the incorrect answer, write down what they incorrectly retrieved.

Fixation Induction/Misleading Associates

10. First, fill out the Pecolsus ID number on the top of each Retrieval Practice sheet.
11. Then, give the participant the cue-response study sheet. Tell them they have **4** minutes to study the words, and they will later be tested. (Stopwatches are on the hook behind the door of the main lab room)
12. Give the participant the cue-response plus 2-stem sheet. Tell them they have **3** minutes to fill in as much as they can.
13. Give the participant the cue-response sheet with no stems. Tell them they have **2** minutes to fill in as much as they can.

Remote Associates Task-1 (RAT-1)

14. Then, open up the "RIF-RAT" folder in the "Running Experiments" folder.
15. Open up the correct Powerpoint experimental condition (on the top of their data sheet) by right clicking "Show". Choose the correct condition for the participant, depending on how the participant sheet is labeled at the top (RAT1- 60A, RAT1- 60B, RAT1- 60C, RAT1- 60D or RAT1- 30A, RAT1- 30B, RAT1- 30C, RAT1- 30D). The participant will only receive one of these four conditions.

16. Read the instructions on the screen with the participant and move along the instructions by pressing the space bar. Please clarify if the participant is confused at any point. When you reach the "Get ready" screen, stop for a moment.
17. When the participant is ready, start your timer and their RAT slideshow at the same time by pressing your "Start" button AND their space bar simultaneously. (This way, you will be able to see the timing on your screen for their responses.)
18. Mark down any answers the participant says on your sheet WITH the response time for that answer. This means you will have to look at the timer screen while listening for their answers to mark down all responses and their response times. If the participant correctly solves the problem, please circle the correct answer/response time on the sheet (for coding purposes).
19. The experiment will end with a tone, at which point you may close out the program.

Incubation Tasks

1. Card Sorting Test
    a. Get Instructions sheet. Allow for 1.5 minutes to read instructions with participant/answer questions about the task. After that time has elapsed, give participant 3 minutes to complete Part 1. After Part 1, give participants 3 more minutes to complete Part 2.
2. Paper Folding Test
    a. Get Instructions sheet. Allow for 1.5 minutes to read instructions with participant/answer questions about the task. After that time has elapsed, give participant 3 minutes to complete Part 1.

****[If a participant is in the Delay Condition, please continue to RAT-2 instructions. If the participant is in the Continuous Condition, skip RAT-2 and continue to the Subject Information/Questionnaire phase.]**

RAT-2 (For Delay Condition ONLY)

1. In the "RIF-RAT" folder, open up the correct Powerpoint that corresponds with whatever letter condition they received in RAT-1 (RAT2- 30A, RAT2- 30B, RAT2- 30C, RAT2- 30D).
2. Open the slideshow by right clicking and pressing "Show".
3. Read the instructions on the screen with the participant and move along the instructions by pressing the space bar. Please clarify if the participant is confused at any point. When you reach the "Get ready" screen, stop for a moment.
4. When the participant is ready, start your timer and their RAT slideshow at the same time by pressing the space bar simultaneously. (This way, you will be able to see the timing on your screen for their responses.)
5. Mark down any answers the participant says on your sheet WITH the response time for that answer. This means you will have to look at the timer screen while listening for their answers to mark down all responses and their response times. If the participant correctly solves the problem, please circle the correct answer/response time on the sheet (for coding purposes).
6. The experiment will end with a tone, at which point you may close out the program.

Subject Information/Questionnaire

20. Ask the participants the demographic information and questionnaire on the front of the participant sheet/ write answers.
21. Then, give debriefing form. Say that it will explain what our lab generally studies. We do not want to go into too much detail, in case they are going to be in another lab experiment.
22. Say they will get Pecolsus credit within the next day. If there are any questions, e-mail us through the system and the system will contact me, the researcher.
23. Sign the participant's experiment card if they have it.
24. Ask them to not talk about the experiment with anybody else and thank them again for their participation.
25. Write down any additional comments you have on the "Comments" part of the Subject Information sheet. This may include if there were technical difficulties, if the participant's cell phone rang, if the participant fell asleep, if the participant was not following instructions, if you think you see something weird with the materials, etc. PLEASE write down ANYTHING you think is important for me to know!

