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Effects of repeated collaborative retrieval on individual memory vary as a function of recall versus recognition tasks

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Our research examines how prior group collaboration modulates later individual memory. We recently showed that repeated collaborative recall sessions benefit later individual recall more than a single collaborative recall session (Blumen & Rajaram, 2008). Current research compared the effects of repeated collaborative recall and repeated collaborative recognition on later individual recall and later individual recognition. A total of 192 participants studied a list of nouns and then completed three successive retrieval sessions in one of four conditions. While two collaborative recall sessions and two collaborative recognition sessions generated comparable levels of individual recall (C*Recall*-C*Recall*-**I*Recall*** ~ C*Recognition*-C*Recognition*-**I*Recall***, Experiment 1a), two collaborative recognition sessions generated greater levels of individual recognition than two collaborative recall sessions (C*Recognition*-C*Recognition*-***IRecognition*** > C*Recall*-C*Recall*-**I*Recognition***, Experiment 1b). These findings are discussed in terms of two opposing mechanisms that operate during collaborative retrieval—*re-exposure* and *retrieval disruption*—and in terms of transfer-appropriate processing across collaborative and individual retrieval sessions.

Keywords: Collaborative memory; Collaborative inhibition; Retrieval disruption; Transfer-appropriate processing; Group-strategy hypothesis.

Study groups and group assignments are common educational practices. Students attend study groups in preparation for exams and teachers create group assignments to elucidate course material. Such group rehearsal or collaborative retrieval is assumed to enhance later individual exam (or memory) performance. Yet the effects of collaborative retrieval on later individual retrieval remain largely unexplored. We addressed this issue in the present study.

We were specifically interested in the role of two opposing mechanisms that operate during collaborative retrieval—the negative effects of *retrieval disruption* that accrue from seeing or hearing other group members' responses, and the positive effects of *re-exposure* to study material that accrue from seeing or hearing other group members retrieve information that one would not have retrieved alone (Basden, Basden, Bryner & Thomas, 1997; Weldon & Bellinger, 1997). The goal was not to

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isolate these mechanisms per se but to carefully consider their relative contributions across conditions with the overall aim of selecting collaborative retrieval situations that optimise later individual retrieval. We compared the effects of collaborative recall and collaborative recognition on later individual retrieval because (as will be described later) retrieval disruption and re-exposure vary across these tasks.

We were also interested in the role of transfer-appropriate processing (TAP)—or a task match versus mismatch—across collaborative and individual retrieval sessions. The TAP principle states that memory benefits to the extent that the cognitive processes used during encoding overlap with those used during retrieval (Morris, Bransford, & Franks, 1977; Roediger, Weldon, & Challis, 1989). An extension of this principle to the current study focus—the effects of collaborative retrieval on later individual retrieval—predicts that collaborative recall would be optimal for later individual recall whereas collaborative recognition would be optimal for later individual recognition. Therefore we compared the effects of collaborative recall and collaborative recognition on later individual recall and later individual recognition.

RETRIEVAL DISRUPTION AND COLLABORATIVE RETRIEVAL

Retrieval disruption is a widely supported explanation of *collaborative inhibition*—the counter-intuitive finding that a collaborating group of individuals recall less information than the non-overlapping, or pooled recall, of an equal number of individuals working alone (a *nominal group*; Basden et al., 1997; Weldon & Bellinger, 1997). The retrieval disruption account maintains that an individual's ability to recall information in a group setting suffers because the information provided by the other group members disrupts her idiosyncratic organisation of the to-be-remembered information and blocks her from recalling additional information that she would have remembered had she recalled alone. Multiple lines of evidence favour this account (e.g., Basden et al., 1997; Basden, Basden, & Henry, 2000; Finlay, Hitch, & Meudell, 2000; Takahashi & Saito, 2004; Weldon & Bellinger, 1997; Wright & Klumpp 2004). Furthermore, intuitively appealing explanations related to motivation cannot account for the collaborative inhibition effect in free recall (Weldon, Blair, & Huebsch, 2000).

Interestingly, collaborative inhibition is reduced or disappears when cued tasks such as cued recall and recognition—as opposed to uncued task such as free recall—are used during collaborative retrieval (Basden et al., 2000; Clark, Hori, Putnam, & Martin, 2000; Finlay et al., 2000). These studies suggest that retrieval disruption is reduced in the presence of retrieval cues because partial (cued recall) or complete (recognition) retrieval cues guide retrieval and render idiosyncratic organisation of the to-be-remembered information less critical for successful retrieval (e.g., Finlay et al., 2000). Given these task differences in susceptibility to retrieval disruption during collaborative retrieval, it is possible that collaborative recall and collaboration recognition will have different effects on later individual retrieval as well. Yet little prior evidence speaks to whether the effects of collaborative retrieval on later individual retrieval vary as a function of test format.