Almost done…

26. Enter in M/F credit hours on Pecolsus sheet on main computer.
27. On Pecolsus online, mark the participant "Attended" ONLY if they showed up.
28. HOWEVER, if the participant did not show up or could not complete the study for any reason, do not mark anything in Pecolsus. Please e-mail me (rkoppe2@uic.edu) and tell me what happened. I will take care of the rest.
29. Put the data packet in the metal tray in the main computer room for Kristy to later enter the data.
30. After you are done, please turn off the computer monitor in the room. Return everything to their place and lock up the doors/turn off the lights. Make sure all of the lab doors are locked.
31. Remember, if you have to leave the lab for ANY reason, lock all of the open lab doors and bring your keys!

** If you ever need ANYTHING, you can text me and I will try to get back to you ASAP. My cell is 703.220.5117, and our office is BSB 1079 (if I'm not in there, somebody in there usually knows where I am.) Thanks!**

Appendix I

Retrieval-induced forgetting instructions and examples of stimuli in different phases

Study phase instructions: A series of word-pairs will appear on the screen. The first word will be the category. The second word will be a member of that category. Each pair will appear on the screen for screen for three seconds. Please spend that time relating each member to its category. For example:

Tools: Hammer

Tools is the category. Hammer is a member of the category Tools. Do you have any questions? Get ready!

Study phase stimuli examples:

Drinks: Vodka

Metals: Iron

Drinks: Bourbon

Metals: Gold

Retrieval practice instructions: Now there will be a fill in the blank task. The task will look like this:

Tools: Ha_____

Using the two letters as a hint, tell the experimenter the member of the category that begins with the letters Ha. The answer here would be: Hammer. Tools: Hammer. Please say the entire word to the experimenter. The answers may or may not come from the list that you just learned. There will be repetitions. Any questions? Get ready to begin…

Retrieval practice phase stimuli:

Metals: Fr_____

Weapon: Ri_____

Metals: Ch_____

Weapon: Gr_____

Final test instructions: You will now be tested on some of what you learned. A category name, and a single letter of a member of that category, will come onto the screen for 3 seconds. Please say the name of that category member out loud to the experimenter. Once a new cue appears on the screen, you may not respond to an old one. Get Ready…

Final test stimuli examples:

Drinks: V_____

Metals: I_____

Drinks: B_____

Metals: G_____

Appendix J

Instructions for the Remote Associates Task:

You will be asked to solve a series of word problems.

Each problem will consist of three words.

Your task in solving these problems is to come up with a fourth word that is related to each of the three words.

The fourth word can be semantically related (related in meaning), a synonym of one of the three words, or part of a commonly spoken phrase with one of the three words.

Any of these relations are possible answers, just so long as the fourth word is associated with each of the three words in some way.

When you come up with the fourth word, tell the experimenter out loud. The experimenter will not tell you if your answer is correct because they do not know the correct answers.

For example, what word is associated with all three of the following?

WORM

SCOTCH

RED

The answer is TAPE.

Explanation: The words “measure” ("tape measure"), “desk” (tape is found on a desk) and “scotch” ("scotch tape") are separate characteristics of tape.

Please try your best to answer each problem. Although each problem may appear to have several answers, we are looking for one specific answer that is the best fit. Try to generate the best answer.

Even when you think you have generated the answer, continue to think of other solutions until time runs out to make sure you have thought of the BEST solution.

You will now do three PRACTICE TRIALS.

ENVY

GOLF

BEANS

The answer is GREEN.

Let's try another…

JUMP

KILL

BLISS.

The answer is JOY.

Let's try one more…

PUSS

TART

SPOILED

The answer is SOUR.

Good Job! You have now finished the practice problems and are ready to move on to the experiment. You will be following exactly the same directions, except this time you will not be shown the answer after you are finished. There are 20 problems and you will have (30 or 60) seconds to solve each problem.

You will see words that you saw before. However, the correct answer will NEVER be one of the word pairs that you learned earlier.