RE-EXPOSURE AND LATER INDIVIDUAL RETRIEVAL

The limited evidence available on the effects of collaborative retrieval on later individual retrieval suggests that a single session of collaborative recall compared to individual recall sometimes improves later individual recall (Weldon & Bellinger, 1997) but it can also produce equivalent benefits (Finlay et al., 2000). We recently showed that the particular sequence of repeated retrieval is an important factor in determining when collaborative recall benefits later individual recall (Blumen & Rajaram, 2008). The key finding from this study showed that repeated collaborative recall sessions generated greater benefits on final individual recall than those acquired either from repeated individual recall sessions (CC**I** > II**I**) or from a single collaborative recall session (CC**I** > CI**I**). This finding supports the *group-strategy hypothesis*: group-retrieval strategies must be strengthened through repeated collaborative recall sessions for individual recall to benefit from collaborative recall. In other words, collaboration benefits on individual recall depend not only on being *re-exposed* to additional information provided by the other group members but also on being able to integrate this input into a stable retrieval pattern during repeated collaborative recall sessions (see also Weldon & Bellinger, 1997). These benefits of integration through repeated collaboration occurred even though collaborative inhibition persisted such that nominal group recall was greater than collaborative recall during the first and second collaborative recall session across the III and CCI conditions. But collaborative inhibition also seemed to attenuate and retrieval organisation improved during the second collaborative recall session compared to the first collaborative recall session.

As mentioned before, collaborative recall and collaborative recognition could have different effects on later individual retrieval because susceptibility to retrieval disruption differs across these tasks. However, collaborative recall and collaborative recognition could also have different effects on later individual retrieval because re-exposure differs across these tasks. Unlike collaborative recall where re-exposure is limited to study items recalled by the other group members, complete re-exposure to study items is provided during collaborative recognition. Such re-exposure can then be further augmented by the input from others during the collaborative process.

Finally, it is possible that the effects of collaborative recall and collaborative recognition on later individual memory are modulated by the type of final test that an individual receives—recall or recognition. From this perspective, collaborative recognition would be optimal for later individual recognition while collaborative recall would be optimal for later individual recall, consistent with the TAP principle (Morris et al., 1977; Roediger et al., 1989). However, findings from repeated retrieval studies on *individual* memory suggest that prior recall is more beneficial than prior recognition to final individual memory, regardless of whether the final test is recall or recognition (Carpenter & DeLosh, 2006; Duchastel, 1981; Glover, 1989). If this pattern carries over to a situation where prior retrieval involves collaboration, individual memory would be better following collaborative recall than collaborative recognition.

THE CURRENT STUDY

We compared the effect of repeated collaborative recall and repeated collaborative recognition on later individual recall and later individual recognition. Participants completed a collaborative-collaborative-individual retrieval sequence in one of four conditions:

1. CRecall-CRecall-IRecall
2. CRecognition-CRecognition-IRecall
3. CRecognition-CRecognition-Irecognition
4. CRecall-CRecall-IRecognition.

Because individual recall and individual recognition yield different levels of performance for reasons that are unrelated to collaborative retrieval history, individual recall and individual recognition were assessed in two separate experiments. Experiment 1a compared the effects of repeated collaborative recall and repeated collaborative recognition on later individual recall (C*Recall*-C*Recall*-**I*Recall*** versus C*Recognition*-C*Recognition*-**I*Recall***). Experiment 1b compared the effects of repeated collaborative recall and repeated collaborative recognition on later individual recognition (C*Recognition*-C*Recognition*-***IRecognition*** versus C*Recall*-C*Recall*-**I*Recognition***).

METHOD

Participants

A total of 192 undergraduates from Stony Brook University participated in this study for partial course credit.

Design

Type of retrieval sequence (C*Recall*-C*Recall*-**I*Recall***, C*Recognition*- C*Recognition*-**I*Recall***, C*Recognition*-C*Recognition*-**I*recognition***, and C*Recall*-C*Recall*-**I*Recognition***) was a between-participants factor. A total of 16 three-person groups (48 participants) were randomly assigned to each retrieval sequence.