Do you have any questions?

Get ready…

Instructions for the Remote Associates Task after incubation:

Now you're going to see each word problem you saw before for 30 more seconds. Seeing these problems again has nothing to do with your previous performance.

We still have your earlier answers, so please continue to think of other solutions until time runs out. Make sure you have thought of the BEST solution.

If you did not solve the problem before, try to solve it this time.

Do you have any questions?

Get ready…

Appendix K

Additional Results and Discussion

Response Time

First 30 seconds of problem solving. Response times were analyzed for correct answers provided during the first 30 seconds of RAT problem solving. Theoretically, the first 30 seconds of problem solving should be the same in the incubated and the non-incubated condition because incubation does not occur until after 30 seconds. Therefore, there is no a priori reason to expect a difference between the incubated and the non-incubated condition response times in the first 30 seconds. As predicted, there was no significant difference in response time between the non-incubated condition (M = 13.28s, SE = .57) and incubated condition (M = 12.53s, SE = .76), $t(93) = .79$, $p = .43$, $d = .16$.

A correlational analysis examined the relationship between retrieval-induced forgetting and response time. If participants who exhibit more retrieval-induced forgetting are better at inhibiting inappropriate answers and resolving competition among possible solutions in memory, they should provide correct answers faster than participants who exhibit less retrieval-induced forgetting. This pattern of results should occur in the incubated and non-incubated condition, because there should be no differences in the first 30 seconds of problem solving prior to incubation. As predicted, in the incubated condition, participants who exhibited more retrieval-induced forgetting trended toward responding faster than participants who exhibited less retrieval-induced forgetting, $r = -.27$, $p = .07$. However, retrieval-induced forgetting did not significantly correlate with response times in the non-incubated condition, $r = .07$, $p = .65$.

Intrusions

The proportion of intrusions was analyzed for the first 30 seconds of problem solving and the final 30 seconds of problem solving. Intrusions are misleading associates that are provided

as a response during problem solving. The proportion of intrusions was computed by dividing the total number of intrusions by the total number of responses for each participant. Therefore, measuring the proportion of intrusions takes into account the number of intrusions *and* the number of other responses generated by the participant. Overall, there was no significant difference in the proportion of intrusions after 60 seconds of problem solving between the non-incubated (M = 14.05%, SE = 2.46%) and incubated condition (M = 14.14%, SE = 1.92%), $t(98) = 1.28$, $p = .21$, $d = .26$.

First 30 seconds of problem solving. First we analyzed the proportion of intrusions during the first 30 seconds of RAT problem solving. Theoretically, there should be no difference between the non-incubated and incubated conditions in the first 30 seconds of problem solving prior to when incubation would occur. As predicted, there was no significant difference in intrusions between the non-incubated (M = 11.77%, SE = 2.55%) and incubated condition (M = 15.69%, SE = 2.09%), $t(98) = 1.19$, $p = .24$, $d = .24$.

A correlational analysis examined the relationship between retrieval-induced forgetting and the proportion of intrusions during the first 30 seconds of problem solving. If participants who exhibit more retrieval-induced forgetting are better at inhibiting inappropriate responses, their responses should reflect a lower proportion of intrusions during problem solving. This pattern should be the same in both conditions because no differences exist prior to incubation. However, retrieval-induced forgetting did not significantly correlate with intrusions in the non-incubated, $r = -.25$, $p = .09$, or incubated condition, $r = .08$, $p = .58$.

Final 30 seconds of problem solving. We then analyzed the proportion of intrusions for the final 30 seconds of RAT problem solving. If incubation attenuates fixation from misleading associates there should be fewer intrusions in the incubated condition than in the non-incubated

condition. However, there was no significant difference in intrusions between the non-incubated (M = 14.01%, SE = 2.36%) and incubated condition (M = 11.45%, SE = 1.50%), $t(98) = .91$, $p = .36$, $d = .18$

Moreover, a correlational analysis examined the relationship between retrieval-induced forgetting and the proportion of intrusions during the final 30 seconds of problem solving. If participants who exhibit more retrieval-induced forgetting are already better at reducing interference from misleading associates, then they should benefit less from incubation than individuals who exhibit less retrieval-induced forgetting. However, individuals who exhibit more retrieval-induced forgetting should be better at resolving competition from misleading associates in the non-incubated condition. Therefore, we predicted that participants who exhibited more retrieval-induced forgetting would also have a lower proportion of intrusions in the non-incubated condition, however, this relationship would disappear in the incubated condition because incubation dissipates fixation for all participants. However, retrieval-induced forgetting did not significantly correlate with intrusions in the non-incubated, $r = .17$, $p = .25$, or incubated condition, $r = .20$, $p = .17$.

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Initial Review (Response To Modifications)

January 21, 2011; ***2nd Revision 01/28/2011***

Rebecca Koppel, BA
Psychology
1007 W Harrision, M/C 285
Chicago, IL 60612
Phone: (703) 220-5117

RE: Protocol # 2010-1018
"Problem Solving and Memory"

Dear Ms. Koppel:

2nd Revision includes the reflection of determination for Research Involving Minors (below), which was inadvertently omitted in the original approval letter.

Your Initial Review (Response To Modifications) was reviewed and approved by Members of IRB #2 by the Expedited review process on January 13, 2011. You may now begin your research

Please note the following information about your approved research protocol:

Protocol Approval Period: January 13, 2011 - January 12, 2012
Approved Subject Enrollment #: 3400
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk. Therefore, in accordance with 45CFR46.408, the IRB determined that only one parent's/legal guardian's permission/signature is needed. Wards of the State may not be enrolled unless the IRB grants specific approval and assures inclusion of additional protections in the research required under 45CFR46.409. If you wish to enroll Wards of the State contact OPRS and refer to the tip sheet.
Performance Sites: UIC
Sponsor: No
Research Protocol(s):

a) Problem Solving and Memory; as submitted to OPRS on 11/17/2010

Recruitment Material(s):

a) Problem Solving and Memory Print Ad, Version 3, 1/4/11
b) Problem Solving and Memory Flyer, Version 3, 1/4/11
c) Problem Solving and Memory Pre-Screening Form, Version 2, 12/1/10
d) Problem Solving and Memory Internet Ad, Version 3, 1/4/11

Informed Consent(s):

a) Waiver of Signed Consent Document granted under 45 CFR 46.117 for Pre-Screening Only

b) Problem Solving and Memory, Version 3, 1/4/11

Parental Permission(s):

a) A waiver of parental permission has been granted under 45 CFR 46.116(d) and 45 CFR 46.408(c); however, as per UIC Psychology Subject Pool policy, at least one parent must sign the Blanket Parental Permission document prior to the minor subject's participation in the UIC Psychology Subject Pool.

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
11/17/2010	Initial Review	Expedited	11/21/2010	Modifications Required
12/06/2010	Response To Modifications	Expedited	12/13/2010	Modifications Required
01/10/2011	Response To Modifications	Expedited	01/13/2011	Approved

Please remember to:

→ Use your **research protocol number** (2010-1018) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 355-2939. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Jewell Hamilton

Jewell Hamilton, MSW
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

Enclosure(s):

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Informed Consent Document(s):**
   a) Problem Solving and Memory, Version 3, 1/4/11
3. **Recruiting Material(s):**
   a) Problem Solving and Memory Print Ad, Version 3, 1/4/11
   b) Problem Solving and Memory Flyer, Version 3, 1/4/11
   c) Problem Solving and Memory Pre-Screening Form, Version 2, 12/1/10
   d) Problem Solving and Memory Internet Ad, Version 3, 1/4/11

cc: Gary E. Raney, Psychology, M/C 285
Benjamin Storm, Faculty Sponsor, Psychology, M/C 285

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice
Continuing Review

December 12, 2011

Rebecca Koppel, BA
Psychology
Psychology
1007 W Harrision, M/C 285
Chicago, IL 60612
Phone: (703) 220-5117

RE: **Protocol # 2010-1018**
"Problem Solving and Memory"

Please note that the Problem Solving and Memory Print Ad (Version 3, 1/4/2011) was not included with this Continuing Review submission. If this document is still going to be in use please submit an Amendment so it may be reviewed and approved for the coming year. Please note that this document must be accompanied by an Amendment form when submitted to the UIC IRB.