Materials

A total of 160 target nouns were divided into four sets of 40 items each (Clark & Paivio, 2004). Four study lists (composed of 40 targets, 3 primacy buffers, and 3 recency buffers) and 12 recognition booklets (composed of 40 targets and 40 non-studied distractors) were created from these four sets for counterbalancing purposes. A different presentation order and a different set of non-studied items were used in each recognition session in the repeated recognition conditions (i.e., C*Recognition*- C*Recognition*-**I*Recall*** and

C*Recognition*- C*Recognition*-**I*Recognition***). All (40) targets were presented during each recognition session in these conditions; i.e., repeated re-exposure to all study items was provided.

Procedure

During the study phase, participants rated the pleasantness of 46 nouns (40 targets, 3 primacy buffers, and 3 recency buffers) on a scale from 1 to 5 (*very unpleasant* to *very pleasant*). Immediately after the study phase, participants completed a distractor task for 7 minutes (recalling names of US cities) and returned to the lab 50 minutes later to participate in the retrieval phase. Participants were not informed about the upcoming retrieval tasks and were told not to discuss the study with each other during the delay. Of the three sequential retrieval tasks, separated by a gap of 5 minutes each, Retrieval 1 and Retrieval 2 were completed in groups of three and Retrieval 3 was completed individually. During collaborative retrieval sessions (recall or recognition), one person was randomly selected to record the responses of the group.[1] Participants within a group were asked to resolve disagreements among themselves. These procedural details were identical to those of Blumen and Rajaram (2008), except that the study presentation time was reduced from 6 seconds to 1 second and a 50-minute delay was introduced between the end of the distractor task and the beginning of the retrieval phase. These adjustments were made to avoid high recognition levels and low recall levels while ensuring an identical procedure across recall and recognition conditions. Each retrieval session (collaborative or individual, with recall or recognition) lasted 7 minutes. The recognition task was a standard yes–no recognition task in which participants circled "yes" if they thought they had studied the item previously and "no" if they thought they had not studied the item previously. The entire procedure took approximately 2 hours.

[1] Neither final individual recall (Experiment 1a) nor final individual recognition (Experiment 1b) was different for scribers and non-scribers, *F*s <1. Thus the effects of repeated collaborative recall and repeated collaborative recognition on later individual recall and later individual recognition did not vary as a function of the participants' scriber status during prior collaborative retrieval.

RESULTS

The proportions of correct recall, hits, false alarms, corrected recognition (hits-false alarms), memory sensitivity (d′), and response criterion (β) during each retrieval session in each retrieval sequence condition are shown in Table 1.

Experiment 1a

Individual recall after two collaborative recall sessions (C*Recall*-C*Recall*-**I*Recall***) was .33 and individual recall after two collaborative recognition sessions was .34 (C*Recognition*- C*Recognition*-**I*Recall***). This between-participants comparison of individual recall did not differ, $t(94) = 0.66$, $SE = .02$, $p > .05$. This finding suggests that individual recall is equally affected by the reduction of retrieval disruption and the increase in re-exposure associated with the repeated collaborative recognition condition as the combination of limited re-exposure (facilitated by the stabilisation of group-retrieval strategies) and the task match (between collaborative and individual retrieval) associated with the repeated collaborative recall condition.

Next, within-participants comparisons revealed an increase in retrieval from Retrieval 1 to Retrieval 2 (hypermnesia; Payne, 1987) in both conditions. Collaborative recall increased from Recall 1 (.33, **C*Recall*-**C*Recall*-I*Recall*) to Recall 2 (.35, C*Recall*-**C*Recall***-I*Recall*), $t(47) = 4.08$, $SE = .01$, $p < .001$ (Cohen's $d = 0.34$; Cohen, 1992) and corrected collaborative recognition increased from Retrieval 1 to Retrieval 2 (**C*Recognition*-C*Recognition***-I*Recall*, .90 to .93) as did d′ (3.57 to 3.84), $t(47) = 3.93$, $SE = .06$, $p < .001$ ($d = 0.68$), and $t(47) = 2.93$, $SE = .64$, $p < .01$ ($d = 0.89$), respectively. These findings suggest that collaborative recall and collaborative recognition benefit from repeated retrieval sessions and discount the concern that corrected collaborative recognition may have been at ceiling while collaborative recall may have been at floor. Note also that the increase in recognition that was observed from Retrieval 1 to Retrieval 2 was driven by a reduction in false alarms, $t(47) = 5.03$, $SE = .01$, $p < .001$, $d = 0.86$.

There was also a decrease in response criterion (β) in the **C*Recognition*-C*Recognition***-I*Recall* condition from Retrieval 1 (2.44) to Retrieval 2, (1.27), $t(47) = 4.47$, $SE = .26$, $p < .001$ ($d = 0.68$).

TABLE 1
Result: Experiments 1a and 1b

	Proportion correct recall	*Hits*	*FA*	*Hits-FA*	*d′*	*β*
Experiment 1a						
CRecall-CRecall-I*Recall*	.33 (.01)					
CRecall-**CRecall**-I*Recall*	.35 (.01)					
CRecall-CRecall-***IRecall***	.33 (.02)					
Crecognition-CRecognition-I*Recall*		.97 (.00)	.07 (.01)	.90 (.01)	3.57 (.09)	2.44 (.33)
Crecognition-**CRecognition**-I*recall*		.97 (.00)	.03 (.00)	.93 (.01)	3.84 (.06)	1.27 (.11)
CRecognition-CRecognition-***IRecall***	.34 (.01)					
Experiment 1b						
Crecognition-CRecognition-I*recognition*		.98 (.00)	.07 (.01)	.91 (.01)	3.69 (.07)	2.79 (.27)
CRecognition-**Crecognition**-I*recognition*		.97 (.00)	.04 (.00)	.93 (.00)	3.81 (.06)	1.45 (.17)
Crecognition-Crecognition-***Irecognition***		.91 (.01)	.04 (.01)	.88 (.02)	3.50 (.12)	0.71 (.11)
Crecall-Crecall-I*recognition*	.35 (.01)					
Crecall-**Crecall**-I*recognition*	.39 (.01)					
CrecallCRecall-***Irecognition***		.88 (.01)	.15 (.02)	.73 (.02)	2.44 (.10)	1.57 (.20)

Proportions of correct recall, hits, false alarms and corrected recognition (hits-false alarms and d′) and response criterion (β) across retrieval trials in Experiments 1a and 1b. The standard error for each measure is displayed in parentheses.

This finding suggests that groups adopted a less conservative response criterion during the second collaborative recognition session than the first collaborative recognition session. This finding makes sense given that participants were very accurate in their collaborative recognition judgements during the first retrieval session and were therefore willing to lower their response criterion during the second collaborative recognition session.

Experiment 1b

Corrected individual recognition was .88 after two collaborative recognition sessions (C*Recognition*-C*Recognition*-**I*Recognition*)** and .73 after two collaborative recall sessions (C*Recall*-C*Recall*-**I*Recognition***). This between-participants comparison was significant, $t(94) = 5.24$, $SE = .03$, $p < .001$ ($d = 1.07$). The d′ measure revealed a similar pattern: d′ was 3.50 after two collaborative recognition sessions (C*Recognition*-C*Recognition*-**I*Recognition***) and 2.44 after two collaborative recall sessions (C*Recall*-C*Recall*-**I*Recognition***), $t(94) = 6.79$, $SE = .16 < .001$ ($d = 1.39$). These findings suggest that individual recognition is better following the reduction in retrieval disruption and the increase in re-exposure associated with the repeated collaborative recognition condition than following the limited re-exposure facilitated by the stabilisation of group retrieval strategies associated with the repeated collaborative recall condition. Unlike the outcome of Experiment 1a, these findings are consistent with the TAP principle because a task match generated better performance than a task mismatch.

As in Experiment 1a, we observed a within-participants increase in retrieval from Retrieval 1 to Retrieval 2 in both conditions. In the **C*Recognition*- C*Recognition***-I*Recognition* condition, collaborative recognition improved in corrected recognition (.91 to .93) and d′ (3.69 to 3.81), $t(47) = 4.36$, $SE = .01$, $p < .001$ ($d = 0.52$) and $t(47) = 2.48$, $SE = .05$, $p < .05$ ($d = 0.30$), respectively. In the **C*Recall*-C*Recall***-I*Recognition* condition, collaborative recall increased from .35 to .39, $t(47) = 7.74$, $SE = .01$, $p < .001$ ($d = 0.35$). As in Experiment 1a, there was a reduction in false alarms from Retrieval 1 to Retrieval 2, $t(47) = 6.02$, $SE = .01$, $p < .001$ ($d = 0.74$). However, hits also decreased from Retrieval 1 to Retrieval 2, $t(47) = 3.82$, $SE = .01$ $p < .001$ ($d = 0.76$).

As in Experiment 1a, β decreased from Retrieval 1 (2.80) to Retrieval 2 (1.45) in the repeated collaborative recognition condition (**CRecognition- CRecognition**-I*Recall*), $t(47) = 6.53$, $SE = .21$, $p < .001$ ($d = 0.87$). Again, this finding suggests that following the very accurate collaborative recognition performance during the first retrieval session participants adopted a less conservative response criterion during the second retrieval session. We also observed a difference in β during the individual recognition session; the β value was .71 following two collaborative recognition sessions (C*Recognition*-C*Recognition*-**I*recognition***) and 1.57 following two collaborative recall sessions (C*Recall*-C*Recall*-**I*recognition***), $t(94) = 3.79$,

$SE = .23$ ($d = 0.77$). It is reasonable to expect that complete re-exposure to study items during repeated collaborative recognition augmented by the input from other group members, not only increases memory sensitivity but also leads to a less conservative response criterion during later individual recognition compared to when preceding sessions involved repeated collaborative recall.