Dear Ms. Koppel:

Your Continuing Review was reviewed and approved by the Expedited review process on December 12, 2011. You may now continue your research.

Please note the following information about your approved research protocol:

Protocol Approval Period: December 12, 2011 - December 10, 2012
Approved Subject Enrollment #: 3400 (1061 enrolled)
Additional Determinations for Research Involving Minors: The Board determined that this research satisfies 45CFR46.404, research not involving greater than minimal risk.
Performance Sites: UIC
Sponsor: None
PAF#: Not Applicable
Research Protocol(s):

a) Problem Solving and Memory; as submitted to OPRS on 11/17/2010

Recruitment Material(s):

a) Problem Solving and Memory Flyer, Version 3, 1/4/11
b) Problem Solving and Memory Pre-Screening Form, Version 2, 12/1/10
c) Problem Solving and Memory Internet Ad, Version 3, 1/4/11

Informed Consent(s):

a) Waiver of Signed Consent Document granted under 45 CFR 46.117 for Pre-Screening Only
b) Problem Solving and Memory, Version 3, 1/4/11
c) Debriefing Form (no version number, no date)

Parental Permission(s):

a) A waiver of parental permission has been granted under 45 CFR 46.116(d) and 45 CFR 46.408(c); however, as per UIC Psychology Subject Pool policy, at least one parent must sign the Blanket Parental Permission document prior to the minor subject's participation in the UIC Psychology Subject Pool.

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category(ies):

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

Receipt Date	Submission Type	Review Process	Review Date	Review Action
12/07/2011	Continuing Review	Expedited	12/12/2011	Approved

Please remember to:

→ Use your **research protocol number** (2010-1018) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the enclosure,
"UIC Investigator Responsibilities, Protection of Human Research Subjects"

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-1711. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Alison Jones, MSW, MJ
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

Enclosure(s):

1. **UIC Investigator Responsibilities, Protection of Human Research Subjects**
2. **Data Security Enclosure**
3. **Informed Consent Document(s):**
   a) Problem Solving and Memory, Version 3, 1/4/11
   b) Debriefing Form (no version number, no date)
4. **Recruiting Material(s):**
   a) Problem Solving and Memory Flyer, Version 3, 1/4/11
   b) Problem Solving and Memory Pre-Screening Form, Version 2, 12/1/10
   c) Problem Solving and Memory Internet Ad, Version 3, 1/4/11
5.

cc: Jon D. Kassel, Psychology, M/C 285
Benjamin Storm, Psychology, M/C 285

VITA

Rebecca H. Koppel
University of Illinois at Chicago
Department of Psychology (M/C 285)
1007 W. Harrison St.
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rkoppe2@uic.edu

EDUCATION

Fall 2009-Present	*Doctoral Program, University of Illinois at Chicago* Major: Cognitive Psychology Advisor: Benjamin C. Storm, Ph. D.
B.A. 2009	College of William and Mary, Williamsburg, VA Major: Psychology Major: French Summa Cum Laude, High Honors

Language Skills: Fluent in French
Study Abroad: Université Paul-Valéry Montpellier III, Montpellier, France (Spring 2008)

AWARDS AND HONORS

UIC Psychology Department Travel Award (Fall 2010, Fall 2009)
UIC Graduate Student Council Travel Award (Fall 2010, Fall 2009)
Phi Beta Kappa Membership (Spring 2009)
Psi Chi Membership (Psychology National Honors Society)
Dean's List, College of William and Mary (Fall 2005-Spring 2009)
Robert C. Byrd Honors Scholarship, State of Virginia (Fall 2005-Spring 2009)
French House Resident, College of William and Mary (Fall 2006-Spring 2007)

CONFERENCE PRESENTATIONS

Koppel, R. H., Wilson, B. M., Jobe, T. A., & Storm, B. C. (November, 2011). *Examining selective directed forgetting.* Poster presented at the 52nd Annual Meeting of the Psychonomic Society. Seattle, Washington.

Koppel, R. H., & Storm, B. C. (May, 2011). *Does a dual task exacerbate fixation in problem solving?* Poster presented at the 83rd Annual Meeting of the Midwestern Psychological Association. Chicago, Illinois.

Wilson, B., Koppel, R. H., & Storm, B. C. (May, 2011). *Examining the validity of selective directed forgetting.* Poster presented at the 83rd Annual Meeting of the Midwestern Psychological Association. Chicago, Illinois.

Koppel, R.H., Storm, B.C., & Reilly, S. (November, 2010). *The blocking and unblocking of memory.* Poster presented at the 51st Annual Meeting of the Psychonomic Society. Saint Louis, Missouri.

Koppel, R. H., & Storm, B. C. (April, 2010). *Memory blocking and unblocking.* Poster presented at the Chicago Psychology Graduate Student Research Symposium. Chicago, Illinois.

Ball, C. T., & Koppel, R. H. (November, 2009). *Eye movement effects on traumatic memories: More support for a central executive hypothesis?* Poster presented at the 50th Annual Meeting of the Psychonomic Society. Boston, MA.

RESEARCH EXPERIENCE

Master's Thesis Research: Incubation Moderates the Relationship between Retrieval-Induced Forgetting and Overcoming Fixation (Fall 2010-Fall 2011)
Advisor: Benjamin C. Storm, Ph. D., University of Illinois at Chicago, Chicago, IL
Storm and Angello (2010) demonstrated that individuals with better inhibitory functioning, as measured by retrieval-induced forgetting, had superior performance on the Remote Associates Task under fixated conditions (RAT; Mednick, 1962). We examined whether an incubation period moderates the effects of retrieval-induced forgetting on RAT performance under fixated conditions.

Examining the Validity of Selective Directed Forgetting (Fall 2010-Fall 2011)
Advisor: Benjamin C. Storm, Ph. D., University of Illinois at Chicago, Chicago, IL
Across three experiments, we failed to find any evidence that participants can selectively forget a subset of to-be-learned information via directed forgetting. This finding has important implications for theoretical accounts of directed forgetting and contradicts recent work which has suggested that selective directed forgetting is possible.

Does a Dual Task Exacerbate Fixation in Problem Solving? (Fall 2010-Spring 2011)
Advisor: Benjamin C. Storm, Ph. D., University of Illinois at Chicago, Chicago, IL
Many problems are difficult to solve because old and inappropriate ideas cause fixation, thus interfering with our ability to generate new and appropriate ideas. Using the Remote Associates Task, we examined whether engaging in a concurrent task makes problem solvers more susceptible to this form of fixation.

Research Apprenticeship: The Blocking and Unblocking of Memory (Fall 2009-Spring 2010)
Advisor: Benjamin C. Storm, Ph. D., University of Illinois at Chicago, Chicago, IL
The memory blocking effect (Smith & Tindell, 1997) is the result of implicit memory and, subsequently, very difficult to eliminate. We examined whether the inhibition of negative primes via retrieval-induced forgetting or directed forgetting can reduce, or even eliminate, the memory blocking effect. These experiments provide important implications for theoretical accounts of retrieval-induced forgetting, directed forgetting and the memory blocking effect.

Senior Honors Thesis: Rapid Eye Movement Effects on Traumatic Memories: A Test of the Working Memory Hypothesis (Fall 2008-Spring 2009)
Advisor: Christopher T. Ball, Ph. D., College of William and Mary, Williamsburg, VA
Examined two working memory hypotheses proposed to explain how rapid eye movements affect the vividness, emotionality and completeness of traumatic memories. Researched procedures, created six working memory tasks and EMDR procedures on SuperLab, compiled and analyzed data.

Research Assistant: The Cognitive Advantage of Percussive Auditory Information (Spring 2009)
Advisor: Jeanine K. Stefanucci, Ph. D., College of William and Mary, Williamsburg, VA

Processed participants and administered trials for various experiments examining episodic memory encoding and retrieval, and the link between emotion and perception.