GENERAL DISCUSSION

Our research examines how prior group collaboration modulates later individual memory. The current study compared the effects of repeated collaborative recall and repeated collaborative recognition on later individual recall and later individual recognition. Our key finding was that the effects of test format used during repeated collaborative retrieval (recall or recognition) differ as a function of whether individual memory is tested with recall or recognition. While repeated collaborative recall and repeated collaborative recognition generated comparable levels of individual recall repeated collaborative recognition generated greater levels of individual recognition than repeated collaborative recall.

The current findings support the general idea that a reduction in retrieval disruption, coupled with complete re-exposure to study items during repeated collaborative recognition efforts, generate better individual memory than limited re-exposure facilitated by the integration of other group members input during repeated collaborative recall efforts. This is because individual memory following repeated collaborative recognition was as good as or better than individual memory following repeated collaborative recall. However, current findings also show that when later individual memory is assessed with a recognition task, repeated collaborative recognition generated better individual memory than repeated collaborative recall, consistent with the TAP principle. Hence, the benefits of a reduction in retrieval disruption and an increase in re-exposure during collaborative recognition efforts are better realised with individual recognition than individual recall.

Current findings clearly support the benefits of enhanced re-exposure and reduced retrieval disruption across the two experiments. Nonetheless, it is useful to consider whether inhibition might also play a role in these retrieval situations. Retrieval-induced forgetting (RIF) has been proposed as a possible basis for collaborative inhibition in some collaborative recall situations (Cuc, Koppel, & Hirst, 2007). The RIF account maintains that items recalled by one of the group members (cued items) are covertly retrieved by the other group members and lead to inhibition of non-cued items; i.e., the items that remain to be recalled. While it is possible that this mechanism was active in the current testing conditions, it is unlikely that it made a major contribution to the outcomes. This is because in Experiment 1a repeated collaborative recall (where repeated collaboration would have inhibited recall of non-cued items) did not lower later individual recall compared to repeated collaborative recognition (where complete re-exposure to study items occurred twice).

Findings from Experiment 1b may also be relevant to the discussion of a possible role of inhibition because collaborative recall sessions generated lower individual recognition than collaborative recognition sessions. While re-exposure is greater in the latter condition, one could argue that in the former condition previous recall sessions inhibited some items and thereby lowered later individual recognition. Under some conditions inhibition has been implicated to contribute to a parallel phenomenon in individual memory; namely, part-list cuing inhibition (Bäuml & Aslan, 2006). Inhibition is posited to play a role when low inter-item associations exist among study items (i.e., following a single study trial with no specific encoding instructions). However, the current study promoted high inter-item associations among study items (typically provided by repeated study and test trials or deep encoding instructions) and under these conditions retrieval disruption is posited to be the likely mechanism. Thus, an explanatory framework based on retrieval disruption and re-exposure is better suited to the current findings.

Findings from our previous study that employed similar experimental procedures (Blumen & Rajaram, 2008) also cast doubt on the role of inhibition in the current study. In an analysis of the components of hypermnesia—i.e., reminiscence (items gained from one retrieval session to another retrieval session) and forgetting (items lost from one retrieval session to another retrieval session) —forgetting was similar from Recall1 to Recall3 when collaboration was involved (.05 IRecall–CRecall–IRecall; ICI) and when no collaboration was involved (.04; IRecall–CRecall–IRecall; III). Furthermore, in a comparison of the CRecall–CRecall–IRecall (CCI) and CRecall-IRecall-IRecall (CII) conditions, forgetting was greater from Recall 1 to Recall 3 in the CII (.14) condition where only one collaborative recall session took place than in the CCI condition (.11) where two collaborative recall sessions took place—as is the case in the condition of interest in the current study, i.e., CRecall-CRecall-IRecognition.

Taken together, our previous findings and those from the current study render a significant role of inhibition unlikely in the current retrieval situations. Nonetheless, we believe that inhibition can be involved during collaboration under other testing conditions and that the current findings pave the way for future research to examine when and how inhibitory mechanisms may be involved. Finally, current findings underscore the importance of considering the test format used in memory tasks when collaborative learning and retrieval tools are used to improve later individual memory (or exam) performance.

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