Personnel Psychologist Intern, U.S. Office of Personnel Management
(6/2008–8/2008)
Supervisor: Brigitte Schay, Ph. D., Assessment Services Branch (ASB), Washington, D.C.
Applied I/O psychology in the Human Resources Products and Services Division. Revised proposals and evaluations, proofed data reports, created crosswalks, and cleaned and analyzed comments. Researched the ROI of change initiatives, concentrating on the five high-impact dimensions, specifically targeting fairness and treatment of others. Organized raw data, and generated and analyzed corresponding statistics for a Government-wide pre-pilot program. Helped plan a strategic training retreat and constructed group activities for ASB, comprised of 15+ Personnel Research Psychologists.

Research Assistant, Human Cognition Lab (Spring 2007-Fall 2007)
Advisor: Christopher T. Ball, Ph. D., College of William and Mary, Williamsburg, VA
Studied the relationship between working memory and schizophrenic tendencies. Processed participants and administered trials for automatic n-back tasks (short term memory assessments). Orally administered scripted recall testing and collected questionnaire data. Organized and analyzed information for entry into the SPSS statistical data analysis program.

SUMMARY OF TEACHING EXPERIENCE

PSCH 352 Cognition and Memory
Teaching Assistant (Summer 2011, Spring 2011, Fall 2010, Summer 2010, Spring 2010)
Duties: Helped students with class material. Proctored and graded exams and assignments.

Guest Lecture: Motivated Forgetting (Summer 2011)
Guest Lecture: Semantic Networks and Spreading Activation (Spring 2011)
Guest Lecture: Thought Suppression (Spring 2011, Spring 2010)
Guest Lecture: Visual Imagery (Fall 2010)
Guest Lecture: Working Memory (Summer 2010)

PSCH 353 Lab in Cognition and Memory
Teaching Assistant (Fall 2011, Fall 2010)
Duties: Helped students with class material and creating experiments.

Guest Lecture: Problem Solving and Literature Reviews (Fall 2011, Fall 2010)

Substitute Teacher: High School Level (Spring 2007– Fall 2008)
Fairfax County Public Schools, Chantilly, VA
Responsible for instruction according to teacher plans and maintaining a safe and orderly environment. Accountable for knowing where students were and what they were engaged in at all times.

MENTORING EXPERIENCE

Undergraduate Mentor (Fall 2011, Spring 2011, Fall 2010, Spring 2010)

Coordinated lab schedules for research assistants, listed below, explained methodological and ethical research practices, and helped prepare presentations.

Assistant	*Term*	*Course Level*	*Project*
Garrett Hartman	Spring 2010	RA (Psych 396)	Directed Forgetting and Memory Blocking Effect
Esther Grimaldo	Spring 2010	RA (Psych 396)	Directed Forgetting and Memory Blocking Effect
Brittany Wilson	Fall 2010	RA (Psych 396)	Dual Task and Remote Associates Task
Kristy Hack	Fall 2010	RA (Psych 396)	Dual Task and Remote Associates Task
Meghan Rhode	Fall 2010	RA (Psych 396)	Dual Task and Remote Associates Task
Brittany Wilson	Spring 2011	RA (Psych 396)	Incubation and Inhibition
	Spring 2011	Independent Project	Selective Directed Forgetting
Kristy Hack	Spring 2011	RA (Psych 396)	Incubation and Inhibition
Caroline Terazawa	Spring 2011	RA (Psych 396)	Incubation and Inhibition
Tami Marron	Spring 2011	RA (Psych 396)	Incubation and Inhibition

PROFESSIONAL DEVELOPMENT

Midwestern Psychological Association
Psi Chi Psychology Honor Society
Phi Eta Sigma Academic Honor Society
Phi Alpha Delta Pre-Law Fraternity

ADDITIONAL SKILLS & CERTIFICATION

SPSS Data Analysis, E-Prime 2.0, Super Lab 4.0, MS Word, MS Excel, MS PowerPoint
Moderate Risk Government Security Clearance, Certified June 2008